CURRICULUM AND DETAILED SYLLABI

FOR

B.E. / B.Tech. DEGREE PROGRAMMES

FIRST SEMESTER

FOR THE STUDENTS ADMITTED IN THE

ACADEMIC YEAR 2014-15 ONWARDS

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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Credit Distribution

S.No.	Category	Credits	Institute Requirement	Department Core
1.	Humanities and Social Sciences	15	15	0
2.	Basic Sciences	26	5-11	15
3.	Engineering sciences	21	11-14	7
4.	Programme Core	63	0	63
5.	Programme Electives	21	0	21
6.	Project	12	0	12
7.	General Electives	6	6	0
	Total Credits	164	37-46	118-127

- General electives are courses offered by different departments that do not have any prerequisites and could be of interest to students of any branch
- All students have to undertake co-curricular and extra-curricular activities that include activities related to NCC, NSS, Sports, Professional Societies, participation in identified activities which promote the growth of Departments and the College

BASIC SCIENCE COURSES		**20-26**
Engineering Mathematics-1 (Common)	3	
Engineering Mathematics-2 (Programme Specific)	3	
Engineering Mathematics-3 (Programme Specific)	3	
Engineering Mathematics-4 (Programme Specific)	3	
Engineering Mathematics-5 (Programme Specific) (As per the Individual programme Requirement)	3	
Physics	3	
Physics Laboratory	1	
Chemistry	3	
Chemistry Laboratory	1	
Department selected course (Programme Specific) (As per the individual programme Requirement)	3	
HUMANITIES AND SOCIAL SCIENCES COURSES		**15**
English Communication	3	
Professional Communication (Theory cum practical)	3	
Project Management	3	
Accounting and Finance	3	
Environment Science	3	
ENGINEERING SCIENCE COURSES		**18-21**
Basics of Civil and Mechanical Engineering	2	
Basics of Electrical & Electronics Engineering	2	
Engineering Graphics	3	
Engineering by Design	3	
Problem Solving using Computers	3	
Workshop	1	
Capstone Course –I	2	
Capstone Course-II	2	
Data Structures (CSE, IT, ECE)	3	
PROGRAMME CORE (Foundation, System, Application)		**63-72**
PROGRAMME ELECTIVES		**21**
GENERAL ELECTIVES		**06**
PROJECT		**12**
Total		**164**

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. / B.Tech. Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15 onwards)

FIRST SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			credits
			L	T	P	
THEORY						
14MA110	Engineering Mathematics I	BS	2	2	-	3
14PH120	Physics	BS	3	-	-	3
14CH130	Chemistry	BS	3	-	-	3
14EG140	English Communication	HSS	3	-	-	3
14ES150	Basics of Civil and Mechanical Engineering	ES	2	-	-	2
14ES160	Basics of Electrical and Electronics Engineering	ES	2	-	-	2
THEORY CUM PRACTICAL						
14ME170	Engineering Graphics	ES	2	-	2	3
PRACTICAL						
14PH180	Physics Laboratory	BS	-	-	2	1
14CH190	Chemistry Laboratory	BS	-	-	2	1
Total			**17**	**2**	**6**	**21**

BS : Basic Science
HSS : Humanities and Social Science
ES : Engineering Science

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. / B.Tech. Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

FIRST SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam **	Max. Marks	Terminal Exam	Total
THEORY								
1	14MA110	Engineering Mathematics I	3	50	50	100	25	50
2	14PH120	Physics	3	50	50	100	25	50
3	14CH130	Chemistry	3	50	50	100	25	50
4	14EG140	English Communication	3	50	50	100	25	50
5	14ES150	Basics of Civil and Mechanical Engineering	3	50	50	100	25	50
6	14ES160	Basics of Electrical and Electronics Engineering	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14ME170	Engineering Graphics	3	50	50	100	25	50
PRACTICAL								
8	14PH180	Physics Laboratory	3	50	50	100	25	50
9	14CH190	Chemistry Laboratory	3	50	50	100	25	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** Terminal Examination will be conducted for maximum marks of 100 and subsequently be reduced to 50 marks for the award of terminal examination marks

	Category	L	T	P	Credit
14MA110 ENGINEERING MATHEMATICS - I	BS	2	2	0	3

Preamble

The driving force in engineering mathematics is the rapid growth of technology and the sciences. Matrices have been found to be of great utility in many branches of engineering applications such as theory of electric circuits, aerodynamics, mechanics and so on. Many physical laws and relations can be expressed mathematically in the form of differential equations. Based on this we provide a course in matrices, calculus and differential equations.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO1:Find the inverse and the positive powers of a square matrix	Understand
CO2:Apply the concept of orthogonal reduction to diagonalise the given matrix	Apply
CO3:Find the radius of curvature, circle of curvature and centre of curvature for a given curve.	Understand
CO4:Determine the evolute and envelope for a given family of curves	Apply
CO5:Classify the maxima and minima for a given function with several variables, through by finding stationary points	Analyse
CO6:Apply Lagrangian multiplier method for finding maxima and minima of an unconstrained problem	Apply
CO7:Predict the suitable method to solve second and higher order differential equations	Apply

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	30	30	30	20
Apply	40	40	40	50
Analyse	20	20	20	10
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Suppose an nxn matrices A and B have the same eigen values $\lambda_1, \lambda_2, ...\lambda_n$ with the same
   Independent eigen vectors $X_1, X_2, ...X_n$. Show that A = B.

2. Find the 2x2 matrix having eigen values λ_1=2 and λ_2=5 with corresponding eigen vectors $X_1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$, $X_2 = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.
3. Find A^{-1} and A^4 for a given square matrix A = $\begin{pmatrix} 7 & 2 & -2 \\ -6 & -1 & 2 \\ 6 & 2 & -1 \end{pmatrix}$, using Cayley Hamilton theorem.
4. Compute the eigenvalues and eigenvectors of A = $\begin{pmatrix} 7 & 2 & - \\ 1 & 1 & -2 \\ -1 & -2 & 1 \end{pmatrix}$

Course Outcome 2 (CO2):

1. Transfer the given quadratic form $6x_1^2 + 3x_2^2 + 14x_3^2 + 4x_1x_2 + 4x_2x_3 + 18x_3x_1$ to canonical by an orthogonal transformation.
2. Diagonalise the matrix A = $\begin{pmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{pmatrix}$
3. Discuss when a quadratic form is singular. What is the rank then?

Course Outcome 3 (CO3)

1. Predict the radius of curvature of the curve $x^3 + xy^2 - 6y^2 = 0$ at (3,3).
2. Identify the centre of curvature of the curve $y = x^3 - 6x^2 + 3x + 1$ at (1,-1).
3. Find the equation of the circle of curvature of the curve $y^3 + x^3 = 3axy$ at the point $\left(\frac{3a}{2}, \frac{3a}{2}\right)$.

Course Outcome 4 (CO4)

1. Predict the evolute of the parabola $x^2 = 4ay$.
2. Predict the envelope of the straight line $\frac{x}{a} + \frac{y}{b} = 1$, where a and b are parameters that are connected by the relation a+b=c.
3. Is it possible to find the curvature of a straight line? Justify your answer.

Course Outcome 5 (CO5)

1. Examine the extrema of $f(x, y) = x^2 + xy + y^2 + \frac{1}{x} + \frac{1}{y}$.
2. Identify the saddle point and the extremum points of $f(x, y) = x^4 - y^4 - 2x^2 + 2y^2$.
3. Analyse the extrema of the function $f(x, y) = x^2 - 2xy + y^2 + x^3 - y^3 + x^4$ at the origin

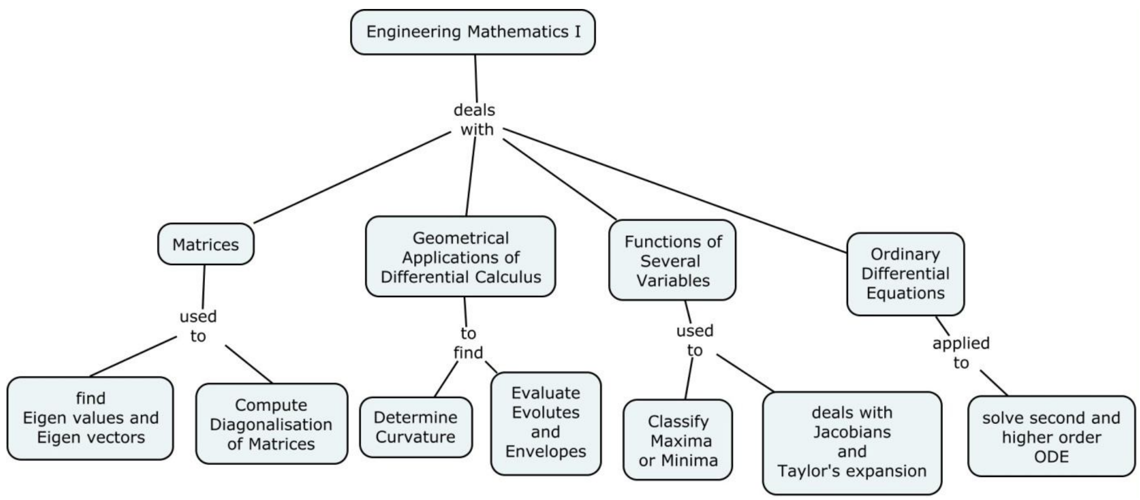
Course Outcome 6 (CO6)

1. Apply Lagrangian multiplier method to find the shortest and the longest distances from the point (1,2,-1) to the sphere $x^2 + y^2 + z^2 = 24$.
2. Exhibit the point on the curve of intersection of the surfaces z=xy+5 and x+y+z=1 which is nearest to the origin.
3. The temperature at any point (x,y, z) in a space is given by $T = kxyz^2$, where k is a constant. Find the highest temperature on the surface of the sphere $x^2 + y^2 + z^2 = a^2$.

Course Outcome 7 (CO7)

1. Solve the equation $y'' + a^2 y = \tan ax$ by the method of variation of parameters.
2. Compute the solution of the given equation $(x^2D^2 - 2xD - 4)y = 32(\log x)^2$.
3. Predict the solution of $((2x+3)^2 D^2 - 2(2x+3)D - 12)y = 6$.
4. Solve the simultaneous equations $x' + 2x - 3y = 5t, \ y' - 3x + 2y = 2e^{2t}$.

Concept Map



Syllabus

MATRICES: Characteristic equation – Eigen values and Eigen vectors of a real matrix – Properties of Eigen values –Cayley Hamilton theorem- Orthogonal reduction of a symmetric matrix to diagonal form –Orthogonal matrices –Reduction of quadratic form by orthogonal transformation, Applications.

GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS: Curvature – Cartesian and Polar coordinates – Centre of curvature, Circle of curvature – Evolutes and Envelopes, **Applications.**

FUNCTIONS OF SEVERAL VARIABLES: Function of two variables – Partial derivatives – Total derivative – Change of Variables - Jacobians - Taylor's expansion – Maxima and Minima – Constrained Maxima and Minima by Lagrangian Multiplier method, Applications.

ORDINARY DIFFERENTIAL EQUATIONS: Linear differential equations of second and higher order with constant coefficients - Method of variation of parameters – Equations reducible to linear equations with constant coefficients: Cauchy's homogeneous linear equation and Legendre's linear equation - Simultaneous linear equations with constant coefficients. Applications.

Text Book

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley & Sons. Singapore, 10th edition, 2012.
2. Grewal.B.S, Higher Engineering Mathematics, Khanna Publications, 42nd Edition, 2012.

Reference Books

1. Veerarajan.T, "Engineering Mathematics I", Tata McGraw Hill Publishing Co, New Delhi, 5th edition, 2006.
2. Kandasamy .P et.al. "Engineering Mathematics", Vol.I (4th revised edition), S.Chand &Co, New Delhi, 2000.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lectures
1	**MATRICES**	
1.1	Characteristic equation – Eigen values and Eigen vectors of a real matrix	2
1.2	Properties of Eigen values	1
	Cayley Hamilton theorem	2
	Tutorial	1
1.3	Orthogonal reduction of a symmetric matrix to diagonal form	2
1.4	Orthogonal matrices –Reduction of quadratic form by orthogonal transformation.	1
1.5	Applications	1
	Tutorial	1
2	**GEOMETRICALAPPLICATIONSOFDIFFERENTIALCALCULUS**	
2.1	Curvature – Cartesian and Polar co-ordinates	2
2.2	Centre of curvature, Circleofcurvature	2
	Tutorial	1
2.3	Evolutes	2
2.4	Envelopes.	2
2.5	Applications	1
	Tutorial	1
3	**FUNCTIONS OF SEVERAL VARIABLES**	
3.1	Function of two variables – Partial derivatives	1
3.2	Total derivative	1
	Tutorial	1
3.3	Change of Variables ,Jacobians	2
3.4	Taylor's expansion	1
3.5	Maxima and Minima	2
3.6	Constrained Maxima and Minima by Lagrangian Multiplier method	2
3.7	Applications	1
	Tutorial	1
4	**ORDINARY DIFFERENTIAL EQUATIONS**	
4.1	Linear differential equations of second and higher order with constant coefficients.	2
	Tutorial	1
4.2	Cauchy's homogeneous linear equation	1
4.3	Legendre's linear equation	1
4.4	Method of variation of parameters	1
4.5	Simultaneous linear equations with constant coefficients.	2
4.6	Applications	1
	Tutorial	1
	Total	**44**

Course Designers:

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		Category	L	T	P	Credit
14PH120	**PHYSICS**	BS	3	0	0	3

Preamble

The course work aims in imparting fundamental knowledge of thermodynamics, quantum physics and optics which are essential in understanding and explaining engineering devices and measuring instruments. The objective of the course is to help students acquire a basic knowledge for thermal applications, electron microscopy techniques and fibre optic communication systems.

Prerequisite

Basic course (No prerequisite)

Course Outcomes

On the successful completion of the course, students will be able to

Assessment Pattern

CO1:	Compute the theoretical efficiency of a Carnot's engine	Apply
CO2:	Calculate the change in entropy in a thermal cycle	Apply
CO3:	Explain the basic concept of quantum theory	Understand
CO4:	Describe the working principle of SEM and TEM	Understand
CO5:	Compare and contrast the properties and applications of laser and ordinary incandescent light	Analyse
CO6:	Illustrate the principle of light transmission in a fibre and compare its advantages as a wave guide over the conventional co-axial cable	Analyse
CO7:	Explain the basic principle, construction and working of optical fibre sensor	Understand

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	40	40	40	40
Analyse	20	20	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Show that the efficiency of an ideal heat engine depends only on the temperature of the source and sink.
2. Compute the efficiency of a Carnot's engine working between the steam point and the ice point.
3. A Carnot's engine is operated between two reservoirs at temperature of 450K and 350K.If the engine receives 1000 calories of heat from the source in each cycle. Calculate the amount of heat rejected to the sink and work done by the engine in each cycle.

Course Outcome 2 (CO2):

1. Compute the change in entropy when 5 kg of water at 100ºC is converted into steam at the same temperature. (Latent heat of vaporisation=540cal/g)
2. Show that the area of the temperature-entropy diagram of a Carnot's cycle is the useful work done per cycle.
3. One mole of a gas expands isothermally to four times its volume. Calculate the change in entropy in terms of gas constant.

Course Outcome 3 (CO3):

1. Describe Planck's law of black body radiation.
2. Summarize the physical significance of wave function.
3. Explain Compton Effect and derive an expression for the wavelength of the scattered photon.

Course Outcome 4 (CO4):

1. Explain the construction and working of TEM.
2. Explain the wave-particle duality of matter and obtain an expression for de Broglie wavelength.
3. Describe the construction and working of SEM.

Course Outcome 5 (CO5):

1. Find the ratio of population of two energy states in a Laser, the transition between which is responsible for the emission of photons of wavelength 6893A at a temperature of 300K.Comment on the type of emission based on the ratio of population.
2. Analyse the role of mixture of gases for a CO2 laser and predict the working of the laser without Helium gas in the mixture.
3. Differentiate between CO_2 laser and NdYAG Laser with respect to their construction and energy level diagram.

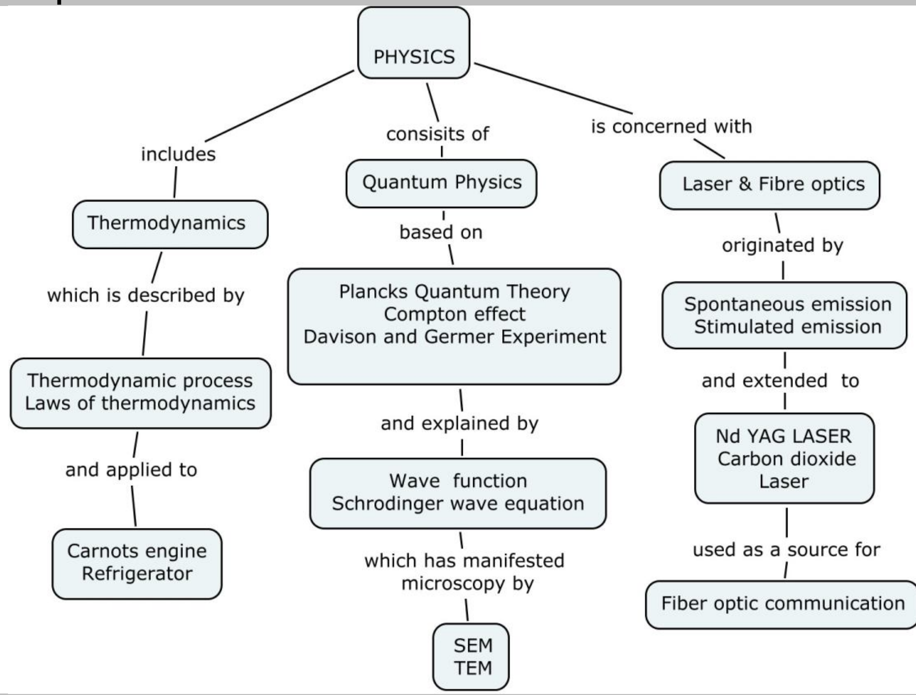
Course Outcome 6 (CO6):

1. Compare and contrast the material properties of core and cladding
2. Identify the major advantages of optical fibre communication system over conventional communication systems
3. Draw the refractive index profile of step index and graded index fibres and comment on the advantages of graded index fibre based on refractive index profile.

Course Outcome 7 (CO7)

1. Define a sensor with an example.
2. Explain the classification of fibre optic sensors based on their working principle.
3. Explain the principle and working of temperature sensor

Concept Map



Syllabus

Thermodynamics

Introduction to thermodynamics-Thermodynamic process-Work done in isothermal and adiabatic process- First and second law of thermodynamics- Carnot's engine-Refrigerator, Temperature-Entropy diagram-Change in entropy in reversible and irreversible process-Entropy of a perfect gas. Application: Otto cycle- Internal Combustion engine.

Quantum Physics

Planck's quantum theory of blackbody radiation-Compton effect-De-Broglie Hypothesis-Davisson & Germer experiment-wave function and its properties-Uncertainty principle-Schrodinger wave equation-Time dependent and time independent equations-particle in a box.

Application: Scanning Electron Microscope-Transmission Electron Microscope

Laser and Fibre Optics

Fundamentals of laser-Spontaneous and Stimulated emission-Laser action-characteristics of laser beam-Einstein coefficients-Nd-YAG laser, CO_2 laser-applications of laser- Holography

Fibre Optics-Principle and propagation of light in Optical fibre-Numerical aperture-Acceptance angle-Classification of Optical fibre based on material, refractive index and mode-Fibre Optic communication system.

Application: Fibre Optic sensors- temperature, and displacement sensors.

Text Book

1. Paul G Hewitt, "Conceptual Physics", 12th Edition Pearson Higher Education Pvt. Ltd., 2014.
2. Gour R.K. and Gupta S.L., "Engineering Physics", 8thEdition Dhanpat Rai Publications, 2006

Reference Books

1. Arthur Beiser," Concepts of Modern Physics",McGraw Hill Education(India)Pvt Limited ,6th Edition, 2003
2. Stephen Blundell, "Concepts in Thermal Physics", Oxford University Press, 2nd Edition 2010.
3. Gerd keiser," Optical fiber communications",Tata Mc Graw Hill Pvt Ltd, 4th Edition 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Thermodynamics**	
1.1	Introduction to thermodynamics-Thermodynamic processes	2
1.2	Work done in isothermal and adiabatic process	2
1.3	First and second law of thermodynamics	2
1.4	Carnot’s engine- theoretical efficiency expression-Refrigerator	2
1.5	Temperature-Entropy diagram	1
1.6	Change in entropy in reversible and irreversible process	2
1.7	Entropy of a perfect gas	2
1.8	Application: Otto cycle- Internal Combustion engine.	2
2.	**Quantum Physics**	
2.1	Planck’s quantum theory of blackbody radiation	2
2.2	Compton effect- derivation	3
2.3	Davisson & Germer experiment	2
2.4	Wave function and its properties-Uncertainty principle	2
2.5	Schrodinger wave equation-Time dependent and time independent equations	2
2.6	Particle in a box - Problems	2
2.7	Application: Scanning Electron Microscope-Transmission Electron Microscope	2
3.	**Laser and Fibre Optics**	
3.1	Fundamentals of laser, Spontaneous and Stimulated emission	1
3.2	Laser action-characteristics of laser beam	2
3.3	Einstein coefficients	1
3.4	Nd-YAG laser	1
3.5	CO_2 laser	1
3.6	Applications of laser- Holography	1
3.7	Principle and propagation of light in Optical fibre	1
3.8	Numerical aperture-Acceptance angle	2
3.9	Classification of Optical fibre based on material, refractive index and mode	2
3.10	Fibre Optic communication system	1
3.11	Application: Fibre Optic sensors- temperature, and displacement sensor	2
	Total	**42**

Course Designers:

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3. Mr. D.Ravindran drphy@tce.edu

14CH130 CHEMISTRY

Category	L	T	P	Credit
BS	3	0	0	3

Preamble

The objective of this course is to bestow better understanding of basic concepts of chemistry and its applications on diverse engineering domains. It also imparts knowledge on properties of water and its treatment methods, Engineering materials and its protection from corrosion, Energy storage technologies, properties of fuels and combustion. This course also highlights criteria behind selecting materials for various engineering applications and their characterization.

Prerequisite

Basic Course (no prerequisite)

Course Outcomes

On the successful completion of the course, students will be able to

CO 1.	Estimate the hardness of water	Apply
CO 2.	Identify suitable water treatment methods	Analyze
CO 3.	Describe the components and working of energy storage devices	Understand
CO 4.	Illustrate control methods for various forms of corrosion	Apply
CO 5.	Enumerate the quality of fuels from its properties	Remember
CO 6.	Outline the important features of fuels	Analyze
CO 7.	Select appropriate materials for specific applications	Apply

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	40	40	40
Analyze	0	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate temporary and permanent hard water.
2. 50 ml of given water sample consumed 18 ml of EDTA during titration using EBT indicator. 25 ml of same EDTA consumed by 50 ml of standard hard water containing 1 mg of pure $CaCO_3$ per ml. Calculate the hardness of given water samples in ppm.
3. Describe the essential characteristics of drinking water.

Course Outcome 2 (CO2):

1. Compare the mechanisms involved in ion exchange and zeolite methods of water treatment.
2. Appraise the treatment steps followed in municipal water supply.
3. Criticize the internal treatment methods of water.

Course Outcome 3 (CO3):

1. Describe the working of lithium ion battery with the help of electrode reactions.
2. Demonstrate the advantages of fuel cell over conventional batteries.
3. Explain the types of battery.

Course Outcome 4 (CO4)

1. Illustrate the different forms of corrosion
2. Collect and explain the factors which influence the corrosion.
3. Exhibit the various forms of corrosion control methods

Course Outcome 5 (CO5)

1. Define the calorific value of the fuel
2. Describe the cetane and octane numbers of the fuel.
3. List the characteristics of good fuel

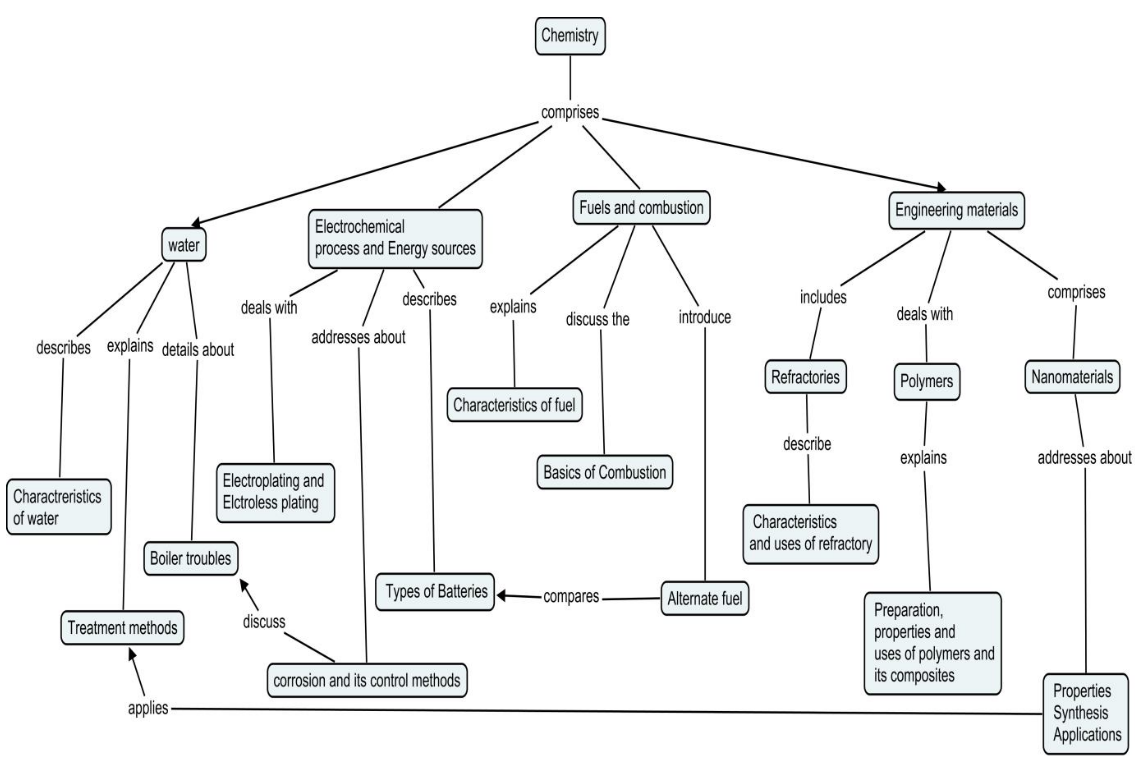
Course Outcome 6 (CO6)

1. Assess the quality of coal by performing proximate and ultimate analysis
2. Calculate the minimum volume of air required for the complete combustion of 1 m^3 of gaseous fuel containing the following composition by volume. CO: 23%; H_2:12%; CH_4: 3%; CO_2: 5%; N_2: 55%; and O_2: 2%.
3. Compare: Liquefied petroleum gas and bio gas.

Course Outcome 7 (CO7)

1. Explicate the characteristics of good refractory material.
2. Demonstrate the preparation of nano materials by sol-gel method.
3. Exhibit the applications of polymer composites.

Concept Map



Syllabus

WATER: Standards for drinking water, Hardness. Softening of water: External and Internal treatments of water, Boiler troubles, Methods of treatment of municipal water .

ELECTROCHEMICAL PROCESSES AND ENERGY SOURCES: Introduction - Electroplating – Principle- Significant parameters and applications-PCB manufacturing-Electroless plating. **Batteries** –Primary and secondary batteries – Characteristics-Examples. Fuel cells - Classification and working principles. **Corrosion**: Principle-types-forms and control methods.

FUELS AND COMBUSTION: Fuels-Introduction- classification of fuels- calorific values - analysis of coal. **Combustion** –principle- calculation of fuel and air ratio- knocking characteristics - flue gas analysis –gaseous fuels - alternate fuels.

ENGINEERING MATERIALS: Refractories: Definition, characteristics, classification, properties-requisites of good refractory and their uses – **Polymers**: classification-Industrially important polymers – PE, PET, PVC – PU – nylon – epoxy resins – Bakelite-preparation properties and uses-conducting polymer-bio-polymer-polymer composites- **Nanomaterials**: Size-dependent properties – synthesis by physical and chemical methods –applications-future perspectives.

Text Book

1. Jain & Jain, " Engineering Chemistry", Dhanpat Rai publishing Company (P) Ltd, NewDelhi,15th Edition, 2008.

Reference Books

1. S.S. Dara and S.S.Umare, "A Textbook of Engineering Chemistry", S.Chand & Company, 12th Edition, Reprint, 2013.
2. V R Gowariker, N V Viswanathan and Jayadev Sreedhar, "Polymer Science" New age International Publisher, 2012.
3. Charles P.Poolejr and Frank J.Owens, "Introduction to Nanotechnology", Wieli-India, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Water**	
1.1	Introduction: importance of water, standards for drinking water, physical, chemical & biological parameters. (WHO, BIS & ICMR standards)	1
1.2	Alkalinity (principle only) ,Hardness of water – types, units,	1
1.3	Determination of hardness by EDTA method and problems	2
1.4	Softening of water: External treatment methods: Lime-soda process (concept only), zeolite process,	1
1.5	ion exchange process, reverse osmosis, electro dialysis	2
1.6	Solar and multistage flash distillation , nanofiltration	1
1.7	Boiler trouble: scale and sludge formation, boiler corrosion, priming and foaming, caustic embrittlement,	2
1.8	Internal treatment methods: Carbonate, Phosphate, Colloidal, Calgon conditioning,	1
1.9	municipal water treatment	1
2.0	**Electrochemical process and Energy sources**	
2.1	Electrochemistry- introduction-Electroplating- Definition, Principles- Significant parameters	2
2.2	Nickel and Chromium electroplating	1
2.3	Electroless plating –PCB manufacturing	1

Module No.	Topic	No. of Lectures
2.4	Corrosion- definition, mechanism, forms of corrosion	2
2.5	Factors influencing corrosion and corrosion control methods	2
2.6	Batteries- Definition, types-dry cell, lead acid and lithium batteries	2
2.7	Fuel cells- principle, types and applications. (H_2O_2 fuel cell)	1
3.0	**Fuels and combustion**	
3.1	Introduction- Classification of fuels	1
3.2	Calorific Values- Theoretical calculation using Dulong's formula	1
3.3	Coal – classification- Analysis of coal- Proximate and Ultimate analysis	2
3.4	Refining of petroleum- Knocking characteristics-Octane and Cetane numbers	1
3.5	Natural gas- Liquefied petroleum gas- producer gas-bio gas-alternate fuels- power alcohol- bio diesel	2
3.6	Combustion- calorific intensity- SIT- Calculation of minimum quantity of air required for combustion	2
3.7	Flue gas analysis	1
3.8	Gaseous fuels	1
3.9	Alternate fuels	1
4.0	**Engineering materials**	
4.1	Refractories: Definition-physical and chemical characteristics-classification, properties-requisites of good refractory and their uses	2
4.2	Polymers: classification-Industrial important polymers – PE, PET, PVC – PU– nylon – epoxy resins- Bakelite- preparation properties and uses	2
4.3	conducting polymer mechanism -bio-polymer-polymer composites	1
4.4	Nanomaterials: Size-dependent properties – synthesis by physical (laser ablation, PVD) and	2
4.5	chemical methods (solgel, hydro thermal) - applications-future perspectives	2
	Total number of Lectures	44

Course Designers:

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14EG140 ENGLISH COMMUNICATION

Category	L	T	P	Credit
HSS	2	1	0	3

Preamble

English (14EN140) is a life skill course necessary for all students of Engineering and Technology. The course work aims at developing communication skills in English essential for understanding and expressing the ideas in different social, academic and professional contexts. The outcome of the course is to help the students acquire the language skills of listening, speaking, reading and writing competency in English language thereby making them competent and employable in the globalised scenario.

Prerequisite

No prerequisite

Course Outcomes

On the successful completion of the course, students will be able to

CO1. listen, understand and respond to others in different situations	Apply
CO2. speak correctly and fluently in different situations using appropriate communication strategies.	Create
CO3. read and comprehend a variety of texts adopting different reading skills	Analyze
CO4. write with clarity in simple, apt and flawless language with coherence and cohesion	Create
CO5. use their communicative competency with precision and clarity in the context of science and technology	Create
CO6.be interpersonal and proactive in using language confidently and effectively for personal and profession growth	Create

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	15	15	15	15
Apply	40	40	40	40
Analyse	15	15	15	15
Evaluate	-	-	-	-
Create	20	20	20	20

Course Level Assessment Questions

Course Outcome 1 (CO1):

4. Tested by way of assignments like – listening to short speeches of contexts - general and technical
5. Answering questions – objective and descriptive
6. Note taking

Course Outcome 2 (CO2):

1. Tested by way of assignments like role play, mini presentation, self-introduction, situational conversation and one-to-one debate

2. Write down an imaginary dialogue between a father and a son about his/her fresh college experience. (in five exchanges, not more than 150 words)

3.Choose the right option that at best fits in the blanks (Mention A or B or C or D only)

They are to ____ a question paper to identify the moral ____of the young candidates.

A. /privent/-/kæriktəʳ/ B. /sət/-/kə̳ndʌkt/ C. /pripeəʳ/-/kɒ̳ndʌkt/ D. /prezəns/-/kəud/

3. Read the following phonemic sentence and answer the question below:

/ ðeəʳ iz nəu klɒk in ðə klɑ:sru:m/

What is unavailable in the learning place?

Course Outcome 3 (CO3):

1. Read the following passage and answer the following questions.

A passage from the context of science and technology/current issues will be given followed by different types of questions/exercises like:

- Descriptive questions for eliciting short answers
- True or False
- Sentence Completion
- Objective type
- Synonyms /meaning of the words in the text

2. Read the passage given under Q.No. 1a and ‘make notes’ (Not exceeding 100 words).

3. Read the passage given under Q.No.1a and write a summary (Not exceeding 100 words).

Course Outcome 4 (CO4):

1. Rewrite the following sentence using the appropriate modal auxiliary
   The variation in reading is to be noted down every minute compulsorily for the first five minutes.
2. Expand the nominal compounds: 1. Credit Card 2. Newspaper Glasses

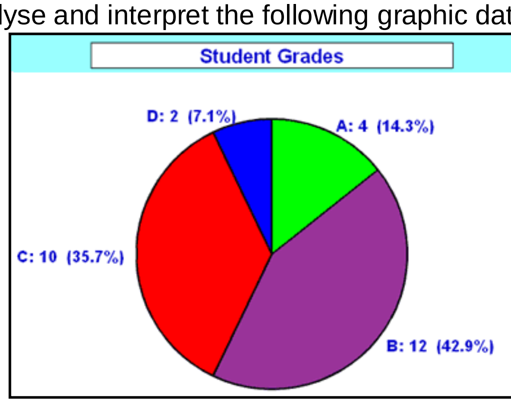
3. Complete the following: The function of a mini drafter -----------------

4. What is meant by a topic sentence?

5. Write a set of recommendations to save electric power.

Course Outcome 5 (CO5):

1. Analyse and interpret the following graphic data in about 100 words:

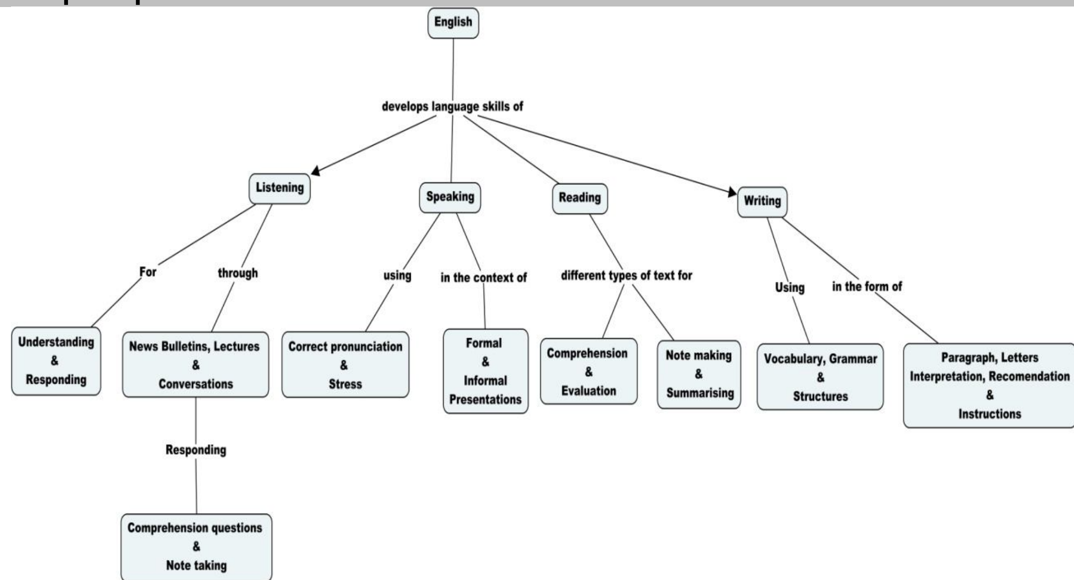


2. Write a basic definition of an MP3 player.
3. Establish cause and effect relationship for the following:
   The trade imbalance is likely to rise again in 2015. A new set of policy actions will be required soon.

Course Outcome 6 (CO6):

1. Write a letter to the HR Manager, TCS, Chennai, requesting him to grant permission for your In-plant Training during your summer vacation.
2. Write a paragraph in about 100 words on “The Impact of Technology on Nature”
3. Prepare a set of 10 instructions on how to draw money from an ATM.

Concept Map



Syllabus

Listening

Listening to news bulletins, lectures and conversations; answering comprehension questions; active listening; note-taking

Speaking

Pronunciation, Syllable and Stress; Contracted forms, Courtesy words; Situational conversation, One-to one debate and Mini presentation on extensive reading and Dailies.

Reading

Skipping, Scanning and Skimming; Reading for information and pleasure; Study skills – Comprehension, Note-making and Summarizing

Writing

Vocabulary : Word analysis, Parts of Speech (Nouns, Verbs, Adjectives, Adverbs Articles, Prepositions, Conjunctions); Sentences Types (Affirmative, Negative, Interrogative, Imperative, Exclamatory) ; Sentence Structure (Subject Verb Agreement, Tenses, Voices, Modals, Conditionals, Relative clauses, Reported Speech); Dialogue Writing, Notions (Nominal Compounds, Definition, Classification, Cause and Effect, Purpose and Function) Paragraph Writing: Compare and Contrast, Descriptive; Formal Letters; Interpretation of Graphics; Instructions and Recommendations.

Text Book

Study Material prepared by the Department of English

Reference Books

1. Department of English, Anna University, Mindscapes: English for Technologists and Engineers, Orient Blackswan, Chennai, 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering, Orient Blackswan, Chennai, 2011
3. Murphy, Raymond English Grammar in Use with Answers: Reference and Practice for Intermediate Students, Cambridge : CUP, 2004
4. Jones, Daniel. An English Pronouncing Dictionary, Cambridge: CUP, 2006
5. Prasad, Hari Mohan , Sinha, Uma Rani , Objective English for Competitive Examinations, Tata McGraw-Hill: Noida, 2010
6. Thomson, A.J. and Martinet, A.V. A Practical English Grammar, OUP, New Delhi:1986
7. Lewis, Norman, Word Power Made Easy, Goyal Publishers, New Delhi: 2004

Extensive Reading

1. A compilation of select texts (extracts) from different disciplines.(for speaking activities)

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	Introduction	1
2.	Listening to News, Lectures, Conversations - Practice	1
3.	Comprehension Exercises	1
4.	Active Listening and Note-taking	1
5.	Introduction to Phonemes	1
6.	Syllables and Stress	1
7.	Contracted Forms, Courtesy Words	1
8.	Situational Conversation, Telephonic Conversation	1
9.	Reading - Skimming, Skipping and Scanning	1
10.	Note Making and Summarizing	1
11.	Dialogue Writing	1
12.	Vocabulary - Word Analysis, Parts of Speech	1
13.	Types of Sentences	1
14.	Tutorial	1
15.	Presentation Skills (Activity)	2
16.	Reading Comprehension	2
17.	Subject Verb Agreement	1
18.	Tenses	2
19.	Voices	1
20.	Modals	1
21.	Conditions	1
22.	Relative Clause	1
23.	Reported Speech	1
24.	Formal Letter Writing	1
25.	Instruction Writing	1
26.	Tutorial	1
27.	Nominal Compounds	1
28.	Definition and Classification	1
29.	Cause and Effect	1
30.	Purpose and Function	1
31.	Paragraph Writing	2
32.	Recommendation Writing	1
33.	Interpretation of Graphics	2
34.	Spoken Assignment	3
35.	Tutorial	1
36.	Revision	2
37.	Feedback	1
	Total	45

Course Designers:

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		Category	L	T	P	Credit
14ES150	**BASICS OF CIVIL AND MECHANICAL ENGINEERING**	ES	2	0	0	2

A. BASICS OF CIVIL ENGINEERING

Preamble

This course will create awareness on fundamental knowledge on various domains of Civil Engineering

Prerequisite

- No prerequisite courses

Course Outcomes

On the successful completion of the course, students will be able to:

CO1:	Identify the branches of Civil Engineering and roles of a Civil Engineer	Understand
CO2:	Explain the properties and uses of building materials, Concept of green building	Understand
CO3:	Identify and explain the functions of various components of a residential building and building safety devices	Understand
CO4:	Explain the properties and classifications of soils and appropriate foundation for different soil conditions	Understand
CO5:	Identify the various sources of water and need for rain water harvesting	Understand
CO6:	Explain the various stages of works involved in water supply and sewerage projects.	Understand
CO7:	Classify roads and explain the importance of signalling	Understand

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	--	20
Understand	30	30	--	30
Apply	---	---	---	---
Analyse	---	---	---	---
Evaluate	---	---	---	---
Create	---	---	---	---

CAT 3 – ASSIGNMENT (GROUP PRESENTATION)

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. List the various branches of Civil Engineering
2. Compare the roles of Structural and Environmental Engineers
3. Discuss the various functions of a Civil Engineer

Course Outcome 2 (CO2):
1. Discuss the properties of a building stone
2. Mention the types of cement
3. Compare PCC and RCC and mention the applicability of each

Course Outcome 3 (CO3)
1. Draw the cross section through a wall and explain the functions of various components
2. Compare arches and lintels
3. Write the purpose of DPC in buildings

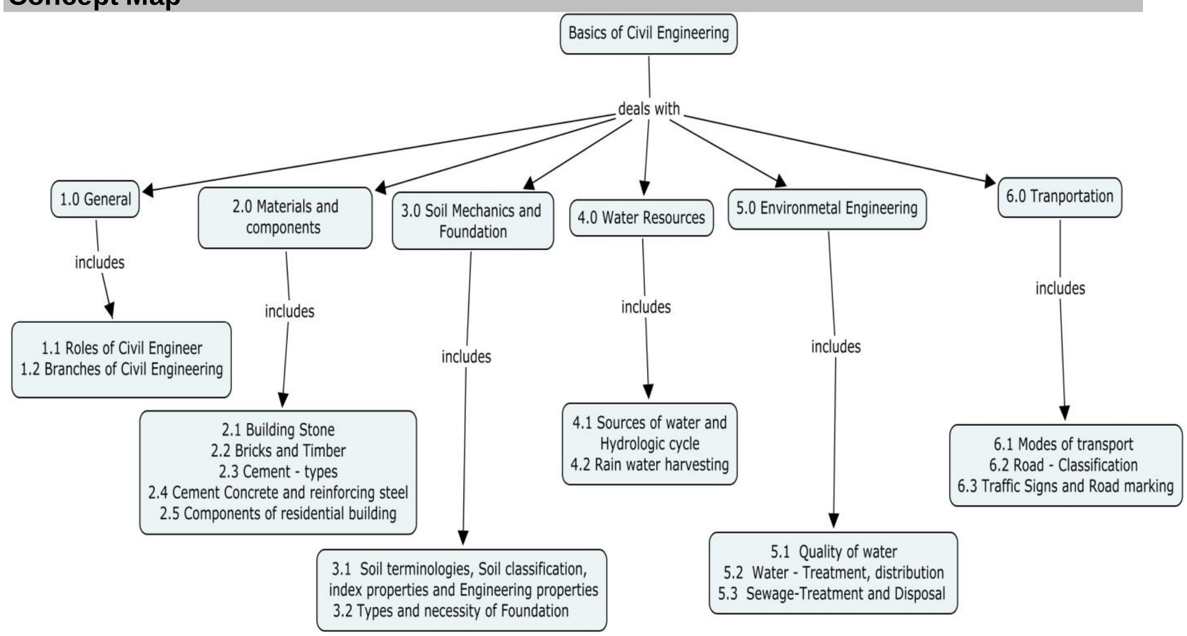
Course Outcome 4 (CO4)
1. Define foundation and mention its various types
2. Enumerate the various engineering properties of soil
3. Explain the situations requiring deep foundations.

Course Outcome 5 (CO5)
1. Explain the various sources of water
2. Draw and explain the hydrological cycle
3. Write the need for preserving water, mentioning its methods

Course Outcome 6 (CO6)
1. Define per capita demand
2. Explain the necessity for treatment of water
3. Explain the need for sewerage

Course Outcome 7 (CO7)
1. Discuss the classification of roads
2. List the various modes of transportation
3. Write the need and importance for signalling in roads.

Concept Map



Syllabus

General: Introduction – Functions and role of Civil Engineer- Branches of Civil Engineering. **Materials and Components:** Materials – Properties, classification and characteristics of building stones, bricks, timber, cement and cement concrete, reinforcing steel- Components of residential building. Green building concepts and building safety devices. **Soil Mechanics and Foundation:** Geological cycle – Soil classification –Engineering properties. Foundation – Types and necessity. **Water Resources:** Sources of water – Hydrologic cycle – Rain water harvesting – importance – methods of rain water harvesting. **Environmental Engineering**- Water demand estimation – Sources of water – Quality of water – Treatment of water- Water distribution. Sewerage – need and importance – collection, treatment and disposal of sewage – Septic tanks. **Transportation:** Modes of transport – types. Roads – Classification of rural and urban roads. Traffic signs and road marking – Traffic signals.

Text Book:

1. Lecture Notes prepared by TCE Civil Engineering Faculty

Reference Books

1. G.Shanmugam and M.S.Palanichamy, "Basics of Civil and Mechanical Engineering", Tata McGraw Hill Publishers, New Delhi, 2014
2. T. Jha and S.K. Sinha, "Construction and Foundation Engineering" , Khanna publishers, Delhi, 2003
3. Ahuja and Birdi, , "Fundamentals of Building Construction" Dhanpat Rai and sons Delhi, 2000
4. Rangwala and S.B.Patel, "Engineering materials", Charotar publishing house, Anand, 2002
5. S.K. Garg, "Water Supply Engineering", Khanna publishers, Delhi, 2005
6. S.K. Garg, "Sewage Disposal and Air Pollution Engineering", Khanna publishers, Delhi, 2005
7. Khanna and Justo, "Highway Engineering", New Chand and Bros, Roorkee, 2000

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**General**	
1.1	Roles of Civil Engineer	1
1.2	Branches of Civil Engineering	
2.0	**Materials and Components**	
2.1	Building stone – properties, types, characteristics and uses	1
2.2	Bricks and timber - properties, types, characteristics and uses	1
2.3	Cement- properties, types, characteristics and uses	
2.4	Cement concrete and reinforcing steel - properties and uses	1
2.5	Components of residential buildings – purpose	2
3.0	**Soil Mechanics and Foundation**	
3.1	Geological Cycle- Soil classification, engineering properties	1
3.2	Types and necessities of foundation	1
4.0	**Water Resources**	
4.1	Sources of water and hydrologic cycle	1
4.2	Rain water harvesting- importance and methods	1
5.0	**Environmental Engineering**	
5.1	Water demand estimation, quality and treatment of water	1
5.2	Methods of water distribution	1
5.3	Sewerage- need and importance, collection, treatment and disposal-Septic tank	1
6.0	**Transportation**	
6.1	Modes of transport	1
6.2	Road classification	
6.3	Traffic signs and road marking	2
	Total periods	16

Course Designers:

1.	Dr. T. Vel Rajan	tvciv@tce.edu
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5.	Dr. T. Baskaran	tbciv@tce.edu
6.	Dr. R. Ponnudurai	rpciv@tce.edu

B. BASICS OF MECHANICAL ENGINEERING

Preamble

Basic Mechanical Engineering gives the fundamental ideas in the areas of engineering design, manufacturing and thermal engineering. An engineer needs to understand the design procedures, manufacturing techniques and working principle of an engineering component.

Prerequisite

NIL

Course Outcomes

On successful completion of the course, students will be able to

CO1: Describe the steps involved in component design and transmission systems	Understand
CO2: Explain the manufacturing processes such as casting, forming, joining, and machining	Understand
CO3: Describe the Functions of Prime movers, working of IC engines and refrigerator	Understand
CO4: Explain the various safety practices in industries and personal protective elements	Understand

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	40	Assignment evaluation	40
Understand	60	60		60
Apply				
Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO 1):

1. Describe the evolution of mechanical engineering
2. State the need for design
3. Define stress

Course Outcome 2 (CO 2):

1. What is rolling?
2. What is the need of metal joining
3. State the applications of casting.

Course Outcome 3 (CO 3):

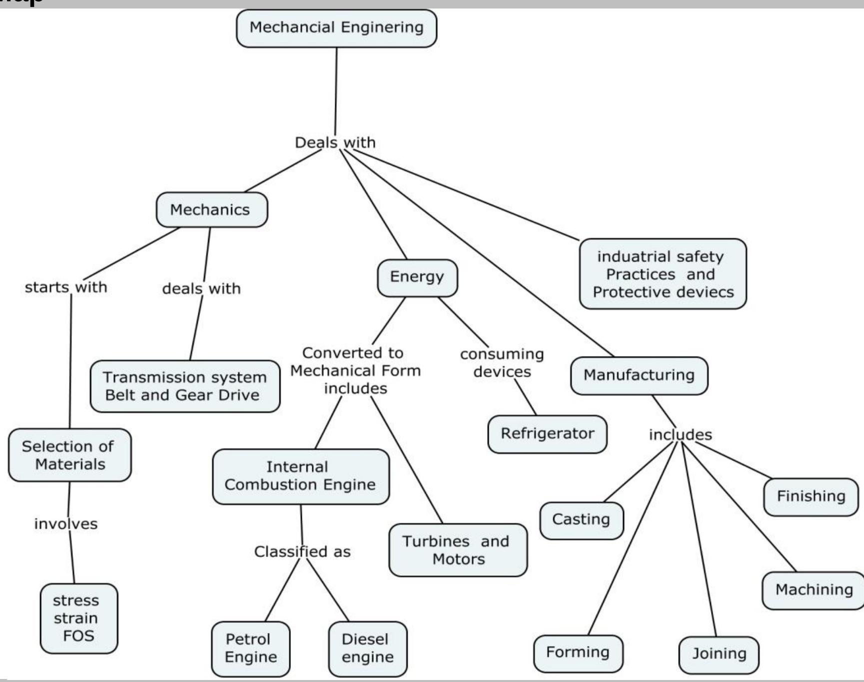
1. State the function of prime mover.

2. Explain the vapour compression refrigeration system
3. Compare the two stroke and four stroke engine

Course Outcome 4 (CO 4):

1. State the various precautions are to taken by the welder
2. Explain the various personal safety practices in industries with reference to OSHA

Concept Map



Syllabus

History and evolution of Mechanical Engineering

Steps of design procedure –Materials for engineering components, stress, strain, Factor of safety. Transmission systems- Belt and gear drives

Manufacturing processes – Types of manufacturing industries and manufacturing systems, foundry - green sand mould casting. Metal forming - forging, rolling, extrusion, drawing, Metal joining – Resistance Arc welding and Gas welding. Metal machining (construction and operation only) - lathe, metal finishing- Surface grinding

Energy resources - Renewable, Non renewable energy. Prime movers- Types and applications. Internal Combustion Engine- working of petrol, diesel engines, Domestic refrigerator – Vapour compression Refrigeration.

Industrial Safety practice & Protective Devices-General requirements- Eye and face protection.- Respiratory Protection - Head protection - Foot protection- Hand Protection.

<u>Note:</u> *All the topics are to be taught / illustrated with product / component examples from domestic appliances (mixer, grinder, refrigerator, table, chair, cook wares, fan, bath tub,*

soap box, water tap, pin, clip), transports (bicycle, car, train, ship, aeroplane), Industrial components (gas stove burner, bolt, nut, window frame, gate, motor, pump, compressor, exhaust fan, nail, keys, table weight), etc

Assignments with power point presentation in other related topics like (not included for terminal examinations)

Different modes of heat transfer, Boilers, Pumps, Thermal, Wind, tidal, geothermal nuclear, Gas turbine power plants, Energy conservation, Alternate fuels, cryogenics, drilling operations, milling operations and surface finishing operations, Additive manufacturing.

Text Book

1. Basic Mechanical Engineering – Lecture notes by Dept. of Mechanical Engg., TCE,.
2. Shanmugam G and Palanichamy M S, “Basic Civil and Mechanical Engineering”, Tata McGraw Hill Publishing Co., New Delhi, 1996.
3. Prabhu.T.J, Jai Ganesh. V and Jebaraj.S, “Basic Mechanical Engineering”, Scitech Publications, Chennai, 2000.

Reference Books

1. Bhandari V B, "Design of Machine Elements", Tata McGraw hill Publications, Second edition, 2009.
2. Hajra Choudhury. S.K, Hajra Choudhury. A.K, Nirjhar Roy, “Elements of Workshop Technology”, Vol. 1, Media Promoters, 2009.
3. Venugopal K. and Prahu Raja V., “Basic Mechanical Engineering”, Anuradha Publishers, Kumbakonam, 2000.
4. Shantha Kumar S R J., “Basic Mechanical Engineering”, Hi-tech Publications, Mayiladuthurai, 2000.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	History and evolution of Mechanical Engineering	1
2.0	Steps of design procedure – Materials for engineering components, stress, strain, Factor of safety	2
2.1	Transmission systems- Belt and gear drives	1
3.0	Manufacturing processes	
3.1	Types of manufacturing industries and manufacturing systems, foundry - green sand mould casting	1
3.2	Metal forming - forging, rolling, extrusion, drawing,	2
3.3	Metal joining – Resistance Arc and Gas welding	1
3.4	Metal machining (construction and operation only) - lathe	2
3.5	Metal finishing- Surface grinding	1
4.0	Energy resources - renewable, non renewable	1
4.1	Prime movers- Types and applications.	1
4.2	Internal Combustion Engine- Working of petrol, diesel engines	2
4.3	Domestic refrigerator – Vapour compression Refrigeration	1
5.0	Industrial Safety Practice & Protective Devices	1
6	Assignments with power point presentation	5
	Total no. of periods	22

Course Designers:

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		Category	L	T	P	Credits
14ES160	**BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING**	ES	2	0	0	2

A. BASICS OF ELECTRICAL ENGINEERING

Preamble

It is an introductory course which emphasize the fundamental concepts and overview of Electrical Engineering.The concepts discussed herein are intended to provide clarification on basic electrical engineering for beginners of all engineering graduates.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, the students will be able to:

CO1	Explain the evolution of electricity and list the inventors.	Remember
CO2	Explain the basic electrical quantities and laws.	Understand
CO3	Explain the types of electrical equipment, machines and its applications.	Understand
CO4	Show the tariff for a given load and energy consumption.	Understand
CO5	Explain the electrical safety issues and protective devices.	Understand
CO6	Explain the roles of authorities governing Indian Electricity.	Understand
CO7	Explain the concept of renewable and non renewable resources of power generation systems.	Understand

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	Through Assignment and Seminar	10
Understand	40	40		40
Apply	0	0		0
Analyse	0	0		0
Evaluate	0	0		0
Create	0	0		0

Course Level Assessment Questions

Course Outcome 1:

1. Name the invention of Benjamin Franklin in 1747.
2. List the names of inventors of electrical quantities.
3. Write the year of installation of first hydro electric power plant.

Course Outcome 2:

1. State Ohm's Law.
2. Define Power & Energy.
3. Differentiate DC and AC supply.

Course Outcome 3 :

1. List the types of electric machines.
2. Name the types of analog meters for measuring current & voltage.
3. List the applications of induction motor.

Course Outcome 4 :

1. Show the energy consumed per year by a load of 60 W operated for 5 hours a day.
2. Write the expression relating power and energy.
3. State the need of star rating for equipment.

Course Outcome 5:

1. Distinguish between circuit breaker and lightning arrester.
2. List the various types of electrical hazards.
3. List the few electrical safety devices.

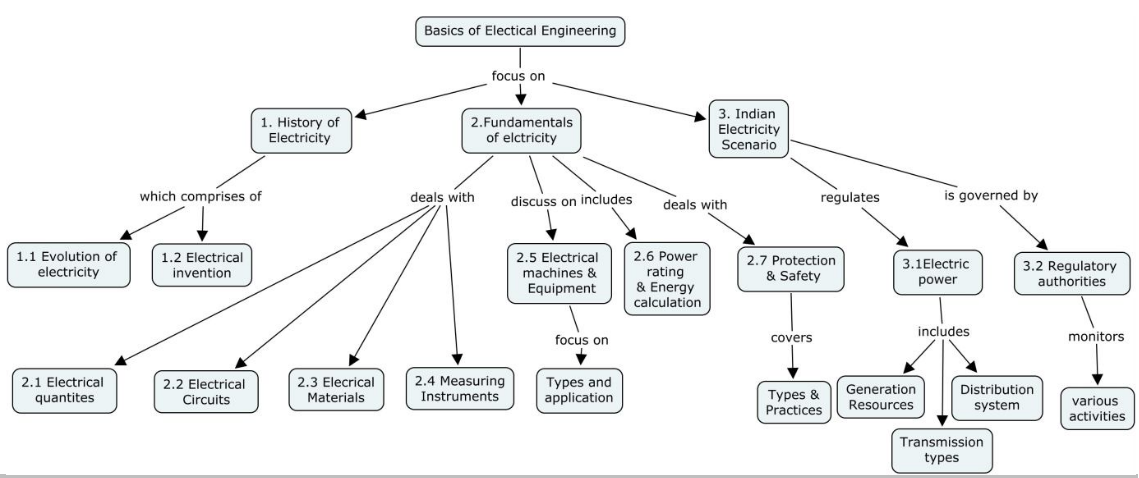
Course Outcome 6 :

1. List the various authorities governing Indian electricity.
2. List the activities of TEDA.
3. State the role of Central Electricity Regulatory Commission.

Course Outcome 7 :

1. State the significances of renewable power generation.
2. List the sources of renewable power.
3. State the limitation of non renewable power generation.

Concept Map



Syllabus

<u>**History of Electricity**</u>

Evolution of Electricity and Electrical inventions.

<u>**Fundamentals of Electricity**</u>

Electrical quantities- Charge, Electric potential, voltage, current, power, energy, DC, AC, time period, frequency, phase, flux, flux density, RMS, Average, Peak, phasor & vector diagram.

Electric Circuits - Passive components (RLC), Ohm's law, KCL, KVL, Faraday's law, Lenz's law.

Electrical materials – Conducting and insulating materials.

Measuring Instruments – Analog and Digital meters – Types and usage.
Electrical Machines & Equipment- Types, Specifications and applications.
Power rating and Energy calculation – for a sample load (domestic loads). Energy Efficient equipment – star ratings.
Protection & Safety - Hazards of electricity - shock, burns, arc-blast, Thermal Radiation, explosions, fires, effects of electricity on the human body. Electrical safety practices, Protection devices.

Indian Electricity Scenario

Electric Power- Generation resources, Transmission types & Distribution system (levels of voltage, power ratings and statistics)
Regulatory Authorities governing Indian Electricity - Roles of : MNRE,NTPC, NPCIL PGCIL, APTEL, **CERC,** SERC, CTU, STU, NLDC, RLDC,SLDC, RFO,BEE,TNEB, IREDA,TEDA.

Text Book

1. Basics of Electrical Engineering – Lecture Notes, Dept. of EEE, TCE, Madurai.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**History of Electricity**	
1.1	Evolution of Electricity and Electrical inventions.	2
2.	**Fundamentals of electricity**	
2.1	**Electrical quantities**- Charge, Electric potential, voltage, current, power, energy, DC,AC, time period, frequency, phase, flux, flux density, RMS, Average, Peak, phasor & vector diagram.	2
2.2	**Electrical circuits** - Passive components (RLC), Ohm's law, KCL, KVL, Faraday's law, Lenz's law.	1
2.3	**Electrical materials** – Conducting and insulating materials.	1
2.4	**Measuring Instruments-** Analog and Digital meters – Types and usage	1
2.5	**Electrical Machines & Equipment -** Types, Specifications and applications.	2
2.6	**Power rating and Energy calculation –** for a sample load (domestic loads). Energy Efficient equipment – star ratings.	1
2.7	**Protection & Safety -** Hazards of electricity - shock, burns, arc-blast, Thermal Radiation, explosions, fires, effects of electricity on the human body. Electrical safety practices, Protection devices.	2
3.	**Indian Electricity Scenario**	
3.1	**Electric Power-** Generation resources, Transmission types & Distribution system (levels of voltage, power ratings and statistics).	2
3.2	**Regulatory Authorities governing Indian electricity** - Roles of : MNRE,NTPC, NPCIL PGCIL, APTEL, CERC, SERC, CTU, STU, NLDC, RLDC,SLDC, RFO,BEE,TNEB, IREDA,TEDA.	2
4	**Assignments/Seminars:** Evolution of Electrical Engineering, Electrical Equipment, Machines and its applications, Energy tariff calculation, Power generation, Protection devices, Indian Electricity Governance.	6
	Total	22

Course Designers:

1. Mr.B.Ashok Kumar ashokudt@tce.edu
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3. Mr.G.Sivasankar qsiva@tce.edu
4. Mr.V.Seetharaman vseetharaman@tce.edu

B.BASICS OF ELECTRONICS ENGINEERING

Preamble

Basic Electronics is a primary course for all engineering students. The course work aims in imparting fundamental knowledge on electronic components and communication engineering concepts. The objective of this course is to help students acquire knowledge in real life applications.

Prerequisite

Basic course (No prerequisite)

Course Outcomes

On the successful completion of the course, students will be able to

CO1: Understand the basic electronic components	Understand
CO2: Identify Frequency Spectrum and Applications	Apply
CO3: Explain the operation of Communication blocks	Understand
CO4:Understand the applications of Electronics and Communication devices	Understand

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	Assignment and Seminar	15
Understand	20	30		25
Apply	0	0		10
Analyse	0	0		0
Evaluate	0	0		0
Create	0	0		0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate Electrical and Electronics.
2. Explain the operation of Diodes and Transistors.

Course Outcome 2 (CO2):

1. Explain different configurations of Transistors
2. Identify the frequency spectrum for mobile communications.

Course Outcome 3 (CO3):

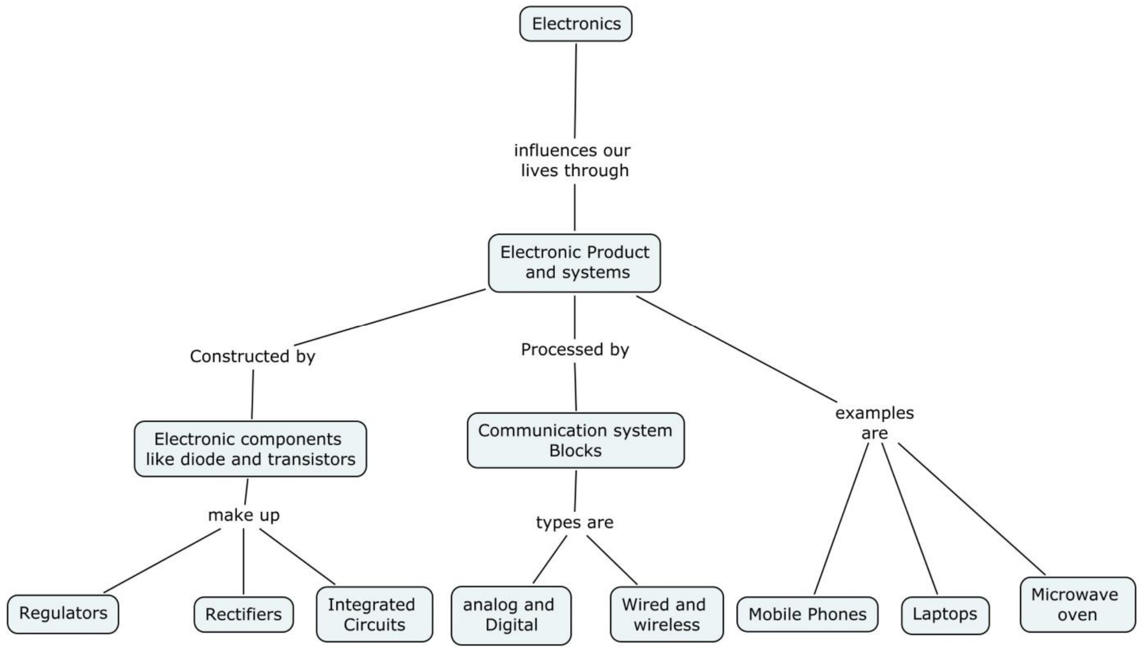
1. Describe the operation of communication transceivers
2. Specify the types of communication systems.

Course Outcome 4 (CO4):

1. List different Real time Electronics Products.

2. Explain the concept behind satellite communication

Concept Map



Syllabus

Electronics

Electrical Vs Electronics, Electronic products and systems, Electronic Devices (Diode – Forward bias, reverse bias, Transistor (CE, CB, CC)), Electronic components, Electronic Circuit (Rectifier, Regulator & IC), Amplifiers and Oscillators

Communication

Frequency spectrum and applications, Types of Communication systems (analog Vs digital, wire –optical, wireless, satellite), Communication system Block diagram (Transmitter and Receiver)

Applications

Mobile Phones, Laptop, Satellite, Microwave Oven – Qualitative Approach.

Text Book

1. Basic Electronics and Communication Engineering – Lecture Notes, Dept. of ECE, TCE, Madurai.

Reference Books

1. Albert Paul Malvino,” Electronic Principles”, Tata Mcgraw Hill,2002
2. Simon Haykin, “ Communication Systems”, Wiley Eastern, Third Edition,1996
3. Faculty of Network Institutions, “Analog electronics”, Project Network Engineering Series,2004
4. Simon Haykin,Barry Van Veen,” Signals and Systems”, Wiely,2nd Edition,2002

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Electronics**	
1.1	Electrical and Electronics Principles	1
1.2	Electronic products and systems	1
1.3	Electronic Devices – Diodes and Transistors	1
1.4	Transistor Configuration CE,CB and CC	1
1.5	Electronic Circuits –Rectifier, Regulator &IC	1
1.6	Amplifiers and Oscillators	2
2.	**Communication**	
2.1	Frequency spectrum and applications	1
2.2	Types of Communication systems	1
2.3	Communication system Block diagram	1
2.4	Transmitter	1
2.5	Receiver	1
3.	**Applications -Qualitative Approach.**	
3.1	Mobile Phones	1
3.2	Laptops	1
3.3	Satellite	1
3.4	Microwave Oven	1
	Total	**16**

Course Designers:

1. Dr.S.Raju hodece@tce.edu
2. Dr.RSukanesh drsukanesh@tce.edu
3. Dr.M.Suganthi msuganthi@tce.edu
4. Dr.M.S.K.Manikandan manimsk@tce.edu
5. Dr.D.Gracia Nirmala Rani gracia@tce.edu

14ME170 ENGINEERING GRAPHICS

Category	L	T	P	Credit
ES	2	0	2	3

Preamble

Engineering Graphics is referred as language of engineers. An engineer needs to understand the physical geometry of any object through its orthographic or pictorial projections. The knowledge on engineering graphics is essential in proposing new product through drawings and interpreting data from existing drawings. This course deals with orthographic and pictorial projections, sectional views and development of surfaces.

Prerequisite

NIL

Course Outcomes

On successful completion of the course, students will be able to

CO1:	Draw the orthographic projections of points, straight lines, plane surfaces and solids.	Apply
CO2:	Draw the orthographic projections of sectioned solids and true shape of the sections.	Apply
CO3:	Develop lateral surfaces of the uncut and cut solids.	Apply
CO4:	Draw the pictorial projections (isometric and perspective) of simple solids.	Apply
CO5:	Sketch by free hand the orthographic views from the given pictorial view.	Apply

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember				
Understand				
Apply	100	100	100	100
Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1: Students will be able to draw the orthographic projections of points, straight lines, plane surfaces and solids.

1. Draw the projection of points on a common reference line. Take *20 mm* distance between the projectors.
    1. Point *K* is *10 mm* above *H.P*. and *25 mm* in front of *V.P*
    2. Point *L* is *10 mm* above *H.P*. and on the *V.P*
    3. Point *M* is *25 mm* below *H.P*. and *20 mm* behind *V.P*
    4. Point *N* is *20 mm* below *H.P*. and *20 mm* in front of *V.P*
    5. Point *O* is on the reference line.
    6. Point *P* is on both *H.P*. and *V.P*

2. A line RS, 80 mm long has its end R, 20 mm above HP and 30 mm in front of VP. The top and front views of the line have the lengths of 50 mm and 65 mm respectively. Draw the projections of the line and find its true inclinations with HP and VP.
3. A thin rectangular plate of sides 60 mm x 30 mm has its shorter side in the V.P and inclined at 30^0 to the H.P. Project the top view oh plate, if its front view is a square of 30 mm side.
4. Draw the projections of a pentagonal prism of base side 30 mm and axis length 60 mm when it lies on the ground on one of its rectangular faces with its axis inclined at 35^0 to V.P and parallel to H.P.

Course Outcome 2: Students will be able to draw the orthographic projections of sectioned solids and true shape of the sections.

1. A square pyramid of base 40 mm side and axis 65 mm long has its base on the ground and all the base edges equally inclined to V.P. It is cut by a section plane, perpendicular to V.P, inclined at 45^0 to H.P and bisecting the axis. Draw the elevation, sectional plan and true shape of the section.
2. A cube of 35 mm side is resting on ground on one of its faces with a vertical face inclined at 30^0 to VP. It is cut by a cutting plane perpendicular to HP and inclined at 60^0 to VP so that a face which makes 60^0 angle with VP is cut into two equal halves. Draw the sectional elevation, plan and true shape of the section.
3. A cone of 60 mm base circle diameter and axis height 70 mm is resting on HP with a point on its circumference such that the generator containing that point is perpendicular to HP. The cone is cut by a plane parallel to HP and perpendicular to VP bisecting the axis. Draw the elevation and sectional plan.

Course Outcome 3: Students will be able to develop lateral surfaces of the uncut and cut solids.

1. A pentagonal pyramid of base 50 mm side and axis 75 mm long has its base on the ground. It is cut by a section plane, perpendicular to V.P, inclined at 30^0 to H.P intersecting the axis at 40 mm from apex. Draw the development of the lateral surface of its lower portion.
2. A hexagonal prism of 45 mm side and axis height 70 mm is resting on ground with its base. It is cut by i) a horizontal cutting plane at 25 mm from base and ii) a cutting plane inclined to HP at 35^0 passing through a point on the axis at 20 mm from its top. Draw the development of the lateral surface of its middle portion.
3. A cylinder of 70 mm base diameter and axis height 90 mm is resting on HP with its base. It contains a circular through hole of 30 mm diameter on its periphery, with the axis of hole parallel to HP and perpendicular to VP, bisecting the cylinder axis. Draw the development of the cylindrical surface.

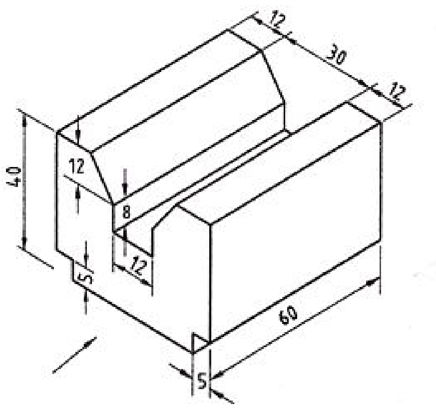
Course Outcome 4: Students will be able to draw the pictorial projections (isometric and perspective) of simple solids.

1. Draw the isometric view of a pentagonal pyramid of base side 32 mm and height 75 mm when its base is parallel to HP with one of its base edges parallel to VP. The vertex is below the base.
2. Draw the isometric projection of a hexagonal prism of base side 30 mm and height 70 mm when it lies on the ground with one of its face edges and axis parallel to HP and VP.
3. A regular hexagonal pyramid of base edge 30 mm and height 50 mm rests on its base on the ground plane with one of its base edges touching the picture plane. The station point is 40 mm above the ground plane and 50 mm in front of PP. The central plane is

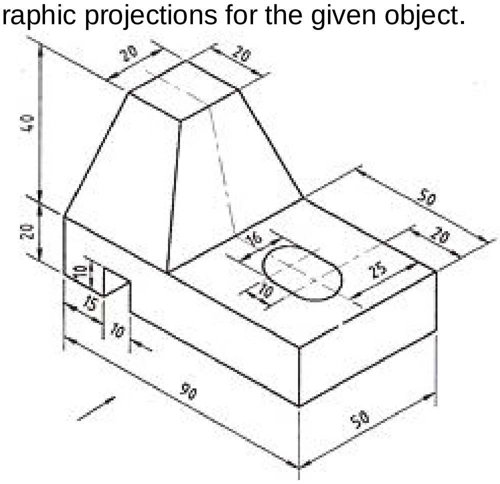
4. 35 mm to the right of the axis. Draw the perspective projection of the pyramid. A cylinder of diameter 40 mm and height 50 mm rests on GP on one of its ends with its axis 40 mm behind the picture plane. The station point is 50 mm to the right of the axis. The station point is 70 mm above the GP and 45 mm in front of PP. Draw the perspective view of the cylinder.

Course Outcome 5: Students will be able to sketch by free hand the orthographic views from the given pictorial view.

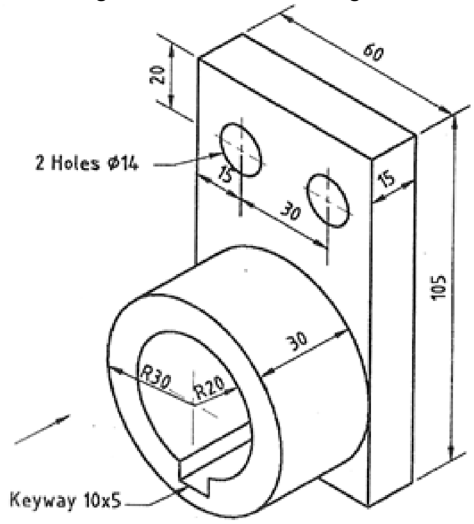
1. Draw the front view, top view and left side views of the given block from its pictorial view.



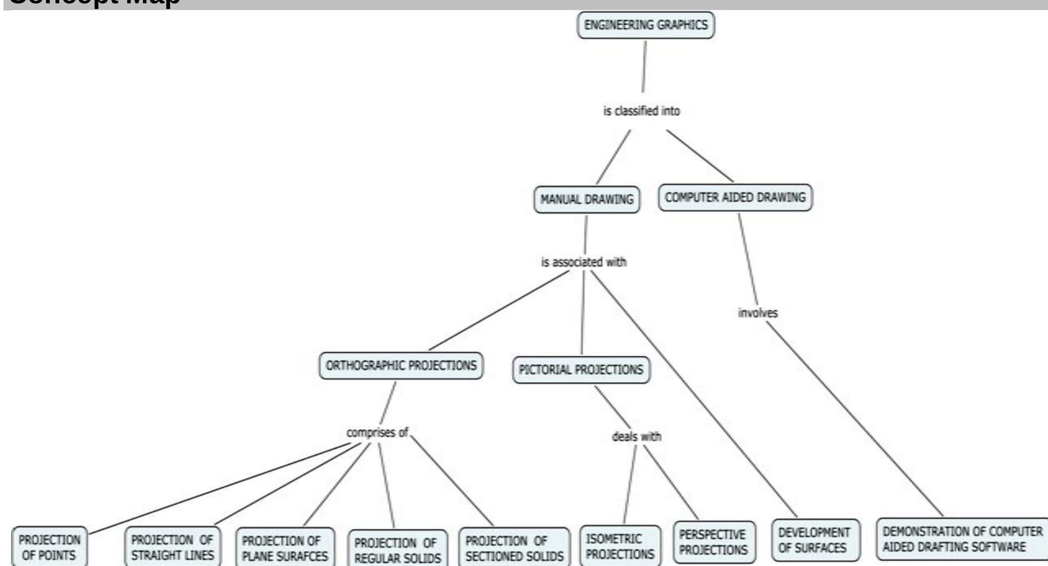
2. Draw the orthographic projections for the given object.



3. Draw the Elevation, Plan and Right side view for the given shaft bracket**.**



Concept Map



Syllabus

Introduction- Importance of graphics in engineering applications – Use of drafting instruments -Size, layout and folding of drawing sheets - BIS Standards – Lettering and dimensioning, construction of polygons.
Orthographic projections - Introduction - Principles -Principal planes-First angle projection.
Projection of points located in all quadrants. **Projection of straight lines** inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method, traces. **Projection of planes** (regular polygonal and circular surfaces) inclined to both the principal planes by rotating object method. **Projection of regular solids*** by rotating object method when the axis is inclined to one of the principal planes. **Projection of sectioned solids** and true shape of the sections (Axis of the solid perpendicular to HP).
Development of lateral surfaces of regular***** and sectioned solids.
Pictorial Projections – Introduction - **Isometric projection** – Principle, isometric scale, Isometric projections of regular solids***** when the axis is i) perpendicular to HP ii) perpendicular to VP (iii) parallel to both HP and VP. **Perspective projection** - Principle,

perspective projection of regular solids* when the axis is perpendicular to i) Ground Plane ii) Picture plane by visual ray method.
Free hand sketching of multiple orthographic views from single pictorial view of objects.
Introduction to drafting packages and demonstration. (Not for examination).
(*****prisms, pyramids, cylinder and cone).

Text Book

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 50th Edition, 2010.

Reference Books

1. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2009.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2008
3. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2008.
4. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore, 2007.

Course Contents and Lecture Schedule

Sl.No	Topic	Lecture Hrs (Periods)	Practical Hrs (Periods)
1	Introduction- Importance of graphics in engineering applications – Use of drafting instruments -Size, layout and folding of drawing sheets – BIS Standards - Lettering and dimensioning, construction of polygons.	2	3
2	Orthographic projection - Introduction - Principles -Principal planes-First angle projection, Projection of points located in all quadrants.	2	3
3	Projection of straight lines inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method, traces.	4	6
4	Projection of planes (regular polygonal and circular surfaces) inclined to both the principal planes by rotating object method.	4	6
5	Projection of regular solids (prisms, pyramids, cylinder and cone) when the axis is inclined to one of the principal planes by rotating object method.	4	6
6	Projection of sectioned solids and true shape of the sections (Axis of the solid perpendicular to HP)	2	3
7	Development of lateral surface of regular and truncated solids.	2	3
8	Isometric projection – Principle, isometric scale, Isometric projections of regular solids when the axis is i) perpendicular to HP ii) perpendicular to VP (iii) parallel to both HP and VP.	2	3
9	Perspective projection - Principle, perspective projection of regular solids when the axis is perpendicular to i)Ground Plane ii) Picture plane by visual ray method.	2	3
10	Free hand sketching of multiple orthographic views from pictorial view of objects.	2	3
11	Introduction to drafting packages and demonstration.	2	-

Sl.No	Topic	Lecture Hrs (Periods)	Practical Hrs (Periods)
	Test		**3**
	TOTAL	**28**	**42**

Question Pattern for Terminal Examination

Question Number	Description	Type	Marks
1	Projection of Points **(OR)** Free hand sketching of orthographic views from pictorial views	Either or	10
2	Projection of lines	Either or	15
3	Projection of planes	Either or	15
4	Projection of solids	Either or	15
5	Section of solids	Either or	15
6	Development of surfaces	Either or	15
7	Isometric Projection **(OR)** Perspective projection	Either or	15
		Total	**100**

Note:
1. Plates (Drawing sheets) submitted by students will be considered for internal assignment marks (30).
2. One test will be conducted locally by respective faculty-in-charge during regular class hours for internal test marks (20).
1. Terminal examination will be conducted centrally by the office of controller of examinations.

Course Designers:

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14PH180	PHYSICS LABAROTARY	Category	L	T	P	Credit
		BS	0	0	2	1

Preamble

The course aims in imparting fundamental knowledge of experimental Physics. The error analysis is essential for understanding and analyzing the results of any experiment. Basic experiments in thermal applications and optics are introduced. Characteristics and uses of Laser & fiber optics have been included. The outcome of the course is to help students determine physical constants, Viscosity, Band gap, wavelength of a Laser and Acceptance angle of a fiber.

LIST OF EXPERIMENTS

1. Error analysis
2. Compound pendulum- acceleration due to gravity
3. Poiseulle's flow method-viscosity determination
4. Solar cell characteristics
5. Plank's constant determination
6. Energy band gap of junction diode
7. Spectrometer – dispersive power of the prism
8. Microscope- thickness of wire by air wedge
9. Laser- particle size and wavelength determination
10. Fiber optics –numerial aperture & acceptance angle determination

Course Designers:

1. Dr.R.Vasuki rvphy@tce.edu
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3. D.Ravindran drphy@tce.edu

	Category	L	T	P	Credit
14CH190 CHEMISTRY LABORATORY	BS	0	0	2	1

Preamble

The objective of this course is to develop the intellectual and psychomotor skills of the students by imparting knowledge in material, quantitative and electrochemical analysis.

Course Outcomes

On the successful completion of the course, students will be able to

• Analyse the material qualitatively	Analyse
• Estimate the chemical parameters of water	Apply
• Calculate the strength of acids, oxidizing and reducing agents	Analyse

List of Experiments

1. **Material analysis**
   - i) Analysis of Boiler scale
   - ii) Analysis of Cement
   - iii) Analysis of alloy sample

2. Quantitative analysis
   - i) Estimation of Total Hardness of water sample
   - ii) Estimation of Ca^{2+} and Mg2+ individual hardness of water sample
   - iii) Estimation of Alkalinity of water sample
   - iv) Estimation of Chloride in a water sample
   - v) Estimation of COD

3. Electrochemical analysis
   - i) Conductometry Titration (Strong acid Vs Strong base, Mixture of acids Vs Strong base)
   - ii) Potentiometric redox Titration ($K_2Cr_2O_7$ Vs FAS, $KMnO_4$ Vs FAS)

Course Designers:

1.	Dr.Mrs.k.Radha	hodchem@tce.edu
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3.	Dr.V.Velkannan	velkannan@tce.edu
4.	Dr.S.Sivailango	drssilango@tce.edu

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

SECOND SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

VISION

Transforming the individuals into globally competent electrical engineers to fulfill the technological needs of the society.

MISSION

Establishing world class infrastructure in Electrical Engineering.

Enhancing the knowledge of the faculty in cutting edge technologies through continuous improvement programmes.

Providing well balanced curriculum in graduate, postgraduate and doctoral programmes.

Adopting innovative content delivery, assessment and continuous improvement methods to achieve desired outcomes.

Facilitating industry institution interaction in teaching & learning, consultancy and research activities to accomplish the technological needs of the society.

Encouraging the faculty and students to carry out innovative research work.

Practicing ethical standards by the faculty and students.

Motivating the students for active participation in co-curricular and extracurricular activities.

Specialization in B.E. EEE Degree Programme

- Electrical Energy Systems
- Analog & Digital Electronic Systems
- Control & Automation
- Power Electronics & Drives

Programme Educational Objectives (PEO's)

PEO1: Graduates of the programme will have successful career in chosen technical or professional fields.

PEO2: Graduates of the programme will have technical competency in solving challenging societal tasks in ethical and economical manner.

PEO3: Graduates of the programme will reveal lifelong learning and team work in their chosen profession.

Graduate Attributes(GAs) of NBA for UG Engineering and Technology programmes

GA1 Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

GA2 Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

GA3 Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

GA4 Conduct investigations of complex problems: The problems:

- that cannot be solved by straightforward application of knowledge, theories and techniques applicable to the engineering discipline. *
- that may not have a unique solution. For example, a design problem can be solved in many ways and lead to multiple possible solutions.
- that require consideration of appropriate constraints/requirements not explicitly given in the problem statement. (like: cost, power requirement, durability, product life, etc.).
- which need to be defined (modeled) within appropriate mathematical
- framework.
- that often require use of modern computational concepts and tools.#

*(*Different from most problems at the end of chapters in a typical text book that allow more or less simple and direct approach àSince this explains what is meant in more detail, could be put into training or supplementary material*).
 # (For example, in the design of an antenna or a DSP filter à Examples could be put into supplementary notes.)

GA5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering 21 activities with an understanding of the limitations.

GA6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

GA7 Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

GA8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

GA9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

GA10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

GA11 Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

GA12 Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Programme Outcomes (POs) for

B.E. Electrical and Electronics Engineering

After the successful completion of the B.E. Electrical and Electronics Engineering degree programme, the students should be able to:

PO1: **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and electrical engineering specialisation to the solution of complex problems in Electrical Energy Systems, Analog & Digital Electronic Systems, Control & Automation and Power Electronics & Drives

PO2: **Problem analysis**: Analyse complex problems in Electrical Energy Systems, Analog & Digital Electronic Systems, Control & Automation and Power Electronics & Drives using first principles of mathematics, science, and engineering sciences to reach substantiated conclusions.

PO3: **Design/development of solutions**: Design process or component that meets the specified needs with appropriate consideration for the public health and safety, cultural, societal, and environmental issues for complex problems in Electrical Energy Systems , Analog & Digital Electronic Systems, Control & Automation and Power Electronics & Drives.

PO4: **Investigation of complex problems**: Conduct investigations of complex problems in Electrical Engineering using research-based knowledge and research methods to provide valid conclusions

PO5: **Modern tool usage**: Select and Apply appropriate modern engineering and IT tools including prediction and modelling to complex activities in electrical engineering with an understanding of the limitations.

PO 6: **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional electrical engineering practice.

PO7: **Environment and sustainability**: Understand the impact of the professional electrical engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.

PO8 **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the electrical engineering practice.

PO9 **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.

PO10 **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 **Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PEO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1												
PEO2												
PEO3												

PO-GA Mapping

GAs are taken from page No. 20 & 21 of UG Tier-I NBA manual. For each GA, corresponding PO is articulated considering four specialization areas of B.E. Electrical and Electronics Engineering programme such as Electrical Energy Systems, Analog & Digital Electronic Systems, Control & Automation, and Power Electronics & Drives. Therefore there is a direct one-to-one mapping between GAs and POs as illustrated in the Table 2.

Table 2 : PO-GA Mapping

	GA1	GA2	GA3	GA4	GA5	GA6	GA7	GA8	GA9	GA10	GA11	GA12
PO1												
PO2												
PO3												
PO4												
PO5												
PO6												
PO7												
PO8												

PO9												
PO10												
PO11												
PO12												

Credit Distribution

S.No.	Category of Courses	Credits
1.	Humanities and Social Sciences	15
2.	Basic Sciences	26
3.	Engineering Sciences	21
4.	Programme Core	63
5.	Programme Electives	21
6.	Project	12
7.	General Electives	6
	Total Credits	164

- General electives are courses offered by different departments that do not have any prerequisites and could be of interest to students of any branch
- All students have to undertake co-curricular and extra-curricular activities that include activities related to NCC, NSS, Sports, Professional Societies, participation in identified activities which promote the growth of Department and the College.

COURSES UNDER EACH CATEGORY		TOTAL CREDITS
BASIC SCIENCE COURSES		**26**
Engineering Mathematics-I (Common)	3	
Engineering Mathematics-II (Programme Specific)	3	
Engineering Mathematics-III (Programme Specific)	3	
Engineering Mathematics-IV (Programme Specific)	3	
Engineering Mathematics-V (Programme Specific)	3	
Physics	3	
Physics Laboratory	1	
Chemistry	3	
Chemistry Laboratory	1	
Materials Science for Electrical Engineering	3	
HUMANITIES AND SOCIAL SCIENCES COURSES		**15**
English Communication	3	
Professional Communication (Theory cum practical)	3	
Project Management	3	
Financial management	3	
Environment Science and Ethics	3	
ENGINEERING SCIENCE COURSES		**21**
Basics of Civil and Mechanical Engineering	2	
Basics of Electrical & Electronics Engineering	2	
Engineering Graphics	3	
Engineering Design	3	
Problem Solving using Computers	3	
Workshop	1	
Capstone Course –I	2	
Capstone Course-II	2	
Electromagnetic fields	3	
PROGRAMME CORE (Fundamentals, System Design, Application)		**63**
PROGRAMME ELECTIVES		**21**
GENERAL ELECTIVES		**06**
PROJECT		**12**
	Total Credits	**164**

B.E.EEE Degree Programme - Second Semester 2014-15

Semester	Theory						Theory cum Practical	Practical		Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	
I	14MA110 Engineering Mathematics I(3)	14PH120 Physics (3)	14CH130 Chemistry (3)	14EG140 English (3)	14ES150 Basics of Civil and Mechanical Engineering (2)	14ES160 Basics of Electrical and Electronics Engineering (2)	14ME170 Engineering Graphics (3)	14PH180 Physics Lab (1)	14CH190 Chemistry Lab (1)	--	**21**
II	14EE210 Engineering Mathematics II (3)	14EE220 Materials Science for Electrical Engineering (3)	14EE230 Environmental Science and Ethics (3)	14EE240 Electromagnetic Fields (3)	14EE250 Analog Devices and Circuits (3)		14EE270 Electric Circuit Analysis (3)	14EE280 Analog Devices and Circuits Lab (1)	14ES290 Workshop (1)	--	**20**
III	14EE310 Engineering Mathematics III (3)	14EE320 Transformers (3)	14EE330 DC machines (3)	14EE340 Measurement Systems (3)	14EE350 Digital Systems (3)		14ES370 Problem solving using Computers (3)	14EE380 DC Machines & Transformers Lab (1)	14EE390 Digital Systems Lab (1)	--	**20**
IV	14EE410 Engineering Mathematics IV (3)	14EE420 Instrumentation Systems (3)	14EE430 Control Systems (3)	14EE440 AC Machines (3)	14EG450 Engineering Design (3)	14EE460 Microcontrollers (3)		14EE480 AC Machines Lab (1)	14EE490 Microcontrollers Lab (1)	14EE4C0 Capstone Course-I (2)	**22**
V	14EE510 Engineering Mathematics V (3)	14EE520 Power Electronic Circuits (3)	14EE530 Digital Controls (3)	14EE540 Energy Resources and utilization (3)	14EE550 Digital Signal Processing (3)	14EEPx0 Prog. Elec.I (3)		14EE580 Digital Signal Processing Lab (1)	14EE590 Control & Instrumentation Lab (1)	--	**20**
VI	14EE610 Financial Management (3)	14EE620 Design of Power Supplies (3)	14EE630 Electric Power Transmission System (3)	14EEPX0 Prog. Elec.II (3)	14EEGx0 Gen. Elec. I (3)		14EG670 Professional Communication (3)	14EE680 Power System Lab (1)	14EE690 Power Electronics and Drives Lab (1)	--	**20**
VII	14EE710 Project Management (3)	14EE720 Drives and Control (3)	14EE730 Industrial Automation (3)	14EEPx0 Prog. Elec.III (3)	14EEPx0 Prog. Elec.IV (3)	14EEGx0 Gen. Elec. II (3)		--		14EE7C0 Capstone Course-II (2)	**20**
VIII	14EEPx0 Prog. Elec.V (3)	14EEPx0 Prog. Elec.VI (3)	14EEPx0 Prog. Elec.VII (3)	--	--	--	--	14EE880 Project (12)		--	**21**
										Total Credits	**164**

Basic Science Courses

Humanities and Social Science Courses

Engineering Science courses

Analog & Digital Electronic System Courses

Electrical Energy System Courses

Power Electronics & Drives Courses

Control & Automation Courses

Core & General Elective Courses, Capstone Courses & Project

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. EEE Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15)

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE210	Engineering Mathematics - II	BS	2	2	-	3
14EE220	Materials Science for Electrical Engineering	BS	2	-	2	3
14EE230	Environmental Science and Ethics	BS	3	-	-	3
14EE240	Electromagnetic fields	ES	2	2	-	3
14EE250	Analog Devices and Circuits	PC	3	-	-	3
THEORY CUM PRACTICAL						
14EE270	Electric Circuit Analysis	PC	2	-	2	3
PRACTICAL						
14EE280	Analog Devices and Circuits Lab	PC	-	-	2	1
14ES290	Workshop	ES	-	-	2	1
Total			**14**	**4**	**8**	**20**

BS : Basic Science
ES : Engineering Science
PC : Programme Core
PE : Programme Elective

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. EEE Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE210	Engineering Mathematics - II	3	50	50	100	25	50
2	14EE220	Materials Science for Electrical Engineering	3	50	50	100	25	50
3	14EE230	Environmental Science and Ethics	3	50	50	100	25	50
4	14EE240	Electromagnetic fields	3	50	50	100	25	50
5	14EE250	Analog Devices and Circuits	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE270	Electric Circuit Analysis	3	50	50	100	25	50
PRACTICAL								
8	14EE280	Analog Devices and Circuits Lab	3	50	50	100	25	50
9	14ES290	Workshop	--	100	--	100	--	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

		Category	L	T	P	Credit
14EE210	**ENGINEERING MATHEMATICS - II**	BS	2	1	0	3

Preamble

Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. The Laplace transform method is a powerful method for solving linear ODEs and corresponding initial value problems as well as systems of ODEs arising in Engineering. The knowledge of transformations is to create a new domain in which it is easier to handle the problem that is being investigated. Complex Integration approach is very useful to evaluate many improper integrals of a real variable.

Prerequisite

Differentiation, Integration and Elementary Calculus.

Course Outcomes

On the successful completion of the course, students will be able to:

CO1: Find double integral over general areas and triple integral over general volumes	Understand
CO2: Apply Gauss Divergence theorem for evaluating the surface integral.	Apply
CO3: Apply Laplace transform technique to solve the given ordinary differential equation. . CO4: Predict an analytic function ,when its real or Imaginary part is known. . CO5: Find the Singularities and its corresponding Residues for the given function CO6: Predict the suitable method to evaluate the Contour integration	Apply Apply Understand Understand

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	60	60	60
Apply	20	20	20	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Predict the value of $\int_0^1\int_0^2\int_0^1 dxdydz$
2. Distinguish between triple integral and volume integral.
3. Estimate the area enclosed by the curves $y = x^2$ and $\mathrm{x+y=2}$
4. Predict the limits of $\int_0^a\int_0^x f(x,y)dydx$, by changing the order of integration.

Course Outcome 2 (CO2):

1. Using Taylor's theorem, show that
$$\log Z = (Z-1) - \frac{(Z-1)^2}{2} + \frac{(Z-1)^3}{3} - \ldots\ldots, \textit{where } |Z-1| < 1$$
2. Using Green's theorem for $\vec{f} = (x^2 + y^2)\vec{i} - 2xy\,\vec{j}$ taken around the rectangle bounded by the lines x=0,x=a, y=0 and y=b.
3. If $f(z) = u(r,\theta) + iv(r,\theta)$ is differentiable at $z = re^{i\theta}$, then show that
$$u_r = \frac{v_\theta}{r}, \mathrm{u}_\theta = -r\,v_r$$

Course Outcome 3 (CO3):

1. Solve the Equation $y'' + 9y = \cos 2t,\ \mathrm{y}(0) = 1\ \&\ \mathrm{y}\left(\frac{\pi}{2}\right) = -1$ using Laplace Transform.
2. Compute $\mathrm{L}^{-1}\left(\frac{p+8}{p^2+4p+5}\right)$

3. Using convolution theorem in Laplace Transform, evaluate $\int_0^t Sinu Cos(t-u)du$

4. Show that $\int_0^t e^{-4t} t \sin 3t dt = \frac{6}{(s^2+8s+25)^2}$.

Course Outcome 4 (CO4):

1. Compute an analytic function f(z)=u+iv, where $u = e^x(x\cos y - y\sin y)$.
2. Using convolution theorem, compute $L^{-1}\left(\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right)$
3. Show that the map w = 1/z maps the circles and straight lines as circles or straight lines.
4. Demonstrate the Milne Thompson method to construct an analytic function f(z)=u+iv, given either u(x,y) or v(x,y).

Course Outcome 5 (CO5):

1. Define the term Residue of f(z) at z = a.
2. Give an example of meromorphic function.
3. Identify the singular points of $\frac{1}{(2\sin z - 1)^2}$
4. Identify the residue of $\frac{z+1}{z^2-2z}$ at its poles.

Course Outcome 6(CO6):

1. Evaluate (i) $\int_0^{2\pi} \frac{Cos2\theta}{5+4Cos\theta} d\theta$

   (ii) $\int_0^{\infty} \frac{x^2}{(x^2+1)(x^2+4)} dx$

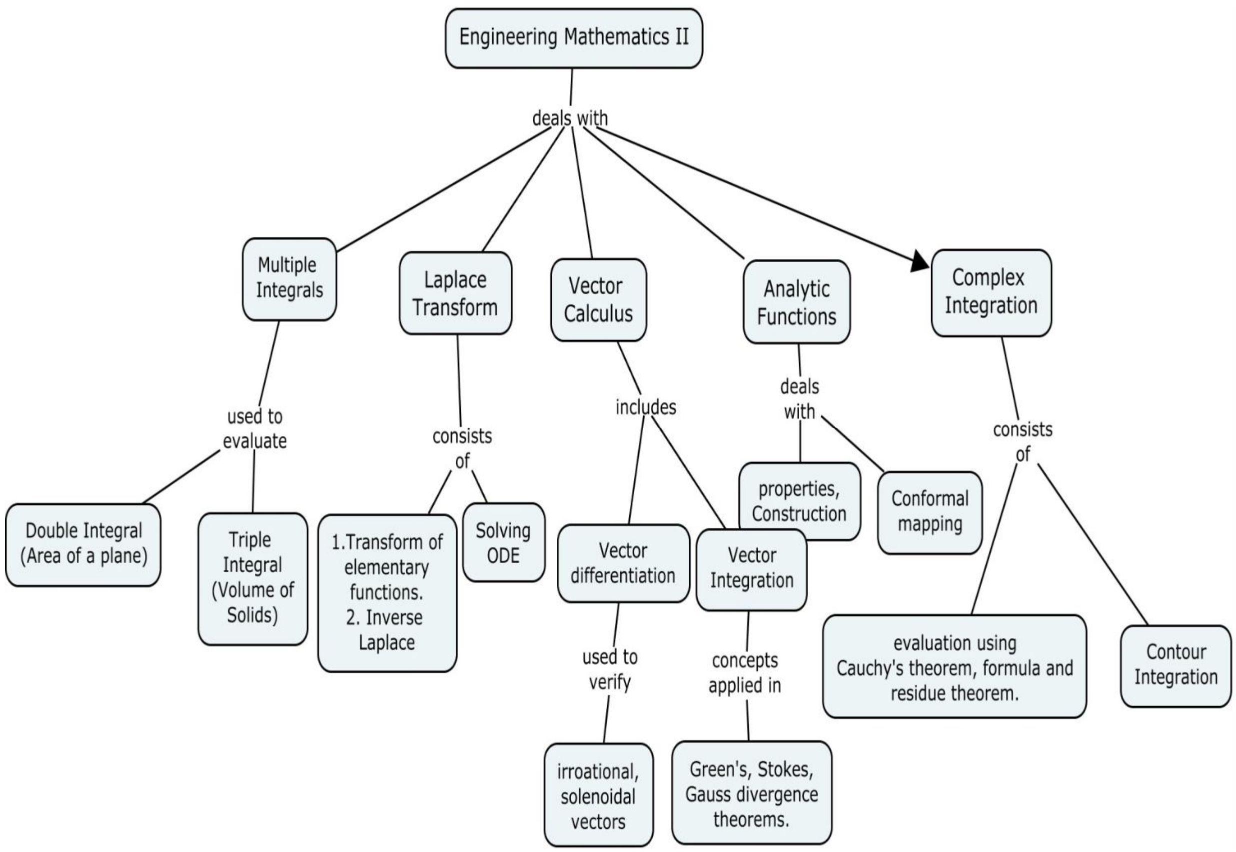
   (iii) $\int_0^{\infty} \frac{x\sin mx}{x^2+a^2} dx$

2. Examine the Laurent's series expansion of $f(z) = \frac{z+4}{(z+3)(z-1)^2}$,

   in (i) 0 < |z-1| < 4 (ii) |z-1| > 4

3. Distinguish between isolated singularity and removable singularity.
4. Distinguish between Cauchy's fundamental theorem and Cauchy's fundamental theorem.

Concept Map



Syllabus

MULTIPLE INTEGRALS: Double integrals –Change of order of integration –Double integrals in polar coordinates –Area enclosed by plane curves –Triple integrals –Volume of Solids –Change of variables in double and triple integrals**.**

VECTOR CALCULUS: Gradient, divergence and curl –Directional derivative –Irrotational and solenoidal vector fields –Simple problems on Vector differentiation–Vector integration –Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem(excluding proofs)–Simple applications.

LAPLACE TRANSFORM : Laplace transform –Sufficient condition for existence –Transform of elementary functions –Basic properties –Transforms of derivatives and integrals of functions -Derivatives and integrals of transforms -Transforms of unit step function and impulse functions –Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem –Initial and final value theorems–Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

ANALYTIC FUNCTIONS : Functions of a complex variable –Analytic functions: Necessary conditions –Cauchy -Riemann equations and sufficient conditions (excluding proofs) –Harmonic and orthogonal properties of analytic function –Harmonic conjugate –Construction of analytic functions –Conformal mapping: $w = z^2$, sinz, e^z and bilinear transformation.

COMPLEX INTEGRATION : Complex integration –Statement and applications of Cauchy's integral theorem and Cauchy's integral formula –Taylor's and Laurent's series expansions –Singular points –Residues –Cauchy's residue theorem –Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

Text Books

1. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, John Wiley & Sons, 2009.

Reference Books

1. T.Veerarajan, "Engineering Mathematics", 3rd Edition, Tata McGraw Hill, New Delhi, 2004.
2. Thomas Phinny, "Calculus", 13th Edition, Pearson Education, New Delhi,2005.
3. .B.V.Ramana, "Higher Engineering Mathematics", Tata McGraw Hill, New Delhi,2011

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**Multiple Integrals**	
1.1	Double integrals and areas	2
1.2	Triple integrals and volumes	2
	Tutorial	1
1.3	Change of order of integration	1
1.4	Change of variables between Cartesian and polar with applications	2
	Tutorial	1
2	**Vector Calculus**	
2.1	Operators Grad, div and curl with properties	2
2.2	Solenoidal and irrotational vectors	2
	Tutorial	1
2.3	Vector integration(three famous theorems)	2
	Tutorial	1
3	**Laplace Transformation**	
3.1	Laplace transformation-properties, inverse laplace transforms	2
	Tutorial	1

3.2	Periodic functions, convolution theorem, initial value theorem and final value theorem	2
3.3	Solution of differential equations and integral equations	2
	Tutorial	1
4	**Analytic Functions**	
4.1	Analytic functions, C-R equations and properties	2
4.2	Harmonic functions and Milne Thomson's method	2
	Tutorial	1
4.3	Conformal maps and bilinear transformations	2
	Tutorial	1
5	**Complex Integration**	
5.1	Cauchy's theorem and consequences	1
5.2	Evaluating integrals using Cauchy's integral formula	2
5.3	Taylor's and Laurent's expansions	2
	Tutorial	1
5.4	Singularities and Cauchy's residue theorem	1
5.5	Contour integration using unit circle and semicircular contours	2
	Tutorial	1
	Total	**43**

Course Designers

1. Dr.S.Jeyabharathi sjbmat@tce.edu
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3. Dr.A.P.Pushpalatha appmat@tce.edu

14EE220	**MATERIALS SCIENCE FOR ELECTRICAL ENGINEERING**	Category	L	T	P	Credit
		ES	2	0	1	3

Preamble

The course work aims in imparting fundamental knowledge of materials science required for electrical engineers. The course work will introduce engineers to different types of conductors, semiconductors and dielectrics. The current magnetic materials, LEDs, Solar cell materials, superconductors and smart materials will be discussed.

Prerequisite

Basic course (No prerequisite)

Course Outcomes

On the successful completion of the course, students will be able to

(CO1)Compute the electrical conductivity of metals based on classical free electron theory.	Apply
(CO2) Compute the thermal and mechanical properties of different types of materials	Apply
(CO3) Explain the behavior of dielectrics with increasing frequency and temperature	Understand
(CO4)Compute the dielectric constant based on polarizability.	Apply
(CO5) Determine the conductivity and band gap of a given semiconductor for different carrier concentration and temperatures	Understand
(CO6)Compute the magnetic properties of different magnetic materials	Apply
(CO7)Explain the properties and application of new engineering materials like nano materials and shape memory alloys	Understand
(CO8)Explain the properties and characteristics of materials used in LED and solar cells.	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**M**
CO2.	**M**	**L**	**-**	**L**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**L**
CO3.	**H**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**L**
CO4	**M**	**M**	**-**	**L**	**-**	**-**	**-**	**-**	**L**	**-**	**-**	**M**
CO5	**H**	**M**	**-**	**M**	**M**	**-**	**-**	**-**	**M**	**M**	**-**	**M**
CO6	**M**	**L**	**M**	**M**	**-**	**-**	**-**	**-**	**M**	**M**	**-**	**L**
CO7	**M**	**L**	**-**	**L**	**-**	**-**	**-**	**-**	**M**	**M**	**-**	**L**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	*3 (Continuous Evaluation of Experiments)	
Remember	20	20	0	20
Understand	50	50	0	50
Apply	30	30	100	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

*

CAT3: EVALUATION WILL BE BASED ON THE REPORT SUBMITTED FOR THE EXPERIMENTS AND LAB TEST.

Course Level Assessment Questions

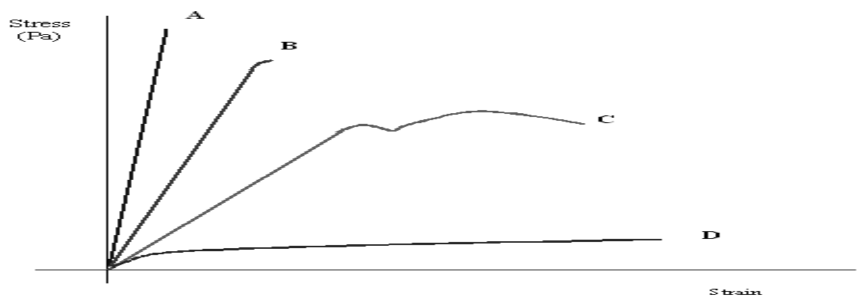
Course Outcome 1 (CO1):

1. Calculate the drift velocity of the free electrons in a conductor of area $10^{-4}m^2$,given the electron density to be $8x10^{28}/m^3$when a current of 5A flows through it.(Understand).
2. Calculate the electron density ,if the drift velocity of electrons in a metal wire of diameter 5mm is $6x10^{-4}$m/s and the current is 10A (Understand).
3. Calculate the relaxation time of free electrons in a metal of resistivity $1.54x10^{-8}$ ohm-m, if the metal has $5.8x10^{28}$ electrons/m^3 .Identify the possible material and suggest the suitability for transformer winding applications.(Apply).

Course Outcome 2 (CO2):

1. A metal wire is 2.5 mm diameter and 2 m long. A force of 12 N is applied to it and it stretches 0.3 mm. Determine the stress and strain in the wire.(Remember).

2 . Identify the material A,B,C and D from stress starin curve shown below .Explain your answer with suitable reasons.



3. Describe the procedure for a tensile test and list the parameters that could be evaluated from a tensile test (Understand).

Course Outcome 3(CO3):

1. Define dielectric constant of a material.(Remember)
2. Explain the frequency dependence of dielectric constant from power frequency to optical frequency(Understand)
3. List the different parameters affecting power loss in a dielectric.(Remember)

Course Outcome 4(CO4):

1. A parallel plate capacitor is charged by connecting it to a 90V Battery. The battery is then disconnected and an insulating liquid is poured between the plates to fill the air gap .The potential difference is now 30 V. Calculate the dielectric constant of the liquid and identify the liquid and suggest suitable applications for the same (Apply)
2. Calculate the dielectric constant of a material of a sphere of radius 2cm if the capacitance is 6 microfarad.(Understand)
3. Calculate the polarizability of a dielectric if the dielectric constant is 4 and the dipolar density is 2.7×10^{25} per m^3.(Understand)

Course Outcome 5(CO5):

1. The intrinsic carrier density at room temperature in Ge is $2.37 \times 10^{19}/m^3$.If the electron and hole nobilities are 0.38 and 0.18 $m^2\ V^{-1}s^{-1}$ respectively, calculate the resistivity.(Understand)
2. For an intrinsic semiconductor with gap width Eg=0.7eV,calculate the concentration of intrinsic charge carriers at 300K assuming $m_e^*=m_h=m_0$(rest mass of electron).(Understand)

3. The energy gap of Si is 1.1 eV. Its electron and hole mobilities at room temperatures are 0.48 and 0.013 $m^2 V^{-1} s^{-1}$ respectively. Evaluate its conductivity.(Understand)

Course Outcome 6 (CO6):

1. A magnetic material has a flux density and magnetization of 0.0044 Wb./m^2 and 3300 A/m respectively. Calculate the magnetizing force and relative permeability of the material. Comment on the type of magnetic material and possible applications.(Apply)
2. The magnetic field strength in copper is 10^6 A/m. If the magnetic susceptibility of copper is $-0.8X10^{-5}$, calculate the flux density and magnetization in copper.(Understand)
3. A para magnetic material has a magnetic field intensity of 10^4 A/m. If the susceptibility of the material at room temperature is $3.7X10^{-3}$ calculate the magnetization and flux density in the material.(Understand)

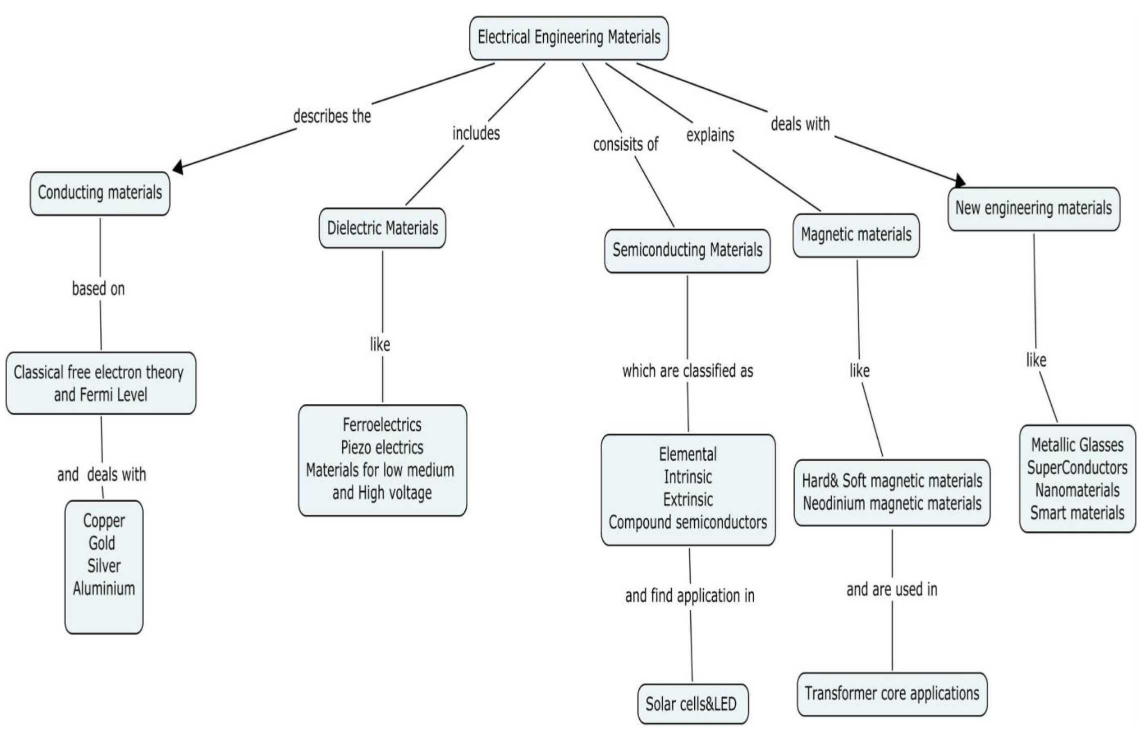
Course Outcome 7 (CO7):

1. Mention any four method of synthesis of nano materials.(Remember)
2. Define a smart material .(Remember)
3. Explain the properties and applications of metallic glasses.(Understand)

Course Outcome 8(CO8)

1. List any four properties required for a semiconductor material to be used as LED.(Remember)
2. Cite any four compound semiconductors used as solar cell materials.(Remember)
3. Explain the properties of Zinc Oxide which make them suitable as a solar cell material.(Understand)

Concept Map



Syllabus

Conducting materials: Conduction in metals-Mobility and Conductivity-Classical free electron theory of metals-Band theory of Solids(Qualitative)-Classification of solids on basis of band theory-Fermi distribution function-Effect of temperature on Fermi function- Work function- Structure ,Property and applications of Cu, Ag, Al, Au.

Thermal Properties-Specific heat capacity and Thermal Conductivity of metals, polymers and ceramics-Widemaan Franz Law .
Mechanical Properties Resilience, Toughness, Hardness, Fatigue.T ensile test and Creep test.

Dielectric materials - Electric Susceptibility-Dielectric Constant-Electronic, Ionic and Orientation -, Frequency and temperature dependence of Polarization-Internal field-Claussius Mosotti Relation- Dielectric Loss-Dielectric Breakdown-Uses of dielectrics(Capacitors and Transformers)- Dielectric materials for Low Voltage, Medium Voltage and High Voltage. PVC,Polyethylene,Rubber,Askerel,SF_6,Vacuum,Insulating Oil,Varnish, Bakelite. Letharoid Paper- Ferroelectric materials Piezoelectric materials.

Semiconducting Materials Classification - Intrinsic, Extrinsic, Mobility and Conductivity, Determination of band gap - Fermi Level and its variation with temperature and impurity concentration. –(Qualitative approach) -Elemental, Semiconductor-Si,Ge ,Single crystals-polycrystalline-Thin film- Solar panel materials. Compound Semiconductors II-VI, III-V property and applications of ZnO, GaAs, GaN, Si C, CdS,-LED materials

Magnetic materials –Classification of magnetic materials-(Dia, Para, Ferro,) Domain theory-Hysteresis- Hard and soft magnetic materials, Epstien frame method,core loss density. Steel, Silicon, Effect of adding silicon with steel on magnetic properties. Magnetic materials in Transformers, Neodinium magnets.

New engineering materials-Metallic Glasses-Types of metallic glasses-Preparation-Properties and applications-Amorphous core materials-Amorphous silicon-Superconductors-High Temperature Superconductor and Applications ,MEMS, Nano materials-Synthesis-Sol Gel, Properties and Applications-Shape memory alloys(SMA)-Types- Application of SMA.

Experiments:

1) Widemaan Franz Law-Determination of thermal conductivity
2) Determination of temperature coefficient of resistance
3) B-H Curve of ferromagnetic materials.

Text Books

1) Dekker, Adrianus ,"Electrical Engineering Materials" PHI Learning, Eastern India Economy Edition ,Digital edition,2006
2) Indulkar C.S and S.Thiruvengadam," An introduction to electrical engineering materials, S.Chand, sixth edition,2011.

Reference Books

1) William Callister, "Materials Science and Engineering" Wiley India Edition, Eight edition, 2012.
2) William F Smith,Javed Hashemi, Ravi Prakash" Materials Science and Engineering" Tata Mac Graw Hill, Fourth edition,2006.
3) J.M.D Coey. Introduction to magnetic and magnetic materials, Cambridge University Press,2009.
4) B.D.Cullity and C.D Graham., Introduction to Magnetic Materials, Wiley ,IEEE Press ,2009.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Conducting materials**	
1.1	Conduction in metals-mobility, conductivity	1
1.2	Classical free electron theory of metals-success and drawbacks	1
1.3	Band theory of solids(qualitative),classification	1
1.4	Fermi distribution function, effect of temperature on Fermi function	1
1.5	Work function, Structure,property and applications of Cu, Ag, Al, Au	1
1.6	Thermal Properties- Specifc heat capacity and Thermal Conductivity of metals, polymers and ceramics-Widemaan Franz Law.	2
1.7	Mechanical Properties Resilience, Toughness, Hardness,Fatigue. Tensile test and Creep test.	2
2.	**Dielectric materials**	
2.1	Electric susceptibility, dielectric constant	1
2.2	Electronic ,Ionic polarization, Orientation and space charge polarization	2
2.3	Frequency and temperature dependence of polarization	1
2.4	Internal field, -Masotti relation	1
2.5	Dielectric loss, dielectric breakdown	1
2.6	Uses of dielectrics(capacitors and transformers)-PVC, Polyethylene, Rubber, Askarals,SF_6, Vacuum, Insulating oils/varnish, Bakelite, letharoid paper	2
2.7	Dielectric materials for low voltage and high voltage applications	1
2.8	Ferroelectric materials- Piezoelectric materials.	1
3.	**Semiconducting Materials.**	
3.1	Classification-intrinsic and extrinsic semiconductors-mobility and conductivity	1
3.2	Determination of band gap	1
3.3	Variation of Fermi level with temperature and impurity concentration	1
3.4	Elemental semiconductor-Si,Ge,-single crystal-polycrystalline materials	1
3.5	II-VIand III-V Compound semiconductors- property and applications	2
3.6	Structure, property and applications of ZnO, GaAs,GaN,SiC CdS,LED materials	2
4.	**Magnetic materials**	
4.1	Classification of magnetic materials-dia, para, ferro antiferro and ferri magnetism	1
4.2	Domain theory-hysteresis, Epstiens frame method, Core energy density	2

Module No.	Topic	No. of Lecture Hours
4.3	Hard and soft magnetic materials	1
4.4	Influence of silicon on the magnetic properties of steel	1
4.5	Magnetic materials in transformers, ferrite for magnetic application	1
4.6	Neodymium magnets	1
5.	**New engineering materials**	
5.1	Metallic glasses-types, preparation, properties and application	2
5.2	Amorphous core materials-amorphous silicon	1
5.3	High Tc superconductors-applications- MAGLEV,SQUID	2
5.4	MEMS- Nano materials-synthesis, properties and applications	2
5.5	Shape memory alloys-types	1
	Total	**42**

Course Designers:

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14EE230	ENVIRONMENTAL SCIENCE AND ETHICS	Category	L	T	P	Credit
		HSS	3	0	0	3

Preamble

This course provides comprehensive insight into ecosystem, natural resources and biodiversity and creates awareness in every electrical engineering graduate about the importance of environment and the effect of technology on the environment and ecological balance and make them sensitive and educate the ways and means to protect the environment in every professional endeavor that they participates. It also imparts fundamental environmental ethics and legal provisions.

Prerequisite

NIL

Course Outcomes

On successful completion of the course, the students will be able to

CO 1. Explain the concept, structure and function of an ecosystem	Understand
CO 2.Identify the values and conservation methods of biodiversity	Understand
CO 3. Demonstrate the environmental impacts of energy development	Apply
CO 4. Describe the effects and control measures of air and noise pollution	Understand
CO 5. Select the suitable management method for solid wastes	Apply
CO 6. Recall the environmental ethics and legal provisions	Remember
CO 7. Identify the appropriate disaster management method	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO4.	**M**					**L**	**M**					
CO5.	**M**		**M**			**L**						
CO3.	**L**		**M**				**M**					
CO4.	**M**					**M**						
CO5.	**S**						**S**					
CO6.	**L**					**S**						
CO7.	**M**					**S**						

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3**	
Remember	40	20		20
Understand	60	60		60
Apply	0	20		20
Analyse	0	0		0
Evaluate	0	0		0
Create	0	0		0

****CAT – 3: Case study report for the selected topic followed by presentation in group (Three students per group).**

Scheme of valuation of CAT-3:

Performance Index	Internal/ External	Marks per individual
Originality	Internal	10
Data collected		10
Solution for the identified issues		10
Presentation	External -Ten [5×2] experts from the department appointed by HOD	10 +10

 # Assignment: Marks will be given for the group presentation (10-15 min) on any selected topics related to environmental studies followed by discussion with group members.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify the basic components of an ecosystem. (Remember)
2. Describe the energy flow models of an ecosystem. (Understand)
3. Illustrate the sequential evolution of an ecosystem initiating from pioneer community to climax community. (Understand)

Course Outcome 2 (CO2):

1. Explain the consumptive and productive values of biodiversity. (Understand)
2. Define habitat fragmentation. (Remember)
3. Discuss the conservation methods for conservation of biodiversity in detail. (Understand)

Course Outcome 3 (CO3):

1. Describe the impacts of hydroelectric power plant on the environment. (Understand)
2. List out the observed issues in the Urban area related to electrical energy. (Remember)
3. Dramatize the environmental impact of Kudankulam Atomic power plant. (Apply)

Course Outcome 4 (CO4):

1. Identify the sources of noise pollution. (Remember)
2. Describe the sources, effects and control measures of air pollution. (Understand)
3. Explain the benefits of green building. (Understand)

Course Outcome 5(CO5):

1. Demonstrate the sequence of waste disposal generated in Indira Gandhi atomic power plant, Kalpakkam. (Apply)
2. Recognize the composition of E-waste. (Remember)
3. Choose the suitable method to treat the E-waste generated while disposing the old computers with all accessories from computer laboratory. (Apply)

Course Outcome 6 (CO6):

1. Identify the need for gender equity to maintain the societal stability. (Remember)
2. Describe the necessities for ethical based environmental education and awareness. (Remember)
3. Recall the theories and codes of Ethics. (Remember)

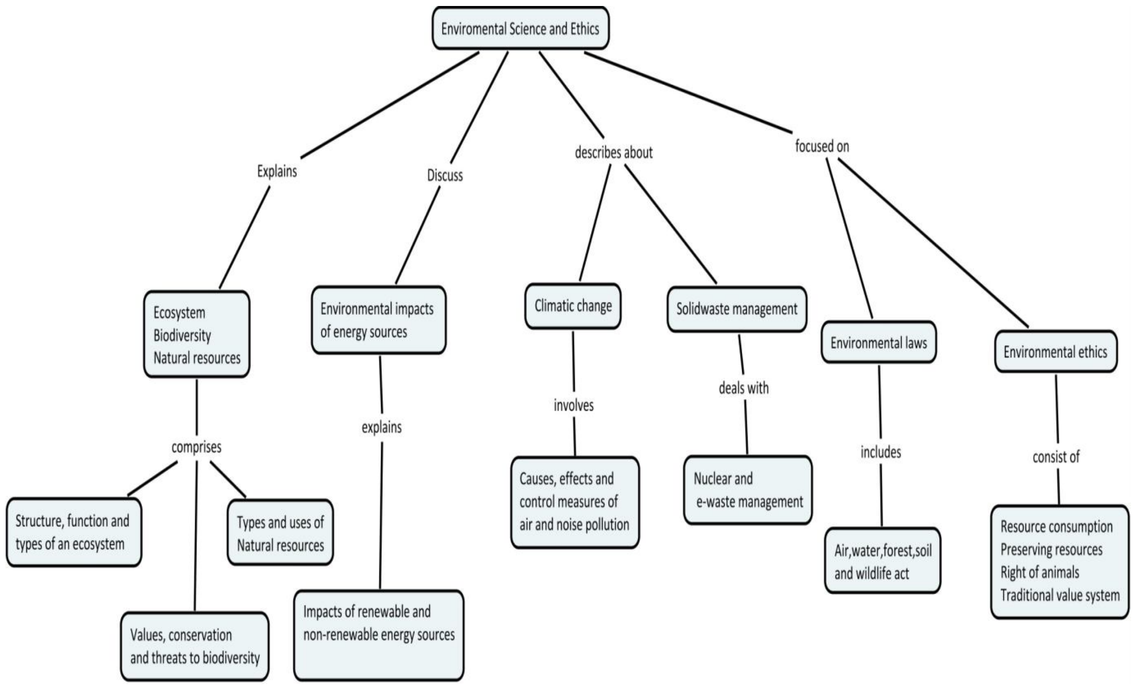
Course Outcome 7 (CO7):

1. Identify the need for disaster management. (Remember)
2. Describe the causes and consequences of flood in Jammu Kashmir during the month of September 2014. (Understand)
3. Outline the precaution measures to protect the lives from earthquake (Understand)

Model titles for case study:

1. Environmental impacts of quarry industries in Melur Taluk.
2. A study on impacts of tanneries on ground water and soil quality in Dindigul district.
3. Effect of pharmaceutical industry on groundwater quality in poikaraipatty village, Alagar Kovil.
4. Solid waste and waste water management in TCE hostel.
5. Environmental effect of Kudankulam atomic power plant.
6. Case study on effect of Sterlite industry.
7. Effect on ground water and soil quality by dyeing industries in Tiruppur.
8. Effect of textile wastes in Karur District.
9. Case study on effect of Sand quarries on ground water level in Cauvery river basin.
10. Effect of fire work waste on atmosphere in Sivakasi region.
11. Study on ISO 14001 documentation in the certified organization.
12. Mock audit - ISO 14001 in the TCE campus.

Concept Map



Syllabus

Environment - an overview - Ecosystem- concept-structure-function-types. Energy flow in ecosystem. Biodiversity and its conservation- values of biodiversity-threats to biodiversity-conservation of biodiversity. Natural resources- types, uses.

Environmental i**mpact of energy sources -**Sources of primary energy- present and future consumption of energy- environmental impacts of energy development- oil, natural gas, coal, hydro electric, nuclear power, wind mill and solar panels- Urban problems related to energy-case studies.

Climatic change and solid waste management- Environmental pollution- air and noise pollution-green house gases- causes, effects- global warming, ozone layer depletion, acid rain-sources and effects of noise pollution. Pollution control strategies- preventive measures-green technologies-green building concepts- standards and regulations-role of individuals. Sustainable development. Hazardous wastes- e-waste-source- effect, management. Nuclear waste-sources, effects, management. Recycling of waste. Future challenges.

Environmental laws and Ethics-Legal provision in India-environmental acts-air, water, forest, soil and wildlife **(not for examination)**. Environmental ethics-theories and codes-resource consumption patterns, equity-disparity, urban-rural equity issues, need for gender equity, preserving resource for future generation, right of animals, ethical basis of environment education and awareness, ethical problem solving- changing attitude, conservation ethics and traditional value systems of India. Effect of social media on the adolescent. Disaster management, ISO 14001 certifications.

Text books

1. Erach Bharucha, "Text book for Environmental sciences for Undergraduate cources", UGC, 2004 *(Module I,III &IV)*
2. Kaushik, A & Kaushik, CP, Environmental Science and engineering", 3rd Edition, New Age International (P) Limited, New Delhi, 2009. *(Module I)*
3. Henry, JG & Heinke, GW, " Environmental Science and Engineering", 2nd Edition, PHI Learning Private limited, New Delhi, 2011. *(Module II)*

Reference books

1. Masters, GM & Ela, WP, " Introduction to Environmental Engineering and Science", 3rd Edition, PHI Learning Private limited, New Delhi, 2009. *(Module III)*
2. Encyclopaedia of environmental ethics and philosophy. Available at < www.gmu.ac.ir/download/booklibrary/e-library/Encyclopaedia of Environmental Ethics and philosophy.pdf *(Module IV)*
3. www.hightech.lbl.gov/dc-india/documents/presentation/greenbuilding-Srinivas.pdf *(Green buildings)*
4. www.bvucoepune.edu.in/pdf's/Research and Publication/Research Publication_2010-11/national conference_2010-11/Green building leader.pdf *(Green buildings)*
5. www.iisc.ernet.in/currsci/dec25200/1534.pdf *(Nuclear waste)*
6. www.cpcb.nic.in/latest/27.06.08 guidelines for E-waste.pdf *(E-Waste)*

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**Environment- an overview**	
1.1	Ecosystem- Definition, concept, structure	1
1.2	Function and types of an ecosystem, ecological succession	1
1.3	Biodiversity- definition, consumptive and productive values	1
1.4	Threats to biodiversity	1
1.5	Conservation of biodiversity	1
1.6	Natural resources – types, uses of energy resource	1
1.7	Role of an individual in the conservation of natural resources	1
2.0	**Environmental impacts of energy sources**	
2.1	Sources of primary energy	1
2.2	Present and future consumption of energy	2
2.3	Environmental impacts of oil, natural gas, coal	2
2.4	Environmental impacts of hydro electric and nuclear power plants	2
2.5	Wind mills and solar panels- effects on environment	2
2.6	Urban problems related to energy	1
3.0	**Climatic change and solid waste management**	
3.1	Sources and effects of air and noise pollution	1
3.2	Global warming, ozone layer depletion, acid rain- causes and consequences	2
3.3	Preventive measures for pollution	1
3.4	green technologies and green buildings	2
3.5	Role of an individuals in pollution control	1
3.6	Sustainable development	1
3.7	E-waste- effects and management	2
3.8	Nuclear waste management	2

Module No.	Topic	No. of Lecture Hours
3.9	Future challenges	1
4.0	**Environmental laws and Ethics**	
4.1	Legal provisions in India – need	1
4.2	Air, water, forest, soil and wildlife act	1
4.3	Environmental ethics- theories and codes	1
4.4	Resource consumption pattern, equity-disparity, Urban-rural equity issues, need for gender equity	1
4.5	Preserving resource for future generation	1
4.6	Right of animals, ethical basis of environmental education and awareness	1
4.7	Conservation ethics and traditional value system in India	1
4.8	Effect of social media on the adolescent	1
4.9	Disaster management	1
4.10	ISO 14001 certification	1
	Total	**40**

Course Designers

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		Category	L	T	P	Credit
14EE240	**ELECTROMAGNETIC FIELDS**	ES	2	1	0	3

Preamble

The Course is designed to impart knowledge of fundamentals of vector calculus, concept of electric and magnetic fields (both static and time varying) applicable to electrical engineering. The course exposes the students to the concept of resistance, capacitance, and Inductance. Students will get an idea about behaviour of field in materials (magnetic, conducting, insulating materials) at the interface of two different materials and their applications to Electrical Engineering. Force, torque, generator and transformer working principles are explained with Electromagnetic Fields.

Prerequisite

14ES160 : Basics of Electrical and Electronics Engineering

14MA110 : Engineering Mathematics - I

Course Outcomes

On the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Bloom's Level
CO1	Describe the coordinate systems and vector calculus to electric and magnetic fields.	Understand
CO2	Compare the nature, characteristics, properties and applications of Electric and Magnetic fields with the help of fundamental laws of fields.	Understand
CO3	Explain voltage, and current using electric fields.	Understand
CO4	Develop resistance, capacitance and inductance of a given electrical component	Apply
CO5	Explain the behaviour of fields at the interface of two different materials and their application to electrical engineering	Understand
CO6	Relate electric and magnetic fields with help of Faraday's Law and Maxwell's Equation, and, their applications to electrical machines	Understand
CO7	Explain Electromagnetic Wave propagation, Poynting Vector and Poynting Theorem	Understand
CO8	Appreciate the significance of electric and magnetic fields in electrical engineering	Responding(A2)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**L**	**L**									
CO2	**M**	**L**	**L**							**M**		**M**
CO3	**M**	**L**	**L**									
CO4	**S**	**M**	**M**	**L**	**S**				**M**			
CO5	**M**	**L**	**L**		**S**				**M**			
CO6	**M**	**L**	**L**									
CO7	**M**	**L**	**L**									
CO8												**S**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			$Terminal Examination
	$1	$2	$3	
Remember	20	20	20	10
Understand	80	50	50	50
Apply	0	30	30	40
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

$ CAT, Terminal Examination should consist of objective type question in Understand Category for 20% of Maximum Marks.

- Negative marking will be given for wrong answers in objective type questions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

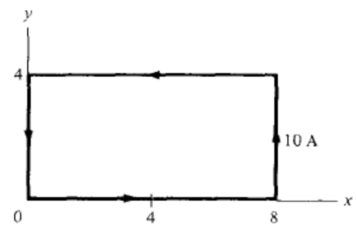
1. Given points P(l, - 3 , 5), *Q(2,* 4, 6), and *R(0,* 3, 8), find: (a) the position vectors of *P* and *R,* (b) the distance vector r_{qr}(c) the distance between *Q* and *R,*
2. Determine the divergence of these vector fields:
   (a) $P = x^2yz\,\hat{x} + xz\,\hat{z}$

(b) Q = $\rho \sin\phi\, \hat{\rho} + \rho^2 z \hat{\phi} + z \cos\phi\, \mathbf{z}$

3. Determine the flux of $\bar{\boldsymbol{D}} = \rho^2 \cos^2 \phi \hat{\rho} + z \sin\phi\, \hat{\phi}$ over the closed surface of the cylinder $0 \le z \le 1$, $\rho = 4$. Verify the divergence theorem for this case.

Course Outcome 2 (CO2):

1. Point charges 5 nC and —2 nC are located at (2,0, 4) and (-3,0, 5), respectively.
   (a) Determine the force on a 1-nC point charge located at (1, —3, 7).
   (b) Find the electric field **E** at (1, - 3 , 7).
2. If $\bar{\mathbf{D}} = (2y^2 + z)\hat{x} + 4xy\hat{y} + x\hat{z}$ C/m^2, find
   (a) The volume charge density at (-1, 0, 3)
   (b) The flux through the cube defined b y $0 \le x \le 1$, $0 \le y \le 1$, $0 \le z \le 1$.
   (c) The total charge enclosed by the cube
3. A charge distribution in free space has ρ_v = 2r nC/m^3 for $0 \le r \le 10$ m and zero otherwise. Determine $\bar{\mathbf{E}}$ at r = 2 m and r = 12 m.
4. A rectangular loop carrying 10 A of current is placed on z = 0 plane as shown in Figure below. Evaluate $\bar{\boldsymbol{H}}$ at



a. (2, 2, 0)
b. (4, 2, 0)
c. (4, 8, 0)

5. Two conductors carrying current in same direction are place side by side. Obtain the force developed between the two conductors and draw the magnetic field lines around it. If the direction of current in one of the conductor is reversed discuss the change in force and field lines.

Course Outcome 3 (CO3):

1. Two point charges - 4 μC and 5 μC are located at (2 , - 1 , 3) and (0, 4, - 2) , respectively. If a third point charge of 3 μC is located at the origin. Find the potential at (- 1 , 5, 2) assuming V(∞) = 0.
2. If $J = \frac{1}{r^3}(2\cos\theta\, \hat{r} + \sin\theta\, \hat{\theta})$ A/m2, calculate the current passing through
   a. A hemispherical shell of radius 20 cm
   b. A spherical shell of radius 10 cm
3. Prove that R = V/I.

Course Outcome 4 (CO4):

1. Derive the formula for the capacitance *C* = *Q/Vo* of a cylindrical capacitor by assuming *Vo* and finding Q

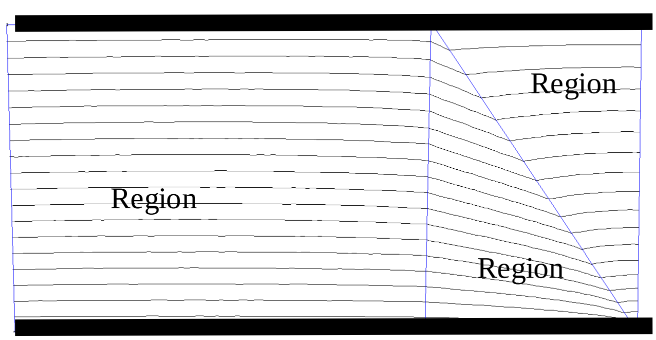
2. At a particular temperature and pressure, a helium gas contains 5 X 10^{25} atoms/m^3. If a 10 kV/m field applied to the gas causes an average electron cloud shift of 10^{-18} m, find the dielectric constant of helium.
3. A toroid of circular cross section whose center is at the origin and axis the same as the z-axis has 1000 turns with total *radius* 10 cm, core radius of 1 cm. If the toroid carries a 100 mA, current, find ***H*** at,
   d. (3 c m , - 4 cm, 0)
   e. (6 cm, 9 cm, 0)
4. A composite conductor 10 m long consists of an inner core of steel of radius 1.5 cm and an outer sheath of copper whose thickness is 0.5 cm
   (a) Determine the resistance of the conductor.

   (b) If the total current in the conductor is 60 A, what current flows in each metal?

   (c) Find the resistance of a solid copper conductor of the same length and cross-sectional areas as the sheath. Take the resistivities of copper and steel as 1.77 * 10^{-8} and 11.8 * 10^{-8} Ωm, respectively

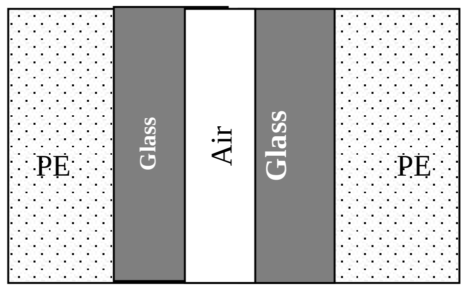
Course Outcome 5 (CO5):

1. A homogeneous dielectric (ε_r = 2.5) fills region 1 (x $\leq$0) while region 2 (x $\geq$0) is free space.
   a. If $\overline{\boldsymbol{D}}_1 = 12\hat{x} - 10\hat{y} + 4\hat{z}$ nC/m^2, find $\overline{\boldsymbol{D}}_2$ and θ_2.
   b. If $\overline{\boldsymbol{E}}_2$ = 12 V/m and θ_2= 60°, find $\overline{\boldsymbol{E}}_1$ and θ_1.
2. The following fig. below shows the equipotential lines between two parallel conducting plates. The top plate is at 100V compared to bottom plate. The dielectric medium in between the two plates is made up of Mica(ε_r = 6), PVC(ε_r = 3) and Air(ε_r = 1).



   a. Identify the material in each medium and justify your answer.
   b. Draw the field lines for this configuration.
   c. If conducting plate dimension is 3" X 1" and the plates are separated by 1.5", the capacitance measured is 0.21µF, then, Find the energy storage:
      i. For the arrangement as shown in Fig.C1
      ii. If the all the dielectric medium has uniform dimension and placed vertically across the length of the conducting plate (i.e.) dimension of each medium is 1"x 1" x 1.5".
      iii. If the all the dielectric medium has uniform dimension and placed horizontally between the two plates (i.e.) each medium has 3" x 1"x 0.5" as its dimension.
      iv. Compare the results for all the above three cases.

3. Two parallel sheets of glass (ε_r = 8.5) mounted vertically are separated by a uniform air gap between their inner surface. The sheets, properly sealed, are covered with polyethylene (ε_r = 3.0) as shown in Fig. below. A uniform electric field of strength 2000 V/m in the horizontal direction exists in the oil. Calculate the magnitude and direction of the electric field in the glass and in the enclosed air gap when (a) the field is normal to the glass surfaces, and (b) the field in the oil makes an angle of 75° with a normal to the glass surfaces. Ignore edge effects.



Course Outcome 6 (CO6):

1. Justify the presence of displacement current and hence modification in Ampere's law.
2. Derive the Maxwell's equation for static fields.
3. Derive the transformer Equation using Faradays Law.

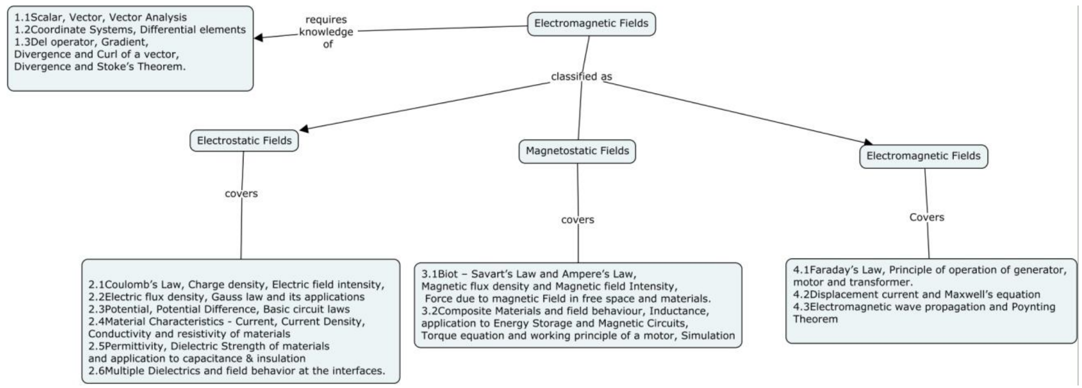
Course Outcome 7 (CO7):

1. Explain Poynting Vector.
2. What do you mean by a lossy dielectric?
3. Derive Helmholts's wave equation.

Course Outcome 8 (CO8):

1. Conducting Quiz on electric and magnetic fields.
2. Getting feedback from the students about the importance of the subject for electrical engineering.

Concept Map



Syllabus

Vector Analysis

Scalar, Vector, Vector addition, Subtraction and Multiplication, Coordinate Systems, Differential elements, Del operator, Gradient, Divergence and Curl of a vector, Divergence and Stoke's Theorem.

Electrostatic Field

Coulomb's Law, Charge density, Electric field intensity, Electric flux density, Gauss law and its applications, Potential, Potential Difference, Potential rise and Potential drop in free space and materials, Basic circuit laws - verifications.

Material Characteristics - Current, Current Density, Conductivity and resistivity of materials. Permittivity, Dielectric Strength of materials and application to capacitance & electrical insulation. Multiple Dielectrics and field behavior at the interfaces. Calculation of capacitance for various application and energy storage. Simulation of Electric Fields using FEM packages.

Magneto static Fields

Biot – Savart's Law and Ampere's Law, Magnetic flux density and Magnetic field Intensity, Force due to magnetic Field in free space and materials. Composite Materials and field behaviour, Inductance, application to Energy Storage and Magnetic Circuits, Torque Equation and working principle of motor. Simulation of Magnetic Fields using FEM packages.

Electromagnetic Field

Faraday's Law, Principle of operation of generator and transformer, Displacement current and Maxwell's equation, Electromagnetic Wave Propagation and Poynting Theorem.

ASSIGNMENTS

1. Simulation of Electrical and Magnetic Fields using FEM packages.
2. Demonstration of Electric and Magnetic fields using simple experiments
3. Seminar on practical applications of electric and magnetic fields like working of XEROX machine, MRI Scan etc.

Text Books

1. William Hayt Jr. and John A. Buck , "Engineering Electromagnetics", TMH publishing co. ltd., 7th Edition, 2006.
2. John D. Kraus, "Electromagnetics", Mcgraw – Hill International Editions, 4th Edition, 1992.
3. Mathew N.O. Sadiku, "Principles of Electromagnetic Fields", 4th Edition, Oxford University Press, 2010.

Reference Books

1. Joseph A. Edminister , "Theory and problems of Electromagnetics", Schaum's series Mc Graw Hill International Edition, 2nd Edition, 1993, Singapore.
2. S.P.Seth," Fundamentals of Electromagnetics", Wiley Eastern Ltd., 1st Edition, 2002.
3. A.S. Mahajan and A.A.Rangwala, "Electricity and Magnetism", TMH publishing co. ltd., 2008.

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lecture Hours
1.0	**Vector Calculus**	
1.1	Scalar, Vector, Vector addition, Subtraction and Multiplication	2
1.2	Coordinate Systems, Differential elements	2
1.3	Del operator, Gradient, Divergence and Curl of a vector, Divergence and Stoke's Theorem.	3
2.0	**Electrostatic Field**	
2.1	Coulomb's Law, Charge density, Electric field intensity,	2
2.2	Electric flux density, Gauss law and its applications	2
2.3	Potential, Potential Difference, Potential rise, Potential drop in free space and materials, Basic circuit laws - verifications	2
2.4	Material Characteristics - Current, Current Density, Conductivity and resistivity of materials	3
2.5	Permittivity, Dielectric Strength of materials and application to capacitance & insulation	3
2.6	Multiple Dielectrics and field behavior at the interfaces.	4

	Calculation of capacitance for various application and energy storage. Simulation	
3.0	**Magneto static Fields**	
3.1	Biot – Savart's Law and Ampere's Law, Magnetic flux density and Magnetic field Intensity, Force due to magnetic Field in free space and materials.	3
3.2	Composite Materials and field behaviour, Inductance, application to Energy Storage and Magnetic Circuits, Torque equation and working principle of a motor, Simulation	4
4.0	**Electromagnetic Field**	
4.1	Faraday's Law, Principle of operation of generator, motor and transformer.	2
4.2	Displacement current and Maxwell's equation	1
4.3	Electromagnetic wave propagation and Poynting Theorem	2
	Total	**35**

Course Designers

1. Dr.R. Rajan Prakash r_rajanprakash@tce.edu
2. Dr.C.K. Babulal ckbeee@tce.edu
3. Dr.V. Prakash vpeee@tce.edu

14EE250	ANALOG DEVICES AND CIRCUITS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Signals contain information about a variety of things and activities in our physical world. An observer, be it a human or a machine, invariably needs to condition and process the signals in some predetermined manner to extract the required information. This signal conditioning/processing is usually most conveniently performed by electronic systems. The signal conversion/conditioning/processing is done by using different semiconductor/signal conditioning devices like diodes, transistors and op-amps. These could involve rectification, amplification, filtering, modulation, demodulation, mixing, frequency synthesizing etc. While the circuits that performed these functions were designed initially using discrete active and passive components, they are now increasingly made available in integrated circuit form.

This course 'Analog devices and circuits' is preceded by a two credit course 'Basics of Electrical and Electronics Engineering' offered in the first semester which presents an overview of the entire field of electronic engineering. This course is followed by courses 'Power Electronics' and 'Design of Power supplies'.

Prerequisite

14ES160 Basics of Electrical and Electronics Engineering

Course Outcomes

On the successful completion of the course, students will be able to

CO No.	COURSE OUTCOMES	Bloom's Level
CO1	Explain the characteristics and applications of electronic devices such as diode, special diodes, BJTs, MOSFETs and op-amp	Understand
CO2	Compare various biasing methods for the BJT and MOSFET amplifiers	Understand
CO3	Explain the working of op-amp based circuits	Understand
CO4	Illustrate the applications of IC555 in astable and monostable mode	Understand
CO5	Explain the application of PLL for frequency multiplication/division and frequency translation	Understand
CO6	Select suitable electronic devices using data sheet for a specific application with proper justifications	Evaluate

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**L**	**L**						**M**	**M**		**M**
CO2.	**M**	**L**	**L**						**M**	**M**		**M**
CO3	**M**	**L**	**L**						**M**	**M**		**M**
C04	**M**	**L**	**L**						**M**	**M**		**M**
CO5	**M**	**L**	**L**						**M**	**M**		**M**
CO6	**S**	**S**	**S**						**M**	**M**		**M**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3*	
Remember	30	30	0	30
Understand	50	40	30	40
Apply	20	30	30	30
Analyse	0	0	20	0
Evaluate	0	0	20	0
Create	0	0	0	0

For the first two tests, 15 marks are allotted for each test and the remaining 20 marks for third test which is based on mini project (5 marks for proper components selection and 15 marks for hardware design, construction and its explanation).

*** Mini project:**

A mini-project has to be done by every batch of three students using the electronic devices. The assessment will be based on the presentation done by the students explaining its construction, design and working principle, layout and the working condition of the mini-project.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define the static and dynamic resistance of a diode.
2. In a combinational clipper circuit, the input sine wave is of 25sinwt. Draw and explain the Output voltage waveform when V_{b1}=5V and V_{b2} = -10V.
3. Explain the construction and characteristics of n-channel depletion MOSFET.

Course Outcome 2 (CO2):

1. Determine the operating points V_{CE} and I_c in the following circuit. The circuit uses silicon transistor with β = 100. Use approximate method. Assume, R1 = 10kΩ, R2 = 5kΩ, Re = 500Ω, Rc = 1kΩ and Vcc = 10V.

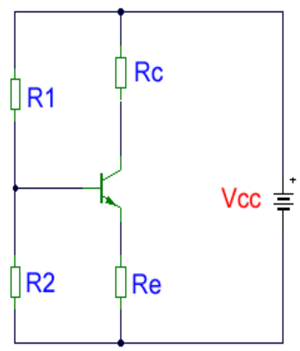


Fig.1

2. Determine Rc and R_B for a fixed bias configuration if Vcc = 12 V, β = 80 and I_{CQ} = 2.5 mA with V_{CEQ} = 6 V. Use standard values.
3. A MOSFET CS amplifier has g_m = 2.5 mA/V and rd = 500KΩ. The load resistance is 10KΩ. Find the value of voltage gain.

Course Outcome 3 (CO3):

1. Define input Offset voltage and slew rate in op-amp.
2. Construct an inverting amplifier with gain of 10 and a non-inverting amplifier with gain of 100 using op-amp.
3. Construct an astable multivibrator for a frequency of 1 KHz using op-amp and also explain its working.

Course Outcome 4(CO4):

1. Explain the internal block diagram of 555 timer with neat sketch.
2. Develop a monostable multivibrator for a time delay of 1ms using 555 and also explain its working.
3. Construct an astable multivibrator for a frequency of 10KHz and having duty cycle of 60% using 555 timer.

Course Outcome 5 (CO5):

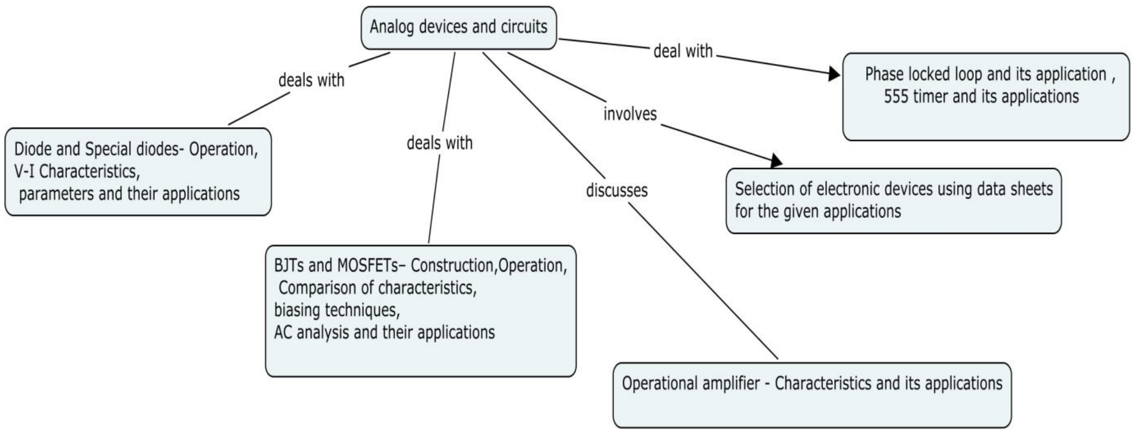
1. Explain the operation of PLL with neat block diagram.
2. Describe the operation of frequency multiplier circuit using PLL.
3. Explain the application of a PLL as a frequency translator.

Course Outcome 6 (CO6):

1. Select a suitable diode to be used in a half wave rectifier which is connected to a 230V AC supply and the load resistance in the circuit is 100 ohms.
2. Select a suitable transistor to be used in the circuit shown in fig. 1.

3. Select a suitable op-amp to design a zero crossing detector that has an input sine wave of 100KHz frequency and the load resistance in the circuit is 200 ohms. The peak to peak voltage of output must be 24V.

Concept Map



Syllabus

Devices for Signal Conditioning Circuits

Diode – Operation, V-I Characteristics, Current equation, Parameters and equivalent circuit, Load line analysis, Transition and Diffusion capacitance, Reverse recovery Characteristics, Application of Diodes – Rectifier, Clipper, Clamper

Special Diodes: Zener diode, Varactor diode, Schottky Diode and their application.

BJTs – Operation, Comparison of characteristics of CB, CE and CC configurations, Fixed and Voltage divider biasing, Stability factor, Application as amplifier and switch, Switching characteristics, DC & AC Load line, Low frequency and high frequency hybrid model, AC analysis of BJT CE amplifier.

MOSFETs: Construction, Operation, Characteristics and Parameters, Voltage divider biasing, AC analysis of MOSFET CS amplifier. Introduction to class A, B, C and D amplifier, Heat sink calculation

Operational amplifier and its applications: Basic concepts, Differential amplifiers, Ideal op-amp, Parameters of op-amp. Basic op-amp applications- Scale changer, Inverting and non-inverting amplifiers, Summer and Subtractor, Differentiator, Integrator**,** Instrumentation amplifier, Precision rectifier

Comparators and Waveform generators: Comparator - Regenerative comparator, Square wave generator - Triangular wave generator, Sine wave oscillators - RC phase shift and wien bridge oscillators

PLL and Timer: Phase locked loop and its application for frequency multiplication/division and frequency translation, 555 timer IC – Monostable and Astable operation- Application of 555 for pulse width modulation and FSK generator - Selection of electronic devices using data sheets for the given applications.

Text Books

1. Robert Boylestad and Lowis Nashelsky, "Electronic Devices and Circuit Theory", 10^{th} Edition, Pearson Education, 2009.
2. D.Roy choudhury and shail B.Jain, "Linear Integrated circuits", 4^{th} edition, New Age International Pvt. Ltd, 2014

Reference Books

1. Floyd T.L," Electronic Devices", 7^{th} Edition, Pearson Education, 2009
2. David A. Bell, " Electronic Devices and Circuits", 5^{th} Edition, Prentice Hall India, 2010
3. Albert Malvino and David J.Bates, "Electronic Principles",7^{th} Edition, Tata Mc-Graw Hill, 2007
4. Jacob Millman, Halkias C.C and Satyabrata Jit, "Electronic Devices and Circuits", 3^{rd} Edition, Tata Mc-Graw Hill, 2010
5. Sedra A.S. and Smith K.C, "Microelectronic Circuits", 5^{th} Edition, Oxford press, 2006
6. Donald A.Neamen, "Electronic circuit analysis and design", Second edition, Tata Mc-Graw Hill, 2003.

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lecture Hours
	Devices for Signal Conditioning Circuits	
1	**Diode**	
1.1	Operation, V-I Characteristics, Current equation, Parameters and equivalent circuit, Load line analysis	2
1.2	Transition and Diffusion capacitance, Reverse recovery Characteristics	1
1.3	Application of Diodes – Rectifier, Clipper, Clamper	2
1.4	**Special Diodes:** Zener diode, Varactor diode, Schottky Diode and their applications	2
1.5	**BJTs** – Operation, Comparison of characteristics of CB, CE and CC configurations	2
1.6	Fixed and Voltage divider biasing, Stability factor	1

1.7	Application as amplifier and switch, switching characteristics, DC & AC Load line	1
1.8	Low frequency and high frequency hybrid model, AC analysis of BJT CE amplifier	2
1.9	**MOSFETs**– Construction, Operation, Characteristics and Parameters	1
1.10	Voltage divider biasing, AC analysis of MOSFET CS amplifier	1
1.11	Introduction to Class A,B, C and D amplifier	1
1.12	Heat sink calculation	1
2	**Operational amplifier and its applications**	
2.1	Basic concepts - Differential amplifiers - Ideal op-amp , Parameters of op-amp	2
2.2	Basic op-amp applications- Scale changer, Inverting and non-inverting amplifiers	2
2.3	Summer and Subtractor	1
2.4	Differentiator, Integrator	2
2.5	Instrumentation amplifier	1
2.6	Precision rectifier	1
3	**Comparators and Waveform generators**	
3.1	Comparator, Regenerative comparator	1
3.2	Square wave generator, Triangular wave generator	2
3.3	Sine wave oscillators- RC phase shift and wien bridge oscillator	2
4	**PLL and Timer**	
4.1	Phase locked loop and its applications for frequency multiplication/division and frequency translation	2
4.2	555 timer IC – Monostable and Astable operation	1
4.3	Application of 555 for pulse width modulation and FSK generator	2
	Total	**36**

Course Designers

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2. Dr.S.Arockia Edwin Xavier saexeee@tce.edu

		Category	L	T	P	Credit
14EE270	**ELECTRIC CIRCUIT ANALYSIS**	PC	2	0	1	3

Preamble

Electric circuit theory is the fundamental theory upon which all branches of electrical engineering are built. Many areas of electrical engineering, such as power, electric machines, control, electronics, communications, and instrumentation, are based on electric circuit theory. Therefore, the basic electric circuit theory course is the most important course for an electrical engineering student, and always an excellent starting point for a beginner in electrical engineering education. Circuit theory is also valuable to students specializing in other branches of the engineering because circuits are a good model for the study of energy systems in general, and because of the applied mathematics, physics, and topology involved.

Prerequisite

Course Code : 14ES160 Basics of Electrical and Electronics Engineering

Course Code : 14MA110 Engineering Mathematics - I

Course Outcomes

On the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Bloom's Level
C01	State various circuit laws and theorems	Remember
C02	Explain circuit's behaviour using Ohm's law and Kirchhoff's laws.	Understand
C03	Explain mesh analysis, nodal analysis and network theorems to interpret the circuit behaviour	Understand
C04	Explain AC circuits using phasor techniques under steady state and transient conditions for any first order and second order systems.	Apply
C05	Explain two-port parameters of networks	Understand
C06	Extend circuit concepts to Three Phase Circuits	Understand
C07	Explain magnetically coupled circuits behaviour	Understand
C08	Perform circuit analysis to prove circuit laws and theorems independently	Precision (S3)
C09	Demonstrate the time and frequency response of electric circuits using simulation tool with an understanding of its limitations	Precision (S3)
C10	Demonstrate the behaviour of three phase circuits using simulation tool independently with an understanding of its limitations	Precision (S3)
C11	Perform accurately equi-potential lines of various electrode configurations experimentally	Precision (S3)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3.	**L**	**L**	**L**	**L**	**L**							
CO4.	**M**	**M**	**L**	**L**	**L**							
CO3	**M**	**M**	**L**	**L**	**L**							
CO4	**S**	**M**	**L**	**L**	**L**							
CO5	**M**	**M**	**L**	**L**	**L**							
CO6	**M**	**M**	**L**	**L**	**L**							
CO7	**M**	**M**	**L**	**L**	**L**							
CO8	**M**	**M**	**M**	**M**	**S**				**M**	**M**		
CO9	**M**	**M**	**M**	**M**	**S**				**M**	**M**		
C10	**M**	**M**	**M**	**M**	**S**				**M**	**M**		
C11	**M**	**M**	**M**	**M**	**S**				**M**	**M**		

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			$Terminal Examination
	$1	$2	3*	
Remember	20	20	20	10
Understand	80	60	60	60
Apply	0	20	20	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

$ CAT – I & 2, Terminal Examination should consist of objective type question for 20% of Maximum Marks in Understand Category.

*CAT – 3 should be conducted as a practical session for assessing the attainment of C08 to C011.

- Negative marking will be applied for objective type questions

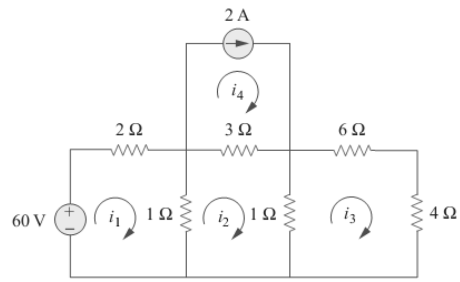
Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State Krichhof'f's Laws
2. Define Ohm's law
3. State Thevenin's theorem

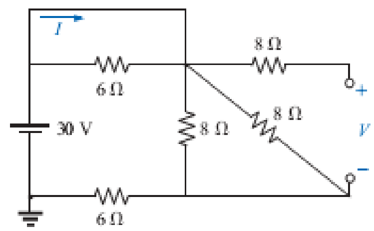
Course Outcome 2 (CO2):

1. Which Krichhoff's law is applied for nodal analysis?
2. What are plannar circuits?
3. Solve mesh currents for the circuit of figure below.

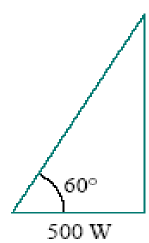


Course Outcome 3 (CO3):

1. Determine the voltage V and current I for the network in figure below using Thevenin's theorem

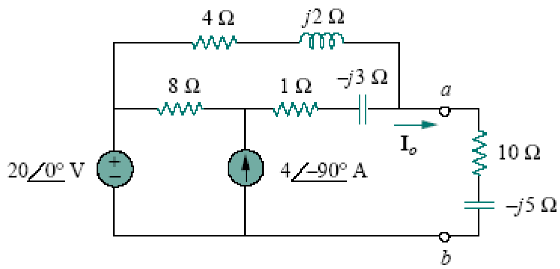


2. In the power triangle shown in Fig. below, the reactive power is:
   (a)1000 VAR leading   (b) 1000 VAR lagging (c) 866 VAR leading (d) 866 VAR lagging

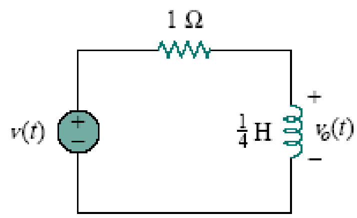


Course Outcome 4 (CO4):

1. Draw the power triangle.
2. Why current lags the voltage in an Inductor?
3. Determine the Norton equivalent of the circuit in Fig. Given as seen from terminals *a-b*. Use the equivalent to find $\mathbf{I}_o$.



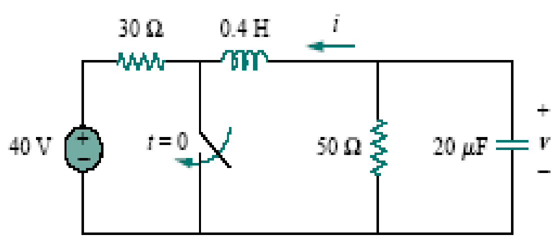
4. At what frequency will the output voltage *vo(t)* in Fig. below be equal to the input voltage *v(t)*?



(a) 0 rad/s (b) 1 rad/s (c) 4 rad/s (d) ∞ rad/s (e) none of the above

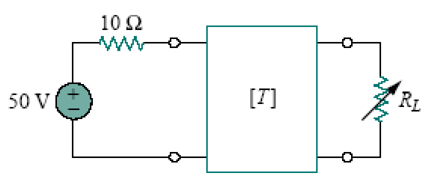
Course Outcome 5 (CO5):

1. Draw the transient current response of a RL series circuit when subjected to step input.
2. Find *v(t)* for *t* > 0 in the *RLC* circuit of Fig. Shown below.



Course Outcome 6 (CO6):

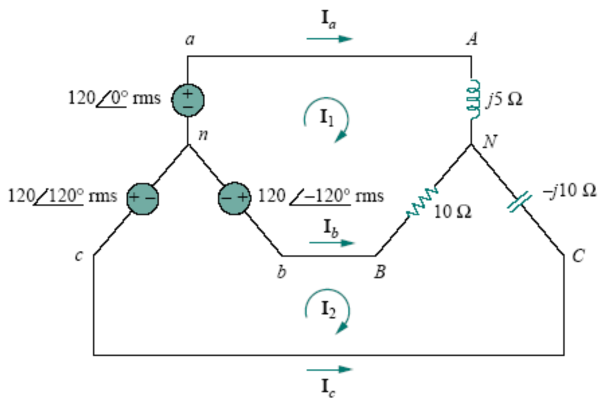
1. Write the governing equations of Y parameters.
2. List out some of the terms in circuit theory and its dual.
3. The ABCD parameters of the two-port network in Fig. below are $\begin{bmatrix} 4 & 20\,\Omega \\ 0.1\,\text{S} & 2 \end{bmatrix}$
   The output port is connected to a variable load for maximum power transfer. Find R_L



and the maximum power transferred.

Course Outcome 7 (CO7):

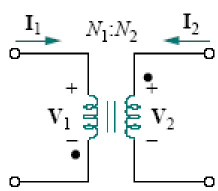
1. Write the relationship between line and phase quantities of a three phase circuit.
2. If in an *acb* phase sequence, $\mathbf{V}_{an} = 100\ \angle 20^\circ$, then $\mathbf{V}_{cn}$ is:
   (a) $100\ \angle 140^o$ (b) $100\angle\ 100^o$ (c)$100\ \angle 50^o$ (d) $100\angle\ 10^o$
3. For the unbalanced circuit in Fig. below, find: (a) the line currents, (b) the total complex power absorbed by the load, and (c) the total complex power supplied by the source.



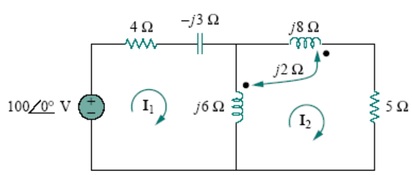
4. If in an *acb* phase sequence, $\mathbf{V}_{an} = 100\ \angle 20^\circ$, then $\mathbf{V}_{cn}$ is:
   (b) $100\ \angle 140^o$ (b) $100\angle\ 100^o$ (c)$100\ \angle 50^o$ (d) $100\angle\ 10^o$

Course Outcome 8 (CO8):

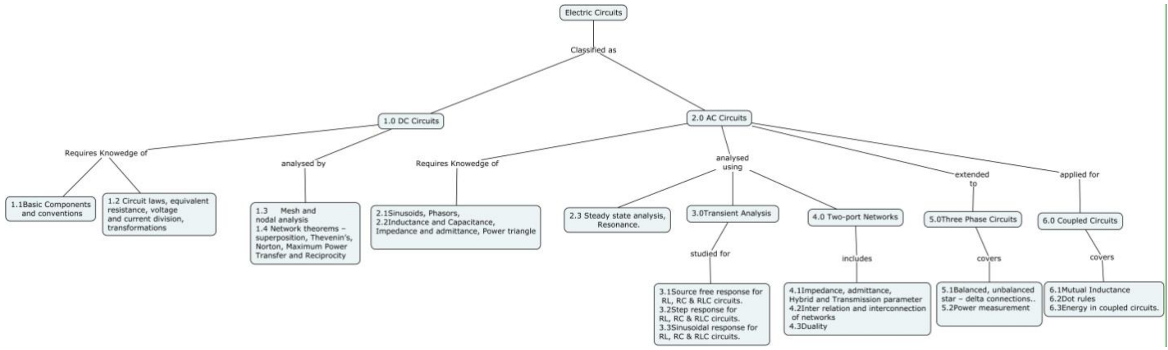
1. Explain Dot Rule in coupled circuits.
2. The ideal transformer in Fig. has $N_2/N_1 = 10$. The ratio V_2/V_1 is:



3. Calculate the mesh currents in the circuit of Fig. below,



Concept Map



Syllabus

DC Circuits: Basic Components and conventions, Circuit laws, equivalent resistance, voltage and current division, transformations, mesh and nodal analysis, network theorems – superposition, Thevenin's, Norton, Maximum Power Transfer and Reciprocity.

AC Circuits: Sinusoids, Phasors, Inductance and Capacitance, Impedance and admittance, Power triangle, steady state analysis, Resonance.

Transient Analysis: Source free, Step and sinusoidal response for RL, RC & RLC circuits.

Two-port Networks: Impedance, admittance, Hybrid and Transmission parameter, Inter relation and interconnection of networks, Duality.

Three Phase Circuits: Balanced, unbalanced star – delta connections. Power measurement.

Coupled Circuits: Mutual Inductance, Dot rules, Energy in coupled circuits.

Laboratory Session: Simulation/Demonstration using PSIM

1. Verification of circuit laws and theorems for DC and AC circuits precisely.
2. Simulation of the characteristics of Inductance and Capacitance using simulation tool independently.
3. Simulation of transient and frequency response characteristics of electric circuit using simulation tool independently.

4. Simulation of behaviour of three Phase circuit using simulation tool independently.

5. Obtain accurately equi-potential lines for various electrode configurations experimentally.

Text Books

1. W.H. Hayt & J.K. Kemmerly and Steven M. Durbin, “Engineering circuit analysis”, Tata McGraw Hill, 7th edition, New Delhi, 2007

2. Mahmood Nahvi, Joseph A Edminister, “Electric Circuits”, Tata McGraw - Hill Education, 5th Edition, 2010.

Reference Books

1. Mahmood Nahvi, Joseph A Edminister, “Electric Circuits”, Tata McGraw - Hill Education, 5th Edition, 2010.
2. Sudhakar A and Shyam Mohan SP, “Electric Circuit Analysis”, Tata McGraw Hill, New Delhi, 2008

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**DC Circuits**	
1.1	Basic Components and conventions	2
1.2	Circuit laws, equivalent resistance, voltage and current division, transformations	3
1.3	Mesh and nodal analysis	3
1.4	Network theorems – superposition, Thevenin’s, Norton, Maximum Power Transfer and Reciprocity	4
2.0	**AC Circuits**	
2.1	Sinusoids, Phasors,	2
2.2	Inductance and Capacitance, Impedance and admittance, Power triangle	2
2.3	Steady state analysis, Resonance.	3
3.0	**Transient Analysis**	
3.1	Source free response for RL, RC & RLC circuits.	3
3.2	Step response for RL, RC & RLC circuits.	3
3.3	Sinusoidal response for RL, RC & RLC circuits.	3
4.0	**Two-port Networks**	
4.1	Impedance, admittance, Hybrid and Transmission parameter	3
4.2	Inter relation and interconnection of networks	2
4.3	Duality	2
5.0	**Three Phase Circuits**	
5.1	Balanced, unbalanced star – delta connections.	3
5.2	Power measurement	1
6.0	**Coupled Circuits**	
6.1	Mutual Inductance	2

Module No.	Topic	No. of Lecture Hours
6.2	Dot rules	2
6.3	Energy in coupled circuits.	2
	Total	**45**

Course Designers

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14EE280	ANALOG DEVICES AND CIRCUITS LAB	Category	L	T	P	Credit
		PC	0	0	1	1

Preamble

This laboratory gives a practical exposure to the students to learn the characteristics of various electronic devices such as diodes, BJT, MOSFET and OPAMP that are used nowadays in most of the electronic circuits. The students also learn the design and the construction of different electronic circuits based on the above electronic devices and different circuits based on IC555 timer. To validate the experimental results, the use of simulation tools for the performance analysis is also introduced to the students.

Prerequisite

14ES160 Basics of Electrical and Electronics Engineering

CO No.	Course outcomes	Blooms level
CO1.	Obtain accurately the characteristics of electronic devices (Diodes, BJT, MOSFET and OP-AMP) independently	Understand, Precision (S3)
CO2.	Construct DC power supply for the given specifications independently	Apply, Precision (S3)
CO3.	Construct accurately wave shaping circuits for the given specifications independently	Apply, Precision (S3)
CO4.	Construct accurately OP-AMP based circuits for the given specifications independently	Apply, Precision (S3)
CO5.	Construct accurately astable and monostable multivibrators using IC555 for the given applications independently	Apply, Precision (S3)
CO6	Make use of simulation tool for the performance analysis of the given electronic circuit independently with an understanding of its limitations	Apply, Precision (S3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L		L				M	M		
CO2	S	M	M	L	M				M	M		
CO3	S	M	M	L	M				M	M		
C04	S	M	M	L	M				M	M		
CO5	S	M	M	L	M				M	M		
CO6	S	M	M	L	S				M	M		

S- Strong; M-Medium; L-Low

List of Experiments:

1. Characteristics of diode, Zener diode, BJT, MOSFET and op-amp. (CO1)
2. Design of DC power supply using voltage regulator ICs for the given specifications (CO2)
3. Design of clipper and clamper circuits using diodes for the given specifications. (CO3)
4. Design of op-amp based inverting, non-inverting amplifiers and arithmetic circuits for the given specifications. (CO4)
5. Design of precision rectifier for the given specifications. (CO4)
6. Design of active I and II order low pass and high pass filters for the given specifications. (CO4)
7. Design of op-amp based sine wave and square wave oscillators for the given specifications. (CO4)
8. Design of frequency divider and PWM circuit . (CO5)
9. Design of FSK generator and Schmitt trigger (CO5)
10. Simulation of above electronic circuits using PSPICE/PSIM/Simulink and to validate the experimental results. (CO6)

Course Designers

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2.Dr.S.Arockia Edwin Xavier	saexeee@tce.edu

14ES290	WORKSHOP	Category	L	T	P	Credit
		ES	0	0	1	1

Preamble

This is the foundation practical course for the students of circuit branches (EEE, ECE, CSE and IT). The aim of this course is to impart fundamental hands-on skill in carrying out experiments at higher semester practical courses.

Prerequisite

14ES160 : Basics of Electrical and Electronics Engineering

Course Outcomes

On the successful completion of the course, students will be able to:

CO No.	Course outcomes	Blooms level
CO1.	Select and use accurately various power supplies and meters	Understand, Precision (S3)
CO2.	Accurately discriminate and use fuses and Circuit breakers	Apply, Precision (S3)
CO3.	Select and make use of components in bread board and soldering in the PCBs	Apply,S3 Precision (S3)
CO4.	Accurately use the AFO and CRO in electronic circuits	Apply, Precision (S3)
CO5.	Trouble shoot the electrical wiring and measure electrical parameters	Apply, Precision (S3)
CO6	Realize the importance of earthing in electrical safety	Apply, Precision (S3)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L		L				M	M		
CO2	S	M	M	L	M				M	M		
CO3	S	M	M	L	M				M	M		
C04	S	M	M	L	M				M	M		
CO5	S	M	M	L	M				M	M		
CO6	S	M	M	L	S				M	M		

S- Strong; M-Medium; L-Low

List of Experiments

EEE:

1. Realization and Discrimination of fuses and Circuit breakers
2. Earthling practices and its significances
3. Wiring practices and testing
4. Functionalities of RPS/AFO/CRO
5. Functionalities and Selection of Analog and Digital meters

ECE:

1. Identifying electronic components and understanding PCB glossary
2. Conversion of schematic into PCB layout and PCB fabrication
3. Practicing of soldering and desoldering

CSE:

1. Practice on different DOS and Unix commands. Basic configuration management of Windows operating system.
2. Practice on designing and preparing reports using word, Power-point and Excel applications.

IT:

1. **Computer Assembly and Configuration: PC Assembling:** Steps for assembling a PC-commonly used devices an overview, assembling a SMPS in a cabinet, fixing a processor in a mother board, assembling RAM in a motherboard, pinning a cooling fan in a mother board, Assembling a hard disc drive in a cabinet, assembling a CD/DVD ROM in a cabinet. Assembling a floppy drive in a cabinet, fixing motherboard In a cabinet, Connecting the cables from the SMPS to motherboard, hard disc, drives & etc, Establishing data connection for to motherboard, hard disc, drives. Fixing wires for power restart switches, fixing wires for power & HDD LED's, fixing wires for external USB and Audio connections.

2. **System Installation:** Steps for installing software's for hardware, Hardware & Software Trouble Shooting.

Course Designers:

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2. Dr.V.Prakash vpeee@tce.edu
3. Dr.P.S.Manoharan psmeee@tce.edu
4. Dr.K.Hariharan khh@tce.edu
5. M.Sivakumar mskcse@tce.edu
6. C.Senthilkumar cskcse@tce.edu
7. M.Thangavel thangavelmuruganme@gmail.com

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

THIRD SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

Semester	Theory						Theory cum Practical	Practical		Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	
I	14MA110 Engineering Mathematics I(3)	14PH120 Physics (3)	14CH130 Chemistry (3)	14EG140 English (3)	14ES150 Basics of Civil and Mechanical Engineering (2)	14ES160 Basics of Electrical and Electronics Engineering (2)	14ME170 Engineering Graphics (3)	14PH180 Physics Lab (1)	14CH190 Chemistry Lab (1)	--	**21**
II	14EE210 Engineering Mathematics II (3)	14EE220 Materials Science for Electrical Engineering (3)	14EE230 Environmental Science and Ethics (3)	14EE240 Electromagnetic Fields (3)	14EE250 Analog Devices and Circuits (3)		14EE270 Electric Circuit Analysis (3)	14EE280 Analog Devices and Circuits Lab (1)	14ES290 Workshop (1)	--	**20**
III	14EE310 Engineering Mathematics III (3)	14EE320 Transformers (3)	14EE330 DC machines (3)	14EE340 Measurement Systems (3)	14EE350 Digital Systems (3)		14EE370 Problem solving using Computers (3)	14EE380 DC Machines and Transformers Lab (1)	14EE390 Digital Systems Lab (1)	--	**20**
IV	14EE410 Engineering Mathematics IV (3)	14EE420 Instrumentation Systems (3)	14EE430 Control Systems (3)	14EE440 AC Machines (3)	14EG450 Engineering Design (3)	14EE460 Microcontrollers (3)		14EE480 AC Machines Lab (1)	14EE490 Microcontrollers Lab (1)	14EE4C0 Capstone Course-I (2)	**22**
V	14EE510 Engineering Mathematics V (3)	14EE520 Power Electronic Circuits (3)	14EE530 Digital Controls (3)	14EE540 Energy Resources and utilization (3)	14EE550 Digital Signal Processing (3)	14EEPx0 Prog. Elec.I (3)		14EE580 Digital Signal Processing Lab (1)	14EE590 Control & Instrumentation Lab (1)	--	**20**
VI	14EE610 Financial Management (3)	14EE620 Design of Power Supplies (3)	14EE630 Electric Power Transmission System (3)	14EEPX0 Prog. Elec.II (3)	14EEGx0 Gen. Elec. I (3)		14EG670 Professional Communication (3)	14EE680 Power System Lab (1)	14EE690 Power Electronics and Drives Lab (1)	--	**20**
VII	14EE710 Project Management (3)	14EE720 Drives and Control (3)	14EE730 Industrial Automation (3)	14EEPx0 Prog. Elec.III (3)	14EEPx0 Prog. Elec.IV (3)	14EEGx0 Gen. Elec. II (3)		--		14EE7C0 Capstone Course-II (2)	**20**
VIII	14EEPx0 Prog. Elec.V (3)	14EEPx0 Prog. Elec.VI (3)	14EEPx0 Prog. Elec.VII (3)	--	--	--	--	14EE880 Project (12)		--	**21**
										Total Credits	**164**

- **Basic Science Courses**
- **Humanities and Social Science Courses**
- **Engineering Science courses**
- **Analog & Digital Electronic System Courses**
- **Electrical Energy System Courses**
- **Power Electronics & Drives Courses**
- **Control & Automation Courses**
- **Core and General Elective Courses, Capstone Courses & Project**

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. EEE Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15)

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week L	T	P	Credits
THEORY						
14EE210	Engineering Mathematics - II	BS	2	2	-	3
14EE220	Materials Science for Electrical Engineering	BS	2	-	2	3
14EE230	Environmental Science and Ethics	BS	3	-	-	3
14EE240	Electromagnetic fields	ES	2	2	-	3
14EE250	Analog Devices and Circuits	PC	3	-	-	3
THEORY CUM PRACTICAL						
14EE270	Electric Circuit Analysis	PC	2	-	2	3
PRACTICAL						
14EE280	Analog Devices and Circuits Lab	PC	-	-	2	1
14ES290	Workshop	ES	-	-	2	1
	Total		**14**	**4**	**8**	**20**

THIRD SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week L	T	P	Credits
THEORY						
14EE310	Engineering Mathematics - III	BS	2	2	-	3
14EE320	Transformers	PC	2	2	-	3
14EE330	DC Machines	PC	2	2	-	3
14EE340	Measurement Systems	PC	3	-	-	3
14EE350	Digital Systems	PC	2	2	-	3
THEORY CUM PRACTICAL						
14EE370	Problem Solving Using Computers	ES	2	-	2	3
PRACTICAL						
14EE380	DC Machines and Transformers	PC	-	-	2	1

	Lab					
14EE390	Digital Systems Lab	PC	-	-	2	1
Total			**13**	**8**	**6**	**20**

BS : Basic Science
ES : Engineering Science
PC : Programme Core
PE : Programme Elective

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. EEE Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE210	Engineering Mathematics - II	3	50	50	100	25	50
2	14EE220	Materials Science for Electrical Engineering	3	50	50	100	25	50
3	14EE230	Environmental Science and Ethics	3	50	50	100	25	50
4	14EE240	Electromagnetic fields	3	50	50	100	25	50
5	14EE250	Analog Devices and Circuits	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE270	Electric Circuit Analysis	3	50	50	100	25	50
PRACTICAL								
8	14EE280	Analog Devices and Circuits Lab	3	50	50	100	25	50
9	14ES290	Workshop	--	100	--	100	--	50

THIRD SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE310	Engineering Mathematics - III	3	50	50	100	25	50
2	14EE320	Transformers	3	50	50	100	25	50

3	14EE330	DC Machines	3	50	50	100	25	50
4	14EE340	Measurement Systems	3	50	50	100	25	50
5	14EE350	Digital Systems	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE370	Problem Solving Using Computers	3	50	50	100	25	50
PRACTICAL								
8	14EE380	DC Machines and Transformers Lab	3	50	50	100	25	50
9	14EE390	Digital Systems Lab	3	50	50	100	25	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

14EE310	ENGINEERING MATHEMATICS - III	Category	L	T	P	Credit
		ES	2	2	0	3

Preamble

Fourier analysis allows modelling periodic phenomena which appears frequently in engineering and elsewhere—thinks of rotating parts of machines, alternating electric currents or the motion of planets. Related period functions may be complicated. Now, the ingenious idea of Fourier analysis is to represent complicated functions in terms of simple periodic functions, namely cosines and sines. The representation of infinite series is called Fourier series. The discovery of Fourier series and Fourier Transform had a huge impetus on applied mathematics as well as mathematics.

In Mathematics, a partial differential equation (PDE) is a differential equation that contains unknown multivariable functions and their partial derivatives. PDEs are very important in many areas of physics and engineering and have many more applications. Partial Differential equations are derived from physics and instruct the methods for solving boundary value problems, that is, methods of obtaining solutions which satisfy the conditions required by the physical situations such as Heat flow Equations of one Dimension and two dimensions.

Prerequisite

Differentiation, Integration and Differential Equations

Course Outcomes

On the successful completion of the course, students will be able to:

CO1 :	Construct the Fourier series expansion of the periodic function	Apply
CO2:	Construct the Fourier series for discrete sequence	Apply
CO3:	Apply Fourier transform technique to evaluate the given integral	Apply
CO4:	Develop Discrete Fourier transform for the given sequence.	Apply
CO5:	Explain the methodology of solving a Partial differential equation	Understand
C06:	Solve the given Heat equation (one dimensional / Two dimensional)	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L					M			
CO2	S	M	L	L					M			
CO3	S	M	L	L					M			
CO4	S	M	L	L					M			
CO5	M	L							M			
CO6	S	M	L	L					M			

S-Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	0
Understand	30	30	30	30
Apply	60	60	60	70
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Find the difference between Odd and Even functions. (Remember)
2. Use the Fourier series expansion of x^2, in the interval $-\pi < x < \pi$ and hence show that $\sum \frac{1}{n^2} = \frac{\pi^2}{6}$ (Understand)
3. Develop the complex form of fourier series of $f(x) = \begin{cases} x, & \text{if } -\pi < x < 0 \\ x^2, & \text{if } 0 < x < \pi \end{cases}$ (Apply)

Course Outcome 2 (CO2):

1. When Fourier coefficients in the Fourier series can be obtained using Practical Harmonic Analysis? (Remember)
2. Explain Discrete Fourier series. (Understand)
3. Construct the first two harmonics of the Fourier series for f(x) from the table below.

X	30^0	60^0	90^0	120^0	150^0	180^0	210^0	240^0	270^0	300^0	330^0	360^0
y	3.5	6.09	7.82	8.58	8.43	7.73	6.98	6.71	6.04	5.55	5.01	5.35

(Apply)

Course Outcome 3 (CO3):

1. Make use of the Fourier transform of $e^{-a^2x^2}$, prove that $e^{-\frac{x^2}{2}}$ is self reciprocal

(Apply)

2. Solve for f(x) from the integral equation $\int_0^\infty f(x) Cosaxdx = e^{-\alpha}$ (Apply)

3. Show that $F\{x^n f(x)\} = (-i)^n \frac{d^n F(s)}{ds^n}$, where F(s) is the Fourier transform of f(x).

(Apply)

Course Outcome 4 (CO4):

1. Find DFT of the sequences x(n) = $Cos\left(\frac{n\pi}{2}\right)$; N =4 (Remember)
2. Construct the IDFT of {X(k)}, given that x(k) = {1, 1+j, 2, 1-2j, 0, 1+2j, 0, 1-j}.(Apply)
3. Construct the DTFT of {X(n)}, for a rectangular pulse $x(n) = \begin{cases} A, & |n| \le N_1 \\ 0, & |n| > N_1 \end{cases}$,

(Apply)

Course Outcome 5 (CO5):

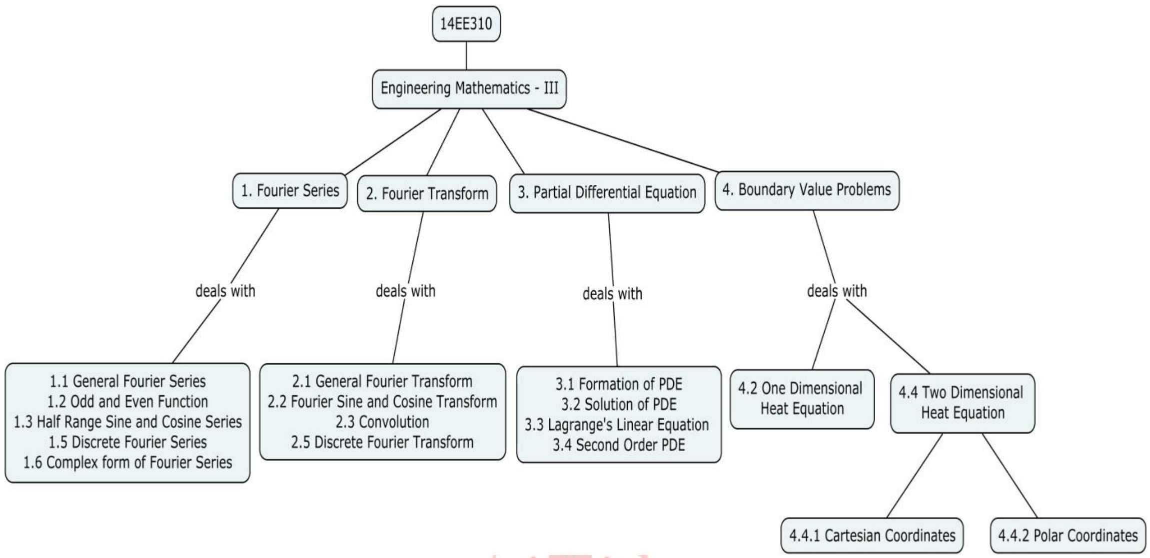
1. Demonstrate the working rule of solving the Lagrange's linear Equation. (Understand)
2. Find the complete integral for $\sqrt{p} + \sqrt{q} = 1$ (Remember)
3. Solve $(x^2 - yz)p + (y^2 - xz)q = (z^2 - xy)$ (Understand)

Course Outcome 6 (CO6):

1. A bar of 10 cm long, with insulated sides has its ends A and B maintained at temperatures 50˚ C and 100˚ C respectively, until steady-state conditions prevail. The temperature at A is suddenly raised to 90˚ C and at B is lowered to 60˚ C . Calculate the temperature distribution in the bar thereafter. (Apply)
2. Calculate the steady state temperature distribution in a rectangular plate of sides a and b insulated at the lateral surfaces and satisfying the boundary conditions: u(0, y) = 0, u(a, y) = 0, for 0 < y < b; u(x,b) = 0 and u(x,0) = x(a - x), for 0 < x < a. (Apply)
3. A plate in the form of the ring is bounded by circles r = 5 and r = 10. Its surfaces are insulated and the temperature along the boundary are $u(5,\theta) = 10\cos\theta + 6\sin\theta$, $u(10,\theta) = 17\cos\theta + 15\sin\theta$. Calculate the steady state temperature in the plate.

(Apply)

Concept Map



Syllabus

Fourier Series: Dirichlet's conditions, General Fourier Series, Half range Sine and Cosine series, Parseval's Identity, Half range Sine and Cosine series , Discrete Fourier Series-Harmonic Analysis , Complex form of Fourier Series.

Fourier Transform: Fourier Integral Theorem, Fourier Transform, Fourier Sine and Cosine Transforms, Convolution Theorem, properties, Parseval's Identity, Discrete Fourier Transform, Discrete Time Fourier Transform.

Partial Differential Equations: Formation, Solution of standard types of first order equations, Lagrange's linear equation, linear partial differential equations of second and higher order with constant coefficient.

Boundary Value Problems: Classification of Second Order linear partial differential equations, Introduction to one dimensional wave equation (up to formatting boundary conditions), One dimensional heat equation - Solution by Fourier Series, Steady State Solution of two dimensional heat equation in Cartesian Co-ordinates - Laplace equation in Polar Co-ordinates - Solution by Fourier Series method.

Text Book

Grewal.B.S, Higher Engineering Mathematics, Khanna Publications, 42nd Edition, 2012.

Reference Books

1. Veerarajan .T, “Engineering Mathematics”, 3rd Edition. , Tata McGraw Hill, New Delhi, 2004
2. Kreyszig,E., “Advanced Engineering Mathematics”, John wiley and sons,(Asia)Pte Ltd., Singapore, 2006.
3. Kandasamy.P, Thilagavathy.K, Gunavathy.K , “Engineering Mathematics Vol. III”,S.Chand & Company Ltd, New Delhi, 2008.
4. P.Ramesh Babu, “Digital signal Processing”, Fourth Edition, SCITECH Publications Pvt. Ltd, Chennai, 2001

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lecture Hours
1.	**Fourier Series**	
1.1	Dirichlet’s conditions, General Fourier Series	2
1.2	Even and Odd function	1
1.3	Half range Sine and Cosine series	1
	Tutorial	1
1.4	Parseval’s Identity	1
1.5	Discrete Fourier Series - Harmonic Analysis	2
1.6	Complex form of Fourier Series	1
	Tutorial	1
1.6	Discrete Fourier series	2
2.	**Fourier Transformation**	
2.1	Fourier Integral Theorem, Fourier Transform	1
2.2	Fourier Sine and Cosine Transforms	2
	Tutorial	1
2.3	Convolution Theorem	2
2.4	Properties, Parseval’s Identity	1
2.5	Introduction of Discrete Fourier Transform	1
2.6	Discrete Fourier Transform, Discrete time Fourier Transform	2
	Tutorial	1
3	**Partial Differential Equations**	
3.1	Formation	2
3.2	Solution of standard types of first order equations	2
	Tutorial	1
3.3	Lagrange’s linear equation	1
3.4	Linear partial differential equations of second and higher order with constant coefficient	3
	Tutorial	1
4	**Boundary Value Problems**	
4.1	Classification of Second Order linear partial differential equations	1
4.2	Method of separation of variables	1
4.2.1	Introduction to one dimensional wave equation (up to formatting boundary conditions)	1
4.2.2	One dimensional heat equation - Solution by Fourier Series	3

	Tutorial	1
4.4	Steady State Solution of two dimensional heat equation	1
4.4.1	Two dimensional heat equation in Cartesian Co-ordinates - Solution by Fourier Series	2
	Tutorial	1
4.4.2	Two dimensional heat equation in polar Co-ordinates - Solution by Fourier Series	3
	Tutorial	1
	Total	**48**

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14EE320	TRANSFORMERS	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

The course aims in imparting fundamental knowledge of Transformer construction, types, Operation and Design concepts required for electrical engineers. The transformer principle was demonstrated in 1831 by Michael Faraday. A transformer is a device used to transfer electrical energy from one circuit to another. A transformer changes electricity from one level to other level of voltage using the properties of electricity. In an electric circuit, there is magnetism around it. Second, whenever a magnetic field changes a voltage is made. Loss in the transformer arises due to winding resistance, hysteresis losses, eddy currents, magnetostriction, mechanical losses, and stray losses. Applications of transformers are due to power level, frequency range, voltage level, cooling type, function, end purpose and winding turns ratio. There are various kinds of transformer like Instrument transformer, Isolation transformer, Power transformer, welding transformer, High frequency transformer, Booster transformer and Auto transformer.

Prerequisite

14EE220	Material Science for Electrical Engineering
14EE240	Electromagnetic Fields
14EE270	Electric Circuits Analysis

Course Outcomes

On the successful completion of the course, students will be able to:

(CO1)	Explain the principles and fundamentals of Transformers.	Understand
(CO2)	Explain the construction of Transformer and role of its Accessories.	Understand
(CO3)	Analyze the performance of transformer using equivalent circuit for the given requirement	Analyze
(CO4)	Explain the role of different types of transformer & its applications.	Understand
(CO5)	Identify the operational issues and remedial measures in Transformers.	Apply
(CO6)	Apply the testing procedures for Transformer as per the standard practice	Apply
(CO7)	Design of Main Dimensions of Transformer for the given Specifications	Apply

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	H	H	M	-	-	-	-	-	-	-	-	-
CO2.	H	L	L	-	-	L	L	-	-	-	-	-
CO3.	H	H	L	H	-	M	L	-	-	-	-	-
CO4	M	L	L	-	-	L	-	-	-	-	-	-
CO5	H	M	L	M	-	M	L	-	-	-	-	-
CO6	H	L	L	-	-	L	-	-	-	-	-	-
CO7	H	L	H	-	-	L	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	-	20
Understand	40	40	-	30
Apply	30	40	-	40
Analyze	10	0	-	10
Evaluate	0	0	-	0
Create	0	0	-	0

CAT 3 – Seminar / Presentation/ Quiz / Role Play

Topics:

1. Selection of Transformer for the given applications:
    a. Constant Load
    b. Variable load
    c. Generating Station
    d. Sub-station
    e. Measurement & Protection
    f. Outdoor/Indoor
    g. Converters / Inverters / Power electronics Applications
    h. Welding
    i. High Frequency power supply
2. IEC, IEEE Testing Standards
3. Power Transformer Mounting / Connections
4. Gas Analysis / Oil testing procedures
5. Transformer Installation and Commissioning procedures

Note :

- Divide the class into 18 groups with 4 students in each group
- Topics will be assigned to all the group on Day 1
- Each group will make a presentation for 20 minutes on the topic given in the list above on the site visit / field trip / industrial visit / laboratory experiments/ Data sheet
- Award marks based on the presentation (technical Content, Question & Answer) for CAT 3
- There will be no written test for CAT 3
- CAT 1 & 2 is a written test covering the remaining topics

***Assignment-3** will be evaluated based on the group presentation in the class on the readings of the following Laboratory experiments and inference.*

- Scott Connection
- Sumpner's Test
- Performance Estimation using various load

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Derive the EMF equation of single phase transformer. (Understand)
2. A 400/200Volts Single phase transformer is supplying a load of 30 Amperes at a power factor of 0.8 lagging. On no-load the current and power factor is 2.1 Amperes & 0.2 lagging respectively on high voltage side. Calculate the current taken from the supply. (Apply)
3. Define the term transformation ratio in Transformer. (Remember)
4. Specify the assumptions made in ideal transformer operation. (Remember)
5. Draw the phasor diagram representing the various electrical parameters of the transformer with Resistive load and inductive load conditions. (Understand)
6. A current transformer has two turns on the primary winding and a secondary winding of 260 turns. The secondary winding is connected to an ammeter with a resistance of 0.2Ω. The resistance of the secondary winding is 0.3Ω. If the current in the primary winding is 650A, determine (a) the reading on the ammeter, (b) the potential difference across the ammeter, and (c) the total load in VA on the secondary. (Apply)
7. A three-phase transformer has 600 primary turns and 150 secondary turns. If the Power supply Line voltage is 1.5kV, determine the secondary phase to phase voltage on no-load when the windings are connected: (a) delta-star (b) star-delta. (Apply)

Course Outcome 2 (CO2):

1. Compare the construction features and performance of Core type and Shell type transformer. (Understand)
2. Mention the advantages of shell type transformer over core type transformer. (Remember)
3. List the various types of cooling methods adopted for transformer cooling? (Remember)
4. Specify the role of breathers in Transformer? (Remember)
5. Explain the operation of on-load tap changer used in Transformer. Also specify the applications and advantages. (Understand)

Course Outcome 3(CO3):

1. Define voltage regulation in Transformer. (Remember)
2. Draw the Equivalent Circuit of a Single phase transformer. Also deduce it into a simplified equivalent circuit mentioning the assumptions. (Understand)

3. Why transformer efficiency is high, when compared to other rotating electrical machines? (Remember)

4. State the conditions for Maximum Efficiency in Transformer. (Remember)

5. Why transformers are rated in KVA? (Remember)

6. A 300kVA transformer has a primary winding resistance of 0.4Ω and a secondary winding resistance of 0.0015Ω. The iron loss is 2kW and the primary and secondary voltages are 4kV and 200V respectively. If the power factor of the load is 0.78, determine the efficiency of the transformer (a) on full load, and (b) on half load. (Apply)

7. A 6 kVA, 100V/500 Volts, single-phase transformer has a secondary terminal voltage of 487.5volts when loaded. Determine the regulation of the transformer. (Apply)

8. A transformer has 600 primary turns and 150 secondary turns. The primary and secondary resistance's are 0.25Ω and 0.01Ω respectively and the corresponding leakage reactance's are 1.0Ω and 0.04Ω respectively. Determine (a) the equivalent resistance referred to the primary winding, (b) the equivalent reactance referred to the primary winding, (c) the equivalent impedance referred to the primary winding, and (d) the phase angle of the impedance.(Apply)

9. A 100kVA, 6600/400 Volts, 50Hz single phase transformer has 80 turns on LV side. At 25Hz, its flux increases by 10%. Calculate the HV and kVA rating at 25Hz. (Analyze).

10. A 220/440 Volts 50Hz 5kVA Single phase transformer operates with 220V, 40Hz supply on high voltage winding side. Analyze the effect of eddy current loss and hysteresis loss. (Analyze)

11. In a transformer, if the iron losses and copper losses are 12kW and 96kW respectively, then at what fraction of load will the efficiency be maximum? (Analyze)

12. The resistance and reactance of a 10 kVA, 400/200Volts, Three phase transformer are 2% and 10% respectively. If the constant losses in the machine is 1%, Calculate the maximum possible percentage efficiency of the transformer. (Analyze)

Course Outcome 4(CO4):

1. Specify are the advantages of using Auto Transformer. (Remember)
2. Mention the application of instrument transformer. (Remember)
3. Draw the Scott connection circuit of Transformer to convert Two phase power supply to three phase supply and Vice versa. (Understand)

Course Outcome 5(CO5):

1. Specify the role of Transformer oil in Transformer? (Remember)

2. Why secondary of current transformer is always short-circuited? (Remember)

3. Specify the need of parallel operation of transformers? Also specify the conditions to be satisfied for parallel operation? (Remember)

4. Calculate the all day efficiency of a 500KVA Distribution Transformer used for domestic power supply, whose iron loss and copper loss are 1600Watts and 5500Watts respectively. In a day it is loaded as follows (Apply)

Duration in Hours	4	10	4	4	2
Load in kW	350	100	300	250	200
Power Factor	0.80	0.70	0.75	0.70	0.75

5. To meet 7MVA power demand, 2 Nos. of 5000kVA 11kVolts/415Volts, three phase transformers are operating in parallel. The % of impedance offered by the Transformer No. 1 is 4.5% and Transformer No. 2 is 5.0%. Calculate the kVA load shared by each transformer? (Apply)

Course Outcome 6 (CO6):

1. Why power factor is Low during Transformer Open Circuit Test? (Remember)

2. State the advantages of Sumpner's test for Transformer. (Remember)

3. A 500KVA, 11kV/425V Three phase Transformer has an efficiency of 97% both at full load and half load at unity power factor. Determine the efficiency at 80% of full load at 0.9 lagging power factor. (Apply)

4. Draw the circuit diagrams for conducting Open Circuit Test and Short circuit test on a single phase transformer. Also explain, how the efficiency and voltage regulation can be estimated by these test. (Understand)

5. Explain the method of conducting polarity test in transformer with a circuit diagram? (Understand)

6. 250kVA transformer has a full load copper loss of 3kW and an iron loss of 2kW. Calculate (a) the output kVA at which the efficiency of the transformer is a maximum, and (b) the maximum efficiency, assuming the power factor of the load is 0.80. (Apply)

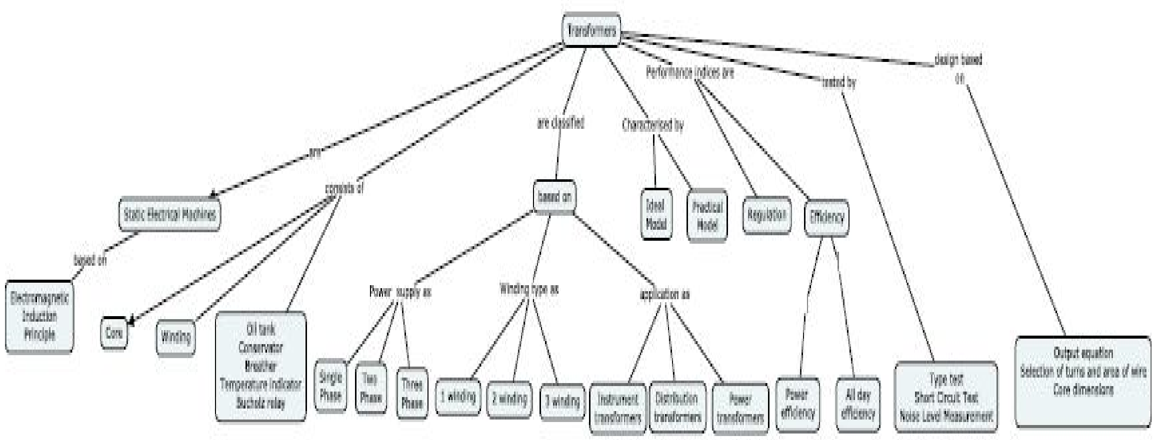
7. Two similar 250/1000 Volts, 10 KVA Transformers are being tested by the sumpner's test method. At rated voltage of 250volts on the Low voltage side the wattmeter reading is found 250watts and ammeter reading is 4Ampers. On the series connected High voltage side, a voltage of 80Volts drives a rated full load current of 10 Amperes. Calculate the efficiency of the transformer at 80% of its full load at 0.9 Power factor leading? (Apply)

Course Outcome 7(CO7)

1. Two transformers of the same type, using the same grade of iron and conductor materials are designed to work at the same flux and current densities, but the linear dimensions of one are two times those of the other in all respects. Calculate the ratio of kVA ratings of the two transformers. (Apply)
2. The emf per turn of a single phase 6.6kV/415V, 50Hz transformer is 12Volts. Calculate the number of turns in the high voltage and low voltage windings and the net cross sectional area of the core for a maximum flux density of 1.4Tesla. (Apply)

3. Determine the main dimensions of the core and window for a 500 kVA, 6600/400V, 50Hz, Single phase core type, oil immersed, self cooled transformer. Assume: Flux density = 1.2 T, Current density = 2.75 A/mm^2 , Window space factor = 0.32, Volt / turn = 16.8, type of core: Cruciform, height of the window = 3 times window width. Also calculate the number of turns and cross-sectional area of the conductors used for the primary and secondary windings. (Apply)
4. Determine the main dimensions of the 3 limb core (i.e., 3 phase, 3 leg core type transformer), the number of turns and cross-sectional area of the conductors of a 350kVA, 11000/ 3300 V, star / delta, 3 phase, 50 Hz transformer. Assume: Volt / turn = 11, maximum flux density = 1.25 T. Net cross-section of core = 0.6 d^2, window space factor = 0.27, window proportion = 3 : 1, current density = 250 A/cm^2, ON cooled (means oil immersed, self cooled or natural cooled) transformer having ±2.5% and ±5% tapping on high voltage winding. (Apply)
5. Calculate the no-load current of a 220/110V, 1kVA, 50Hz, Single phase transformer with the following data: uniform cross-sectional area of the core = 25 cm^2, effective magnetic core length = 0.4m, core weight = 8 kg, maximum flux density = 1.2 T, magnetizing force = 200 AT/m, specific core loss = 1.0 W/kg. (Apply)

Concept Map



Syllabus

Construction

Shell & Core Type Transformer Construction, Types of Core, Windings & Insulation, Bushings & Terminals, Tap Changer, Conservator Tank, Breather, Bucholz Relay, Oil Level Gauge, Temperature Indicators, Methods of Cooling, Transformer Specifications, Drying and Impregnation, Various types of three phase connections of transformers, Vector Groups(Qualitative Treatment only).

Working Principle

Working Principle of Transformer, Elementary theory of an Ideal Transformer, EMF Equation, Voltage Transformation Ratio, Practical single phase transformer - winding Resistance, Magnetic Leakage, Inrush Current, Magnetizing Current Waveform.

Performance Analysis
Analysis of Practical Transformer with Approximate/Exact Equivalent Circuit, Regulation, Losses, Efficiency, Electromagnetic Forces in Power Transformers.
Types and Applications
Auto Transformer, Two & Three Winding Transformer, Power & Distribution , Instrument Transformer, Welding Transformer, Testing Transformer, Scott connected transformer, Phase Shifting Transformer, Dry type Transformer , Traction Transformer, Rectifier Transformer, Converter Transformer, High Frequency Transformer(Qualitative Treatment only).
Operation
Tap changing & Voltage control, Effects of harmonics and harmonic compensation, Condition for Maximum Efficiency, All-day Efficiency, Loading & Life of Transformer, Parallel operation of Transformer, Oil Sampling, Oil Testing, Transformer Oil Filtration, Transformer Protection.
Testing
Transformer Testing – Routine Test-Dielectric & Parametric Tests, Type Test-Temperature Rise & Impulse Test, Special Tests-Short circuit, Unbalance Current, Magnetic Balance, Zero Sequence Impedance & Noise Level measurement Tests, Sumpner's test, IEC/IEEE Standard Practices of Testing.
Design concepts
Output Equation, Selection of Number of Turns, Core Dimensions and Winding Wires & Strips, Size of HV and LV Conductors, Transformer Tank/Cooling Requirements, Transposition of Conductors, Transformer Manufacturing process flow chart, Performance evaluation.

Text Books

1) Bharat Heavy Electricals Limited, "Transformers" Second edition, Eleventh Reprint 2012.

Reference Books

1) Indrajit Dasgupta,"Design of Transformer" McGraw Hill Education (India) Private Limited, Eleventh Reprint, 2014.
2) Feinberg R "Modern Power Transformer Practice" The Macmillan Press Limited, Reprinted 1983.
3) Pavlos S. Georgilakis "Spotlight on Modern Transformer Design" Springer,2009.
4) L. Umanand, S. R. Bhat, **"**Design of Magnetic Components for Switched Mode Power Converters" New Age International Publishers Ltd. 1st Edition, 1992
5) Kulkarni S.V, Khaparde.S.A, "Transformer Engineering" Marshel Dekker Inc, 2004.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Construction**	
1.1	Shell & Core Type Transformer Construction, Types of Core, Windings	2

Module No.	Topic	No. of Lecture Hours
	& Insulation, Bushings & Terminals	
1.2	Tap Changer, Conservator Tank, Breather, Bucholz Relay, Oil Level Gauge, Temperature Indicators, Methods of Cooling, Specifications	2
1.3	Transformer Drying and Impregnation	1
1.4	Various types of three phase connections of transformers, Vector Groups	1
2.	**Working Principle**	
2.1	Working Principle of Transformer, Elementary theory of an Ideal Transformer	1
2.2	EMF Equation, Voltage Transformation Ratio	2
2.3	Practical single phase transformer - winding Resistance, Magnetic Leakage	1
2.4	Inrush Current, Magnetizing Current Waveform	1
3	**Performance Analysis**	
3.1	Analysis of Practical Transformer with Approximate/Exact Equivalent Circuit,	2
3.2	Regulation, Losses, Efficiency	2
3.3	Electromagnetic Forces in Power Transformers	1
4.	**Types and Applications**	
4.1	Auto Transformer, Two & Three Winding Transformer, Power & Distribution	1
4.2	Instrument Transformer, Welding Transformer, Testing Transformer	1
4.3	Scott connected transformer, Phase Shifting Transformer, Dry type Transformer	1
4.4	Traction Transformer, Rectifier Transformer, Converter Transformer, High Frequency Transformer	1
5.	**Operation**	
5.1	Tap changing & Voltage control, Effects of harmonics and harmonic compensation	1
5.2	Condition for Maximum Efficiency, All-day Efficiency	2
5.3	Loading & Life of Transformer, Parallel operation of Transformer	1
5.4	Oil Sampling, Oil Testing, Transformer Oil Filtration	1
5.5	Transformer Protection	1
6.	**Testing**	
6.1	Transformer Testing – Routine Test-Dielectric & Parametric Tests, Type Test-Temperature Rise & Impulse Test,	2
6.2	Special Tests-Short circuit, Unbalance Current, Magnetic Balance, Zero Sequence Impedance & Noise Level measurement Tests, Sumpner's test,	2
6.3	IEC/IEEE Standard Practices of Testing	1
7	**Design Concepts**	
7.1	Output Equation, Selection of Number of Turns, Core Dimensions and Winding Wires & Strips	3

Module No.	Topic	No. of Lecture Hours
7.2	Size of HV and LV Conductors, Transformer Tank/Cooling requirements, Transposition of Conductors	3
7.3	Transformer Manufacturing process flow chart, Performance evaluation	2
	CAT 3- group presentation	6
	Total	**45**

Course Designers:

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14EE330	DC MACHINES	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

Direct Current (DC) machine is a highly versatile energy converting device. They can be designed to give a wide variety of voltage-current or speed- torque characteristics for both dynamic and steady-state operation. Due to their flexibility in speed control, DC motors are widely used in applications requiring a wide range of speeds or precise control of output.

Prerequisite

- 14ES160 : Basics of Electrical and Electronics Engineering

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcomes	
CO1.	Explain the construction and its features of DC machines.	K2
CO2	Explain the principle of operation and types of DC machines.	K2
CO3	Select a suitable DC machine for the given application, based on characteristics.	K3
CO4	Explain the starting methods, speed control, and testing of DC Motors.	K2
CO5	Design the main dimensions of DC machines for the given specification.	K3
CO6	Design the armature windings of DC machines for different specifications.	K3
CO7	Design the field circuit of DC machines for different specifications.	K3
CO8	Analyze the performance of the DC machine for the given design specifications.	K4

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**H**											**M**
CO2	**H**											**L**
CO3		**H**		**H**								**M**
CO4	**H**	**M**		**M**								**L**
CO5	**M**		**H**									**L**
CO6	**M**		**H**									**L**
CO7	**M**		**H**									**L**
CO8			**L**	**H**								**L**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	-	20
Understand	40	40	-	40
Apply	30	30	-	30
Analyse	10	10	-	10
Evaluate	--	--	-	--
Create	--	--	-	--

- ***CAT-3****: Group presentation (Seminar/Quiz/Role play) in the class for the case studies given in the course content through Site visit/Industry Visit/Field trips. Based on the performance of the presentation, CAT-3 mark will be awarded.*

- ***Assignment-3*** *will be evaluated based on the group presentation in the class on the readings of the following Laboratory experiments and inference.*
    - *Load characteristics of DC Generators*
    - *Load characteristics of DC Motors*
    - *Swinburne's and Hopkinson's Tests*

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Enumerate all the parts in a DC machine. State the material and the function of each part.
2. List the similarities and dissimilarities between lap and wave windings in a DC machine.
3. Why is the yoke of a machine not laminated whereas the armature core is laminated?

Course Outcome 2 (CO2):

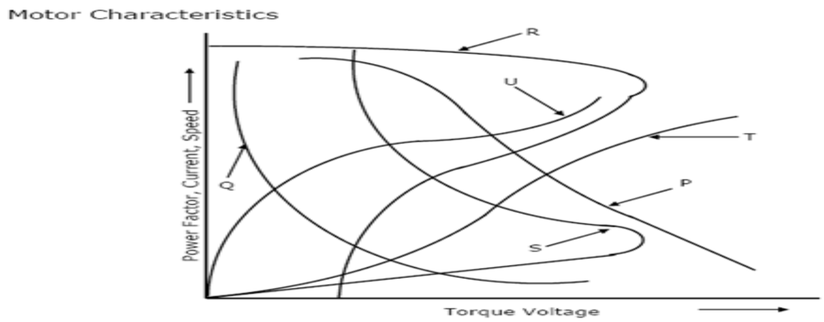
1. Derive the EMF equation of a DC generator.
2. Explain armature reaction in a DC machine.
3. Why DC series motors should be started only on load?

Course Outcome 3 (CO3).

1. A separately excited DC motor runs at 1500 rpm under no load with 200 V applied to the armature. The field voltage is maintained at its rated value. The speed of the motor, when it delivers a torque of 5Nm, is 1400 rpm. The rotational losses and armature reaction are neglected. Find the armature resistance. Also find the armature voltage to be applied to deliver a torque of 2.5 Nm at 1400 rpm.

2. A belt driven DC shunt generator runs at 1500 rpm delivering 10kΩ, at 220 V bus bars. The belt breaks, following which the machine operates as a motor drawing 2 kW power. What will be its speed as a motor? The armature and field resistances are 0.25Ω and 55Ω. Ignore armature reaction and assume the contact drop at each brush to be 1 V.

3. Find the correct characteristics



(a) Speed torque characteristics of DC series motor.
(b) Speed regulation characteristics of DC shunt motor.
(c) Current torque characteristics if dc series motor.

Course Outcome 4 (CO4)

1. Explain the methods of sped control of DC shunt motors.
2. Explain why a starter is required for starting a DC motor.
3. A 200 V DC shunt motor running at 1000 rpm takes an armature current of 17.5 A. It is required to reduce the speed to 600 rpm. What must be the value of resistance to be inserted in the armature circuit if the armature resistance is 0.4Ω?

Course Outcome 5 (CO5)

1. List the factors influencing selection of No. of poles.
2. Find the main dimensions, number of poles and length of air gap of a DC machine having the following data: 400 KW; 500 Volts; 180 rpm; 92 % efficiency; Average flux density in the gap = 0.6 Tesla; Ampere conductor per metre = 35000; Frequency of flux reversal should lie between 25 to 50 Hz; Current per brush arm should not exceed 100 Amps; Armature MMF per pole should not exceed 5250 Amps. Take ratio of Length of armature to Pole pitch as 0.7.
3. Show that
   i) the eddy current loss remains constant and
   ii) the hysteresis loss reduces

   When increasing number of poles from 2 to 4 for the same area of the core.

Course Outcome 6 (CO6)

1. Calculate the Back pitch, Front pitch, Winding pitch & Commutator pitch for a 25 slots, 4 poles, 25 segment simplex lap wound armature.
2. Draw a developed winding diagram for a 4 pole, 12 slot armature having simplex lap winding. Show the positions of poles and brushes.
3. Determine the current through armature conductor and brush of a 200 Volts, 100KW, 4 pole DC Shunt generator. Neglect field current.

Course Outcome 7 (CO7)

1. Design a shunt field coil from the following data:

Field MMF per pole	= 9000
Mean length of turn	= 1.4 mt.
Depth of coil	= 35 cm
Voltage across each field coil	= 40
Resistivity of wire	= 2.1×10^{-8} Ohm-mt.
Thickness of insulating varnish on the wire	= 0.2 mm

Power dissipation from total surface of the coil should not exceed 700 Watts/ m^2. Check your design for power dissipation.

2. Find the Depth of the field coil of DC shunt machine having MMF per unit height of field coil as 39906 Amps; Power dissipation as 700 W / m^2 ; and coil space factor as 0.65.
3. State the disadvantages of selecting larger no. of poles in DC machine design.

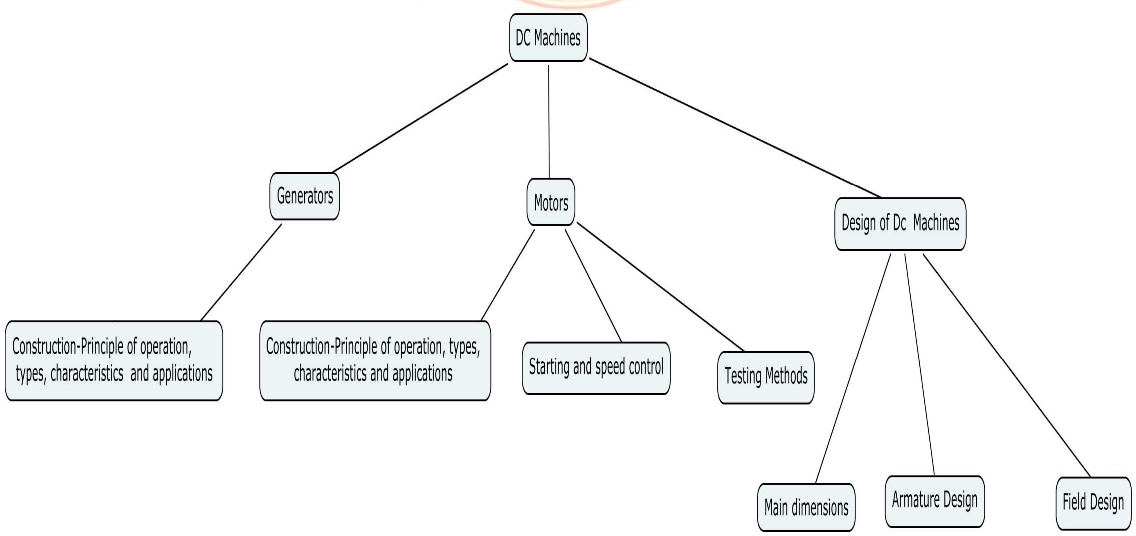
Course Outcome 8 (CO8)

1. The design data of a 37 KW, 230 V, 1400 rpm shunt generator is: no. of poles=4, D=1.3m, L=0.165 m. Validate this design and justify your conclusion. Assume other relevant data.

2. Choose, with reasons, a suitable number of poles for a 400 kW, 250 V, 250n rpm shunt generator having an armature diameter of 1.2 m and a length of 0.3 m.

3. The design data of shunt field winding of a 6 pole, 440 V, dc generator are as follows: height=1.9m, current=0.565 A, turns=1500, area= 2.77 m^2. Validate this design and justify your conclusion. Assume other relevant data.

Concept Map



Syllabus

DC Machine

Construction – Various Parts and its functions– types of cooling, mounting, Standards & Specifications.

DC Generators

Principle of operation, EMF equation, Armature reaction, commutation, Types- self and separately excited - shunt, series and compound, Characteristics, Regulation, Applications – Pilot and Main Exciters, Battery charging and Electro plating- Case studies.

DC Motors

Principle of operation, Torque equation, Types – Series – shunt – compound, characteristics, Losses, Efficiency, Applications- Starter motor, Traction, Lathes, Elevators- Case studies.

Testing of DC motors

Starters, Speed control, Swinburne's Test, Heat run Test, Hopkinson's Test, Testing Standards - IEC, NEMA - Case studies.

Design of DC Machines

Design of Armature core and yoke - Armature windings and diagrams - Poles and field windings – performance evaluation- Case studies.

Text Books

1. D.P.Kothari & I.J.Nagrath, " Electrical Machines", Tata-McGrawhill, New Delhi, 3rd Edition, 2004
2. A.K.Sawhney and A.Chakrabarti, " A course in Electrical Machine Design",6th Edition, Dhanpat Rai & Co (P) Ltd., 2006.

Reference Books

1. R.K.Rajput, " Electrical Technology", Laxmi Publications, 3rd edition, 2005.
2. Vincent Deldoro ," Electromechanical Energy Conversion " PHI III edition,
3. Gupta.J.B,"Theory of Performances of Electrical Machines' Katson, 7th Edition, 1987
4. M.G.Say, Theory and performance of electrical machines, Tata-Mcgraw hill

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**DC machine**	
1.1	Construction- Various parts and functions	1
1.2	Types of cooling, mounting	1
1.3	Standards & Specifications	1
2	**DC Generators**	
2.1	Principle of operation, EMF equation	1
.2	Armature reaction, commutation	1
2.3	Types- self and separately excited - shunt, series and compound	1
2.4	Characteristics	2
2.5	Regulation, Applications – Pilot Exciters	2
2.6	Tutorial	1
2.7	**CAT-3 Evaluation**	3
	Assignment-1	
3	**DC Motors**	
3.1	Principle of operation, Torque equation	1
3.2	Types – Series – Shunt – Compound motors	1
3.3	Characteristics, Losses, Efficiency	2
3.4	Applications- Starter motor	2
3.5	Tutorial	2
3.6	**CAT-3 Evaluation**	3
	Assignment-1	
4	**Design of DC machines**	
4.1	Design of Armature core	1
4.2	Armature windings and diagrams	2
4.3	Poles and field windings	2
4.4	Performance evaluation	1
4.5	Tutorial	3
	CAT-3 Evaluation	3
	Assignment-2	
5	**Testing of DC Machines**	
5.1	Starters, Speed control, Testing methods, Standards-IEC, NEMA	2
	Assignment-3	6
	Total	**45**

Course Designers:

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14EE340	MEASUREMENT SYSTEMS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

The rapid development of new and exciting means of measurement using new technologies, the adoption of new standards are leads us to the state of "Classic Electrical Measurements" are today on the periphery of interest. However knowledge of these subjects is important to understand the principles of modern measuring instruments. This course is designed to impart fundamental knowledge of analog measuring instruments characteristics. This course exposes the knowledge about the construction, principle and applications of analog and digital measuring instruments. Students will get the fundamental knowledge of DC and AC null measurement methods along with its behaviours on it's various applications.

Prerequisite

- 14EE240: Electromagnetic Fields
- 14EE250: Analog Devices and Circuits
- 14EE270: Electric Circuit Analysis

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Explain the Metrics of Electrical parameters, static & dynamic characteristics, Calibration and Standards of measuring instruments.	Understand
CO2	Calculate various types of errors in analog and digital measurements using statistical analysis	Understand
CO3	Explain the construction, working principle and applications of moving coil, moving iron, rectifier type, electro-dynamic, induction type instruments and usage of instrument transformers	Understand
CO4	Choose suitable AC and DC bridge for measuring R, L,C and frequency for the required specifications	Apply
CO5	Explain the specifications, principle of operation, and applications of various Digital instruments such as Voltmeter, Wattmeter, Multimeter, Frequency Meter, DSO, LCR meter, Energy meter, Power factor meter, Harmonic Analyser, and Spectrum analyser	Understand
CO6	Explain the concepts of Smart Meters, Automatic Meter Reading(AMR), and Virtual Instrumentation	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	M	L										
CO3.	M	L										
CO4.	S	M	L									
CO5.	M	L			L					L		
CO6.	M	L			L							L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	10	10	20
Understand	30	20	20	50
Apply	--	20	20	30
Analyse	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

NOTE: For ***Assignment 3***, Maximum of 10 marks will be awarded by evaluating the students performances in the specified activities such as group Seminars, Technical Report writing , Quiz and Group discussions.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. State the meaning for 'International Standard' in measurements. (Remember)
2. Name the few static performance characteristics of a measuring instrument. (Remember)
3. Explain the significance of the dynamic characteristics. (Understand)

Course Outcome 2 (CO2):

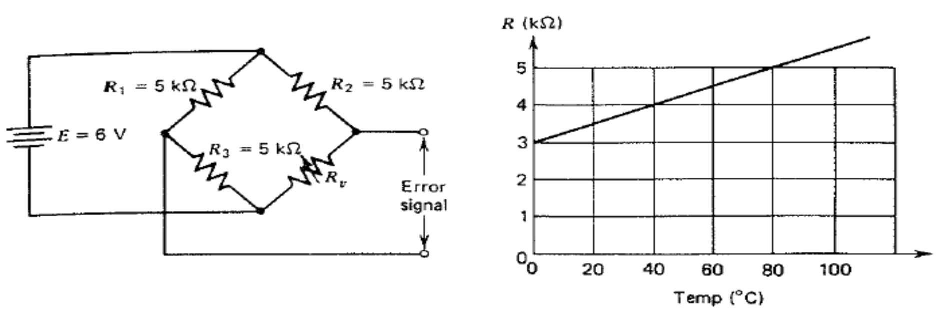
1. Differentiate the following: a) Instrumental Error Vs Environmental Error. (Understand)
2. Define accuracy. (Remember)
3. Explain about Drift and its various types. (Understand)

Course Outcome 3 (CO3)

1. Describe the various forces/torques required in the measuring instruments. (Understand)
2. Derive the expression for equation of motion for permanent magnet moving coil instrument. (Understand)
3. Demonstrate the construction features of a repulsion type MI instruments. (Understand)

Course Outcome 4 (CO4)

1. Resistance R_v given in Figure 1, is a temperature sensitive, the relation between the resistance and temperature is also given in Figure 1. Calculate (a) At what temperature the bridge is balanced; (b) Amplitude of the error signal at 60°. (Apply)



2. Figure 1

3. The Schering bridge shown in Figure 2 is operated at balance. Find the equivalent series resistance and capacitance of Rx and Cx. Also find the Q factor of the capacitor Cx. (Understand)

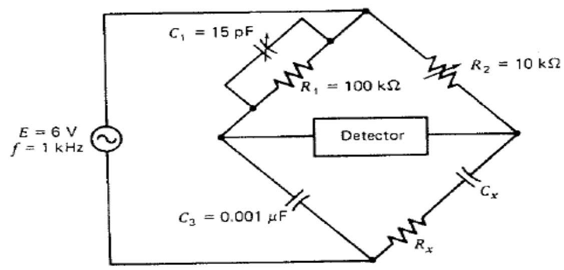


Figure 2

4. A Wheatstone bridge is connected for identify the cable fault as shown in Figure 3. When the switch is in position a, the bridge is balanced with R1=1000Ω, R2=100 Ω, R3=53 Ω. When switch S is in position b, the bridge is balanced with R1=1000 Ω, R2=100 Ω, R3=52.9 Ω. if the resistance of the shorted wire is 0.015 Ω /m. What is the distance between the place of fault and the bridge? (Apply)

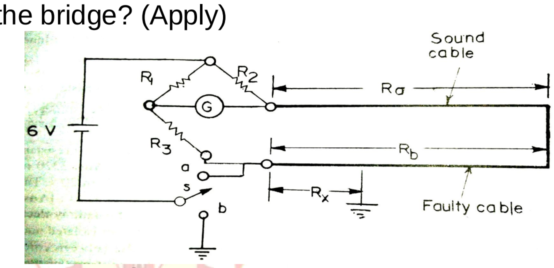


Figure 3

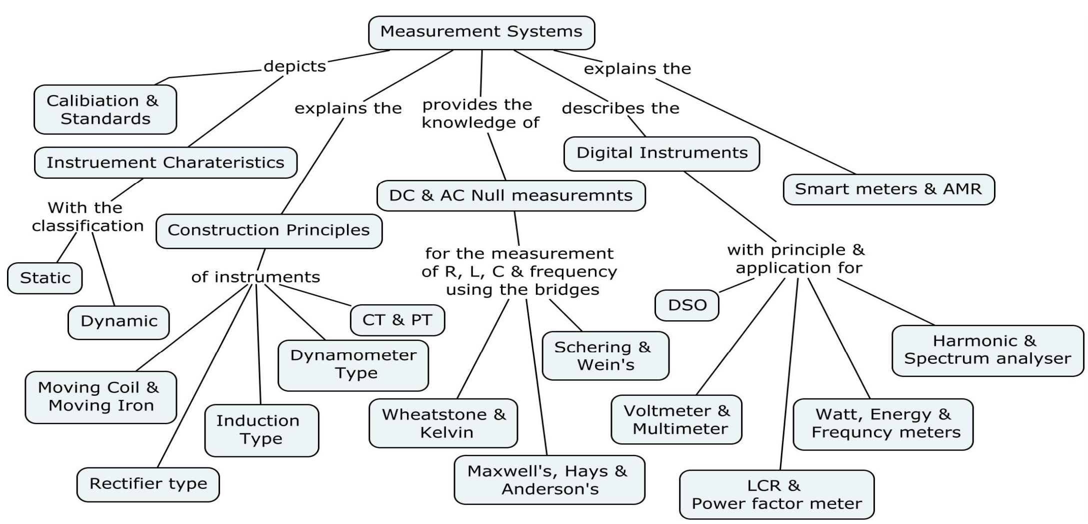
Course Outcome 5 (CO5)

1. Explain the working principle of digital voltmeter. (Understand)
2. Explain the operation of digital energy meter. (Understand)
3. Summarize the advantages of Digital Instruments. (Understand)

Course Outcome 6 (CO6)

1. Demonstrate the significance of smart meters. (Understand)
2. Explain the concept of smart Grid. (Understand)
3. Summarize about the Automatic Meter Reading (AMR). (Understand)

Concept Map



Syllabus

Basics of Measurements - Metrics and Tolerances of various Electrical parameters (V,I, f, Power), Static characteristics-Errors in measurements -Dynamic characteristics, Calibrations and Standards.

Analog Instruments- Introduction to analog measuring instruments-Construction, principle and applications of - Moving Coil instrument- Moving Iron instrument - Rectifier type instrument - Dynamometer type instrument - Induction type instrument, Selection of a measuring instrument for a specific application, Statistical analysis of error data (Simple Problems) - Error correction methods, Measurements of power using CT & PT.

DC and AC null measurements and it's applications -Wheatstone bridge, kelvin bridge - Schering Bridge, Wein's bridge -Maxwell's bridge,Hay's bridge, Anderson Bridge-Selection of a suitable bridge for specific application (eg.cable fault identification).

Digital Instruments (Principle and it's applications) - Digital Voltmeter -Digital Multi meter - Digital Watt meter - Digital Frequency Meter - Digital Storage Oscilloscope - LCR meter - Energy meter - Power factor meter - Harmonic Analyser - Spectrum analyser – concepts of Smart Meters - Automatic Meter Reading(AMR) – Net metering. Statistical analysis of error data (Simple Problems) - Error correction methods.

Introduction to Virtual Instrumentation (integrating various digital instruments) using Labview.

Text Book

1. A Course in Electrical and Electronic Measurements and Instrumentation,"A.K. Sawhney", Dhanpat Rai & Co, 2010.

Reference Books

2. Electrical Measurements and Measuring Instruments, "E.W. Golding and F.E. Widdis" Wheeler's student edition, 2009.
3. Electronic Instrumentation , " Kalsi H.S", Tata McGraw-Hill 2003
4. A Course in Electronics and Electrical Measurements and Instrumentation "J.B. Gupta", S.K. Kataria & Sons 2001.
5. Electrical Measurements and Measuring Instruments" "R.K.Rajput" S. Chand and Co., New Delhi, 2008.
6. Modern electronic Instrumentation and Measurement techniques, "Albert D.Helifrick, William D. Cooper", PHI, 1992
7. "Smart Grid: Technology and Applications", Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Wiley, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Basics of Measurements**	
1.1	Metrics and Tolerancesof various Electrical parameters(V,I, f, Power)	1
1.2	Static characteristics	2
1.3	Errors in measurements	1
1.5	Dynamic characteristics	1
1.6	Calibrations and Standards	1
2.	**Analog Instruments** (Construction, principle and it's applications)	
2.1	Introduction to analog measuring instruments	1

Module No.	Topic	No. of Lecture Hours
2.2	Moving Coil instrument	2
2.3	Moving Iron instrument	1
2.4	Rectifier type instrument	1
2.5	Dynamometer type instrument	1
2.6	Induction type instrument	2
2.7	Statistical analysis of error data (Simple Problems) - Error correction methods	1
2.8	Measurements of power using CT and PT	1
2.9	Sélection of a measuring instrument for a specific application	1
3.	**DC and AC null measurements and it's applications**	
3.1	Wheatstone bridge, kelvin bridge	2
3.2	Schering Bridge, Wein's bridge	2
3.3	Maxwell's bridge, Hay's bridge, Anderson Bridge	2
3.4	Sélection of a suitable bridge for specific application (e.g.cable fault identification)	1
4.	**Digital Instruments** (Principle and it's applications)	
4.1	Digital Voltmeter	1
4.2	Digital Multi meter	1
4.3	Digital Watt meter	1
4.4	Digital Frequency Meter	1
4.5	Digital Storage Oscilloscope	1
4.6	LCR meter	1
4.7	Energy meter	1
4.8	Power factor meter	1
4.9	Harmonic Analyser	2
4.10	Spectrum Analyser	2
4.11	Concepts of Smart Meters	1
4.12	Automatic Meter Reading (AMR), Net metering	1
4.13	Statistical analysis of error data (Simple Problems) - Error correction methods	1
4.14	Introduction to Virtual Instrumentation (integrating various digital instruments) using Labview	1
	Total	40

Course Designers:

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2. Dr. D. Nelson Jayakumar dnjayakumar@tce.edu

14EE350	DIGITAL SYSTEMS	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

Digital systems encompass the circuits, that process signals by discrete bands of analog levels, rather than by continuous ranges (as used in analog electronics). All levels within a band represent the same signal state. Because of this discretization, relatively small changes to the analog signal levels due to manufacturing tolerance, signal attenuation or parasitic noise do not leave the discrete envelope, and as a result are ignored by signal state sensing circuitry. In most cases the number of these states is two, and they are represented by two voltage bands: one near a reference value typically termed as "ground", and the other a value near the supply voltage. These correspond to the "false" ("0"), and "true" ("1"), values of the Boolean domain, respectively, yielding binary code. Digital electronic circuits are usually made from large assemblies of logic gates. Computer-controlled digital systems can be controlled by software, allowing new functions to be added without changing hardware.

Prerequisite

- **14EE250 Analog devices and Circuits**

Course Outcomes

On the successful completion of the course, students will be able to :

CO1	Explain the different number systems and coding schemes and arithmetic operations on binary numbers	Understand
CO2	Explain the IC fabrication technique, operation of logic gates and their family	Understand
CO3	Explain the basic theorems and properties of Boolean algebra	Understand
CO4	Utilize K- Map for gate level minimization of the given Boolean function	Apply
CO5	Construct combinational logic circuits for the given requirement and determine their performance using verilog simulation tool	Apply
CO6	Construct synchronous and asynchronous sequential logic circuits for the given requirement and determine their performance using verilog simulation tool	Apply
CO7	Explain the memory devices such as RAM,ROM,PROM,EEPROM, FLASH, ADC and DAC	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO4.	**M**	**L**										
CO5.	**M**	**L**										**M**
CO3	**M**	**L**										
CO4	**S**	**M**			**M**							
CO5.	**S**	**M**			**M**							
CO6	**S**	**M**			**M**							
CO7	**M**	**L**										**M**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	30	30	30
Apply	30	50	50	50
Analyse	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
There will be three Assignments each carrying 10 marks.				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Convert the given BCD number to Decimal number and hexadecimal number.
   1001 0011 1011
2. Perform the following binary operations:
   10110110+10111000
   11111000-10101010
3. Convert the given hexa-decimal numbers to binary numbers:
   9BC2, FDA5

Course Outcome 2 (CO2):

1. Explain the operation of CMOS 2 input NAND gate with circuit diagram.
2. List the characteristics of TTL and CMOS logic families.
3. Define Propagation delay, fan-in and fan-out of a logic gate.

Course Outcome 3 (CO3)

1. Simplify the given logic expression using Demorgan's theorem:
   Y=(A+B+(AB)'+CD)'
2. Prove the commutative and distributive laws in Boolean algebra.
3. Simplify the given logic expression:
   Y=ABC+AB'C+A'B'C'+AB'C'

Course Outcome 4 (CO4)

1. Simplify the logic function F(A,B,C,D)= Σm(0,1,2,5,6,8,)+d(3,4,7,14) using K-map in SOP form and implement it using NAND gates.
2. Construct a Karnaugh Map for the Boolean function Y= ABC+ABC'+A'B'C+A'BC and simplify the function.
3. Minimize the given expression using K-map and realize it using NOR gates.
   a. F(A,B,C,D) = ∏M(1,5,8,9,10,11)+d(0,4)

Course Outcome 5 (CO5)

1. Construct a 3x8 decoder by using 2x4 decoders and explain its operation.
2. Realise the Boolean function F(A,B,C,D)= Σm(1,2,5,7,8,11,13) using a 8x1 multiplexer.
3. Construct a two bit multiplier circuit and write its truth table.

Course Outcome 6 (CO6)

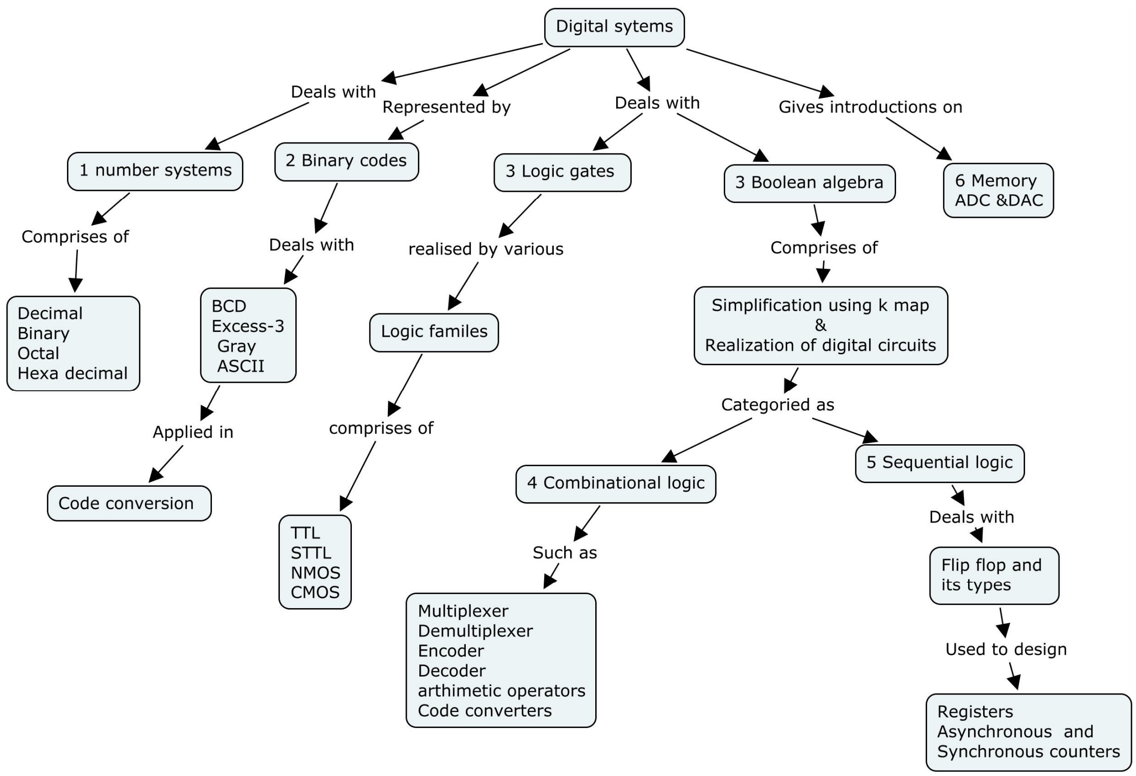
1. Design Mod-5 synchronous up counter using J-K flipflops.
2. Design Mod-10 ripple down counter using T flipflops.
3. Explain the operation of 4-bit PISO shift resister with necessary sketches.

Course Outcome 7 (CO7)

1. Write the differences between PROM AND EEPROM.

2. Draw and explain the structure of 4X4 Static RAM.
3. Explain the working principle of 3-bit flash ADC with neat diagram.

Concept Map



Syllabus

Review of Number systems: Decimal, binary, octal and hexa-decimal numbers.

Binary codes: BCD, Excess-3, Gray, ASCII codes - Code conversions- Binary to Gray code, Gray code to Binary, Binary to ASCII , ASCII to Binary.

Logic gates - Logic gates and their truth table**.**

Logic Families: Characteristics-fan-in, fan-out, propagation delay, power dissipation, TTL ,STTL, NMOS, CMOS, ECL- Implementation of 2 input NOR,NAND gates using TTL & CMOS Logic- open collector output-open drain output- Boolean Algebra and laws- Simplification of Boolean expressions- Introduction to sum of products (SOP) & product of sums (POS)- Logic Minimization using K-map and their realisation using logic gates.

Combinational logic circuits: Multiplexers & Demultiplexers, Encoders, Priority encoder, Decoders, Code converters, Introduction to Verilog simulation tool- Realization of Boolean functions using multiplexers.

Arithmetic Operations: Adders, carry look-ahead adder and Subtracters- Magnitude comparator, 2 bit multiplier – ALU design.

Sequential Logic circuits: Moore and Melay Machines, Latches and Flip-Flops(SR,JK,T,D), State Diagrams, Timing Diagrams and state Tables, Sequential Circuit

Design, Shift Registers, Synchronous counters (up, down, up-down, mod-N, Ring)-Digital clock.

Asynchronous Sequential Logic circuits: characteristics- Racing and Glitches**,** Asynchronous Counters (up, down).

Memory, Oscillator, ADC, DAC: RAM (static and dynamic), ROM (EEPROM, FLASH)- Crystal oscillator - ADC – DAC.

Text Book

1. M.Morris Mano and Michael D.Ciletti, Digital Design, Fourth Edition, Pearson Prentice Hall, 2008

Reference Books

1. Floyd and Jain, Digital Fundamentals, 8th Edition, Pearson Education, 2006
2. Charles H.Roth and Lizy K.John, Digital system design using VHDL, 2nd edition, Cengage learning, 2007
3. Donald Leach, Albert Malvino and Goutam Saha, Digital Principles and Applications, McGraw Hill Publishers,2010
4. J. F. Wakerly Digital Design Principles and Practices, 4th edition, Prentice Hall of India, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**Review of Number systems**	
1.1	Decimal, binary, octal and hexa-decimal	1
2	**Binary codes:** BCD, Excess-3, Gray, ASCII codes	1
2.1	**Code conversion:** Binary to Gray code, gray code to binary, Binary to ASCII , ASCII to Binary	1
3	**Logic Gates:**	
3.1	Logic gates and their truth table	1
3.2	**Logic Families:** -fan-in, fan-out, propagation delay, power dissipation	1
3.3	TTL ,STTL,NMOS,CMOS, ECL	1
3.3	Implementation of 2 input NOR,NAND gates using TTL & CMOS LOGIC	1
3.4	Open collector output-open drain output	1
3.5	Boolean Algebra and laws- Simplification of Boolean expressions	1
3.6	Introduction to sum of products (SOP) & product of sums (POS)	1
3.7	Logic Minimization using K-map and their realisation using logic gates	2
4	**Combinational logic Circuits:**	
4.1	Multiplexers & Demultiplexers	1
4.2	Encoders, Priority encoder	1
4.3	Decoders, Code converters	2
4.4	Introduction to Verilog simulation tool	1
4.5	Realization of Boolean functions using multiplexers.	1
4.6	**Arithmetic Operations:**	
4.6.1	Adders ,carry look-ahead adder and Subtracters	2

4.6.2	Magnitude comparator, 2 bit multiplier	1
4.6.3	ALU design.	1
5	**Sequential Logic Circuits:**	
5.1	Moore and Melay Machines	1
5.2	Latches and Flip-Flops(SR,JK,T,D)	2
5.3	State Diagrams, Timing Diagrams and state Tables	1
5.4	Sequential Circuit Design	1
5.5	Shift Registers	2
5.6	Synchronous counters (up, down, up-down, mod-N, Ring)	2
5.7	Digital clock	1
5.7.1	**Asynchronous Sequential Logic circuits**	
5.7.2	characteristics- Racing and Glitches	1
5.7.3	Asynchronous Counters (up,down)	2
6	**Memory, Oscillator, ADC, DAC**	
6.1	RAM (static and dynamic)	1
6.2	ROM (EEPROM,FLASH)	1
6.3	Crystal oscillator	1
6.4	ADC and DAC	2
	Total	**40**

Course Designers:

1. Dr.M.Saravanan mseee@tce.edu
2. Dr.R.Helen rheee@tce.edu
3. B.Ashok Kumar ashokudt@tce.edu

14EE370	PROBLEM SOLVING USING COMPUTERS	Category	L	T	P	Credit
		ES	2	0	2	3

Preamble

This syllabus is intended for the candidate who desires to learn problem-solving techniques and the design of computer solutions in a precise manner. The syllabus emphasizes problem-solving methodologies, algorithm designs and developments and computer-programming skills. The intention is to provide sufficient depth in these topics to enable candidates to achieve better understanding of problem solving using computers. Besides the written papers, lab-based examinations are included as part of the assessment requirements for the study. The lab-based examinations will test the candidate's ability to develop computer-programming solutions for a series of programming tasks of varying complexity.

The modules in the syllabus reflect solving general problems via programming solution. Thus, modules collectively focus on programming concepts, strategies and techniques; and the application of these toward the development of programming solutions.

Prerequisite

- Nil

Course Outcomes

On the successful completion of the course, students will be able to:

1.	Develop algorithms for solving simple mathematical and engineering problems and examine the suitability of appropriate repetition and/or selection structures for given problems	Apply
2.	Solve matrix problems, merging, searching, sorting and string manipulation problems using iteration, modularization or recursion as applicable.	Apply
3.	Organize files to perform text operations like editing, pattern searching using structures.	Apply
4.	Implement the algorithms for matrix problems, merging, searching, sorting, and string manipulation and file problems and debug and test using any procedural programming language	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO6.	S	S	M						M			M
CO7.	S	S	M						M			M
CO3.	S	S	M						M			M
CO4.	S	S	M						M			M

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1(T)	2(T)	3(Practical)	Theory
Remember	10	10	-	10
Understand	10	10	-	20
Apply	30	20	50	60
Analyse	-	10	-	10
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Recall the list of symbols used in flowcharts for various purposes. (Remember)
2. Summarize the steps involved in exchanging values of variables. (Understand)
3. Choose proper selection control structures to solve area of rectangle, triangle and circle. (Apply)

Course Outcome 2 (CO2):

1. What is the use of an array? (Remember)
2. Compare function call and recursive call. (Understand)
3. Make use of arrays and functions to transpose an mxn matrix. (Apply)
4. Analyze the performance of search algorithms. (Analyze)

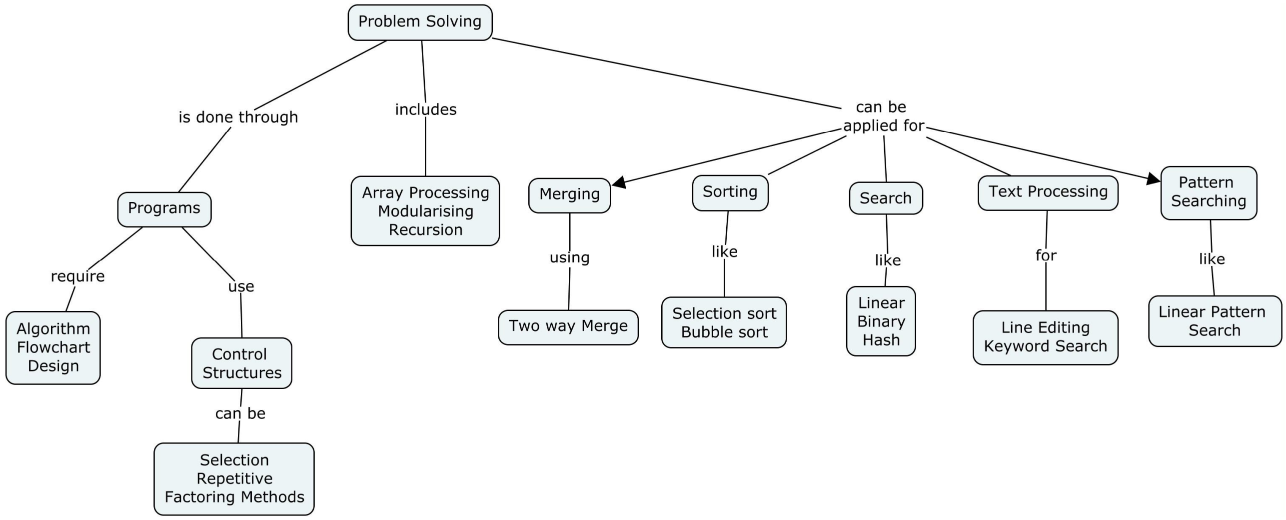
Course Outcome 3 (CO3):

1. What is text processing?
2. Explain the algorithm for linear pattern searching
3. Develop an algorithm for comparing two strings.

Course Outcome 4 (CO4):

1. Develop a C program to convert decimal to binary of a given number using non recursive and recursive techniques. (Apply)
2. Develop a C program to multiply two nxn matrices using arrays and pointers. (Apply)
3. Develop a C program to create a text file to store records of addresses of N persons and retrieve and display the records with city="Madurai". (Apply)

Concept Map



Syllabus

Introduction to Computer Problem Solving : Introduction to Computer, Program Design, Flowcharts, developing an Algorithm, Efficiency of algorithms, Analysis of algorithms, Fundamentals Algorithms, Exchanging values of variables, Counting.

Practical Component:
Problem Solving with Fundamental Algorithms (use data types and expressions)

Factoring methods and Control structures: Selection Control Structures, Repetition Control Structures, Algorithms Using Selection and Repetition, Factoring Methods

Practical Component:
Problem solving with Selection Control Structures and Decision Statements (use if-else, switch-case, break, and continue)

Problem solving with Repetition Control Structures and Loop Statements (use while, do-while and for loops)

Array Processing and Techniques : Array Processing and Techniques, Modularization and recursion, Merging, Sorting and Searching- Two way merge, Sorting by selection, Linear search, Binary search, Simple Hash searching.

Practical Component:
Problem solving with array based problems (use 1D and 2D arrays and pointers) and function oriented problems (functions and recursive functions)

Text Processing and pattern searching :Text Processing and pattern searching, Text line editing, keyword searching, Linear pattern searching.

Practical Component:
Problem solving using text and strings (use string, structures and files)

Text Books

1. How to solve it by Computer, R.G Dromey, Pearson education, Delhi, 2008.
2. Simple Program Design, A Step-by-Step Approach, Lesley Anne Robertson, 5th Edition, Thomson, 2007.

3. E. Balagurusamy, “Programming in ANSI C”, IV Edition, Tata McGraw Hill Publication Company, 2008.

Reference Books

1. Let us C, Yashavant P. Kanetkar ,12th edition, BPB Publications, 2012.
2. ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-087-practical-programming-in-c-january-iap-2010/download-course-materials/

Course Contents and Lecture Schedule for Theory

Module No.	Topic	No. of Lecture Hours
1	**Introduction to Computer Problem Solving**	
1.1	Introduction to Computer, Program Design, Developing an Algorithm	1
1.2	Flowcharts	1
1.3	Efficiency of algorithms, Analysis of algorithms	1
1.4	Fundamentals Algorithms	1
1.5	Exchanging values of variables, Counting.	1
2	**Factoring methods and Control structures**	
2.1	Selection Control Structures, Repetition Control Structures	1
2.1.1	Summation of set of numbers, Factorial computation, Sine function computation	1
2.1.2	Fibonacci sequence generation, Reversing the digits of an Integer	1
2.1.3	Base conversion, Character to number conversion	1
2.2	Factoring Methods	
2.2.1	Finding square root of a number, The smallest divisor of an integer	1
2.2.2	Generating Prime numbers	1
2.2.3	Generating Pseudo-random numbers, Computing n^{th} Fibonacci number	1
3	**Array Processing and Techniques**	
3.1.1	Array technique, Finding the maximum number in a set, Finding k^{th} smallest number	1
3.1.2	Removal of duplicates from an ordered array, Partitioning array,	1
3.1.3	Histogramming, Longest Monotone subsequence	1
3.2	Matrix manipulations (add, subtract, multiply, transpose)	2
3.3	Modularization and recursion, Sorting by selection, Two way merge	1
3.4	Linear search, Binary search, Simple Hash searching	2
4	**Text Processing and pattern searching**	
4.1	String Manipulations	1
4.2	Text line editing	1
4.2.1	keyword searching	1
4.2.2	Linear pattern searching	1
	Total	**24**

Course Contents and Schedule for Laboratory classes

Module No.	Topic	No. of Hours
1	Introduction to C components	1
2	Problems on Fundamentals Algorithms	2
3	Factoring Methods in C	1
4	Problems on Factoring Methods	2
5	Selection Control Structures, Repetition Control Structures in C	1
6	Problems on Selection Control Structures, Repetition Control Structures	2
7	Array techniques in C	1
8	Problems on Array techniques	2
9	Functions and recursion in C	1
10	Problems on Functions and recursion	2
11	Concepts of String in C	1
12	Problems on Strings	2
13	Concepts of structures in C	1
14	Problems on structures	2
15	Concepts of Files in C	1
16	Problems on Files	2
	Total	**24**

Note: Students must be given Electrical data for solving the problems like Measurement Errors, Electricity Bill, and Electrical Circuits.

Course Designers:

1. S. Sudha ssj@tce.edu
2. S. Prasanna sprcse@tce.edu

14EE380	DC MACHINES AND TRANSFORMERS LAB	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

This laboratory gives a practical exposure to the students to learn the characteristics of Transformers and DC Machines that are used nowadays in Electrical Systems. The students also learn to select the suitable DC Electrical Machines for an application based on its characteristics. To familiarize the standard testing procedures of DC Machines and Transformers.

Prerequisite

Nil

COs No.	Course outcomes	Blooms level
CO1.	Obtain the characteristics of DC Generator (Shunt, Series & Compound) independently	Apply, Precision (S3)
CO2.	Obtain the characteristics of DC Motor (Shunt & Series) independently	Apply, Precision (S3)
CO3.	Obtain the Voltage Regulation and Efficiency characteristics of Transformer independently	Apply, Precision (S3)
CO4.	Testing of Transformer for Efficiency Calculation & Modeling	Apply, Precision (S3)
CO5.	Testing of DC Machine to monitor efficiency and enhance it	Apply, Precision (S3)
CO6.	Obtain Thermal & Vibration characteristics of DC Machines and Transformers	Apply, Precision (S3)
CO7.	Identify Transformer Terminals to connect as per the requirements	Apply, Precision (S3)

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	M						S	L		
CO2	M	L	M						S	L		
CO3	M	L	M						S	L		
CO4	M	L	M						S	L		
CO5	M	L	M						S	L		
CO6	L	L	M	L	S				S	L		
CO7	M	L	M						S	L		

S- Strong; M-Medium; L-Low

List of Experiments:

DC Machines

1. Methods of Starting and Speed Control of DC Motors (CO2)
2. Methods of Excitation and Voltage Control of DC Generators (CO1)

3. Thermal and Vibration Analysis of DC Machines (CO6)
4. Regenerative Braking (CO5)
5. Measuring the resistance of Armature and Field Windings (CO1)

Experiments to be considered for Assignment 3 in the course "14EE330 DC Machines":

6. Swinburne's & Hopkinson's tests (CO5)
7. Load characteristics of DC Generators (CO1)
8. Load Characteristics of DC Motors (CO2)

Transformers

1. Voltage Ratio and Polarity identification (CO7)
2. Parallel operation (CO7)
3. Thermal and Vibration Analysis of Transformer (CO6)
4. Performance calculation using equivalent circuit (CO4)
5. Measurement of Winding Resistance and Inductance (CO4)

Experiments to be considered for Assignment 3 in the course "14EE320 Transformers":

6. Performance estimation using various load (CO4)
7. Scott connection (CO7)
8. Sumpner's test (CO4)

Course Designers

1. Dr.V.Saravanan vseee@tce.edu
2. Dr.V.Prakash vpeee@tce.edu

Category	L	T	P	Credit
PC	0	0	2	1

14EE390 DIGITAL SYSTEMS LAB

Preamble

This laboratory gives a practical exposure to the students to learn the characteristics of logic gates, various digital circuits such as Multiplexers, Demultiplexers, Encoders, Decoders, Code converters, counters and shift registers and their applications. To validate the experimental results, the use of simulation tool (Verilog HDL) for the performance analysis of digital circuits is also introduced.

Prerequisite

- 14EE280 Analog Devices and Circuits Lab

CO No.	Course outcomes	Blooms level
CO1.	Demonstrate minimization of the given Boolean function using K-Map and realize it using logic gates	Apply, Precision
CO2.	Construct combinational logic circuit for the given application and analyse its performance using Verilog simulation tool	Analyse, Precision
CO3.	Construct synchronous / asynchronous sequential logic circuits for the given application and analyse its performance using Verilog simulation tool	Analyse, Precision

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**M**	**L**		**L**				**M**	**M**		
CO2	**S**	**S**	**M**	**M**	**S**				**M**	**M**		
CO3	**S**	**S**	**M**	**M**	**S**				**M**	**M**		

S- Strong; M-Medium; L-Low

List of Experiments:

Basic Level :

1. Simplification and Realization of digital circuits using logic gates(CO1)
2. Decoder and Encoder, Adder and Subtractor (CO2), Multiplexer and Demultiplexer (CO2)
3. Code Converters-BCD to 7 Segment code, Binary to Gray Code and Gray to binary code (CO2)
4. Ripple counter, Synchronous Counter and Shift Registers (CO3)

Design level:

5. Design of Arithmetic Logic Unit for the given expression (CO2)
6. Design of Automatic tank level control circuit (CO2)
7. Design of Automobile parking system (CO3)

8. Design of motor's speed measurement circuit (CO3)
9. Design of Digital clock circuit (CO3)
10. Serial and parallel transmission of binary data (CO3)
11. Key Board Encoder(CO2)
12. Realization of Logic circuits using FPGA Kit (CO2 &CO3)

Course Designers

1.	Dr.M.Saravanan	mseee@tce.edu
2.	Dr.R.Helen	rheee@tce.edu
3.	B.Ashok Kumar	ashokudt@tce.edu

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

FOURTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

Semester	Theory						Theory cum Practical	Practical		Special Courses	Credits
	1	2	3	4	5	6	7	8	9	10	
I	14MA110 Engineering Mathematics I(3)	14PH120 Physics (3)	14CH130 Chemistry (3)	14EG140 English (3)	14ES150 Basics of Civil and Mechanical Engineering (2)	14ES160 Basics of Electrical and Electronics Engineering (2)	14ME170 Engineering Graphics (3)	14PH180 Physics Lab (1)	14CH190 Chemistry Lab (1)	--	**21**
II	14EE210 Engineering Mathematics II (3)	14EE220 Materials Science for Electrical Engineering (3)	14EE230 Environmental Science and Ethics (3)	14EE240 Electromagnetic Fields (3)	14EE250 Analog Devices and Circuits (3)		14EE270 Electric Circuit Analysis (3)	14EE280 Analog Devices and Circuits Lab (1)	14ES290 Workshop (1)	--	**20**
III	14EE310 Engineering Mathematics III (3)	14EE320 Transformers (3)	14EE330 DC machines (3)	14EE340 Measurement Systems (3)	14EE350 Digital Systems (3)		14EE370 Problem solving using Computers (3)	14EE380 DC Machines and Transformers Lab (1)	14EE390 Digital Systems Lab (1)	--	**20**
IV	14EE410 Engineering Mathematics IV (3)	14EE420 Instrumentation Systems (3)	14EE430 Control Systems (3)	14EE440 AC Machines (3)	14EE450 Engineering Design (3)	14EE460 Microcontrollers (3)		14EE480 AC Machines Lab (1)	14EE490 Microcontrollers Lab (1)	14EE4C0 Capstone Course-I (2)	**22**
V	14EE510 Engineering Mathematics V (3)	14EE520 Power Electronic Circuits (3)	14EE530 Digital Controls (3)	14EE540 Energy Resources and utilization (3)	14EE550 Digital Signal Processing (3)	14EEPx0 Prog. Elec.I (3)		14EE580 Digital Signal Processing Lab (1)	14EE590 Control & Instrumentation Lab (1)	--	**20**
VI	14EE610 Financial Management (3)	14EE620 Design of Power Supplies (3)	14EE630 Electric Power Transmission System (3)	14EEPX0 Prog. Elec.II (3)	14EEGx0 Gen. Elec. I (3)		14EG670 Professional Communication (3)	14EE680 Power System Lab (1)	14EE690 Power Electronics and Drives Lab (1)	--	**20**
VII	14EE710 Project Management (3)	14EE720 Drives and Control (3)	14EE730 Industrial Automation (3)	14EEPx0 Prog. Elec.III (3)	14EEPx0 Prog. Elec.IV (3)	14EEGx0 Gen. Elec. II (3)		--		14EE7C0 Capstone Course-II (2)	**20**
VIII	14EEPx0 Prog. Elec.V (3)	14EEPx0 Prog. Elec.VI (3)	14EEPx0 Prog. Elec.VII (3)	--	--	--	--	14EE880 Project (12)		--	**21**
										Total Credits	**164**

Basic Science Courses

Humanities and Social Science Courses

Engineering Science courses

Analog & Digital Electronic System Courses

Electrical Energy System Courses

Power Electronics & Drives Courses

Control & Automation Courses

Core and General Elective Courses, Capstone Courses & Project

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. EEE Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15)

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week L	T	P	Credits
THEORY						
14EE210	Engineering Mathematics - II	BS	2	2	-	3
14EE220	Materials Science for Electrical Engineering	BS	2	-	2	3
14EE230	Environmental Science and Ethics	BS	3	-	-	3
14EE240	Electromagnetic fields	ES	2	2	-	3
14EE250	Analog Devices and Circuits	PC	3	-	-	3
THEORY CUM PRACTICAL						
14EE270	Electric Circuit Analysis	PC	2	-	2	3
PRACTICAL						
14EE280	Analog Devices and Circuits Lab	PC	-	-	2	1
14ES290	Workshop	ES	-	-	2	1
	Total		**14**	**4**	**8**	**20**

THIRD SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week L	T	P	Credits
THEORY						
14EE310	Engineering Mathematics - III	BS	2	2	-	3
14EE320	Transformers	PC	2	2	-	3
14EE330	DC Machines	PC	2	2	-	3
14EE340	Measurement Systems	PC	3	-	-	3
14EE350	Digital Systems	PC	2	2	-	3
THEORY CUM PRACTICAL						
14EE370	Problem Solving Using Computers	ES	2	-	2	3
PRACTICAL						
14EE380	DC Machines and Transformers	PC	-	-	2	1

	Lab					
14EE390	Digital Systems Lab	PC	-	-	2	1
Total			**13**	**8**	**6**	**20**

FOURTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	**T**	**P**	
THEORY						
14EE410	Engineering Mathematics - IV	BS	2	2	-	3
14EE420	Instrumentation Systems	PC	3	-	-	3
14EE430	Control Systems	PC	3	-	-	3
14EE440	AC Machines	PC	3	-	-	3
14EE450	Engineering Design	PC	1	-	4	3
14EE460	Microcontrollers	PC	3	-	-	3
PRACTICAL						
14EE480	AC Machines Lab	PC	-	-	2	1
14EE490	Microcontrollers Lab	PC	-	-	2	1
14EE4C0	Capstone Course-I	PC	-	-	4	2
Total			**15**	**2**	**12**	**22**

BS : Basic Science
ES : Engineering Science
PC : Programme Core
PE : Programme Elective

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. EEE Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE210	Engineering Mathematics - II	3	50	50	100	25	50
2	14EE220	Materials Science for Electrical Engineering	3	50	50	100	25	50
3	14EE230	Environmental Science and Ethics	3	50	50	100	25	50
4	14EE240	Electromagnetic fields	3	50	50	100	25	50
5	14EE250	Analog Devices and Circuits	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE270	Electric Circuit Analysis	3	50	50	100	25	50
PRACTICAL								
8	14EE280	Analog Devices and Circuits Lab	3	50	50	100	25	50
9	14ES290	Workshop	--	100	--	100	--	50

THIRD SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE310	Engineering Mathematics - III	3	50	50	100	25	50
2	14EE320	Transformers	3	50	50	100	25	50

3	14EE330	DC Machines	3	50	50	100	25	50
4	14EE340	Measurement Systems	3	50	50	100	25	50
5	14EE350	Digital Systems	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE370	Problem Solving Using Computers	3	50	50	100	25	50
PRACTICAL								
8	14EE380	DC Machines and Transformers Lab	3	50	50	100	25	50
9	14EE390	Digital Systems Lab	3	50	50	100	25	50

FOURTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE410	Engineering Mathematics - IV	3	50	50	100	25	50
2	14EE420	Instrumentation Systems	3	50	50	100	25	50
3	14EE430	Control Systems	3	50	50	100	25	50
4	14EE440	AC Machines	3	50	50	100	25	50
5	14EE450	Engineering Design	--	100	--	100	--	50
6	14EE460	Microcontrollers	3	50	50	100	25	50
PRACTICAL								
7	14EE480	AC Machines Lab	3	50	50	100	25	50
8	14EE490	Microcontrollers Lab	3	50	50	100	25	50
9	14EE4C0	Capstone Course-I	--	100	--	100	--	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

		Category	L	T	P	Credit

		Category	L	T	P	Credit
14EE410	**ENGINEERING MATHEMATICS - IV**	EE	2	2	0	3

Preamble

An engineering student needs to have some basic mathematical tools and techniques to apply in diverse applications in Engineering. This emphasizes the development of rigorous logical thinking and analytical skills of the student and appraises him the complete procedure for solving different kinds of problems that occur in engineering. Based on this, the course aims at giving adequate exposure in random variables, probability distributions, random process sampling theory and Z-transforms.

Prerequisite

- 14MA110 - Engineering Mathematics-I

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Solve the given difference equations using Z- transform.	Apply
CO2	Infer expectation, variance, standard deviation Moments and moment generating function for discrete and Continuous random variables.	Apply
CO3	Derive the probability density function of a given function of a random variables.	Apply
CO4	Apply the concept of testing of hypothesis for small and large samples by using various tests like t-test, F-test, z-test and chi-square test.	Apply
CO5	Estimate the functions of time when the probability measure is associated through random process.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M					M	M					
CO2.	M	L									L	
CO3.	M	L				M	S					
CO4.	M	L										
CO5.	M	L										

S- Strong; **M-**Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember (K1)	10	10	10	0
Understand (K2)	30	30	30	30
Apply (K3)	60	60	60	70
Analyse (K4)	--	--	--	--
Evaluate (K5)	--	--	--	--
Create (K6)	--	--	--	--

Course Level Assessment Questions

Course Outcome 1 (CO1): (Apply)

1. Compute $Z[a^n \sin n\theta]$ **and** $Z[a^n \cos n\theta]$
2. State and prove final value theorem
3. Use convolution theorem to evaluate $Z^{-1}\left[\frac{z^2}{(z-a)(z-b)}\right]$
4. Using Z transform, solve $u_{n+2} + 4u_{n+1} + 3u_n = 3^n$ with $u_0 = 0$ and $u_1 = 1$**.**

Course Outcome 2 (CO2): (Apply)

1. If X is a Poisson variate with parameter $\lambda > 0$, prove that E(X is even) $= \frac{1}{2}(1+e^{-2\lambda})$
2. 20% of the bolts produced in a factory found to be defective. Find the probability that in a sample of 10 bolts chosen at random, exactly two will be defective by using (i). binomial distribution, (ii). Poisson approximation to binomial distribution.
3. Derive mean and variance of weibull distribution.
4. In a test on 2000 electric bulbs, it was found that bulbs of a particular make, was normally distributed with an average life of 2040 hours and S.D of 60 hours. Estimate the number of bulbs likely to bourn for more than 2150 hours, less than 1950 hours, more 1920 hours but less than 2100 hours.

Course Outcome 3 (CO3): (Apply)

1. What is meant by independent random variable?
2. If the joint pdf of X and Y is f(x,y)= x+y,0<x<2,0<y<1

   = 0 elsewhere,

   Then find the joint density function of $\sqrt{X^2+Y}$
3. The current I and resistance R in a circuit are independent continuous RVs with the following density functions.

   f(i) = 2i, 0≤i≤1
   = 0 elsewhere, and

   g(r) = $\frac{r^2}{9}$, 0≤ri≤3
   = 0 elsewhere,
   Find the pdf of the voltage E in the circuit, where E IR. Show that X and Y are statistically dependent.

Course Outcome 4 (CO4): (Apply)

1. Examine whether the two samples for which the data are given in the following table could have been drawn from populations with the same SD.

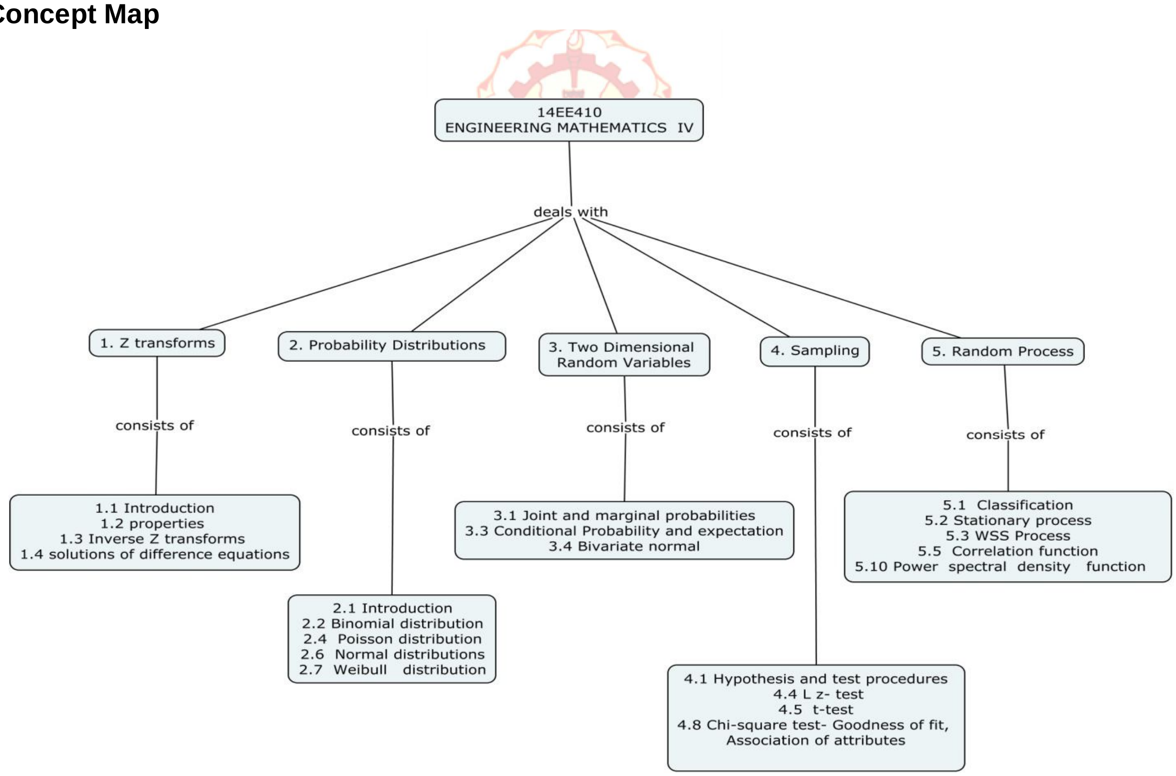
	Size	S.D
Sample 1	100	5
Sample 2	200	7

2. The heights of 10 males of a given locality are found to be 175, 168, 155, 170, 152, 170, 175, 160, and 165 cm. Based on this sample, determine the 95% confidence limits for the height of males in that locality.
3. The following are the number of minutes it took a sample of 15 men and 12 women to complete the application form for a position.
   Men: 16.5, 20.0, 17.0, 19.8, 18.5, 19.2, 19.0, 18.2, 20.8, 18.7, 16.7, 18.1, 17.9, 16.4, 18.9.
   Women: 18.6, 17.8, 18.3, 16.6, 20.5, 16.3, 19.3, 18.4, 19.7, 18.8, 19.9, 17.6.
   Apply the Mann-Whitney test at the level of significance $\alpha = 0.05$ to the null hypothesis that the two samples come from identical population.

Course Outcome 6 (CO6): (Apply)

1. What is wide sense stationary process?
2. Check whether the random process X(t) =A$e^{i\omega t}$ is a WSS if E[A]=0
3. If the random process X(t)= sin($\omega t + y$) where y is a random variable uniformly distributed in the interval (0,2π),prove that for the process X(t),
   $C(t_1,t_2) = R(t_1,t_2) = \frac{\cos\omega(t_1-t_2)}{2}$

Concept Map



Syllabus:

Z transforms : Definitions, properties, transforms of derivatives , Inverse Z transforms, Application to solutions of difference equations.
Probability Distributions: Discrete & continuous distribution - Binomial distribution, Poisson distribution, Normal distribution and Weibull distribution.

Two-Dimensional Random Variables: Joint probability distribution-Distribution function-Density function, Conditional Probability, Conditional probability and expectation, the bivariate normal Transformation of random variables.

Sampling: Testing of Hypothesis - Test of significance for small samples- t-test, F-test. Large sample tests and chi-square test: Goodness of fit, Association of attributes.

Random Process: : Classification – Stationary process – Auto correlation functions – properties - Power spectral density - The matched filter - The Wiener filter - The Wiener–Khinchin theorem.

Text Books

1. Li Tan, Digital Signal Processing Fundamentals and Applications, Academic Press, 2008. (Module 1)
2. Jay L. Devore ,Probability and Statistics for Engineering and the Sciences (English) 8^{th} Edition, Cengage Learning India Pvt Ltd, New Delhi, 2012. (Module 2, 4)
3. John A. Gubner, Probability And Random Processes For Electrical And Computer Engineers, Cambridge University Press, New York, 2006 (Module 3, 5)

Reference Books

1. B.S.Grewal, "Higher Engineering Mathematics" 39^{th} Edition, Khanna Publishers, New Delhi, 2005
2. T.Veerarajan, "Probability , Statistics and Random Processes" Second Edition, Tata McGraw Hill publishing Company Limited, New Delhi, 2006
3. John A. Gubner, " Probability And Random Processes For Electrical And Computer Engineers" Cambridge University Press, 2006

Course Contents and Lecture Schedule

Module No	Topic	No.of Lectures
1	**Z Transforms**	
1.1	Introduction	1
1.2	Properties	1
	Tutorial	1
1.3	Inverse z-Transform	1
1.4	Solution of Difference Equations Using the z-Transform	1
	Tutorial	1
2	**Probability Distributions**	
2.1	Introduction - Random Variables, Probability Distributions for Discrete Random Variables Expected Values, Expected values for discrete and continuous random variables	2
2.2	The Binomial probability distribution	1
2.3	The Binomial Probability Distribution	1
	Tutorial	1
2.4	The Poisson Probability Distribution	1
2.5	Probability Density Functions and Expected Values	1
	Tutorial	1

2.6	The Normal Distribution	2
2.7	Weibull Distribution	1
	Tutorial	1
3.	**Two-Dimensional Random Variables**	
3.1	Joint and marginal probabilities	1
3.2	Jointly continuous random variables	1
	Tutorial	1
3.3	Conditional probability and expectation	1
3.4	The bivariate normal	1
	Tutorial	1
4	**Sampling**	
4.1	Hypotheses and test procedures	1
4.2	Tests concerning a population mean	1
4.3	Tests Concerning a population proportion	1
4.4	*z* Tests and confidence intervals for a difference between two population means	1
	Tutorial	1
4.5	The two-Sample *t* Test and confidence interval	1
4.6	Inferences concerning a difference between population proportions	1
4.7	Inferences concerning two population variances	1
4.8	Chi-Square tests	1
	Tutorial	1
5.	**Random Process**	
5.1	Definition and examples , Characterization of random processes	1
5.2	Strict-sense and wide-sense stationary processes	1
5.3	WSS processes through LTI systems	1
5.4	Power spectral densities for WSS processes	1
	Tutorial	1
5.5	Characterization of correlation functions	1
5.6	The matched filter	1
5.7	The Wiener filter	1
5.8	The Wiener–Khinchin theorem	1
5.9	Mean-square ergodic theorem for WSS processes	1
5.10	Power spectral densities for non-WSS processes	1
	Tutorial	1
	Total	**46**

Course Designers

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14EE420	**INSTRUMENTATION SYSTEMS**	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Instrumentation systems helps to create, construct and maintain measuring devices and systems found in manufacturing plants and research institutions. Its main objective is to ensure that systems and processes operate safely and efficiently. This course will provide an adequate exposure to various sensors, transducers, signal conditioning processes, data acquisition and interfacing. This course also provides detail knowledge about the usage of suitable sensing elements for the vital parameters like pressure, temperature, Speed, magnetic field, Current, Voltage & liquid level.

Prerequisite

- 14EE340: Measurement System
- 14EE350: Digital Systems

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Define traceability of standards pertaining to calibration of instruments.	Understand
CO2	Explain the need of signal conditioning for sensors and transducers	Understand
CO3	Explain the effects of various noises (thermal, electromagnetic) in the electrical and electronics systems and their remedies (shielding, grounding)	Understand
CO4	Explain the building blocks of Data Acquisition systems	Understand
CO5	Explain the advantages and limitations of data transmission using pneumatic loop, current loop (4-20mA), digital interfaces (RS232,485) , protocols (HART) and Fieldbus (PROFIBUS)	Understand
CO6	Explain the importance of instrumentation in power system domain	Understand
CO7	Application of suitable sensors/transducers for the measurement of pressure, temperature, speed, magnetic field, Current - Voltage & liquid level	Apply
CO8	Realize the basics and importance of recent developments in instrumentation, like smart sensors, MEMS, Nano sensors	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO6.	M					M	M					
CO7.	M	L									L	
CO8.	M	L				M	S					
CO9.	M	L										
CO10.	M	L										
CO11.	L				M		S					
CO12.	S	S	S	L						M	L	
CO13.	M	L										

S- Strong; **M-**Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember (K1)	20	20	20	20
Understand (K2)	80	50	50	50
Apply (K3)	--	30	30	30
Analyse (K4)	--	--	--	--
Evaluate (K5)	--	--	--	--
Create (K6)	--	--	--	--

Note:

1. Assignments will be in the form of seminar & quiz

Tentative titles for seminars will be:

i. Design and justify: a bridge amplifier circuit to measure temperatures in the temperature range 25°c to 50°c.
ii. Design and justify: a signal-conditioner for a sensor that varies its resistance from 1kΩ to 5kΩ over its operating range to interface to an analog to digital converter operating in the range of 0v to 5v
iii. Practical aspects of serial interface and data transmission
iv. Communication protocols in Digital instrumentation systems
v. Serial Interface standards: RS422 & RS485
vi. Fieldbus: modbus
vii. Discuss and elaborate the instrumentation system involved in power quality analyzer
viii. Collect the details of various parameters measurement and related instrumentation systems involved in Thermal power plant – Elaborate the same.
ix. MEMS applications to electrical engineering
x. Concepts of Nano Sensors

Course Level Assessment Questions

Course Outcome 1 (CO1):

2. What is mean by Traceability? ***(K1)***
3. Why are calibrations and traceability necessary? ***(K2)***
4. Explain the traceability hierarchy with respect to the traceability of measurement.***(K2)***

Course Outcome 2 (CO2):

5. List the common signal conditioning operations. ***(K1)***
6. Compare the three types of isolation amplifier. ***(K2)***
7. What are the two drawbacks of differential amplifier that are solved in instrumentation amplifier? ***(K1)***

Course Outcome 3 (CO3):

8. What is the basic principle of shielding electric field interference? ***(K1)***
9. Can both ends of a shield be connected to grounds? What would happen if both ends are connected to grounds? ***(K2)***
10. Which types of filter do you choose to eliminate 50Hz noise? ***(K2)***

Course Outcome 4 (CO4):

11. List the various Data Acquisition Configurations. ***(K1)***
12. Explain the blocks of PC based Data Acquisition Systems ***(K2)***
13. Explain the GPIB data acquisition. ***(K2)***

Course Outcome 5 (CO5):

14. List the advantages and disadvantages of Pneumatic loop. ***(K1)***

15. Summarize the importance of current loop control. ***(K2)***
16. List the applications where serial communication is preferred. ***(K1)***

Course Outcome 6 (CO6):

17. Define PMU. ***(K1)***
18. List the primary sensing element for power measurements ***(K1)***
19. Illustrate the parameters needs to be controlled in a thermal power plant? ***(K1)***

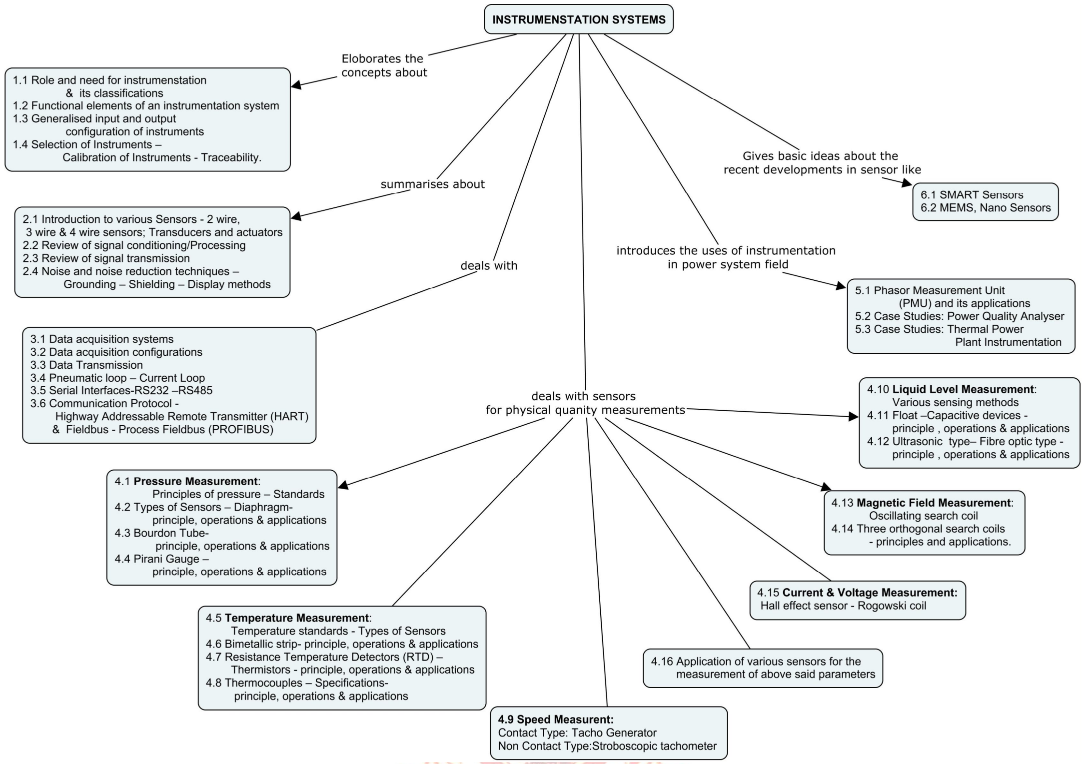
Course Outcome 7 (CO7):

20. A pressure gage is to be used in an LVDT – diaphragm combination. The LVDT has sensitivity of 1V/mm, and the diaphragm is to be constructed of steel (E=200GPa, v=0.3 and density 7800kg/m3) with a diameter of 20cm. Calculate the diaphragm thickness in accordance with the restriction that the maximum deflection does not exceed one fourth of this thickness. The maximum pressure is 2MPa. If a millivoltmeter capable of measuring a minimum of 1mV and that can be measure in steps of 1mV, is used for measurement, What is the lowest pressure in kPa which may be sensed by this instrument, resolution and the natural frequency of the diaphragm? ***(K3)***
21. An experiment is conducted to calibrate a copper –constant thermocouple. With cold junction at 0°C, emf obtained at boiling point of water (100°C) and boiling point of sulphur (445°C) are 5 mV and 25 mV, respectively. If the relation is assumed to be $e_{t1-t2}=a(t_1-t_2)+b\,(t_1^2-t_2^2)$. Determine constants a and b. ***(K2)***
22. A resistance thermometer is to be constructed of nickel wire. Thermometer resistance at 20°C is 100Ω. What length of 0.4mm-diameter wire should be used. What would be the length if 2mm diameter wire is used? (Resistivity =0.8 Ωm). If resistance varies linearly with temperature then what would be the resistance at t = -50°C and 100°C? (Sensitivity = 0.2 Ω /°C). ***(K3)***

Course Outcome 8 (CO8):

23. Define SMART SENSOR. ***(K1)***
24. Explain a smart sensor with block diagram. ***(K2)***
25. What is mean by MEMS? ***(K1)***

Concept Map



Syllabus

INTRODUCTION TO INSTRUMENTATION

Role & Needs of instrumentation – Classification of Instrument - Functional elements of an instrumentation system –Generalised input and output configuration of instruments– Selection of Instruments – Calibration and Traceability of measuring Instruments.

BASICS OF SENSORS AND TRANSDUCERS

Introduction to various Sensors- two wire, three wire & four wire sensors; Transducers and actuators – Review of signal conditioning/Processing – Review of signal transmission - noise and noise reduction Techniques – Grounding – Shielding – Display methods

DATA ACQUISITION AND INTERFACING

Data acquisition systems – Data acquisition configurations – Data Transmission – Pneumatic loop – Current Loop – Serial Interfaces-RS232 –RS485 – Communication Protocol – Highway Addressable Remote Transmitter (HART) - Fieldbus - Process Fieldbus (PROFIBUS)

APPLICATION OF SENSORS FOR PHYSICAL QUANTITY MEASUREMENTS

Pressure Measurement: Principles of pressure – Standards - Types of Sensors – Diaphragm - Bourdon Tube – Pirani Gauge – principle, operations & applications; **Temperature Measurement:** Temperature standards - Types of Sensors – Bimetallic strip – Resistance Temperature Detectors (RTD) – Thermistors – Thermocouples – Specifications-principle, operations & applications; **Speed Measurement**: Contact type - Tachometer generator, Non Contact Type - Stroboscopic tachometer; **Liquid Level Measurement:** Various sensing methods- Float –Capacitive devices - Ultrasonic type – Fibre optic type - principle , operations & applications; **Magnetic Field Measurement:** Oscillating search coil – three orthogonal search coils – principles and applications; **Current & Voltage Measurement:** Hall effect sensor **-** Rogowski coil; Application of various sensors for the measurement of above said parameters.

INTRODUCTION TO INSTRUMENTATION IN POWER SYSTEMS
Introduction - Phasor Measurement Unit (PMU) and its applications – Case Studies: Power Quality Analyser – Power Plant Instrumentation

INTRODUCTION TO RECENT DEVELOPMENTS IN SENSORS
Introduction – SMART Sensors, MEMS, Nano Sensors

Text Books

1. A.K. Sawhney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpat Rai & Co, 2010.
2. E.O. Doebelin, Measurement Systems – Application and Design, Tata McGraw Hill publishing company, 2003.

Reference Books

1. Robert.B.Northrop, Introduction to instrumentation and measurements, Allied Publishers, 2002.
2. Patranabis,D, Principles of Industrial Instrumentation, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2010.
3. B. E. Jones, Instrumentation measurement and Feedback, Tata McGraw-Hill, 2000.
4. Kalsi H.S, Electronic Instrumentation , Tata McGraw-Hill 2003
5. Alan S. Morris, Principles of Measurement and Instrumentation, Prentice-Hall of India Pvt. Ltd., New Delhi, 2003
6. http://www.nist.gov/pml/mercury_traceability.cfm *(Module 1.4)*
7. http://www.european-accreditation.org/publication/ea-4-07-m *(Module 1.4)*

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**INTRODUCTION TO INSTRUMENTATION**	
1.1	Role & Needs of instrumentation – Classification of Instrument	1
1.2	Functional elements of an instrumentation system	1
1.3	Generalised input and output configuration of instruments	1
1.4	Selection of Instruments – Calibration of Instruments - Traceability.	1
2	**BASICS OF SENSORS AND TRANSDUCERS**	
2.1	Introduction to various Sensors- two wire, three wire & four wire sensors; Transducers and actuators	1
2.2	Review of signal conditioning/Processing	2
2.3	Review of signal transmission	1
2.4	Noise and noise reduction techniques – Grounding – Shielding – Display methods	2
3	**DATA ACQUISITION AND INTERFACING**	
3.1	Data acquisition systems	1
3.2	Data acquisition configurations	1
3.3	Data Transmission	1
3.4	Pneumatic loop – Current Loop	1
3.5	Serial Interfaces-RS232 –RS485	2
3.6	Communication Protocol - Highway Addressable Remote Transmitter (HART), Fieldbus - Process Fieldbus (PROFIBUS)	2
4	**APPLICATION OF SENSORS FOR PHYSICAL QUANTITY MEASUREMENTS**	
4.1	**Pressure Measurement:** Principles of pressure – Standards	1
4.2	Types of Sensors – Diaphragm- principle, operations & applications	1

Module No.	Topic	No. of Lectures
4.3	Bourdon Tube- principle, operations & applications	1
4.4	Pirani Gauge – principle, operations & applications	1
4.5	**Temperature Measurement:** Temperature standards - Types of Sensors	1
4.6	Bimetallic strip- principle, operations & applications	1
4.7	Resistance Temperature Detectors (RTD) – Thermistors - principle, operations & applications	1
4.8	Thermocouples – Specifications- principle, operations & applications	1
4.9	**Speed Measurement**: Contact type - Tachometer generator, Non Contact Type - Stroboscopic tachometer;	1
4.10	**Liquid Level Measurement:** Various sensing methods	1
4.11	Float –Capacitive devices - principle , operations & applications	1
4.12	Ultrasonic type– Fibre optic type - principle , operations & applications;	1
4.13	**Magnetic Field Measurement:** Oscillating search coil	1
4.14	Three orthogonal search coils – principles and applications.	1
4.15	**Current & Voltage Measurement:** Hall effect sensor **-** Rogowski coil	1
4.16	Application of various sensors for the measurement of above said parameters.	1
5	**INTRODUCTION TO INSTRUMENTATION IN POWER SYSTEMS**	
5.1	Introduction - Phasor Measurement Unit (PMU) and its applications	1
5.2	Case Studies: Power Quality Analyser	1
5.3	Case Studies: Thermal Power Plant Instrumentation	
6	**INTRODUCTION TO RECENT DEVELOPMENTS IN SENSORS**	
6.1	SMART Sensors	1
6.2	MEMS, Nano Sensors	1
	TOTAL	**38**

Course Designers:

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14EE430	CONTROL SYSTEMS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

This course is to impart in students a good understanding of fundamental principles in control engineering. The course includes: Mathematical Modelling of Linear Continuous Time Invariant Single Input - Single Output Dynamical Systems, Transfer Functions and State Space Models, Performance Specifications, Analysis and Design of Closed Loop Control Systems.

Prerequisite

Linear Algebra, Calculus and Differential Equations, and Laplace Transform.

Course Outcomes

On the successful completion of the course, students will be able to:

COs	Course outcomes	Blooms Level
CO1	Explain the needs and effects of feedback in a control system	Understand
CO2	Identify the type (Linear, nonlinear) of a given system from mathematical model and input output characteristics (steady state and transient response)	Apply
CO3	Obtain mathematical model of a given Electrical, electro-mechanical system in transfer functions and state space models	Apply
CO4	Explain mathematical models (transfer functions and state space) of hydraulic, Pneumatic, thermal and liquid level systems.	Understand
CO5	Explain the characteristics and principle of operation of control system components (including final control elements)	Understand
CO6	Analyze the system's stability and performance (both in time domain and frequency domain) in terms of the key characteristics of the models.	Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	L	L	L								
CO2	S	M	M	L								
CO3	S	S	M	M	L							
CO4	S	S	L	L	L							
CO5	S	L	M	L								
CO6	S	S	S	S	S							

S-Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Note: Analyse level for CO 6 will be tested with assignments/tutorials

Course Level Assessment Questions

Course Outcome 1 (CO1):

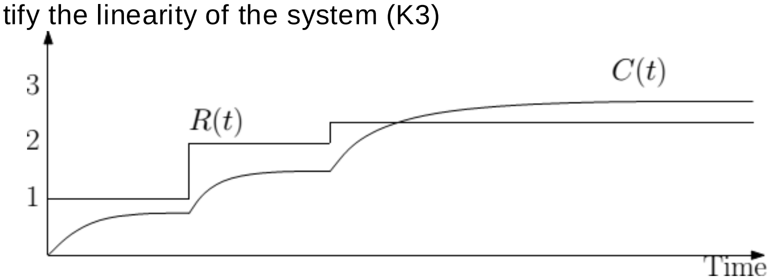
1. List the difference between closed loop and open loop systems (K1)
2. Explain the issues with ON/OFF control in dynamic systems (K2)
3. Explain the effects of feedback (K2)

Course Outcome 2 (CO2):

1. Identify the causality and linearity of the systems modelled with the differential equations shown below (K3)
   a. $\frac{dy(t)}{dt} + 2y(t) = 3u(t+3)$
   b. $\frac{d^2y(t)}{dt} + 2y^2(t) = 3u(t-2)$
2. I/O characteristics of the system is shown below. Identify the linearity of the system (K3)

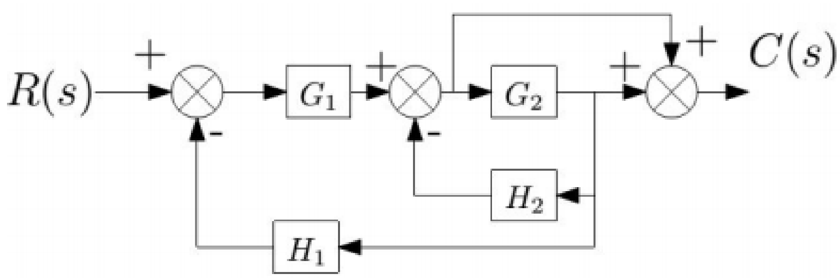
Input U	0	1	3	4
Output Y	-1	2	3.5	4.5

3. Series of step input R(t) is applied to a system and the response C(t) is recorded as below. Identify the linearity of the system (K3)

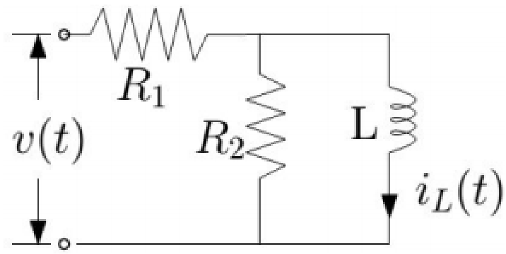


Course Outcome 3 (CO3):

1. Define transfer function (K1)
2. Reduce the block diagram and find C(s)/R(s) (K3)



3. Develop the transfer function $I_L(s)/V(s)$ (K3)



Course Outcome 4 (CO4):
1. Explain the implementation of PI controller using pneumatic systems. (K2)
2. Derive the transfer function of non-interacting cascaded tank system. (K2)
3. Derive the first order model of thermometers.(K2)

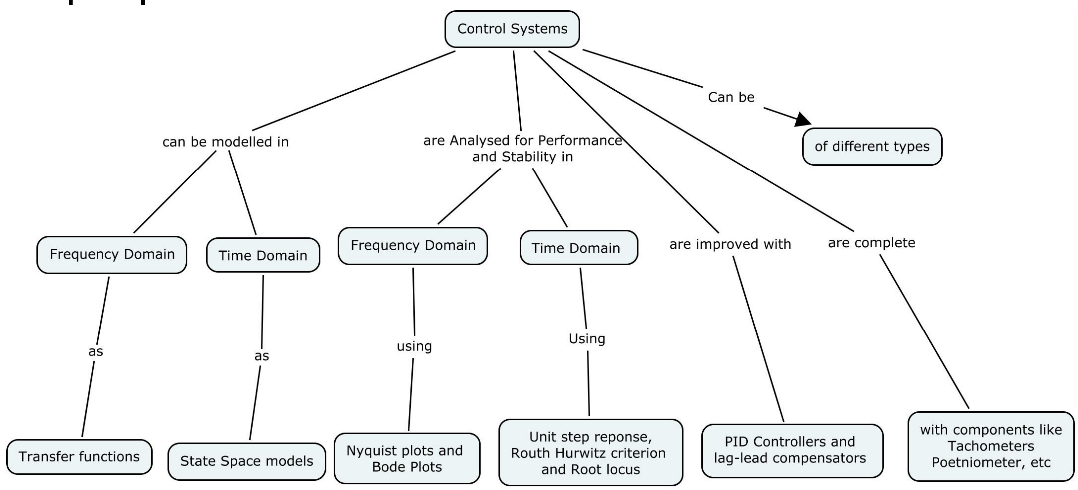
Course Outcome 5 (CO5):
1. List the unique characteristics of servo motors. (K1)
2. With suitable diagram explain the principle of operation of tachometers. (K2)
3. Describe the operation of incremental encoders with neat diagram. (K2)

Course Outcome 6 (CO6):
1. The open loop transfer function of a unity feedback control system is given by $G(s)=\dfrac{0.4s+1}{s(s+0.6)}$. (K3)
    a. Calculate the closed loop transfer function and calculate the response for unit step reference
    b. Calculate the maximum peak overshoot
2. Sketch the root locus for $G(s)H(s)=\dfrac{K}{s(s+1)(s+3)}$ and find the value of K for damping ratio $\zeta=0.5$ (K3)
3. Sketch the bode plot of the system $G(s)H(s)=\dfrac{2000}{s(s+2)(s+100)}$ and determine gain margin and phase margin. (K3)
4. A negative unity feedback system has the forward transfer function

$$G(s)H(s)=\frac{K}{s(s+1)(s+3)}$$

If *K* is set to 20, find the changes in closed-loop pole location for a 5% change in *K. (K4)*

Concept Map



Syllabus

Basic concepts: Systems- Types of control systems-Notion of feedback- open and closed-loop systems –Fundamental control actions (ON/OFF, Hysteresis control), Problems with ON OFF control in dynamic systems – Logical Control vs. Continuous control - Effects of feedback

Modelling: Modelling and representations of (electrical, electro-mechanical, hydraulic, Pneumatic, thermal and liquid level) control systems: Ordinary differential equations - Transfer functions - Block diagrams - Signal flow graphs - State-space representations.

Control System Components: Potentiometer, Tachometers, Encoders, Servo Motors and actuators (control valves, solenoids)

Time domain analysis and stability: Test Signals- Unit Step response, Time domain specifications and Steady state errors- Time response of First order and second order systems- Effect of addition of poles and Zeros- Dominant poles and zeros of Transfer function- PID Controllers -Stability and Characteristic equation-Routh-Hurwitz criteria- Root-locus construction, root sensitivity. Solution of state equation

Frequency-domain analysis: Frequency responses and Frequency domain specifications - Nyquist stability criterion- Relative stability assessment using Bode plot- Nichol's chart, Lead-lag compensators

Text Books

1. B.C. Kuo, and F.Golnaraghi, Automatic Control Systems, 9th Edition. Wiley India Pvt limited 2014. (Student edition)
2. IJ Nagrath and M Gopal, Control Systems engineering, 5th Edition, New Age International, 2007

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition, PHI, 2010
2. John JD Azzo, Constantine H Houpis, and Stuart N Sheldon, Linear Control Systems: Analysis and Design with MATLAB, 5th Edition, Taylor and Francis, 2003
3. Norman S. Nise, Control Systems Engineering, 6th edition, John Wiley, 2010. (Indian edition)
4. Robert H Bishop and Richard C Dorf, Modern Control Systems, 12th Edition, Pearson Education, 2010
5. M Gopal, Control Systems-Principles and Design, 4th Edition, McGraw Hill India, 2012

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lecture Hours
1	Systems; Types of Control systems- Open loop and Feedback Systems	2
2	Effects of feedback	2
3	Differential Equations for Electrical, Mechanical, Electro-mechanical, hydraulic, pneumatics, thermal and liquid systems	4
4	Transfer function	1
5	Block Diagram	1
6	Signal flow graph	1
7	State space models	2
8	Control System Components-Potentiometer, Tachometer, Encoders, Servo Motors and actuators(control valves, solenoids)	2
9	Test Signals, Unit step response, Time domain Specifications and steady state error	2
10	Time response of First and Second Order systems; Effect of addition of poles and zeros; Dominance of poles and zeros; PID Controllers; Solution of state equation	5
11	Stability and Routh Hurwitz criterion	2
12	Root locus Construction and Root sensitivity	3
13	Frequency domain specifications and Nyquist stability criterion	3
14	Relative stability assessment using Bode plots	2
15	Frequency response of closed loop systems; Nichol's chart	2
16	Lead-lag compensators	1
	Total	**36**

Course Designers:

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14EE440	AC MACHINES	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Rotating electrical machines are widely used for the purpose of converting energy from one form to another. AC machines are becoming more and more attractive in many applications such as those requiring variable speed and flexible control. Alternating Current (AC) machines are the most preferred for generation of electric power. AC motors are the commonly used in industry for motive power for applications. Electrical drive is superior to other forms of prime movers in terms of efficiency, control and pollution. There are three families of rotating machines one of which is the synchronous machine commonly in the form of the AC synchronous generator such machines are widely used in power stations for electric power generation. The synchronous motor has limited application. However an asynchronous machine, the induction motor has wide spread industrial and domestic application such that about 85 % of electric power consumption is due to induction motor loads. Single phase motor has wide spread small power application for example in the home. Due to their low cost and economical advantages, AC motors are widely used in applications requiring a wide range of speeds or precise control of output.

Prerequisite

14EE220	Material Science for Electrical Engineering
14EE240	Electromagnetic Fields
14EE270	Electric Circuits Analysis

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course Outcomes	Bloom's Level
CO1.	Explain the Fundamentals and laws governing motoring and Generating Action of AC Machines	Understand
CO2	Explain the construction of AC Machines and role of its parts	Understand
CO3	Obtain the performance of AC Generators	Apply
CO4	Obtain the performance of AC Motors using equivalent circuit	Apply
CO5	Explain the Operation and Control of AC Machines	Understand
CO6	Apply the testing procedures for AC Machines as per the standard practice	Apply
CO7	Design of Main Dimensions of AC Machines for the given Specifications	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**											**M**
CO2	**S**											**L**
CO3		**S**		**S**								**M**
CO4	**S**	**M**		**M**								**L**
CO5	**M**		**S**									**L**
CO6	**M**		**S**									**L**
CO7	**M**		**S**									**L**

S- Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	-	20
Understand	40	40	-	40
Apply	40	40	-	40
Analyse	--	--	--	--
Evaluate	--	--	-	--
Create	--	--	-	--

- ***CAT-3**: Group presentation (Seminar/Quiz/Role play) in the class for the case studies given below through Site visit/Industry Visit/Field trips. Based on the performance of the presentation, CAT-3 mark will be awarded.*

1. Energy Efficient Induction Motors
2. Duty Cycle , Type of Cooling ,Mounting & Enclosures
3. Induction Motor Manufacturing & Testing Standards
4. Alternator types and applications
5. Alternator – types of Cooling
6. Parallel operation of Alternators
7. Various faults in Synchronous and Asynchronous machines
8. Types of motors for Mixie, Grinder, Ceiling fan, Fridge, Air conditioners, Washing machines, Pumps, Compressors
9. Alternators in Hydro power plants / Thermal Power Plants/Wind Mills/ Gas & Diesel Power Plants.
10. Dielectric materials in various parts of Synchronous and Asynchronous machines.
11. Magnetic materials in various parts of Synchronous and Asynchronous machines.
12. Conducting materials in various parts of Synchronous and Asynchronous machines
13. Starting methods of various Synchronous and Asynchronous machines.
14. Condition monitoring of Synchronous and Asynchronous machines.
15. Routine maintenance in Synchronous and Asynchronous machines.

Note :

1. Divide the class into 18 groups with 4 students in each group
2. Topics will be assigned to all the group on Day 1

3. Each group will make a presentation for 20 minutes on the topic given in the list above on the site visit / field trip / industrial visit / laboratory experiments/ Data sheet
4. Award marks based on the presentation (technical Content, Question & Answer) for CAT 3
5. There will be no written test for CAT 3
6. CAT 1 & 2 is a written test covering the remaining topics in the syllabus content.

Course Level Assessment Questions

Course Outcome 1 (CO1):

Course Outcome 2 (CO2):

1. Specify the role of damper winding in Alternator?
2. What does skewing means in squirrel cage Induction motor?
3. Specify the purpose of connecting a capacitor in the auxiliary winding of a single-phase induction motor?

Course Outcome 3 (CO3).

1. Define the term voltage regulation in Alternator?
2. Specify the need of parallel operation of alternators.
3. Explain the method of finding voltage regulation using synchronous impedance method for alternator?
4. Find the synchronous impedance and reactance of an alternator in which a given field current produces an armature current of 200 amperes on short circuit and a generated EMF of 50 volts on open circuit. The armature resistance is 0.1 Ohms. Calculate the induced voltage of armature, if it is deliver a load of 100 amperes at a power factor of 0.8 lagging with terminal voltage of 200 Volts?

Course Outcome 4 (CO4)

1. Draw the v curve of Synchronous motor and specify its axis parameters?
2. Discuss the effect of rotor resistance and reactance with the help of speed torque curve of induction motor?
3. Find the percentage of tapping required on an auto-transformer required for a squirrel cage induction motor to start the motor against $1/3^{rd}$ of full load torque? The short circuit current on nominal voltage is 7 times of the full load current and the full load slip is 2%.
4. A Three phase induction motor has a 4 pole Delta connected stator winding and runs on a 415 Volts, 50Hz supply. The rotor resistance per phase is 0.18 ohms and reactance 1.2 ohms. The ratio of stator to rotor turns is 1.8. The full load slip is 3%. Calculate the load torque in kg-m and speed at maximum torque?

Course Outcome 5 (CO5)

1. Two alternators A and B are operating in Parallel and supply a load of 10MW at 0.8p.f. lagging. Suggest with justification, the possible way to carry out the following and hence determine the reactive and active power share by each alternator.
   i) Is the real power shared by alternator A is increased to 6 MW.
   ii) If the p.f. of alternator B is increased to 0.94.
2. With neat sketch explain the various speed control techniques applied for three phase induction motor.
3. Design a five step rotor resistance starter for a three phase induction motor. The slip at the maximum starting current is 2% with slip – ring short circuited and the resistance per rotor phase 0.02 Ohm.

Course Outcome 6 (CO6)

1. A three phase, 6600V, 50 Hz, star – connected alternator gave the following test results.

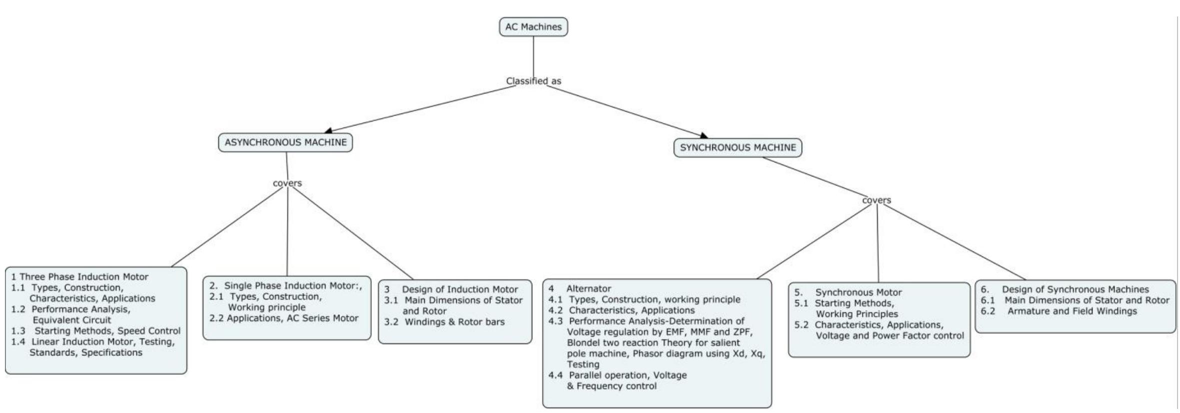
V_{OC}	3100	4900	6600	7500	8300
I_f	16	25	37.5	50	70

   A field current of 22A is required to circulate full load current on short circuit test. Calculate the full load voltage regulation for, 0.8 p.f. lagging using EMF and MMF method. Give your interpretation for difference in the regulation calculated.
2. With neat sketch explain the slip test on a salient pole alternator.

Course Outcome 7 (CO7)

1. A 1250 KVA 3 phase ,50 Hz,3300V, star connected ,300 rpm alternator has D =1.9m, L = 0.335m,pole arc/pole pitch = 0.66,turns/phase = 150,single layer concentric winding with 5 conductors per slot, short circuit ratio = 1.2.Assume that the distribution of gap flux is rectangular under pole arc with zero values in the interpolar region. Calculate a)specific magnetic loading b)armature mmf per pole c) gap density over pole arc d)air gap length.
2. Determine the main dimensions, number of radial ventilating ducts, number of stator slots and the number of turns/phase of a 3.7 KW,400 V,3 phase,4 pole,50 Hz squirrel cage induction motor to be started by star-delta starter. Assume B_{av} = 0.45 wb/m^2 .ampere conductors/m = 23,000,efficiency = 0.85and pf = 0.84,winding factor =0.955.Choose the main dimension to give good efficiency.
3. Calculate the main dimensions, turns per phase, number of slots, conductor area and slot area of a 250 HP, 3 phase, 50 Hz, 400 Volts, Delta connected Slip Ring Induction motor. The data given are:
   Bav. = 0.5 Tesla; ac = 30,000 A/Mt.; Efficiency = 90%; P.f. =90%;
   Kws = 0.955 ; Current Density = 3.5 A / mm ^{2} ; Space factor = 0.4;
   Ratio of core length to pole pitch = 1.5

Concept Map



Syllabus

ASYNCHRONOUS MACHINE

Three Phase Induction Motor : Types, Construction, Working Principle, Characteristics, Applications, Performance Analysis, Equivalent Circuit, Starting Methods, Speed Control, Linear Induction Motor, Testing, Standards, Specifications.

Single Phase Induction Motor: Types, Construction, Working principle, Applications, AC Series Motor.

Design of Induction Machines: Main Dimensions of Stator and Rotor, Windings.

SYNCHRONOUS MACHINE

Alternator: Types, Construction, working principle, Characteristics, Applications, Performance Analysis, Testing, Parallel operation, Voltage & Frequency control

Synchronous Motor: Starting Methods, Working Principles, Characteristics, Applications, Voltage and Power Factor control.

Design of Synchronous Machines: Main Dimensions of Stator and Rotor, Armature and Field Windings.

Text Books

1. H.Wayne Beaty & Jame. L.Kirtley.Jr " Electric Motor Handbook", McGraw-Hill, USA, 1st Edition, 1998.
2. A.K.Sawhney and A.Chakrabarti, "A course in Electrical Machine Design",6th Edition, Dhanpat Rai & Co (P) Ltd., 2006.
3. Gupta.J.B,"Theory of Performances of Electrical Machines' Katson, 7th Edition, 1987

Reference Books

1. R.K.Rajput, " Electrical Technology", Laxmi Publications, 3rd edition, 2005.
2. Vincent Deldoro ," Electromechanical Energy Conversion " PHI III edition,
3. M.G.Say, The Performance and Design of Alternating Current machines, Tata-McGraw Hill.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
	ASYNCHRONOUS MACHINE	
1	**Three Phase Induction Motor**	
1.1	Types, Construction, Characteristics, Applications	2
1.2	Performance Analysis, Equivalent Circuit	3
1.3	Starting Methods, Speed Control	2
1.4	Linear Induction Motor, Testing, Standards, Specifications	2

Module No.	Topic	No. of Lecture Hours
2.	**Single Phase Induction Motor**:,	
2.1	Types, Construction, Working principle	1
2.2	Applications, AC Series Motor	1
3	**Design of Induction Motor**	
3.1	Main Dimensions of Stator and Rotor	2
3.2	Windings & Rotor bars	2
	SYNCHRONOUS MACHINE	
4	**Alternator**	
4.1	Types, Construction, working principle	1
4.2	Characteristics, Applications	1
4.3	Performance Analysis-Determination of Voltage regulation by EMF, MMF and ZPF, Blondel two reaction Theory for salient pole machine, Phasor diagram using Xd, Xq, Testing	3
4.4	Parallel operation, Voltage & Frequency control	2
5.	**Synchronous Motor**	
5.1	Starting Methods, Working Principles	1
5.2	Characteristics, Applications, Voltage and Power Factor control	2
6.	**Design of Synchronous Machines**	
6.1	Main Dimensions of Stator and Rotor	3
6.2	Armature and Field Windings	2
	CAT 3- group presentation	8
	Total	**38**

Course Designers

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14EE50	ENGINEERING DESIGN	Category	L	T	P	Credit
		PC	1	0	4	3

Common for all B.E./B.Tech. Degree Programmes
(Course Codes: 14CE450, 14ME420, 14EC450, 14IT450, 14CS340,14MT420)

Preamble

Engineering design is normally taught, not as a unified course in India. The courses like Product design, Machine design, Electrical machine design and transformer design, Control system design and Communication system design are tailored to specific topics There were many new approaches developed over a period of time. There is a need to discuss a unified approach of design in a course.

Prerequisite

- None

Course Outcomes

On the successful completion of the course, students will be able to

CO1: Explain the steps involved in Engineering Design	Understand
CO2. Explain the Engineering Design process and review designs with societal considerations.	Understand
CO3: Provide specification for customer needs/requirements, considering engineering Characteristics and quality Function Deployment.	Apply
CO4: Prepare conceptual design document.	Apply

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		
	CAT 1	Review 1	Review 2
Remember	20	0	0
Understand	40	0	0
Apply	40	100	50
Analyse	0	0	50
Evaluate	0	0	0
Create	0	0	0

- Milestones:

  1. Problem description (3 weeks)
  2. Framework (4 weeks)
     i. Functional requirements
     ii. User requirements
     iii. Performance requirements
     iv. Specifications
  3. Preliminary design (conceptual) (3 weeks)
     i. Cost estimates
  4. Final design (conceptual document) (2 weeks)

Review 1 for milestones1 & 2 and Review 2 for milestones 3 & 4

List of Sample Projects:

Design and Testing of:

1. Speaker Amplifier – Power: 10 W;
2. Magnetic Shielding for a solenoid;
3. Digital Voltmeter :DC 0-1/10/30 V
4. Digital Ammeter :DC 0-30/50/100 mA
5. Transformer : 230/12-0-12, 100 mA
6. Variable DC power supply:0-24 V, 100 mA
7. Battery Charger: 12V, 100AHr
8. Digital Clock – LED display :Hr-Min-Sec, Date
9. Room Temperature Indicator - LED display :ºC/ºF
10. Current Transformer;5/1A
11. Welding Transformer;230/10V; 30A
12. Electromagnet: to lift 100gm weight
13. Digital Counter-LED display 4 digits: increment/decrement
14. Human weight & BMI measurement - LED display: Kg/Lb
15. Timer ON/OFF 5 sec. to 24 hrs. – LED display
16. LED light with driver & heat sink:10x1Watts/230V(White LED array-5 rows & 2 columns)

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Engineering Design
2. State different activities involved in Product Engineering Life Cycle
3. List different design considerations that are required for a good design
4. Explain different types of design
5. List the characteristics of environmentally responsible design

Course Outcome 2 (CO2):

1. List different modes to collect user requirements.
2. Briefly explain the classification of different types of User requirement
3. Define Benchmarking or Reverse Engineering or Product Dissection
4. List two categories of Redesign
5. Explain different activities involved in Design process
6. Explain different steps involved in Conceptual Design process

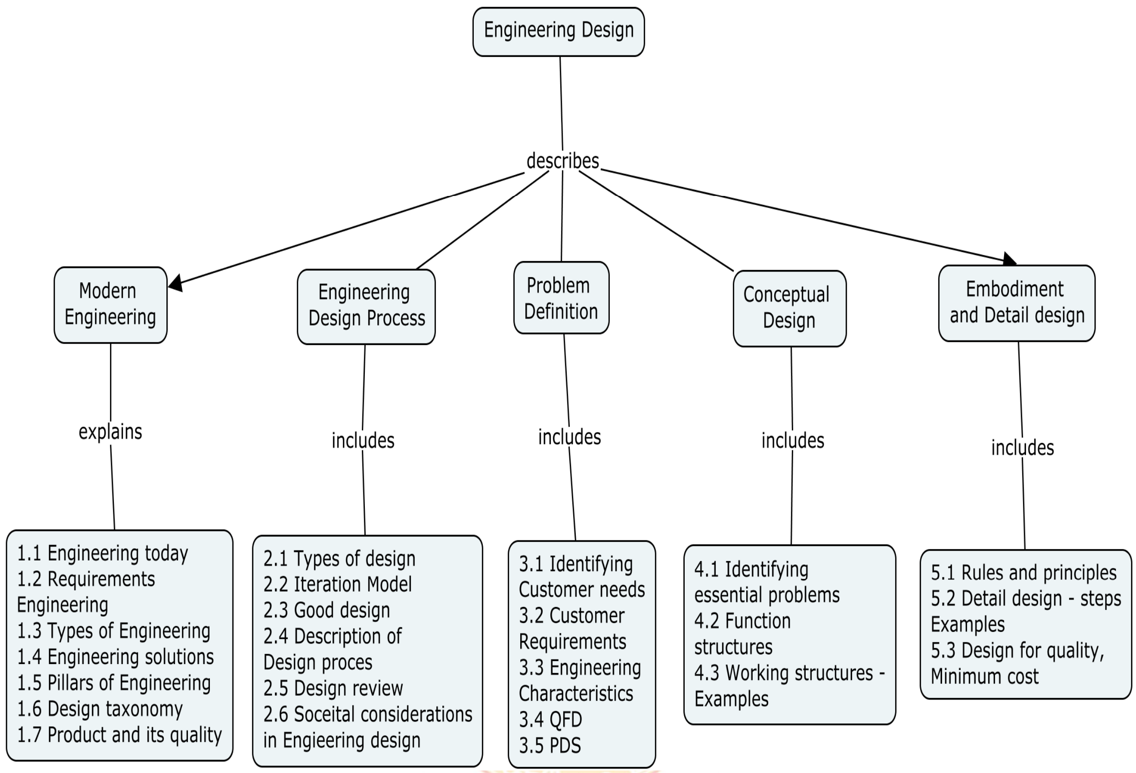
Course Outcome 3 (CO3)

1. Write product design specifications for any of the following product - Desktop Computer or Bicycle or Pencil or Computer Table or mobile.
2. Translate customer requirements into **Engineering characteristics** of any product like mobile or computer or bicycle.

Course Outcome 4 (CO4)

1. Prepare conceptual design document for any complex engineering problem related to societal engineering under specific domain.

Concept Map



Syllabus

Modern Engineering: Introduction, Engineering today, Requirements of engineering, Types of engineering, Engineering Solutions, Pillars of Engineering, Design Taxonomy, Product, Quality of product.
Engineering Design Process: Types of Designs, A Simplified Iteration Model, Considerations of a Good Design, Description of Design Process, Design Review, Societal Considerations in Engineering Design,
Problem Definition and Need Identification: Identifying Customer Needs, Customer Requirements, Establishing the Engineering Characteristics, Quality Function Deployment, product Design Specification

Conceptual Design: Steps, Abstracting to Identify the Essential Problems, Establishing Function Structures, Developing Working Structures and concepts. Examples
Embodiment and Detail Designs: Steps, Basic Rules and Principles of Embodiment Design, Detail Design, Design for Quality and minimum Cost. Examples

Reference Books

1. G.Pahl and W.Beitz (Translated by Ken Wallace et al.,) 'Engineering Design: A Systematic Approach, Second Edition, Springer, 2005.
2. George E. Dieter and Linda C. Schmidt, "Engineering Design", Fourth Edition, McGraw Hill Higher Education, 2009.
3. Power Point Presentation material by Prof.D.K.Subramanian in the Workshop on Engineering Design at TCE, Madurai.
4. Foundation Skills in Integrated Product Development, NASSCOM, Edition 2015

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Modern Engineering**	
1.1	Introduction - Engineering today	1
1.2	Requirements of engineering	
1.3	Types of engineering	1
1.4	Engineering Solutions	
1.5	Pillars of Engineering	
1.6	Design Taxonomy	1
1.7	Product and Quality of product	
2	**Engineering Design Process**	
2.1	Types of Designs	1
2.2	A Simplified Iteration Model	
2.3	Considerations of a Good Design	
2.4	Description of Design Process	1
2.5	Design Review	
2.6	Societal Considerations in Engineering Design	1
3	**Problem Definition and Need Identification**	
3.1	Identifying Customer Needs	1
3.2	Customer Requirements	
3.3	Establishing the Engineering Characteristics	
3.4	Quality Function Deployment	1
3.5	Product Design Specification	
4	**Conceptual Design**	2
4.1	Steps, Abstracting to Identify the Essential Problems	
4.2	Establishing Function Structures	
4.3	Developing Working Structures and concepts - *Examples*	
5	**Embodiment and Detail Design**	2
5.1	Steps, Basic Rules and Principles of Embodiment Design	
5.2	Detail Design – *Examples*	
5.3	Design for Quality and minimum Cost	
	Total Lectures	12

Course Designers:

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14EE460	**MICROCONTROLLERS**	Category	L	T	P	Credit
			3	0	0	3

Preamble

Microprocessors are the predecessors to microcontrollers and they are mainly used as CPU in the desktop computers and laptops nowadays and they are also used for measurement and control applications in the past few decades. Due to the development in VLSI technology, microcontrollers evolve which function similar to microprocessors but they have most of the peripherals built on-chip. Microcontroller is used as the main controller in most of the embedded systems nowadays. This course makes the students to be familiar with the architecture and programming of Microcontrollers. Introduction to Microprocessors and their evolution is also given. This course provides a detailed study of architecture and assembly language & embedded 'C' language programming of Intel 8051 microcontroller and interfacing various peripherals with 8051. This course also introduces the architecture and hardware features of PIC 16F877 and ARM7 (LPC2148) microcontrollers.

Prerequisite

- 14EE350 - Digital systems
- 14EE390 - Digital Systems Lab

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	**Course outcomes**	Blooms level
CO1	Explain the evolution and architecture of microprocessors and microcontrollers.	Understand
CO2	Explain the 8051 architecture and the function of on-chip hardware units in 8051.	Understand
CO3	Develop 8051 Assembly Language programs for data manipulations and accessing on-chip hardware units.	Apply
CO4	Develop 8051 embedded C programs for interfacing Matrix Keyboard, LCD, DAC, ADC and 7segment LED Display.	Apply
CO5	Explain the architecture and hardware features of PIC 16F877 and ARM7 (LPC2148).	Understand

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**S**						**S**					
CO2	**S**	**M**	**M**				**M**					
CO3	**S**	**S**	**S**		**M**		**M**					**S**
CO4	**S**	**S**	**S**	**M**	**S**				**S**	**M**	**M**	**S**
CO5	**S**											**M**

S- Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	20	20	20
Understand	40	20	20	20
Apply	20	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Note: Assignment evaluation is based on a mini-project which has to be done by a group of five students. The mini-project will be evaluated based on the reviews and demonstration.

Tentative List of Mini Projects:

1. Temperature / Speed measurement and display
2. Speed control of DC motor/stepper motor
3. Automatic Switching on/off of Appliances
4. SCR based Rectifier control
5. Wireless control using RF/Bluetooth/ Zigbee module

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. Explain the evolution of microprocessors.
2. State the applications of microprocessors and microcontrollers.
3. Compare microprocessors and microcontrollers.
4. Distinguish Harvard and Von Neuman architectures.
5. Give examples for RISC machines.
6. Explain the architecture of any one 8- bit microprocessor.

Course Outcome 2 (CO2):
1. Write the hardware features of 8051.
2. What is the function of EA* and PSEN* signals in 8051 (*-Active low signal)?
3. If a 12 MHz crystal is connected to 8051, how much is the time duration for one state and one machine cycle?
4. How to program the external interrupts of 8051 as falling edge or low level triggered interrupt?
5. Why external pull-up resistor is required for port-0 in 8051?
6. What must be done to configure a port as input port in 8051?
7. What is the difference between timer and counter in 8051?
8. Explain the function of various bits in the special function registers associated with serial communication in 8051.

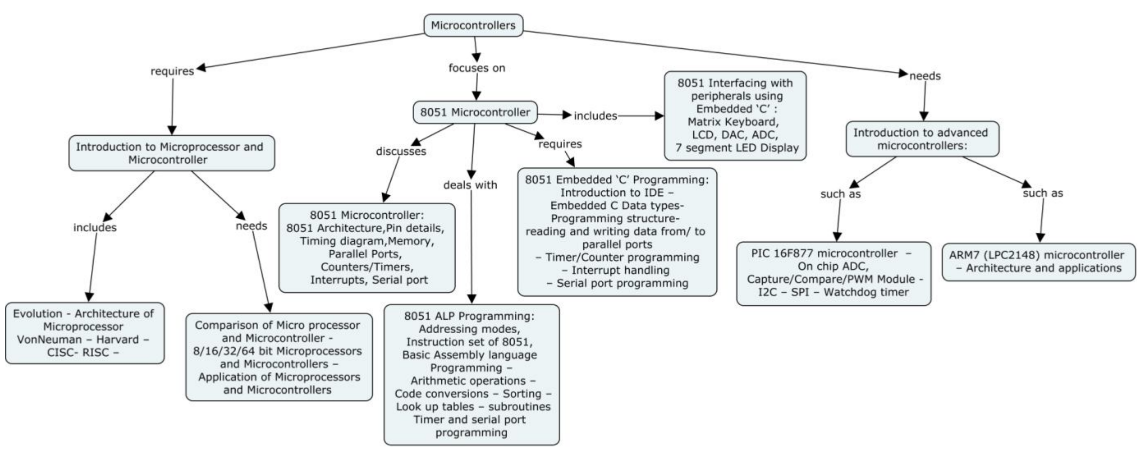
Course Outcome 3 (CO3):
1. What is meant by indirect addressing in 8051?
2. Write the 8051 ALP to add the bytes in an array, stored in the external data memory from the address 2000H and store the result in the addresses 3000H and 3001H. The array contains one hundred bytes of data.
3. Write the 8051 ALP to find the largest byte in an array, stored in the external data memory from the address 2000H and store the result in the address 3000H. The array contains one hundred bytes of data.
4. Write 8051 ALP to convert the given 8-bit binary number into BCD number.

5. Write 8051 ALP to convert the given 8-bit binary number into ASCII number.
6. Write 8051 ALP to find the seven segment code of an 8-bit binary number using look-up table technique.
7. Write 8051 ALP to evaluate the expression A/B+C*D where A,B,C and D are 8-bit data. Assume A is perfectly divisible by B.

Course Outcome 4 (CO4):
1. Interface an 2*16 LCD with 8051 and write embedded 'C' program to display the name of the Department and College in the middle portion of the LCD.
2. Interface an 8-bit ADC with 8051 and write ALP to get 100 samples of input data each taken at a time interval of 100 micro seconds and store the result in external data memory from the address 2000H. The crystal frequency is 12 MHz.
3. Interface an 8-bit DAC with 8051 and generate sine wave and triangular wave of 2 KHz frequency. The crystal frequency is 12 MHz.
4. Write 8051 based embedded C program to identify the key pressed in the matrix keyboard interfaced with 8051 and send the ASCII code of the key pressed in Port 0.
5. Write 8051 embedded C program to generate a square wave of 1 KHz using timer 0 of 8051. The crystal frequency is 12 MHz.
6. Interface two seven segment LEDs with 8051 and develop embedded C program to display the numbers from 00 to 99 in the LEDs.

Course Outcome 5 (CO5):
1. What is the function of watch dog timer?
2. Draw the start and stop signal timing diagram of I^2C interface.
3. List the on-chip hardware units available in PIC 16F877 microcontroller.
4. Explain the architecture of ARM 7 microprocessor.
5. Specify the function of CCP module in PIC 16F877 microcontroller.
6. State the applications of ARM microprocessor.

Concept Map



Syllabus

Introduction: Introduction to Microprocessor and Microcontroller – Evolution – Architecture of Microprocessor -Von Neumann and Harvard architecture – CISC and RISC –– Comparison of Microprocessor and Microcontroller – Overview of 8/16/32/64 bit Microprocessors and Microcontrollers – Applications of Microprocessors and Microcontrollers.

8051 Microcontroller: 8051 Architecture – Pin details- Timing Diagram - Memory - Parallel Ports - Counters/Timers – Interrupts - Serial port.

8051 Assembly Language Programming: Addressing modes, Instruction set of 8051, Basic Assembly language Programming – Arithmetic operations – Code conversions – Sorting – Look up tables – subroutines – Timer and serial port programming.

8051 Embedded 'C' Programming: Introduction to IDE – Embedded C Data types- Programming structure- reading and writing data from/ to parallel ports – Timer/Counter programming – Interrupt handling – Serial port programming.

8051 Interfacing with peripherals using Embedded 'C': Matrix Keyboard – LCD – DAC – ADC – 7-segment LED Display.

Introduction to advanced microcontrollers: PIC 16F877 microcontroller – Architecture- On chip ADC, Capture/Compare/PWM Module - I^2C – SPI – Watchdog timer – ARM7 (LPC2148) microcontroller – Architecture and applications.

Text Books

1. The 8051 Microcontroller and Embedded Systems, (second edition). By Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay © 2005 Pearson Education, Inc
2. Ajay V.Deshmukh, "Microcontrollers- Theory and applications", Tata McGraw-Hill, publisher,2005.
3. N.Senthil kumar, M.Saravanan, S.Jeevanandhan, "Microprocessors and Microcontrollers", Oxford university press, 2010.
4. P.S.Manoharan, P.S.Kannan, "Microcontroller based system design", Scitech Publications Pvt. Ltd., Chennai, 2007.
5. Steve Furber, ARM System-on-Chip Architecture, Addison-Wesley Longman Limited, 2000.

Reference Books

1. Kenneth .J. Ayala, The 8051 Microcontroller, Architecture, Programming & Applications (third edition), Penram International, India (2004).
2. John B.Peatman, Design with PIC Microcontrollers, Pearson Education, 2002.
3. Shibu K V, 'Introduction to Embedded Systems', Tata McGraw Hill Education Private Limited, 2009.
4. http://www.nxp.com/documents/data_sheet/LPC2141_42_44_46_48.pdf

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Introduction**	
1.1	Introduction to Microprocessor and Microcontroller– Evolution	1
1.2	Architecture of Microprocessor	1
1.3	VonNeuman and Harvard architecture – CISC- RISC	2
1.4	Comparison of Micro processor and Microcontroller	0.5

1.5	Overview of 8/16/32/64 bit Microprocessors and Microcontrollers	0.5
1.6	Application of Microprocessors and Microcontrollers	1
2.	**8051 Microcontroller**	
2.1	8051 Architecture, Pin details	1
2.2	Timing diagram	1
2.3	Memory	1
2.4	Parallel Ports	1
2.5	Counters/Timers	1
2.6	Interrupts	1
2.7	Serial port	1
3.	**8051 ALP Programming**	
3.1	Addressing modes	1
3.2	Instruction set of 8051	2
3.3	Basic Assembly language Programming – Arithmetic operations	1
3.4	Code conversions - Sorting	1
3.5	Look up tables – subroutines – Timer and serial port programming	2
4.	**8051 Embedded 'C' Programming**	
4.1	Introduction to IDE	1
4.2	Embedded C Data types-Programming structure	1
4.3	reading and writing data from/ to parallel ports	1
4.4	Timer/Counter programming	1
4.5	Interrupt handling	1
4.6	Serial port programming	1
5	**8051 Interfacing with peripherals using Embedded 'C'**	
5.1	Matrix Keyboard	1
5.2	Liquid Crystal Display	1
5.3	DAC	1
5.4	ADC	1
5.5	7 segment LED Display	1
6	**Introduction to advanced microcontrollers**	
6.1	PIC 16F877 microcontroller – On-chip ADC	1
6.2	Capture/Compare/PWM Module	1
6.3	I^2C – SPI –Watchdog timer	1
6.4	ARM7 (LPC2148) microcontroller – Architecture and applications.	2
	Total	**36**

Course Designers:

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2. Dr.D.Kavitha dkavitha@tce.edu

PC 0 0 2 1

14EE480 **AC MACHINES LAB**

Preamble

This laboratory gives a practical exposure to the students to fundamental concepts regarding AC Machines that are currently used in Electrical Systems. The students also learn to select the suitable AC Electrical Machines for an application based on its characteristics, perform suitable capacitor additions to improve power factor and to familiarize the standard testing procedures of AC Machines. The students can also perform evaluation of efficiency improvement by switching over to Adjustable speed drives and also can know about the various harmonic components that arise due to Adjustable speed drives.

Prerequisite

14ES290 - Workshop
14EE320 - Transformers
14EE330 - DC Machines

COs No.	Course outcomes	Blooms level
CO1.	Obtain the load characteristics of AC Generator (Salient Pole & Cylindrical Rotor type) experimentally	Apply, Precision (S3)
CO2.	Obtain the load characteristics of AC Motor (Squirrel Cage, Slip ring, Single Phase & Synchronous) experimentally	Apply, Precision (S3)
CO3.	Demonstrate predetermination efficiency of AC Motor experimentally	Apply, Precision (S3)
CO4.	Obtain the characteristics of Synchronous motor experimentally	Apply, Precision (S3)
CO5.	Demonstrate experimentally a generative action of induction machine	Apply, Precision (S3)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**M**	**L**						**S**	**S**		
CO2	**S**	**M**	**L**			**M**	**M**	**S**	**S**	**S**		
CO3	**S**	**M**	**L**						**S**	**S**		
CO4	**S**	**M**	**L**						**S**	**S**		
CO5	**S**	**M**	**L**			**M**	**S**	**S**	**S**	**S**		

S- Strong; **M**-Medium; **L**-Low

List of Experiments:

Asynchronous Machines

1. Power factor improvement of 3 Phase Induction motor using capacitor banks (CO2)
2. Determination of Induction Motor efficiency using circuit model (CO3)

3. Performance Characteristics of Induction Motor (CO2)
4. Performance Characteristics of Induction Motor using VFD (CO2)

Single Phase Induction Motor

5. Performance Characteristics of Single Phase Induction Motor (CO2)

Induction Generator

6. Load Characteristics of Induction Generator (CO5)

Synchronous Machines

7. Real & Reactive Power control using Synchronous machine (CO4)
8. Slip test on Salient Pole Synchronous generator(CO1)
9. Regulation characteristics of Cylindrical pole Alternator (CO1)
10. Synchronization of Alternators

Experiments for Demonstration or Assignments:

Synchronous Machines

1. Polarity test of Synchronous machine windings
2. Polarity test for field poles
3. Test for Short Circuit field turns
4. Phase sequence test
5. Tests for Transient and Sub-transient reactance
6. Three Phase connection for harmonic elimination in Synchronous machines
7. Determination of Positive sequence resistance for synchronous machine

Asynchronous Machine

8. Single phase running of Three phase Induction motor
9. Reversal of rotation and Braking of Induction Motor
10. Slip Power recovery of Wound rotor Induction motors
11. Stray load loss determination of Induction motor
12. Insulation resistance, winding resistance measurement, current balance, NL current and power measurement of Induction motor
13. Shaft voltage test of induction motor
14. Methods of Starting of 3 phase Induction motors and Synchronous motors
15. Characteristics of Universal motor with AC and DC supply

Course Designers

1. Dr.V.Prakash vpeee@tce.edu
2. Dr.V.Saravanan vseee@tce.edu

14EE490	**MICROCONTROLLERS LAB**	Category	L	T	P	Credit
			0	0	2	1

Preamble

Microcontroller is used as the main controller in most of the embedded systems nowadays. This course makes the students to be familiar with the assembly language and Embedded 'C' language programming of Intel 8051 and TI's TM4C123 ARM Cortex microcontroller for interfacing various peripherals and also performing them through simulation using software tools.

Prerequisite

- 14EE350 - Digital Systems
- 14EE390 - Digital Systems Lab

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level
CO1	Write 8051 and TM4C123 assembly language programs and embedded 'C' programs for microcontroller to implement arithmetic operations and code conversions by software tools.	Apply
CO2	Develop 8051 and TM4C123 based embedded 'C' programs for ADC and DAC interfacing, timer/counter applications and serial communication	Apply
CO3	Develop 8051 and TM4C123 based embedded 'C' programs to implement the given application through hardware realisation and/or simulation by software tools.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**M**			**S**					**M**		**S**
CO2	**S**	**M**			**S**					**M**		**S**
CO3	**S**	**S**	**S**	**M**	**S**			**M**	**S**	**M**	**M**	**S**

S- Strong; **M**-Medium; **L**-Low

List of Experiments:

1. Evaluation of arithmetic expressions (CO1)
2. Code conversions (BCD to binary and vice-versa, ASCII to binary and vice-versa) (CO1)
3. ADC and DAC interfacing (CO2)
4. Timer/Counter applications: (i) square wave generation (ii) Frequency measurement (CO2)
5. Serial communication (I^2C, UART) (CO2)
6. Generation of PWM waveform with variable duty cycle and frequency (CO3)

7. Measurement and monitoring of RMS value of an AC voltage waveforms (Sine, square and triangle) (CO3)
8. Measurement of real power, reactive power and power factor for the given voltage and current signals (CO3)
9. Speed control of DC motor / Stepper motor (CO3)
10. Control of illumination of LED string / Traffic light (CO3)
11. Use of software simulation tools (CO1,CO2,CO3)
12. Interfacing of Temperature sensor, Bluetooth Module, Zigbee Module and Micro SD card (CO3)
13. Development of programs for IoT applications (CO3)

Course Designers:

1.	Dr.M.Saravanan	mseee@tce.edu
2.	Dr.P.S.Manoharan	psmeee@tce.edu
2.	Dr.D.Kavitha	dkavitha@tce.edu

14EE4C0	CAPSTONE - I	Category	L	T	P	Credit
		PC	0	0	4	2

Common for all B.E. / B.Tech. Degree Programmes
(Course Codes: 14CE4C0, 14ME4C0, 14EC4C0, 14IT4C0, 14CS4C0,14MT4C0)

Preamble:

The purpose of this course is to apply the concept of Mathematics, Science and Engineering Fundamentals and an Engineering Specialization to solve complex engineering Problem.

Assessment Pattern:

Comprehensive Test and Viva (40 Marks)

- Marks scored in Objective Type Questions in each group (Average to 30 Marks)
  - The courses offered in 1- III semesters are divided into 4 groups
- Marks scored in Review (Explanations for the answers) in each group (Average to 10 Marks)

Complex Engineering Problem Solving (60 Marks)

- Selection of a Complex Engineering Problem by students and approved by Faculty Members (Batch Size:3) (5 marks)
- Literature survey on the chosen problem – 5 Marks
- Critics on Literature-Problem formulation – 10 Marks
- Solution Methodology – (10 Marks)
- Observations/inference/Result and Analysis - (10 Marks)
- Viva-Voce (10 Marks)
- Technical Report (10 Marks)

Course Designers:

1.	Dr.S.Baskar	sbeee@tce.edu
2.	S.Sivakumar	siva@tce.edu
3.	B.Ashok Kumar	ashokudt@tce.edu

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

FIFTH SEMESTER

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING

(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)

MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
Fax: 0452 2483427
Web: www.tce.edu

B.E.EEE Degree Programme (Fifth Semester) 2014-15

Semester	Theory						Theory cum Practical	Practical Courses			Credits
	1	2	3	4	5	6	7	8	9	10	
I	14MA110 Engineering Mathematics I(3)	14PH120 Physics (3)	14CH130 Chemistry (3)	14EG140 English (3)	14ES150 Basics of Civil and Mechanical Engineering (2)	14ES160 Basics of Electrical and Electronics Engineering (2)	14ME170 Engineering Graphics (3)	14PH180 Physics Lab (1)	14CH190 Chemistry Lab (1)	--	**21**
II	14EE210 Engineering Mathematics II (3)	14EE220 Materials Science for Electrical Engineering (3)	14EE230 Environmental Science and Ethics (3)	14EE240 Electromagnetic Fields (3)	14EE250 Analog Devices and Circuits (3)		14EE270 Electric Circuit Analysis (3)	14EE280 Analog Devices and Circuits Lab (1)	14ES290 Workshop (1)	--	**20**
III	14EE310 Engineering Mathematics III (3)	14EE320 Transformers (3)	14EE330 DC machines (3)	14EE340 Measurement Systems (3)	14EE350 Digital Systems (3)		14EE370 Problem solving using Computers (3)	14EE380 DC Machines and Transformers Lab (1)	14EE390 Digital Systems Lab (1)	--	**20**
IV	14EE410 Engineering Mathematics IV (3)	14EE420 Instrumentation Systems (3)	14EE430 Control Systems (3)	14EE440 AC Machines (3)	14EE450 Engineering Design (3)	14EE460 Microcontrollers (3)		14EE480 AC Machines Lab (1)	14EE490 Microcontrollers Lab (1)	14EE4C0 Capstone Course-I (2)	**22**
V	14EE510 Numerical Methods (3)	14EE520 Power Semiconductor Devices (3)	14EE530 Control System Design (3)	14EE540 Energy Resources and Utilization (3)	14EE550 Digital Signal Processing (3)	14EEPx0 Prog. Elec.I (3)		14EE580 Digital Signal Processing Lab (1)	14EE590 Control and Instrumentation Lab (1)	--	**20**
VI	14EE610 Financial Management (3)	14EE620 Applications of Power Electronic Circuits (3)	14EE630 Electric Power Transmission Systems (3)	14EEPX0 Prog. Elec.II (3)	14EEGx0 Gen. Elec. I (3)		14EE670 Professional Communication (3)	14EE680 Power Systems Lab (1)	14EE690 Power Electronics and Drives Lab (1)	--	**20**
VII	14EE710 Project Management (3)	14EE720 Drives and Control (3)	14EE730 Industrial Automation (3)	14EEPx0 Prog. Elec.III (3)	14EEPx0 Prog. Elec.IV (3)	14EEGx0 Gen. Elec. II (3)		--		14EE7C0 Capstone Course-II (2)	**20**
VIII	14EEPx0 Prog. Elec.V (3)	14EEPx0 Prog. Elec.VI (3)	14EEPx0 Prog. Elec.VII (3)	--	--	--	--	14EE880 Project (12)		--	**21**
										Total Credits	**164**

Basic Science Courses

Humanities and Social Science Courses

Engineering Science courses

Analog & Digital Electronic System Courses

Electrical Energy System Courses

Power Electronics & Drives Courses

Control & Automation Courses

Core and General Elective Courses, Capstone Courses & Project

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. EEE Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15)

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE210	Engineering Mathematics - II	BS	2	2	-	3
14EE220	Materials Science for Electrical Engineering	BS	2	-	2	3
14EE230	Environmental Science and Ethics	BS	3	-	-	3
14EE240	Electromagnetic fields	ES	2	2	-	3
14EE250	Analog Devices and Circuits	PC	3	-	-	3
THEORY CUM PRACTICAL						
14EE270	Electric Circuit Analysis	PC	2	-	2	3
PRACTICAL						
14EE280	Analog Devices and Circuits Lab	PC	-	-	2	1
14ES290	Workshop	ES	-	-	2	1
Total			**14**	**4**	**8**	**20**

THIRD SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE310	Engineering Mathematics - III	BS	2	2	-	3
14EE320	Transformers	PC	2	2	-	3
14EE330	DC Machines	PC	2	2	-	3
14EE340	Measurement Systems	PC	3	-	-	3
14EE350	Digital Systems	PC	2	2	-	3
THEORY CUM PRACTICAL						
14EE370	Problem Solving Using Computers	ES	2	-	2	3
PRACTICAL						
14EE380	DC Machines and Transformers	PC	-	-	2	1

	Lab					
14EE390	Digital Systems Lab	PC	-	-	2	1
Total			**13**	**8**	**6**	**20**

FOURTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE410	Engineering Mathematics - IV	BS	2	2	-	3
14EE420	Instrumentation Systems	PC	3	-	-	3
14EE430	Control Systems	PC	3	-	-	3
14EE440	AC Machines	PC	3	-	-	3
14EE450	Engineering Design	PC	1	-	4	3
14EE460	Microcontrollers	PC	3	-	-	3
PRACTICAL						
14EE480	AC Machines Lab	PC	-	-	2	1
14EE490	Microcontrollers Lab	PC	-	-	2	1
14EE4C0	Capstone Course-I	PC	-	-	4	2
Total			**15**	**2**	**12**	**22**

FIFTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE510	Numerical Methods	BS	2	2	-	3
14EE520	Power Semiconductor Devices	PC	3	-	-	3
14EE530	Control System Design	PC	3	-	-	3
14EE540	Energy Resources and Utilization	PC	3	-	-	3
14EE550	Digital Signal Processing	PC	2	2	-	3
PRACTICAL						
14EE580	Digital Signal Processing Lab	PC	-	-	2	1
14EE590	Control and Instrumentation Lab	PC	-	-	2	1
ELECTIVES						
14EEPxx	Programme Elective -I	PE	Refer the respective courses			3
Total			**13**	**4**	**4**	**20**

BS : Basic Science
ES : Engineering Science
PC : Programme Core
PE : Programme Elective

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. EEE Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE210	Engineering Mathematics - II	3	50	50	100	25	50
2	14EE220	Materials Science for Electrical Engineering	3	50	50	100	25	50
3	14EE230	Environmental Science and Ethics	3	50	50	100	25	50
4	14EE240	Electromagnetic fields	3	50	50	100	25	50
5	14EE250	Analog Devices and Circuits	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE270	Electric Circuit Analysis	3	50	50	100	25	50
PRACTICAL								
8	14EE280	Analog Devices and Circuits Lab	3	50	50	100	25	50
9	14ES290	Workshop	--	100	--	100	--	50

THIRD SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE310	Engineering Mathematics - III	3	50	50	100	25	50
2	14EE320	Transformers	3	50	50	100	25	50

Passed in BOS meeting held on 23-04-2016 Approved in 52nd AC meeting held on 18-06-2016

3	14EE330	DC Machines	3	50	50	100	25	50
4	14EE340	Measurement Systems	3	50	50	100	25	50
5	14EE350	Digital Systems	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE370	Problem Solving Using Computers	3	50	50	100	25	50
PRACTICAL								
8	14EE380	DC Machines and Transformers Lab	3	50	50	100	25	50
9	14EE390	Digital Systems Lab	3	50	50	100	25	50

FOURTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE410	Engineering Mathematics - IV	3	50	50	100	25	50
2	14EE420	Instrumentation Systems	3	50	50	100	25	50
3	14EE430	Control Systems	3	50	50	100	25	50
4	14EE440	AC Machines	3	50	50	100	25	50
5	14EE450	Engineering Design	--	100	--	100	--	50
6	14EE460	Microcontrollers	3	50	50	100	25	50
PRACTICAL								
7	14EE480	AC Machines Lab	3	50	50	100	25	50
8	14EE490	Microcontrollers Lab	3	50	50	100	25	50
9	14EE4C0	Capstone Course-I	--	100	--	100	--	50

Passed in BOS meeting held on 23-04-2016 Approved in 52nd AC meeting held on 18-06-2016

FIFTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE510	Numerical Methods	3	50	50	100	25	50
2	14EE520	Power Semiconductor Devices	3	50	50	100	25	50
3	14EE530	Control System Design	3	50	50	100	25	50
4	14EE540	Energy Resources and Utilization	3	50	50	100	25	50
5	14EE550	Digital Signal Processing	3	50	50	100	25	50
PRACTICAL								
6	14EE580	Digital Signal Processing Lab	3	50	50	100	25	50
7	14EE590	Control and Instrumentation Lab	3	50	50	100	25	50
ELECTIVES								
8	14EEPxx	Programme Elective -I	3	50	50	100	25	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

14EE510	NUMERICAL METHODS	Category	L	T	P	Credit
		BS	2	2	0	3

Preamble

An Under Graduate Electrical Engineering student needs to know sufficient numerical tools and techniques for solving engineering problems arises in their field. This course aims at developing the ability to formulate an engineering problem in a mathematical form appropriate for subsequent computational treatment and to choose an appropriate numerical approach.

Prerequisite

14MA110 Engineering Mathematics
14EE210 Engineering Mathematics II
14EE310 Engineering Mathematics III

Course Outcomes

On successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Bloom's level
CO1	Solve the system of linear algebraic equations and single non linear equations arising in the field of Electrical Engineering	Apply
CO2	Estimate the intermediate value in discrete data by means of continuous function.	Apply
CO3	Apply tools to find integration, derivatives of one and two variable functions.	Apply
CO4	Solve the IVPs in ODE using single step and multistep methods and BVPs in PDE using finite difference methods.	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	S	M	M	S	-	-	-	-	-	-	-
CO2.	S	S	M	M	S	-	-	-	-	-	-	-
CO3.	S	S	M	M	S	-	-	-	-	-	-	-
CO4.	S	S	S	S	S	-	-	-	-	-	-	-

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	20	20	20	20
Apply	70	70	70	70
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

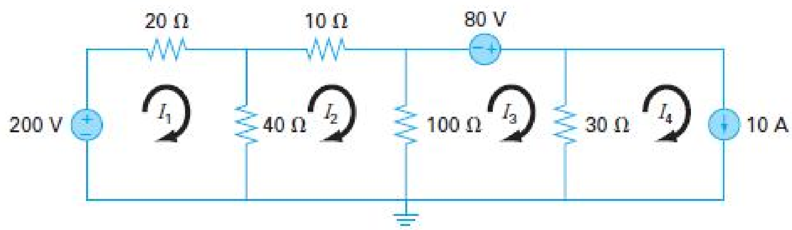
Passed in BOS meeting held on 23-04-2016 Approved in 52nd AC meeting held on 18-06-2016

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give the physical significance of Secant method.

2. The following system of equations was generated by applying the mesh current law to the circuit shown below:



$60I_1 - 40I_2 = 200$
$-40\ I_1 + 150\ I_2 - 100\ I_3 = 0$
$-100\ I_1 + 130\ I_3 = 230$
Solve for I_1, I_2, and I_3 using Gauss Seidal Method.

3. An oscillating current in an electric circuit is described by $i = 9e^{-t}\cos(2\pi t)$, where t is in seconds. Determine a value of t such that $i = 3.5$. Using Newton's method.

Course Outcome 2 (CO2):

1. Write the recurrence formula used in cubic spline interpolation.
2. You measure the voltage drop V across a resistor for a number of different values of current i. The results are

i	0.25	0.75	1.25	1.5	2.0
	−0.45	−0.6	0.70	1.88	6.0

Fit a fourth-order polynomial interpolation to estimate the voltage drop for $i = 1.15$. Interpret your results.

3. A sinusoidal function is described by $y(t) = A_0 + C_1\cos(\omega_0 t + \theta)$.GIven $A_0 = 1.7$, $C_1 = 1$, $\omega_0 = 4.189$. Calculate 10 discrete values of for this curve at interval $\Delta t = 15$ for the range $t = 0$ to 1.35. Use this information to find the coefficients A_0, A_1, B_1.

Course Outcome 3 (CO3):

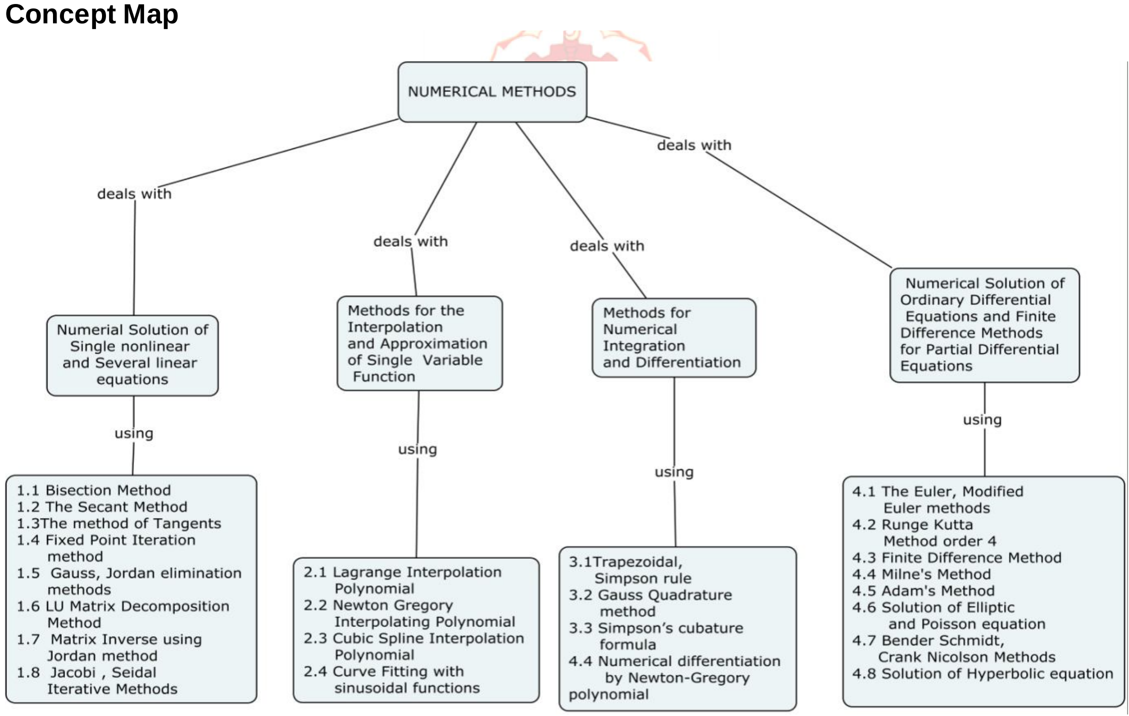
1. Mention the formula for computing the first two derivatives using Newton's forward difference formula.
2. Find the value of the integral $\int_1^2\int_1^2 \frac{dxdy}{x+y}$ using Simpson's cubature formula for integration.
3. Faraday's law characterizes the voltage drop across an inductor as $V_L = L\frac{di}{dt}$ where V_L=voltage drop (V), L=inductance (in henrys; 1H=1 V ・s/A), i =current (A), and t = time (s). Determine the voltage drop as a function of time from the following data for an inductance of 4 H.

t	0	0.1	0.2	0.3	0.5	0.7
i	0	0.16	0.32	0.56	0.84	2.0

Course Outcome 4 (CO4):

1. Differentiate between single step and multistep method in solving ordinary differential equations.
2. The voltage drop may be nonlinear and the circuit dynamics is described by a relationship such as $L\frac{di}{dt}+R\left[\frac{i}{I}-\left(\frac{i}{I}\right)^3\right]=0$, where i = current, L = inductance, and R = resistance. Solve for i, if L = 1, R = 1.5, and $i(0)$ =0.5 and I is a known reference current equal to 1 Solve this problem with a numerical method.
3. Poisson equation for electrostatic fields can be represented in two dimensions as $\frac{\partial^2 V}{\partial x^2}+\frac{\partial^2 V}{\partial x^2}=\frac{\rho_v}{\varepsilon}$, where ρv = volumetric charge density. Use this Poisson's equation to compute the electric potential over a unit square (1 × 1) plate with zero voltage at the edges and point charge sources of $\frac{\rho_v}{\varepsilon}(0.5, 0.5) = 1$ and $\frac{\rho_v}{\varepsilon}(-0.5,-0.5) = -1$. Employ $\Delta x = \Delta y = 0.1$.

Concept Map



Syllabus

Methods for Numerical solution of Single Nonlinear Equations:
Bisection Method - The Secant Method - The method of Tangents (Newton-Raphson),convergence - Fixed Point Iteration method, convergence.
Methods for Numerical solution of Several Linear Equations: Gauss, Jordan elimination methods - LU Matrix Decomposition Method, Method of Inverse of a Matrix using Jordan method - Jacobi , Seidal Iterative Methods, convergence .

Methods for the Interpolation and Approximation of Single Variable Function: Lagrange Interpolation Polynomial - Newton Gregory Interpolating Polynomial - Cubic Spline Interpolation Polynomial - Curve Fitting with sinusoidal functions.

Methods for Numerical Integration and Differentiation :
Newton Cote's methods of Integration,Trapezoidal, Simpson rule - Gauss Quadrature method - Simpson's cubature formula for Integration of Two variable Functions - Numerical differentiation by using Newton-Gregory polynomial.

Methods for Numerical Solution of Ordinary Differential Equations and Finite Difference Methods for Partial Differential Equations:
The Euler, Modified Euler methods - Runge Kutta Method RK4 - Milne's method - Adam - Bashforth method -Solution of second order differential equation by finite difference method - Solution of Elliptic equation for Laplace and Poisson equation - Parabolic equation by Bender Schmidt Method, Crank-Nicolson Scheme - Solution of hyperbolic equation by finite difference method.

Text Books

1. Steven C. Chapra, Raymond P. Canale, "Numerical Methods for Engineers", MC Graw Hill Higher Education, 2010.
2. S. R. K. Iyengar, R. K. Jain, Mahinder Kumar Jain, "Numerical methods for Scientific and Engineering Computations", New Age International publishers , 6th Edition, 2012.

Reference Books

1. S.K Gupta, "Numerical Methods for Engineers", New Age International Pvt. Ltd. Publishers, 2015.
2. Joe D. Hoffman , Steven Frankel, "Numerical Methods for Engineers and Scientists", 3rd Edition, 2015.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lecture Hours
1	**Methods for Numerical solution of Single Nonlinear Equations and Several Linear Equations**	
1.1	Introduction to Numerical Methods, Bisection Method	1
	Tutorial	1
1.2	The Secant Method	1
	Tutorial	1
1.3	The method of Tangents (Newton-Raphson), convergence	1
	Tutorial	1
1.4	Fixed Point Iteration method, convergence	1
	Tutorial	1
1.5	Gauss, Jordan elimination methods	1
	Tutorial	1
1.6	LU Matrix Decomposition Method	1
	Tutorial	1
1.7	Method of Inverse of a Matrix using Jordan method	1
	Tutorial	1
1.8	Jacobi , Seidal Iterative Methods, , convergence	1
	Tutorial	1
2	**Methods for the Interpolation and Approximation of Single Variable Function**	

Module No.	Topic	No.of Lecture Hours
2.1	Lagrange Interpolation Polynomial	1
	Tutorial	1
2.2	Newton Gregory Interpolating Polynomial	1
	Tutorial	1
2.3	Cubic Spline Interpolation Polynomial	1
	Tutorial	1
2.4	Curve Fitting with sinusoidal functions.	1
	Tutorial	1
3	**Methods for Numerical Integration and Differentiation**	
3.1	Newton Cote's methods of Integration,Trapezoidal, Simpson rule	1
	Tutorial	1
3.2	Gauss Quadrature method	1
	Tutorial	1
3.3	Simpson's cubature formula for Integration of Two variable Functions	1
	Tutorial	1
3.4	Numerical differentiation by using Newton-Gregory polynomial.	1
	Tutorial	1
4	**Methods for Numerical Solution of Ordinary Differential Equations and Finite Difference Methods for Partial Differential Equations**	
4.1	The Euler, Modified Euler methods	1
	Tutorial	1
4.2	Runge Kutta Method order 4	1
	Tutorial	1
4.3	Solution of second order differential equation by finite difference method	1
	Tutorial	1
4.4	Milne's Method.	1
	Tutorial	1
4.5	Adam - Bashforth Method	1
	Tutorial	1
4.6	Solution Elliptic equation for Laplace and Poisson equation	1
	Tutorial	1
4.7	Parabolic equation by Bender Schmidt Method, Crank-Nicolson Scheme	1
	Tutorial	1
4.8	Solution of hyperbolic equation by finite difference method	
	Tutorial	1
	Total	**48**

* Tutorials problems are to be solved using MatLab/Maple Software.

Course Designers:

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2. Dr. V.Gnanaraj vignanaraj@gmail.com

			Category	L	T	P	Credit
14EE520	**POWER SEMICONDUCTOR DEVICES**		PC	3	0	0	3

Preamble

This course aims to impart the students, in depth knowledge about of power semiconductor devices. The course includes: Construction, working principle of different types of power semiconductor devices and their switching characteristics -protection- on-state losses- gate drive and snubber circuits -applications-ratings.

Prerequisite

14EE250-Analog Devices and Circuits

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course Outcomes	Bloom's level
CO1	Illustrate the basic structure, static and switching characteristics of Power diode, Power transistor, SCR, MOSFET, IGBT, BTRAN,IPM,IGCT, MESFET	Understand
CO2	Design driver and protection /snubber circuits for the given SCR, MOSFET and IGBT using device datasheets	Apply
CO3	Explain losses associated with power devices	Understand
CO4	Design a heat sink for the given SCR, MOSFET and IGBT using device datasheets	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L			S							
CO2	S	M	L	L	S							
CO3	M	L	L	L	S							
CO4	S	M			S							

S-STRONG; M-MEDIUM; L-LOW

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	20
Understand	25	25	25	50
Apply	15	15	15	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

* **Assignment 3** - Simulation of performance characteristic of power semiconductor devices using PLECS/MATLAB/PSPICE softwares

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the construction, working principle and characteristics of p-channel enhancement MOSFET.
2. Explain the concept of conductivity modulation in power diode.
3. Explain the construction, working principle and characteristics of SCR.
4. Describe the construction, static and switching characteristics of IGBT with neat diagrams.

Course Outcome 2 (CO2):

1. The input voltage is 200V with load resistance of R=5Ω. The load and stray inductance are negligible and the thyristor is operated at a frequency of f=2kHz. If the requires dv/dt is 100V/µs and the discharge is to be limited to 100A, determine (a) the values of Rs and Cs (b) the snubber loss (c) the power rating of the snubber resistor.

2. The input voltage is 200V with a load resistance of R=15Ω and a load inductance of L=50µH. If the damping ratio is 0.7 and the discharging current of the capacitor is 5A, determine (a) the values of Rs and Cs (b) the maximum dv/dt.

3. A 240V,50Hz supply is connected to an RC trigger circuit. If R is variable from 1.5 to 24kΩ,V_{GT}=2.5V and C=047µf find the minimum and maximum values of the firing angle α.

Course Outcome 3 (CO3):

1. Explain the terms thermal resistance and thermal impedance.
2. Explain the ON state losses in power BJT.
3. Explain concept of current crowding in secondary breakdown of power BJT.
4. Explain the switching losses in power MOSFET.

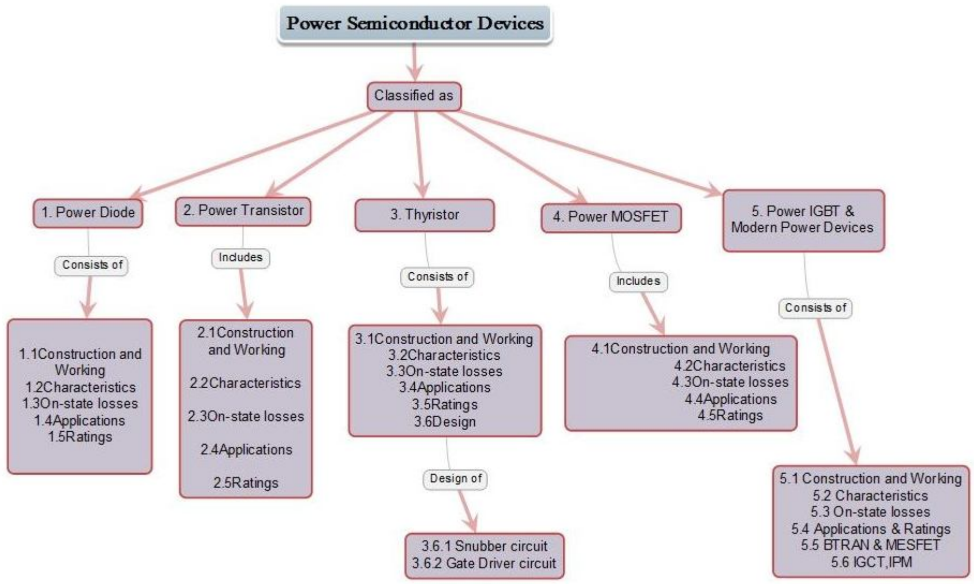
Course Outcome 4 (CO4):

1. A device in a TO-220 package is mounted with a 0.33mm thick insulating foil on a small aluminium heat sink. The thermal resistance of the heat sink is R_{th}=25K/W and its mass is m_{sk}=2g. The surface area of the TO-220 package is A_{sk}=1cm^2. The surface area of the device chip is A_{cu}=10mm^2, the amount of copper around the pyramid stump is m_{cu}=1g and the thickness of the copper is d_{cu}=0.8mm. Find the parameters of the thermal equivalent circuit.(data sheet will provided)

2. The data sheet for a thyristor gives the following values: T_{jm}=125ºC, θ_{jc}=0.15ºC/W, θ_{cs}=0.075ºC/W,. A sinusoidal voltage source of 230V, 50Hz feeds power to a resistive load of R=2Ω. For a firing angle delay of zero degree, choose a suitable heat sink and find the circuit efficiency.

3. For a thyristor, maximum junction temperature is 125ºC. The thermal resistance for the thyristor sink combination are θ_{jc}=0.16ºC/W and θ_{cs}=0.08ºC/W. For a heat sink temperature of 70ºC, compute the total average power loss in the thyristor sink combination.

Concept Map



Syllabus

Power Diode: Introduction- power diodes-construction – types, forward and reverse characteristics-diode as a switch - series and parallel connection for diode-breakdown mechanism –on-state losses-switching characteristics – applications- selection using data sheet.

Power Transistor: BJTs – construction, static characteristics, switching characteristics-negative temperature coefficient and secondary breakdown –safe operating area (SOA)- on-state losses -power darlington - thermal protection- applications- selection using data sheet.

Thyristor: Thyristors – construction and static characteristics – two transistor analogy– concept of latching – gate and switching characteristics –converter grade and inverter grade and other types; series and parallel operation –– steady state and dynamic models of thyristor – thermal protection - mounting types- GTO- gate drive circuits- design of snubbers –protection- applications- selection using data sheet.

Power MOSFET: Power JFET- power MOSFETs- silicon carbide MOSFET**-**basic structure – principle of voltage controlled devices, construction, types, static and switching characteristics – steady state and dynamic models of MOSFET - gate drive circuits - applications- selection using data sheet.

Power IGBT and Modern Power Devices: Power IGBTs- basic structure and operation- static and switching characteristics- latchup in IGBTs - circuit models -device limits and SOAs – gate drive circuits - intelligent power modules(IPMs)- Integrated Gate Commutated Thyristor (IGCT)- characteristics – Bi-directional bipolar TRANsistor (BTRAN) – Metal–Semiconductor Field-Effect Transistor (MESFET)-applications- selection using data sheet.

Text Book

1. Ned Mohan, Tore M. Undeland and William P.Robbins, Power Electronics: Converters, Applications and Design, John Wiley and Sons, 2003.

Reference Books

1. M.H. Rashid, Power Electronics: Circuits, Devices and Application, second edition, Prentice Hall of India, 2004.
2. M D Singh and K B Khanchandani, Power Electronics, Tata McGraw-Hill, 2008.
3. B.W. Williams, Power Electronics: Devices, Drivers, Applications and Passive Components, McGrawHill, 1992.
4. Jayant Baliga, Fundamentals of Power Semiconductor Devices Springer Science, 2008.

Course Contents and Lecture Schedule

Module No.	Topic	No.of Lecture Hours
1	**Power Diode**	
1.1	Introduction- construction of power diodes and types, forward and reverse characteristics , diode as a switch	1
1.2	Series and parallel connection for diode	1
1.3	Breakdown mechanism, on-state losses	1
1.4	Switching characteristics	1
1.5	Applications- selection using sheet	1
2	**Power Transistor**	
2.1	BJTs – Construction and operation	1
2.2	static characteristics, switching characteristics	2
2.3	Negative temperature coefficient and secondary breakdown	2
2.4	Safe operating area, on-state losses -Power Darlington	1
2.5	Thermal protection, applications- selection using sheet	1
3	**Thyristor**	
3.1	Thyristors – construction and static characteristics	1
3.2	Two transistor analogy	1
3.3	Concept of latching – gate and switching characteristics	1
3.4	Converter grade and inverter grade thyristor and other types	1
3.5	Series and parallel operation	1
3.6	Steady state and dynamic models of thyristor	1
3.7	Thermal protection	1
3.8	Mounting types	1
3.9	GTO	1
3.10	Gate drive circuits- design of snubbers	2
3.11	Protection- applications- selection using sheet	1
4	**Power MOSFET**	
4.1	Power JFET	1
4.2	Power MOSFETs, Silicon carbide MOSFET	1
4.3	Static and switching characteristics	1
4.4	Steady state and dynamic models of MOSFET	1
4.5	Gate drive circuits - design of snubbers- applications- selection using sheet	2
5	**Power IGBT and Modern Power Devices**	
5.1	Power IGBTs- basic structure and operation- static and switching characteristics- latchup in IGBTs - circuit models - device limits and SOAs	2
5.2	Gate drive circuits	2
5.3	Intelligent power modules(IPMs)- integrated gate commutated thyristor (IGCT)	1

5.4	Bi-directional bipolar TRANsistor (BTRAN) – metal–semiconductor field-effect transistor (MESFET)-applications-selection using sheet	2
	Total	**37**

Course Designers:

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		Category	L	T	P	Credit
14EE530	**CONTROL SYSTEM DESIGN**	PC	3	0	0	3

Preamble

This course is to impart in students a good understanding of fundamental design principles in control engineering. The course covers design of continuous time and sampled data control systems using transfer function and state space based methods

Prerequisite

- Matrices, Calculus, Differential Equations, Laplace & Z-Transforms.
- 14EE430 Control systems

Course Outcomes

On the successful completion of the course, students will be able to:

COS No.	Course outcomes	Blooms level
CO1	Design compensators using Root locus and Bode plot for continuous time transfer function to achieve given performance specifications	Analyse
CO2	Analyse the time domain and frequency domain characteristics of a given sampled data linear system	Analyse
CO3	Design digital controllers/compensators using root locus and Bode plot for a discrete time system to achieve given specifications	Analyse
CO4	Design state feedback controller and observer using pole placement technique for continuous time and discrete time systems	Analyse
CO5	Analyse the effects of word length in the characteristics of a digital control system	Analyse

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S							
CO2	S	S	M	S	S							
CO3	S	S	S	S	S							
CO4	S	S	S	S	S							
CO5	S	S	M	S	S							

S-Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	60	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Note: Apply level of CO5 and analyse level of all COs shall be evaluated through assignments

Course Level Assessment Questions

Course Outcome 1 (CO1):

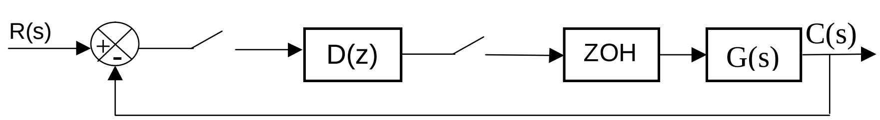
1. List the effects of lead compensator (Remember)
2. Explain the electrical implementation of lag compensator (Understand)
3. Consider the system $G(s) = \dfrac{1}{s(s+1)(s+4)}$. Design a suitable compensator using root locus to achieve following specifications in closed loop.
   Damping ratio =0.5
   Un-damped natural frequency = 2rad/s

Course Outcome 2 (CO2):

1. Write the relation between s plane and z plane (Remember)
2. Using Jury's stability criterion find the number of poles outside |z|=0.5 circle in the z-plane (Apply)
   $\Delta(z) = 2z^4 + 7z^3 + 10z^2 + 4z + 1$
3. A unit impulse sequence $\delta_k = \{1\ 0\ 0\ 0 \cdots\}$ is applied to a system and the output is obtained as $y_k = \{0\ 0.5\ 1\ 1\ 1\ 1 \cdots\}$. (Apply)
   - Find the z transform of signal y(k)
   - Find the discrete transfer function of the system $G(z) = Y(z)/U(z)$ and difference equation governing the system
   - Find the response of the system for unit step sequence.

Course Outcome 3 (CO3):

1. Define warping and pre-warping. (Remember)
2. Derive the control law for discrete PID controller (Understand)
3. Consider the feedback control system shown below. The plant is described by the transfer function G(s)=1/(s+2) . Design digital control scheme using root locus to meet the following specifications.
   - Velocity error constant Kv=6
   - Peak overshoot $M_p \leq 15\%$
   - Settling time $t_s(2\%\ \text{tolerance}) = 5s$



Course Outcome 4 (CO4):

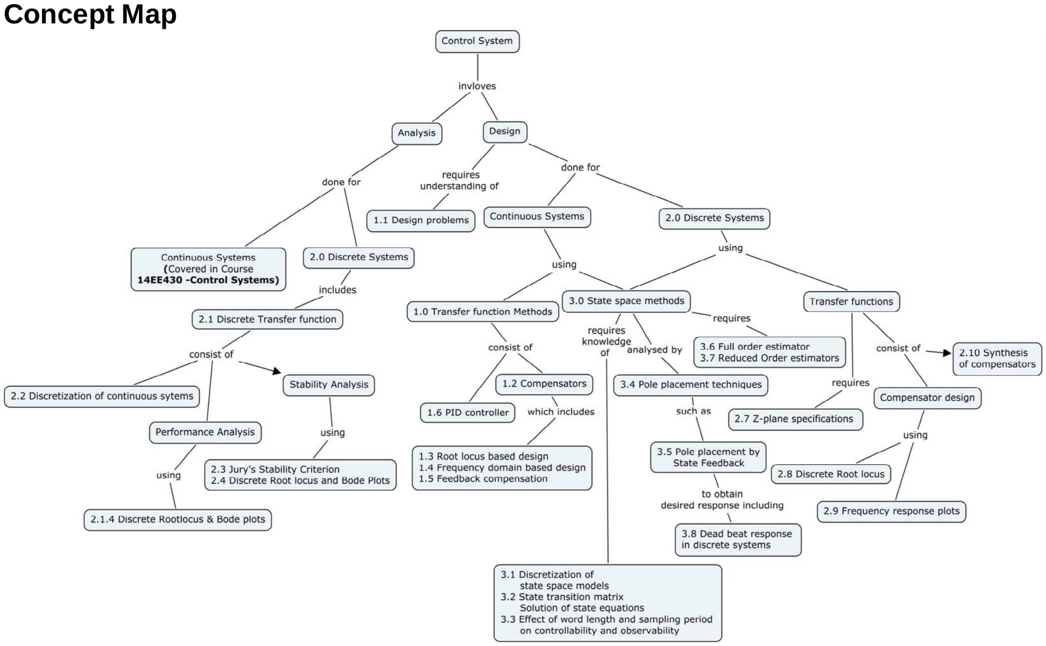
1. Prove that controllability is affected by the choice of sampling period
2. Consider the system $F = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \& G = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$. Design a state feedback controller to obtain dead beat response.

3. Consider the system with $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix}$ & $C = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$. Design a reduced order observer with observer poles at s=-10 & s=-20

Course Outcome 5 (CO5):

1. Define quantization (Remember)
2. Explain the effect of word length on controllability (Understand)
3. Explain the effect of word length on observability (Understand)

Concept Map



Syllabus

Design of continuous systems using Transfer functions:
Design problem – Preliminary consideration of classical design – Realization of lag, lead and lag-lead compensators – Root locus based design of cascade compensators - Frequency domain design of cascade compensators – Feedback compensation - PID controller Analysis & Design - Design using MATLAB

Discrete Control Systems Analysis & Design:
Introduction to Sample data control systems, Z and S domain Relationship- Effect of sampling on poles and zeros, Stability analysis. State space analysis of discrete systems Z-plane specifications of control system design, Digital compensator design using Root locus plots, Digital compensator Design using frequency response plots, Z-plane synthesis-Design using MATLAB

Design in State Space [Continuous & Discrete Systems]:
Discretization of state space models, State transition matrix, Solution of state equations, Effect of word length and sampling period on controllability and observability, Stability improvement by pole placement, pole placement by state feedback, Pole placement by

output feedback, Full order observers- Reduced order observers- Separation principle - dead beat control using state feedback – State space design using MATLAB

Text Books

1. B.C. Kuo, and F.Golnaraghi, Automatic Control Systems, 9th Edition. Wiley India Pvt limited 2014. (Student edition)
2. Norman.S.Nise, “Control System Engineering”, 4th edition, John Wiley And Sons, 2000
3. M. Gopal, “Digital Control and State Variable Methods –Conventional and Intelligent Control Systems”, Tata McGraw Hill Education, 2003.
4. Katsuhiko Ogata, “Discrete Time Control Systems”, 2nd edition, Phi Learning Pvt. Ltd, 2009.
5. Kannan M. Moudgalya, “Digital Control”, John Wiley & Sons,2007

Reference Books

1. Richard C. Dorf and Robert H. Bishop, “Modern Control Systems”, Addison Wesley Eighth Edition, 2008.
2. Jacqueline wilkie, Michael Johnson and Reza Katebi,” Control Engineering”, Palgrave Publishers, edition 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture hours
1.0	**Design of continuous systems using Transfer functions:**	
1.1	Design problem – Preliminary consideration of classical design	1
1.2	Realization of lag, lead and lag-lead compensators	1
1.3	Root locus based design of cascade compensators	2
1.4	Frequency domain design of cascade compensators	3
1.5	Feedback compensation	2
1.6	PID controller analysis and design	2
1.7	Design using MATLAB	1
2.0	**Discrete Control System Analysis & Design**	
2.1	Introduction to Sample data control systems –Sampling, Structure of discrete control system, advantages & disadvantages over continuous control	1
2.2	Discretization of continuous systems	1
2.3	Effect of sampling on poles and zeros, Stability Analysis using Jury’s Stability Criterion	2
2.4	Discrete Root locus and Bode plots	2
2.5	Z-plane specifications of control system design	1
2.6	Digital compensator design using Root locus plots	1
2.7	Digital compensator Design using frequency response plots	2
2.8	Z-plane synthesis	1
2.9	Design using MATLAB	1
3.0	**Design in State Space [Continuous & Discrete Systems]**	
3.1	Discretization of state space models	1
3.2	State transition matrix, Solution of state equations	1

Passed in BOS meeting held on 23-04-2016 Approved in 52nd AC meeting held on 18-06-2016

3.3	Effect of word length and sampling period on controllability and observability	3
3.4	Stability improvement by pole placement	1
3.5	Pole placement by state feedback	2
3.6	Full order Observers	2
3.7	Reduced order observers	2
3.8	Dead beat response in discrete systems	1
3.9	State Space design using MATLAB	1
	Total	**40**

Course Designers:

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2. M.Varatharajan varatharajan@tce.edu

14EE540	ENERGY RESOURCES AND UTILIZATION	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

This course introduces the basic technical and environmental aspects of power generation from non renewable and renewable energy sources (Thermal, Nuclear, Gas, Diesel, Hydro, Wind, Solar PV, Biomass, Geothermal, Tidal and MHD). This course also provides a comprehensive idea about utilization of electrical power such as illumination, electric heating, electric welding, electrolysis and electric vehicle.

Prerequisite

14EE220: Materials Science for Electrical Engineering
14EE330: DC Machines
14EE440: AC Machines

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course Outcomes	Blooms level
CO1	Summarize the world and Indian energy scenarios	Understand
CO2	Explain the basic principles of fossil fuel power plants (Thermal, Nuclear, Gas and DG)	Understand
CO3	Design appropriate Power supply backup (DG set) for a given load requirements.	Apply
CO4	Explain the concept of GHG emission status and its controlling mechanism.	Understand
CO5	Explain the basic principles and technologies of various Renewable energy resource based power generation (Hydro, Wind, Solar PV, Biomass, Geothermal, Tidal and MHD)	Understand
CO6	Design the solar PV power plant and Wind power plant, for the specific energy requirements.	Apply
CO7	Compare the challenges and environmental impacts, among the non Renewable energy and the Renewable energy power plants.	Understand
CO8	Design lighting schemes to Domestic, Office, Industrial and Commercial applications based on the specific lighting level standards.	Apply
CO9	Classify the right Heating and Welding system for specified applications	Apply
CO10	Explain the Sizing of Electrical System to meet the requirement of Electrolytic Process & Summarize the basics of Electrical vehicles	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	L					M	M	M				
CO2.	M	L					L					
CO3.		M	M	L								

CO4.	M			L			M	M				
CO5.	M					L	M				L	L
CO6.		M	M	L			L					
CO7.	L						M	L				
CO8.	M	M	M									
CO9.	M	L	M									
CO10.	M	L	M									

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember (K1)	20	20	20	20
Understand (K2)	50	50	50	50
Apply (K3)	30	30	30	30
Analyse (K4)	--	--	--	--
Evaluate (K5)	--	--	--	--
Create (K6)	--	--	--	--

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the term 'Primary and Secondary Energy' with three examples.
2. What are the major pollutants in burning fossil fuels?
3. How much % of our Country's oil consumption is imported and how much does it cost (approximately) per year?

Course Outcome 2 (CO2):

1. Demonstrate the characteristics of the following: (i) Steam Turbine & (ii) Turbo Alternators.
2. Demonstrate the Principle of a closed cycle Gas turbine plant;
3. Demonstrate the principle of operation of a Gas turbine plant; also explain how its efficiency can be improved?

Course Outcome 3 (CO3):

1. Connected load of plant is 1200kW and diversity factor is 1.8. What is the desirable generator set rating with respect to 0.8PF and the set load factor of 75%.?
2. A power supply company has to install a diesel electric power plant at a hill station having an altitude of 900m above sea level. Four units – 2 each of 500kW and 2 each of 300Kw – are chosen to suit the load curve. The engines used are of the 4 stroke 375 rpm, airless injection type. The maximum demand on the station is to be 1400Kw at 0.8 power factor lagging. The average load factor will be 50% and the annual capacity factor 44%. The generator efficiency may be taken as 93%. Find the ratings of the diesel engines.

Course Outcome 4 (CO4):

1. Discuss the Need and importance of 'Kyoto protocol'.
2. Annotate about the following: (i) Climate change and global warming & (ii) Carbon Credit.
3. Discuss the Importance of 'Renewable Energy Certification'.

Course Outcome 5 (CO5):

1. Annotate about the following: (i) Basic components of wind electric system & (ii) Grid tied Solar PV systems.
2. Demonstrate the Principle of open cycle Magneto Hydro Dynamic Generator Systems.
3. Annotate about the following: (i) Standalone Solar PV systems & (ii) Hybrid Solar PV system

Course Outcome 6 (CO6):
1. Design a Solar PV system for a house which contains 3 fans of 70 watts each running for 4 hours a day, 3 tube lights of 35 watts each running for 8 hours a day and a refrigerator of 250 watts running for 6 hours a day What are the hazards against which a transformer requires protection?
2. Derive the power developed through a wind energy conversion mechanism. Also calculate the power in a wind moving with the speed of 5m/sec incident on a wind turbine with blades of 100m diameter. Also discuss how the power changes if the wind speed increases to 10m/sec.
3. Estimate the required size and cost of the wind turbine for the industry to meet it's the annual energy requirement of 25000kwh. Consider the following additional details: Propeller type wind machine is selected; Co efficient of performance – 0.4; Wind speed at 15metre height is 8 metre/sec (Assume turbine hub is placed at the height of 15metre); Density of air - 1kg/m3; capacity factor – 0.30; No of hours in a year - 8760hours; the turbine generator unit overall losses is considered as 0.90; the cost of a wind turbine - 40000/kw.

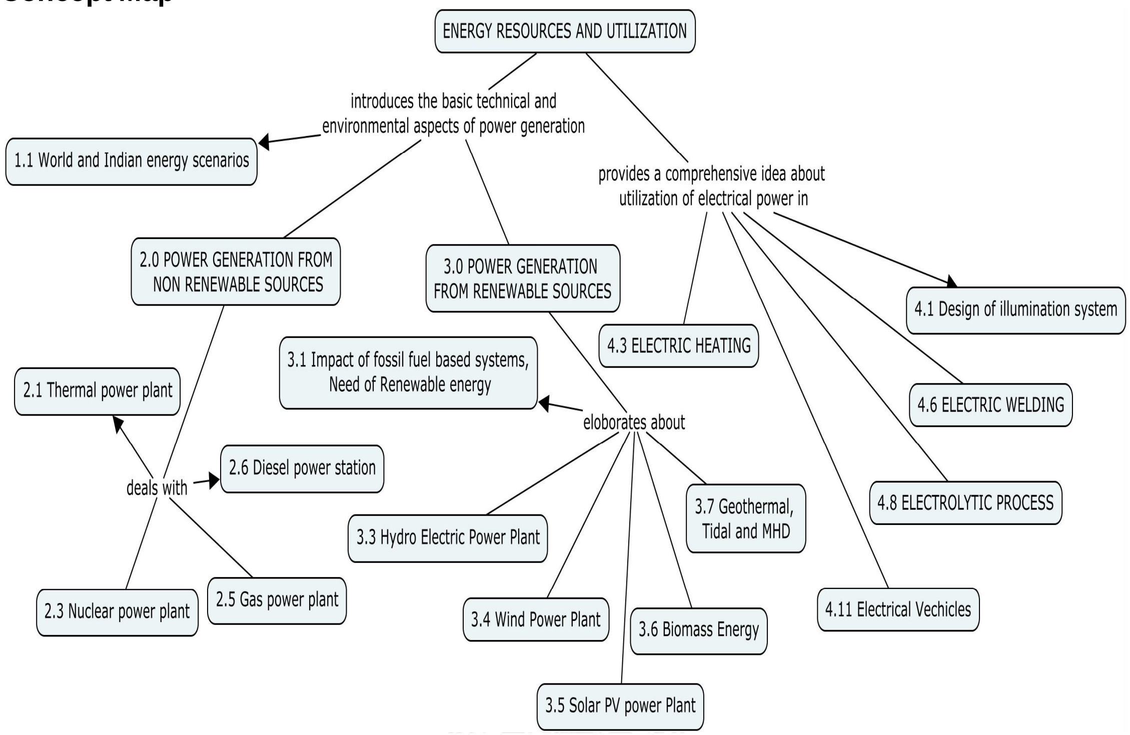
Course Outcome 7 (CO7):
1. Compare the environmental aspects of the non renewable power plants.
2. List the common challenges related with renewable energy power plants.

Course Outcome 8 (CO8):
1. Elaborate the mathematical proof for laws of illuminations.
2. It is desired to illuminate a drawing hall with an average illumination of 200lux. The hall is $30x20m^2$; the lamps are to be fitted 4m from ground floor. Find the number of lamps and wattage/lamp for the lighting scheme. Given efficiency of the lamps available at 25lumens/watt, depreciation factor is 0.8 and co efficient of utilization 0.75, space height ratio between 0.8 to 1.2. Give satisfactory spacing arrangements.
3. Two lamps are hung at a height of 9meter from the floor level. The distance between the lamps is 10meters lamp one is of 500C.P. if the illumination on the floor vertically below the lamp is 20 lux. Find the candle power of the second lamp.

Course Outcome 9 (CO9):
1. Dielectric heating is to be employed to heat a slab of insulating material 20mm thick and $1530mm^2$ in area. Power required is 200W and a frequency of 3MHz is to be used. The material has a permittivity of 5 and power factor of 0.05. Determine the voltage necessary and the current which will flow through the material.
2. A piece of plywood is to be heated by dielectric heating. The area of cross section of the piece is 0.5 m^2 and the thickness is 2.5cm. If the frequency of 25MHz is used and the power absorbed is 1000watt. Find the voltage employed, necessary for heating. The relative permittivity of wood is 3.6 and power factor is 0.046.
3. Compare carbon arc welding and metal arc welding.

Course Outcome 10 (CO10):
1. An 18.258 gm of nickel is deposited by 100A current flowing for 10 minutes, how much copper would be deposited by 50A current in 6 minutes? Atomic weight of nickel and copper are 58.6 and 63.18 respectively and valancy of both is 2.
2. State faraday's laws of electrolysis.
3. Annotate about the factors governing the better Electro Deposition

Concept Map



Syllabus

ENERGY RESOURCES: Introduction **-** World and Indian energy scenarios.

NON RENEWABLE RESOURCES:

Thermal power plant: Schematic arrangement, operation, advantages and disadvantages, choice of site, efficiency of steam power station. Environmental aspects of thermal power plant. **Nuclear power plant:** Schematic arrangement, operation, advantages and disadvantages, selection of site, types of reactors, Hazards, Environmental aspects and locations of nuclear power stations. **Gas power plant:** Schematic arrangement, operation, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, combined cycle power plant & Environmental aspects. **Diesel power plant:** Introduction, Schematic arrangement, operation, advantages and disadvantages, Choice, characteristic of diesel engines, selection of DG set size & Environmental aspects.

RENEWABLE RESOURCES:

Introduction: Impact of fossil fuel based systems, Need of Renewable energy, Green House Gas (GHG) emission status and its controlling mechanism, Renewable Energy Certification (REC), Power Wheeling, Carbon Credits, Power markets, Greenco ratings. **Hydro Electric Power Plant**: Schematic arrangement, advantages and disadvantages, choice of site constituents of hydro power plant, Hydro turbine & Environmental aspects of the plant. **Wind Power Plant:** Introduction to wind, power in the wind, efficiency of wind power, classifications of wind turbine, Basic components of wind energy conversion systems, wind turbine sizing and system design. **Solar PV power Plant:** Basics of Solar radiation, Solar PV Power plant technology, Solar PV systems and their components. Design of Solar PV system. **Biomass Energy:** Types of biomass and their applications, Energy content in biomass, types of conversion process, biomass based fuels and its applications. Basic working principle, types, features and potentials for various power generation technologies like **Geothermal, Tidal and MHD**.

UTILIZATION OF ELECTRICAL ENERGY:

ILLUMINATION: Introduction, Terms used in illumination, laws of illumination, sources of light, effect of voltage variation on lamp efficiency - lighting schemes, Design of lighting schemes for different applications. Factors to evaluate lighting design.
ELECTRIC HEATING: Advantages and methods of electric heating, modes of heat transfer, Stefan's law, resistance heating, design of heating elements, losses and efficiency, construction and working principle of induction furnaces, arc furnaces and dielectric heating.
ELECTRIC WELDING: Types of welding, resistance and arc welding, electric welding equipment, comparison between A.C and D.C Welding.
ELECTROLYTIC PROCESS: Introduction, basic principle of electrolysis deposition, laws of electrolysis, applications of electrolysis, electro deposition, electro plating.
ELECTRICAL VEHICLES: Introduction

Text Books

1. Sivanagaraju s et al., Generation and Utilization of Electrical Energy, Pearson Education India, 2010.
2. Wadhwa C.L., Generation, Distribution and Utilization of Electrical Energy, New Age International publishers, 3rd edition, 2010
3. Chetan Singh Solanki, Renewable Energy Technologies, PHI Learning Private Limited, New Delhi, 5th Printing, 2013.

Reference Books

1. Deshpande M.V, Elements of Electrical Power systems Design, PHI Learning Private Limited, New Delhi, 4th edition, 2012.
2. Gilbert M. Master, Renewables and Efficient Electric Power Systems, John Wiley and Sons, 2004.
3. TAYLOR, OPENSHAW E, Utilization Of Electrical Energy, Orient Blackswan, 1971
4. PARTAB, H, Art And Science Of Utilization Of Electrical Energy, DHANPAT RAI,1997
5. RAI G D, Non-Conventional Sources Of Energy Sources, KHANNA, 2012

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**ENERGY RESOURCES**	
1.1	Introduction - World and Indian energy scenarios	1
2	**NON RENEWABLE RESOURCES**	
2.1	**Thermal power plant**: Schematic arrangement, operation, advantages and disadvantages	2
2.2	Choice of site, efficiency of steam power station. Environmental aspects of thermal power plant.	1
2.3	**Nuclear power plant:** Schematic arrangement, operation, advantages and disadvantages, selection of site,	1
2.4	Types of reactors, Hazards, Environmental aspects and locations of nuclear power stations.	2
2.5	**Gas power plant:** Schematic arrangement, operation, advantages and disadvantages of Gas turbine power plant. Open cycle and Closed cycle gas turbine power plant, combined cycle power plant & Environmental aspects.	2
2.6	**Diesel power plant:** Introduction, Schematic arrangement, operation,	2

Module No.	Topic	No. of Lectures
	advantages and disadvantages, Choice, characteristic of diesel engines, selection of DG set size & Environmental aspects.	
3	**RENEWABLE RESOURCES**	
3.1	Introduction: Impact of fossil fuel based systems, Need of Renewable energy, Green House Gas (GHG) emission status and its controlling mechanism	1
3.2	Renewable energy Certification (REC), Power Wheeling, Carbon Credits, Power markets, Greenco ratings.	1
3.3	**Hydro Electric Power Plant**: Schematic arrangement, advantages and disadvantages, choice of site constituents of hydro power plant, Hydro turbine & Environmental aspects of the plant.	2
3.4	**Wind Power Plant:** Introduction to wind, power in the wind, efficiency of wind power, classifications of wind turbine, Basic components of wind energy conversion systems, wind turbine sizing and system design.	2
3.5	**Solar PV power Plant:** Basics of Solar radiation, Solar PV technology - power generated, Solar PV systems and their components. Design of Solar PV system.	2
3.6	**Biomass Energy:** Types of biomass and their applications, Energy content in biomass, types of conversion process, biomass based fuels and its applications.	2
3.7	Basic working principle, types, features and potentials for various power generation technologies like **Geothermal, Tidal and MHD.**	1
4	**UTILIZATION OF ELECTRICAL ENERGY**	
4.1	**ILLUMINATION** - Introduction, Terms used in illumination, laws of illumination, sources of light, effect of voltage variation on lamp efficiency - lighting schemes	1
4.2	Design of lighting schemes for different applications. Factors to evaluate lighting design.	2
4.3	**ELECTRIC HEATING:** Advantages and methods of electric heating, modes of heat transfer, Stefan's law, resistance heating,	2
4.4	Design of heating elements, losses and efficiency, construction and working principle of induction furnaces,	1
4.5	Arc furnaces and dielectric heating.	1
4.6	**ELECTRIC WELDING:** Types of welding, resistance and arc welding,	2
4.7	Electric welding equipment, comparison between A.C and D.C Welding.	1
4.8	**ELECTROLYTIC PROCESS:** Introduction, basic principle of electrolysis deposition, laws of electrolysis	2
4.9	Applications of electrolysis, electro deposition	2
4.10	Electro plating.	1
4.11	**ELECTRICAL VEHICLES:** Introduction	1
	Total	**38**

Course Designers:

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2. Dr. D. Nelson Jayakumar dnjayakumar@tce.edu

14EE550	DIGITAL SIGNAL PROCESSING	Category	L	T	P	Credit
		PC	2	2	0	3

Preamble

Signals play major role in our life. In general, a signal can be a function of time, distance, position, temperature, pressure etc., and represents some variable of interest associated with system. A signal carries information and objective of signal processing is to extract this information. Signal processing is concerned with representing the signal in mathematical terms and extracting the information by carrying out the algorithmic operations on the signal.

Digital processing of a signal has major advantage over analog techniques. With digital filters, linear phase characteristics can be achieved; Filters can be made to work over a wide range of frequencies. Storage of digital data is very easy. Digital processing is more suited for low frequency signals like seismic signals, biosignals.

Prerequisite
14EE310 –Engineering Mathematics - III

Course Outcomes
On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms Level
CO1	Explain the functional blocks and characteristics of discrete time systems	Understand
CO2	Explain the characteristics of discrete-time signals.	Understand
CO3	Classify the given Discrete Time System based on the properties	Apply
CO4	Compute convolution and correlation of the given discrete-time signals.	Apply
CO5	Apply DTFT, DFT and FFT for the given discrete time signal.	Apply
CO6	Design FIR filter using windowing techniques (Rectangular and Hamming) for the given specifications.	Apply
CO7	Design IIR filter using bilinear and impulse invariance transformation for the given specifications.	Apply
CO8	Discuss the structural of musical sound processing system	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**L**										
CO2	**M**	**L**										
CO3	**S**	**M**	**L**	**L**								
CO4	**S**	**M**	**L**	**L**								
CO5	**S**	**M**	**L**	**L**								
CO6	**S**	**M**	**L**	**L**								
CO7	**S**	**M**	**L**	**L**								
CO8	**M**	**L**										

S- Strong; M-Medium; L-Low

Passed in BOS meeting held on 23-04-2016 Approved in 52nd AC meeting held on 18-06-2016

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	50	50	50
Analyse	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Draw the block diagram of digital signal processing system.
2. Give the advantages and applications of Digital signal processor.
3. Discuss in detail the errors resulting from rounding and truncation.

Course Outcome 2 (CO2):

1. Define Shannon's sampling theorem.
2. Consider the analog signal X(t)= 3cos 100πt. Determine the minimum sampling rate to avoid aliasing.
3. What is the nyquist rate for the given signal, $x(t) = 2sin400\prod t + cos1000\prod t$.

Course Outcome 3 (CO3):

1. Define unit impulse and unit step discrete signals.
2. Determine whether the following signals are periodic. Find the fundamental period for the periodic signals.
   a)$x(n) = cos\frac{\pi}{8}n$ b)$x(n) - e^{j\Pi n}$ c)$x(n) = \sin\left(\frac{\pi}{4}\right)n + \sin\left(\frac{\Pi}{8}\right)n$
3. Find whether the following signals are energy signals or power signals:
   a) $x(n) = 0.2^n u(-n-1)$ b) x(n) = cos (Π/6)n.

Course Outcome 4 (CO4):

1.Find whether the following systems are linear, static and time invariant a) y(n) = x(-n+2) b) $y(n) = nx^2(n)$.

2. Find whether the following systems are causal and stable.
a) $h(n) = 0.2^n u(-n-2)$ b) $y(n) = 0.6^n u(n)\, x(n)+n^2 x(n+1)$

3. Determine the stablity of the given system,
$y(n) = 2^n u(3-n)$.

Course Outcome 5 (CO5):

1. Define Cross correlation and Auto correlation.
2. Find linear and circular convolution of the discrete samples, x1(n)={1,0,4,6}, x2(n)={1,2,1}.
3. Compute correlation of the given signal,
   x(n)={1,0,2,5,4};h(n)= n/2 -3≤n≤3
   = 0 otherwise.

Course Outcome 6 (CO6):

1. What is twiddle factor?
2. Compute the 8 point DFT of the given sequence, x(n) using DIF -FFT algorithm,
   $x(n) =(-1)^n$; 0 ≤ n ≤7
   =0 otherwise.
3. Determine 8 point DFT of the sequence x(n) = {1,1,1,1,1,1,0,0}.

Course Outcome 7 (CO7):

1. Write the Hamming window function.

2. Design a filter with the following specifications,

$$H(e^{j\omega}) = 1 \qquad -\frac{\Pi}{4} \le |\omega| \le \frac{\Pi}{4}$$

$$= 0 \qquad \frac{\Pi}{4} \le |\omega| \le \Pi .$$

Use hamming window with N=7. Realize its structure.

3. Using the rectangular window technique design a LPF with passband gain of unity, cutoff frequency of 1000Hz and working sampling frequency of 5kHz. The length of impulse be 7.

Course Outcome 8 (CO8):

1. Design a digital filter for the given analog system, $H_a(s) = \dfrac{2}{(s+1)(s+4)}$. Use a) impulse invariance method
   b) bilinear transformation method.
2. Design a bandpass filter to pass frequencies in the range,
   w= 1-2 rad/sec using hamming window with N=5. Realize using direct form-II structure.
3. Design a Chebyshev filter for the following specification using bilinear transformation and realize using cascade form.

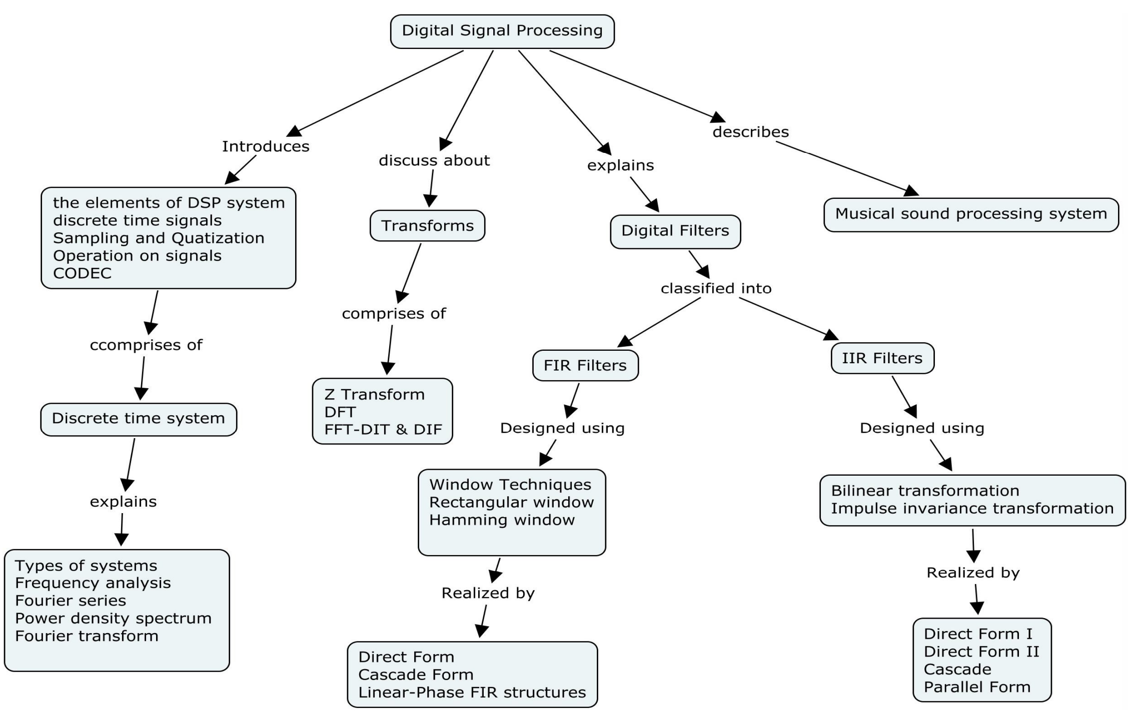
$$0.8 \le |He^{j\omega}| \le 1 \qquad 0 \le |\omega| \le 0.2\pi$$

$$|He^{j\omega}| \le 0.2 \qquad 0.6\pi \le |\omega| \le \pi$$

Course Outcome 9 (CO9):

1. What are the basic reverberator units?
2. Compare Single and Multiple Echo filters.
3. Realize the natural sounding reverberator scheme.

Concept Map



Syllabus

Introduction: Basic elements of a digital signal processing system – Advantages of digital over analog signal processing – Continuous time verses discrete time signals – Sampling of analog signals –Quantization of continuous amplitude signals – Signal representation – Classification of discrete time signal – Operation on signals – Convolution and Correlation of discrete time signals- Introduction on CODEC.

Discrete time system – Causal, dynamic, linear, time invariant, stable systems –Frequency analysis of discrete time signals – Fourier series and its properties for discrete time periodic signals - Power density spectrum of periodic signals– Fourier transform and its Properties for discrete time signals.

Transforms: Overview of Z Transform and its application - Discrete Fourier Transform (DFT) and its properties - Fast Fourier Transform (FFT) algorithms - Radix-2 FFT–DIT & DIF.

Digital Filters Design: Properties and Structures of FIR and IIR filter – Design of FIR filter using rectangular and hamming windows – Design of IIR filter from analog filters using bilinear and impulse invariance transformation.

Realization of Digital Filters: Realization of FIR filters (Direct Form, Cascade Form, Linear-Phase FIR structures)and IIR filters(Direct Form I, Direct Form II, Cascade and Parallel Form) - **Application:** Musical sound processing system

Text Book

1. John G.Proakis & Dimitris G.Manolakis, - Digital Signal Processing Principles, Algorithm and Applications – Pearson Education, New Delhi, 4th Edition, 2003.

Reference Books

1. P.Ramesh Babu - Digital Signal Processing, Scitech Publications of India, 2012.
2. Emmanuel C. Ifeachor & Barrie W. Jervis - Digital Signal Processing - A practical approach, Pearson Education, New Delhi, 2004.
3. A.V. Oppenheim and R.W.Schafer - Digital Signal Processing, Prentice Hall of India, 2001.
4. Sanjit K.Mishra – Digital Signal Processing-A computer based approach, Tata McGraw-Hill, New Delhi, 2004.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**Introduction**	
1.1	Basic elements of a digital signal processing system	1
1.2	Advantages of digital over analog signal processing	1
1.3	Continuous time verses discrete time signals	1
1.4	Sampling of analog signals	1
1.5	Quantization of continuous amplitude signals	1
1.6	Signal representation & Classification discrete time signal	1
1.7	Operation on signals- Convolution and Correlation of discrete time signals	1
1.8	Introduction on CODEC	1
2	**Discrete time system**	
2.1	Causal, dynamic, linear, time invariant, stable systems	2
2.2	Frequency analysis of discrete time signals	2

2.3	Fourier series and its properties for discrete time periodic signals	2
2.4	Power density spectrum of periodic signals	1
2.5	Fourier transform and its Properties for discrete time signals	2
3	**Transforms**	
3.1	**Overview of** Z Transform and its application	1
3.2	Discrete Fourier Transform (DFT) and its properties	2
3.3	Fast Fourier Transform (FFT) : Radix-2 FFT	2
3.4	Fast Fourier Transform (FFT) algorithms: DIT and DIF	2
4	**Digital Filters**	
4.1	Properties and Structures of FIR and IIR filter	1
4.2	Design of FIR filter using rectangular and hamming windows	3
4.3	Design of IIR filter from analog filters using bilinear and impulse invariance transformation	3
5	**Realization of Digital Filters**	
5.1	Realization of FIR and IIR filters(Direct form I, Direct form II, Cascade and parallel form)	2
5.2	**Application:** Musical sound processing system	2
	Total	**35**

Course Designers:

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2. Dr.R.Helen rheee@tce.edu

14EE590	CONTROL AND INSTRUMENTATION LAB	Category	L	T	P	Credit
		PC	0	0	2	1

Preamble

This course is to give an exposure on practical aspects of control and instrumentation. In control aspects, focus is on analysis and design of controllers using modern IT tools and implementation of controllers in real world systems. In instrumentation aspects, signal conditioning, data acquisition and virtual instrumentation are included.

Prerequisite

1. 14EE250 Analog Devices and Circuits
2. 14EE430 Control systems
3. 14EE340 Measurement Systems
4. 14EE460 Microcontrollers

Course Outcomes

On the successful completion of the course, students will be able to:

CO Nos.	Course Outcomes	Blooms level
CO1	Analyse the effect of compensators for continuous time and sampled data system using MATLAB	Analyze, Precision
CO2	Analyse the effect of state feedback controller for continuous time and sampled data system using MATLAB	Analyze, Precision
CO3	Implement discrete PID controller/compensator in microcontroller/DSP processor.	Apply, Precision
CO4	Develop PLC ladder logic programs for given process sequence involving digital i/o, counters & timer	Apply Precision
CO5	Design signal conditioning circuits such as I/V converter, V/I converter and instrumentation amplifier for given specification and demonstrate its operation	Apply Precision
CO6	Analyse the data acquired using data acquisition system in LabVIEW	Analyse Precision

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S							
CO2	S	S	S	S	S							
CO3	S	M	S	M	M							
CO4	S	M	S	M								
CO5	S	M	S	M								
CO6	S	S	M	S	S							

S-Strong; M-Medium; L-Low

List of Experiments:

CONTROL SYSTEM

1. Compensator Design and simulation using MATLAB (CO1)
2. State feedback design and simulation using MATLAB (CO2)
3. PLC based control of sequential processes. (CO4)
4. Analyse the effect of P,PI and PID controllers in pressure control in pneumatic system (CO1)
5. Analyse the effect of P,PI and PID controller in liquid level control system (CO1)
6. Microcontroller based PID control of Buck converter (CO3)

INSTRUMENTATION:

1. Study of LabVIEW (Introduction & Basic Programming) (CO6)
2. LabVIEW based Resistance, Inductance and Capacitance Measurement using bridges (CO6)
3. Analysis of characteristics of LVDT, Thermocouple, and Thermistor using LabVIEW (CO6)
4. Frequency and phase measurement using micro controller (CO5)
5. Microcontroller based data acquisition system (Simulation / Hardware) (CO5)
6. Instrumentation Amplifier (CO5)
7. I/V and V/I Converter (CO5)

Course Designers:

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2. M.Varatharajan varatharajan@tce.edu

		Category	L	T	P	Credit
14EE580	**DIGITAL SIGNAL PROCESSING LAB**	PC	0	0	2	1

Preamble

Digital Signal Processing techniques are increasingly replacing conventional analog signal processing methods in fields, such as speech analysis and processing, music information retrieval, radar and sonar signal processing, biomedical signal analysis and processing, telecommunications, and geo-physical signal processing. In digital signal processing, the signal (pressure of a sound wave, a radio signal, or daily temperature readings, sampled over a finite time interval) is represented as a sequence.

Correlation and Convolution are basic operations needed to extract information from signals and images. They are the simplest operations but they are extremely useful. DFT and FFT are used to convert the sampled function from its original domain (often time or position along a line) to the frequency domain. Digital filters play an important role in radios, mobiles and AV receivers. They perform mathematical operations on a sampled, discrete-time signal to reduce or enhance certain aspects of that signal. To realize the above mentioned mathematical operations simulation software, Matlab is used. To implement those operations in real time, Digital signal processors are used.

Prerequisite
14EE310 –Engineering Mathematics - III

COs No.	**Course outcomes**	**Blooms Level**
CO1	Generate discrete time signals and PWM using CCS and Matlab.	Apply, Precision
CO2	Demonstrate Nyquist sampling theorem and aliasing effects using CCS and Matlab.	Apply, Precision
CO3	Perform DFT, FFT, convolution and correlation for the given Discrete sequences using CCS and Matlab	Apply, Precision
CO4	Design FIR and IIR filters using Matlab, CCS and DSP processor (TMS320C6713) for the given specifications.	Analyze, Precision
CO5	Simulate a musical sound processing system for the given specifications using Matlab	Apply, Precision

Mapping with Programme Outcomes

Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**S**	**M**	**L**		**S**				**S**			
CO2	**S**	**M**	**L**		S				**S**			
CO3	**S**	**M**	**L**		S				**S**			
CO4	**S**	**M**	**L**		S				**S**			
CO5	**S**	**M**	**L**		S				**S**			

S- Strong; M-Medium; L-Low

List of Experiments:

1. Discrete Time Sequences - Generation, Concept of Aliasing and operations using CCS and Matlab
2. Convolution and Correlation using CCS and Matlab
3. FIR Filter Design using CCS and Matlab
4. IIR Filter Design using CCS and Matlab
5. PWM generation using CCS and Matlab
6. Implementation of FIR and IIR filters on TMS320C6713
7. Simulation of musical sound processing system using Matlab

Course Designers

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2. Dr.R.Helen rheee@tce.edu

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

SIXTH,SEVENTH and EIGHTH SEMESTERS

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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Fax: 0452 2483427
Web: www.tce.edu

Semester	Theory						Theory cum Practical	Practical Courses			Credits
	1	2	3	4	5	6	7	8	9	10	
I	14MA110 Engineering Mathematics I(3)	14PH120 Physics (3)	14CH130 Chemistry (3)	14EG140 English (3)	14ES150 Basics of Civil and Mechanical Engineering (2)	14ES160 Basics of Electrical and Electronics Engineering (2)	14ME170 Engineering Graphics (3)	14PH180 Physics Lab (1)	14CH190 Chemistry Lab (1)	--	**21**
II	14EE210 Engineering Mathematics II (3)	14EE220 Materials Science for Electrical Engineering (3)	14EE230 Environmental Science and Ethics (3)	14EE240 Electromagnetic Fields (3)	14EE250 Analog Devices and Circuits (3)		14EE270 Electric Circuit Analysis (3)	14EE280 Analog Devices and Circuits Lab (1)	14ES290 Workshop (1)	--	**20**
III	14EE310 Engineering Mathematics III (3)	14EE320 Transformers (3)	14EE330 DC machines (3)	14EE340 Measurement Systems (3)	14EE350 Digital Systems (3)		14EE370 Problem solving using Computers (3)	14EE380 DC Machines and Transformers Lab (1)	14EE390 Digital Systems Lab (1)	--	**20**
IV	14EE410 Engineering Mathematics IV (3)	14EE420 Instrumentation Systems (3)	14EE430 Control Systems (3)	14EE440 AC Machines (3)	14EE450 Engineering Design (3)	14EE460 Microcontrollers (3)		14EE480 AC Machines Lab (1)	14EE490 Microcontrollers Lab (1)	14EE4C0 Capstone Course-I (2)	**22**
V	14EE510 Numerical Methods (3)	14EE520 Power Semiconductor Devices (3)	14EE530 Control System Design (3)	14EE540 Energy Resources and Utilization (3)	14EE550 Digital Signal Processing (3)	14EEPx0 Prog. Elec.I (3)		14EE580 Digital Signal Processing Lab (1)	14EE590 Control and Instrumentation Lab (1)	--	**20**
VI	14EE610 Accounting and Finance (3)	14EE620 Power Electronics (3)	14EE630 Transmission and Distribution (3)	14EEPX0 Prog. Elec.II (3)	14EEGx0 Gen. Elec. I (3)		14EE670 Professional Communication (2)	14EE680 Power Systems Lab (1)	14EE690 Power Electronics and Drives Lab (1)	--	**19**
VII	14EE710 Project Management (3)	14EE720 Drives and Control (3)	14EE730 Industrial Automation (3)	14EEPx0 Prog. Elec.III (3)	14EEPx0 Prog. Elec.IV (3)	14EEGx0 Gen. Elec. II (3)		14EE780 Automation Lab (1)		14EE7C0 Capstone Course-II (2)	**21**
VIII	14EEPx0 Prog. Elec.V (3)	14EEPx0 Prog. Elec.VI (3)	14EEPx0 Prog. Elec.VII (3)	--	--	--	--	14EE880 Project (12)		--	**21**
										Total Credits	**164**

Basic Science Courses

Humanities and Social Science Courses

Engineering Science courses

Analog & Digital Electronic System Courses

Electrical Energy System Courses

Power Electronics & Drives Courses

Control & Automation Courses

Core and General Elective Courses, Capstone Courses & Project

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015
B.E. EEE Degree Programme

COURSES OF STUDY
(For the candidates admitted from 2014-15)

SECOND SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE210	Engineering Mathematics - II	BS	2	2	-	3
14EE220	Materials Science for Electrical Engineering	BS	2	-	2	3
14EE230	Environmental Science and Ethics	BS	3	-	-	3
14EE240	Electromagnetic fields	ES	2	2	-	3
14EE250	Analog Devices and Circuits	PC	3	-	-	3
THEORY CUM PRACTICAL						
14EE270	Electric Circuit Analysis	PC	2	-	2	3
PRACTICAL						
14EE280	Analog Devices and Circuits Lab	PC	-	-	2	1
14ES290	Workshop	ES	-	-	2	1
Total			**14**	**4**	**8**	**20**

THIRD SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE310	Engineering Mathematics - III	BS	2	2	-	3
14EE320	Transformers	PC	2	2	-	3
14EE330	DC Machines	PC	2	2	-	3
14EE340	Measurement Systems	PC	3	-	-	3
14EE350	Digital Systems	PC	2	2	-	3
THEORY CUM PRACTICAL						
14EE370	Problem Solving Using Computers	ES	2	-	2	3
PRACTICAL						

14EE380	DC Machines and Transformers Lab	PC	-	-	2	1
14EE390	Digital Systems Lab	PC	-	-	2	1
Total			**13**	**8**	**6**	**20**

FOURTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE410	Engineering Mathematics - IV	BS	2	2	-	3
14EE420	Instrumentation Systems	PC	3	-	-	3
14EE430	Control Systems	PC	3	-	-	3
14EE440	AC Machines	PC	3	-	-	3
14EE450	Engineering Design	PC	1	-	4	3
14EE460	Microcontrollers	PC	3	-	-	3
PRACTICAL						
14EE480	AC Machines Lab	PC	-	-	2	1
14EE490	Microcontrollers Lab	PC	-	-	2	1
14EE4C0	Capstone Course-I	PC	-	-	4	2
Total			**15**	**2**	**12**	**22**

FIFTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE510	Numerical Methods	BS	2	2	-	3
14EE520	Power Semiconductor Devices	PC	3	-	-	3
14EE530	Control System Design	PC	3	-	-	3
14EE540	Energy Resources and Utilization	PC	3	-	-	3
14EE550	Digital Signal Processing	PC	2	2	-	3
PRACTICAL						
14EE580	Digital Signal Processing Lab	PC	-	-	2	1
14EE590	Control and Instrumentation Lab	PC	-	-	2	1
ELECTIVES						

14EEPxx	Programme Elective -I	PE	Refer the respective courses	3
Total			**13 4 4**	**20**

SIXTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE610	Accounting and Finance	HSS	3	0	-	3
14EE620	Power Electronics	PC	3	-	-	3
14EE630	Transmission and Distribution	PC	3	-	-	3
14EE670	Professional Communication	HSS	1	-	2	2
PRACTICAL						
14EE680	Power Systems Lab	PC	-	-	2	1
14EE690	Power Electronics and Drives Lab	PC	-	-	2	1
ELECTIVES						
14EEPxx	Programme Elective –II	PE	Refer the respective courses			3
14xxGxx	General Elective - I	GE	Refer the respective courses			3
Total						**19**

SEVENTH SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
14EE710	Project Management	HSS	3	0	-	3
14EE720	Drives and Control	PC	3	-	-	3
14EE730	Industrial Automation	PC	3	-	-	3
PRACTICAL						
14EE780	Automation Lab	PC	-	-	2	1
14EE7C0	Capstone – II	PC	-	-	4	2

ELECTIVES				
14EEPxx	Programme Elective –III	PE	Refer the respective courses	3
14EEPxx	Programme Elective –IV	PE	Refer the respective courses	3
14xxGxx	General Elective - II	GE	Refer the respective courses	3
Total				**21**

EIGHTTH SEMESTER

Course Code	**Name of the Course**	**Category**	**No. of Hours / Week**			**Credits**
			L	**T**	**P**	
PRACTICAL						
14EE880	Project	PC	-	-	24	12
ELECTIVES						
14EEPxx	Programme Elective –V	PE	Refer the respective courses			3
14EEPxx	Programme Elective –VI	PE	Refer the respective courses			3
14EEPxx	Programme Elective –VII	GE	Refer the respective courses			3
Total						**21**

BS : Basic Science
ES : Engineering Science
PC : Programme Core
PE : Programme Elective

L : Lecture
T : Tutorial
P : Practical

Note:

1 Hour Lecture/week is equivalent to 1 credit

2 Hours Tutorial/week is equivalent to 1 credit

2 Hours Practical/week is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015

B.E. EEE Degree Programme

SCHEME OF EXAMINATIONS
(For the candidates admitted from 2014-15onwards)

SECOND SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE210	Engineering Mathematics - II	3	50	50	100	25	50
2	14EE220	Materials Science for Electrical Engineering	3	50	50	100	25	50
3	14EE230	Environmental Science and Ethics	3	50	50	100	25	50
4	14EE240	Electromagnetic fields	3	50	50	100	25	50
5	14EE250	Analog Devices and Circuits	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE270	Electric Circuit Analysis	3	50	50	100	25	50
PRACTICAL								
8	14EE280	Analog Devices and Circuits Lab	3	50	50	100	25	50
9	14ES290	Workshop	--	100	--	100	--	50

THIRD SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								

1	14EE310	Engineering Mathematics - III	3	50	50	100	25	50
2	14EE320	Transformers	3	50	50	100	25	50
3	14EE330	DC Machines	3	50	50	100	25	50
4	14EE340	Measurement Systems	3	50	50	100	25	50
5	14EE350	Digital Systems	3	50	50	100	25	50
THEORY CUM PRACTICAL								
7	14EE370	Problem Solving Using Computers	3	50	50	100	25	50
PRACTICAL								
8	14EE380	DC Machines and Transformers Lab	3	50	50	100	25	50
9	14EE390	Digital Systems Lab	3	50	50	100	25	50

FOURTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE410	Engineering Mathematics - IV	3	50	50	100	25	50
2	14EE420	Instrumentation Systems	3	50	50	100	25	50
3	14EE430	Control Systems	3	50	50	100	25	50
4	14EE440	AC Machines	3	50	50	100	25	50
5	14EE450	Engineering Design	--	100	--	100	--	50
6	14EE460	Microcontrollers	3	50	50	100	25	50
PRACTICAL								
7	14EE480	AC Machines Lab	3	50	50	100	25	50
8	14EE490	Microcontrollers Lab	3	50	50	100	25	50
9	14EE4C0	Capstone Course-I	--	100	--	100	--	50

FIFTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE510	Numerical Methods	3	50	50	100	25	50
2	14EE520	Power Semiconductor Devices	3	50	50	100	25	50
3	14EE530	Control System Design	3	50	50	100	25	50
4	14EE540	Energy Resources and Utilization	3	50	50	100	25	50
5	14EE550	Digital Signal Processing	3	50	50	100	25	50
PRACTICAL								
6	14EE580	Digital Signal Processing Lab	3	50	50	100	25	50
7	14EE590	Control and Instrumentation Lab	3	50	50	100	25	50
ELECTIVES								
8	14EEPxx	Programme Elective -I	3	50	50	100	25	50

SIXTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE610	Accounting and Finance	3	50	50	100	25	50
2	14EE620	Power Electronics	3	50	50	100	25	50
3	14EE630	Transmission and Distribution	3	50	50	100	25	50

4	14EE670	Professional Communication	3	50	50	100	25	50
PRACTICAL								
5	14EE680	Power Systems Lab	3	50	50	100	25	50
6	14EE690	Power Electronics and Drives Lab	3	50	50	100	25	50
ELECTIVES								
7	14EEPxx	Programme Elective –II	3	50	50	100	25	50
8	14xxGxx	General Elective - I	3	50	50	100	25	50

SEVENTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
THEORY								
1	14EE710	Project Management	3	50	50	100	25	50
2	14EE720	Drives and Control	3	50	50	100	25	50
3	14EE730	Industrial Automation	3	50	50	100	25	50
PRACTICAL								
4	14EE780	Automation Lab	3	50	50	100	25	50
5	14EE7C0	Capstone Course-II	--	100	--	100	--	50
ELECTIVES								
6	14EEPxx	Programme Elective –III	3	50	50	100	25	50
7	14EEPxx	Programme Elective –IV	3	50	50	100	25	50
8	14xxGxx	General Elective - II	3	50	50	100	25	50

EIGHTH SEMESTER

S.No.	Course Code	Name of the Course	Duration of Terminal Exam. in Hrs.	Marks			Minimum Marks for Pass	
				Continuous Assessment *	Terminal Exam	Max. Marks	Terminal Exam	Total
PRACTICAL								
4	14EE880	Project	-	50	50	100	25	50
ELECTIVES								
5	14EEPxx	Programme Elective –V	3	50	50	100	25	50
6	14EEPxx	Programme Elective –VI	3	50	50	100	25	50
7	14EEPxx	Programme Elective –VII	3	50	50	100	25	50

* CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

14EE610	ACCOUNTING AND FINANCE	Category	L	T	P	Credit
		HSS	3	0	0	3

Preamble

Engineering profession involves lots of decision making. The decisions may range from operation to non-operation. For taking decisions of these kinds, an engineer needs among other data about the organization routine operations and non-routine operations. Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Finance is an allied but a separate field relying on accounting and enables engineers in taking useful financial and cost related decisions by providing well defined concepts, tools and techniques.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Cos	**Course outcomes**	**Blooms Level**	Expected Proficiency (%)	Expected attainment Level (%)
CO1	Explain the basic concepts and process of accounting and finance.	Understand	80	90
CO2	Develop trail balance and financial statements like Trading, Profit and Loss accounts, Balance sheet and Cost sheet.	Apply	70	70
CO3	Demonstrate the concepts and operations of budgetary control	Understand	80	90
CO4	Apply techniques like breakeven analysis and budgeting for an organization	Apply	70	80
CO5	Select the right sources of finance and mobilize the right quantum of finance and make use of them in most profitable investment avenues.	Apply	70	80

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1.											S	
CO2.											S	
CO3.											S	
CO4.											S	
CO5.											S	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Describe the term Accounting.
2. List the concepts of accounting.
3. Recall the methods of depreciation.
4. Name the factors causing depreciation.
5. Write the classification of cost.
6. Define the term capital budgeting.

Course Outcome 2 (CO2):

1. Prepare trading account from the information given below and calculate the net profit. Gross profit.....Rs.10,000; Office and administrative expenses .....Rs.1000; selling and distribution expenses ....Rs.500; Interest on investment received...Rs.500; commission received....Rs.200
2. Compare Trading and profit and loss account.
   Compute depreciation for an asset worth Rs.10,000 and having a scrap value of Rs.2,000 and a life time of 4 years under straight line method.
3. Outline the cost classification based on the nature of cost.
4. Apply the net present value method of evaluating investment decision and say whether the following project could be selected for investment.

Year	Cash inflows in Rs.
0	10,000
1	3,000
2	4,000
3	4,000
4	2,000
5	2,000

Course Outcome 3

1. Construct journal entries for the following business transactions.
   a) X brings in cash Rs.10,000 as capital b)purchases land worth Rs.2000, c)He purchases goods worth Rs.5,000,d)He sells goods for Rs.10,000,e)He incurs travelling expenses of Rs.200.
2. Estimate Gross profit and Net profit and the financial position from the following trial balance extracted from the books of Mr.kumar as on 31.12.2010.

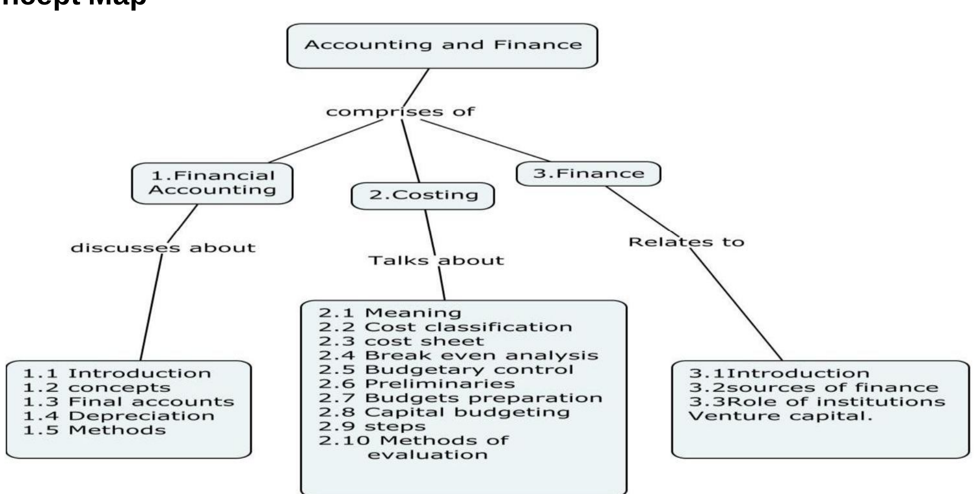
Debit Balances	Amount in Rs.	Credit Balances	Amount in RS.
Buildings	30,000	Capital	40,000
Machinery	31,400	Purchase returns	2,000
Furniture	2,000	Sales	2,80,000
Motor car	16,000	Sundry creditors	9,600
Purchases	1,88,000	Discounts received	1,000
Sales return	1,000	Provision for bad debts	6,00
Sundry debtors	30,000		
General expenses	1,6000		
Cash at bank	9,400		
Rates and taxes	1,200		
Bad debts	4,00		
Insurance premium	8,00		
Discount allowed	1,400		
Opening stock	20,000		
Total	**3,33,200**	**Total**	**3,33,200**

3. Calculate depreciation for a machinery purchased by senthil for Rs.4,00,000 on 1st April 2010.He also adds an additional machinery for Rs.40,000 on 1st April 2011.Depriciation is to be provided at 10% per annum using straight line method. The firm closes its books on 31st March every year.
4. A factory is currently working at 50% capacity and the product cost is Rs.180 per unit as below:
   Material ....Rs.100; Labour.....Rs.30
   Factory overheads....Rs.30 (40% fixed)
   Administration overhead ..Rs.20 (50% fixed)
   The product is sold at Rs.200 per unit and the factory produces 10,000 units at 50% capacity.
   Estimate profit if the factory works to 60% capacity. At 60% working raw material increases by 20% and selling price falls by 20%.

Course Outcome 4

1. From the following information calculate the Breakeven point in terms of units and breakeven point in terms of sales.
   Sales....Rs.10,000; Variable costs Rs.6,000,fixed costs Rs.2000:profit Rs.2,000;No. Of units produced 1,000 units
2. Describe the term „ Breakeven analysis‟
3. Calculate the breakeven point and margin of safety from the following information . Fixed cost ...Rs.10,000, sales in Rs.25,000,selling price per unit Rs.30; variable cost per unit Rs.10

Concept Map



on 22-12-2016

Syllabus

Accounting: Introduction and Definition-Accounting concepts and conventions-Final Accounts-Preparation of Trading, Profit and Loss Account and Balance Sheet.Depriciation-Meaning-Need and objectives-Basic factors-Methods of providing depreciation.

Cost Accounting: Meaning and Importance-Cost-Elements of cost-Cost classification-Preparation of cost sheet. Break even analysis-Managerial applications. Budget and budgetary control. Meaning- Objectives of budgetary control-Preliminaries for operation of budgetary control-Budgets-Types of budgets and their preparation. Capital budgeting-Meaning-Importance-steps in capital budgeting-Information needed-Methods of evaluating capital budgeting decisions.

Finance: Introduction-Definition-objectives-functions of finance-sources of finance-Short-term, Medium term, and Long-term-Role of special financial institutions in financing-Venture capital.

Text Books

1. M.C.Shukla,T.S.Grewal,"AdvancedAccounts-Volume-I,2010 Reprint, S. Chand & company Ltd.,2010.
2. Prasanna Chandra, "Financial Management-Theory and practice" seventh Reprint,Tata McGraw-Hill publishing company Limited,2010.

Reference Books

1. A.Ramachandra Aryasri, V.V Ramana Murthy, "Engineering Economics and Financial Accounting, Tata Mc Graw hill, 2010.
2. Dr.V.R.Palanivelu,"Accounting for Management "Third Edition, 2013, University science press New Delhi.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Financial accounting**	
1.1	Introduction and Definition	1
1.2	Accounting concepts and conventions	2
1.3	Final accounts-Preparation of Trading profit and Loss account and Balance sheet.	4
1.4	Depreciation- Meaning, Need and Objectives	2
1.5	Basic factors-Methods of providing depreciation	3
2.	**Cost Accounting**	
2.1	Meaning and Importance	1
2.2	Cost-Elements of cost-Cost classification	2
2.3	Preparation of cost sheet	2
2.4	Break even analysis-Managerial applications	2
2.5	Budget and budgetary control. Meaning- Objectives of budgetary control	1
2.6	Preliminaries for operation of budgetary control	1
2.7	Types of budgets and their preparation	3
2.8	Capital budgeting-Meaning-Importance	1
2.9	Steps in capital budgeting-Information needed	1
2.10	Methods of evaluating capital budgeting decisions. Payback	3

	period-Rate of Return-Net present value-Internal Rate of return method	
3	**Finance**	
3.1	Introduction-Definition-objectives-functions of finance	2
3.2	sources of finance-Short-term, Medium term, and Long-term	2
3.3	Role of special financial institutions in financing-Venture capital.	3
		36

Course Designers:

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14EE620	POWER ELECTRONICS	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

Power electronics involves the study of electronic circuits intended to control the flow of electrical energy. It deals with the processing and control of 'raw' electrical power from an electrical source such as an AC mains supply, a battery bank, a photovoltaic array, or a wind turbine into a form and quality suitable for a particular electrical load. It is an enabling technology with a very wide range of applications, such as military/avionic products, industrial products, Transportation system, Telecom products, Medical equipments etc.

Prerequisite

14EE250 : Analog Devices and Circuits
14EE270 : Electric Circuit Analysis
14EE520 : Power Semiconductor Devices

Course Outcomes

Course Outcome NO.	Course Outcomes	Bloom's level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain the role of power electronics in various industrial/commercial/residential facilities	Understand	80	70
CO2	Design magnetic components and filters for the given power converters	Apply	60	70
CO3	Design rectifiers and inverters for the given application	Apply	60	70
CO4	Design DC-DC converters and AC-AC converter for the given application	Apply	60	70
CO5	Analyze effect of harmonics in power converters	Analyze	60	70
CO6	Analyze the performance of given power converter using PLECS /PSPICE / MATLAB /PSCAD/PSIM software	Analyze	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	S	M	L	L								
CO3	S	M	L	L								
CO4	S	M	L	L								
CO5	S	S	M	M					S	S		
CO6	S	S	M	M	S				S	S		

S- Strong; M-Medium; L-Low

Assessment Pattern

S. No.	Bloom's Category	Test 1	Test 2	End-semester examination
1.	Remember	10	10	10
2.	Understand	30	30	30
3.	Apply	40	40	40
4.	Analyze	20	20	20
5.	Evaluate	0	0	0
6.	Create	0	0	0

CO6: Only for internal assessment

Third Internal Test: The third internal test mark will be given based on a mini-project. A mini-project has to be done by every batch of five students using power electronic devices. The assessment will be based on design, circuit layout and working condition of the project.

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. List the advantages of power electronic devices.
2. Mention the different application of converters.
3. Discuss the role of boost converters in solar power generation system.
4. Describe the role of 12-pulse converters in HVDC transmission system.

Course Outcome 2 (CO2)**:**

1. Figure 2.1 shows a half-wave rectifier driven by a sinusoidal *current* source supplying a capacitively-filtered output. (Such a configuration is sometimes found in resonant dc-dc converters.) Determine the power factor seen by the current source, assuming that the diodes act ideally and capacitance *Cf* is large enough such that the output voltage has small ripple ($vD \approx VD$).

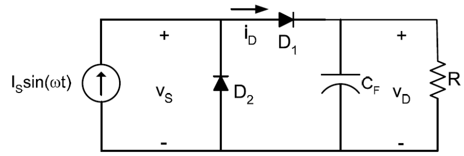


Figure 2.1 A half-wave rectifier driven from a sinusoidal current source

2. Figure 2.2 shows a circuit model for the utility supplying one phase of an ac induction motor. The motor system parameters are Rs = 0.08 Ω, Lls = 1 mH, Lm = 40 mH, Llr = 1 mH, Rr = 0.1 Ω, and Rx = 33 Ω. If the utility voltage is 170·cos(377t), i) what is the current into the motor? and ii) At what power factor is the motor operating?

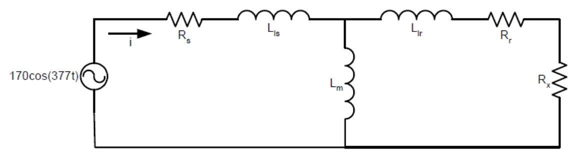


Figure 2.2 A Circuit model for one phase of an induction motor being driven by the utility

Course Outcome 3 (CO3):

1. Discuss the operation of single phase full wave uncontrolled rectifier.
2. Explain the operation of PWM inverters.
3. A 220 V, 50 HZ 1Φ supply is connected with resistive load of 20 Ω through half wave controlled rectifier. If the firing angle is 90 degree, determine a) average output voltage, b) ratio of rectification, c) form factor, d) ripple factor and e) transformer utilization factor.

Course Outcome 4 (CO4):

1. Explain time ratio control of DC-DC choppers.
2. The input to a chopper is from a 100V dc source. The chopper is switched at a frequency of 100KHz with a pulse width of 4 microseconds. What is the average output voltage of the chopper?
3. Figure 4.1 shows a boost (up) converter supplying 12 V to a load of 5 Ω from a 5 V source having an internal resistance of 0.2 Ω. Determine the duty ratio D at which the converter operates. (You may neglect semiconductor device drops in your calculations.)

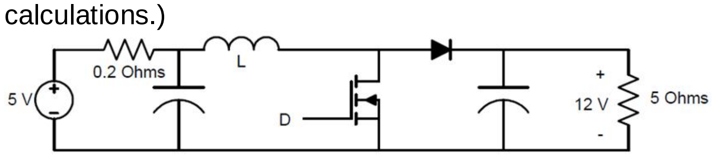


Figure 4.1 Boost converter

Course Outcome 5 (CO5):

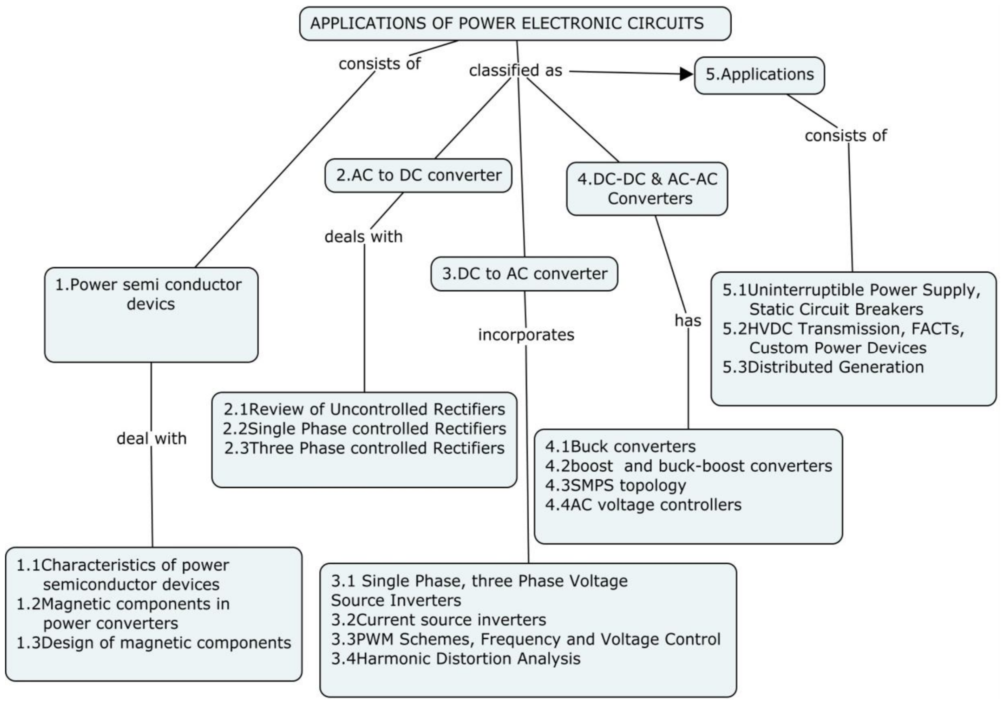
1. Examine different methods of eliminating harmonics.
2. Compare different PWM schemes for harmonics mitigation.
3. Categorize the harmonics generated by the following nonlinear loads.
   i) Single phase rectifiers
   ii)Induction furnace
   iii) 6-pulse converter

iv) 18- pulse converter

Course Outcome 6 (CO6):

1. Design a single phase full converter with RL load using SPICE software.
2. Design a buck converter using MATLAB software.
3. Simulate and analyze the performance parameters of SPWM inverters using PLECS software.

Concept Map



Syllabus

Magnetic components and filters: Design of magnetic components and filters for power converters.
AC to DC Converters: Review of Uncontrolled Rectifiers, Single Phase and Three Phase controlled Rectifiers.
DC to AC Converters: Single Phase and three Phase Voltage Source Inverters, Current source inverter, PWM Schemes, Frequency and Voltage Control, Harmonic distortion Analysis.
DC-DC & AC-AC Converters: Buck, Boost & Buck-Boost Converters, SMPS Topology, AC voltage controller.
Applications: Uninterruptible power Supply, Static Circuit Breakers, HVDC Transmission, FACTs, Custom Power Devices, Distributed Generation.

Text Book

1. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications - Pearson Education India Publication, New Delhi, 7th Impression, 2009.

Reference Book

1. M.D.Singh & K.B.Khanchandani, Power Electronics – Tata Mc Graw Hill publishing company Ltd, New Delhi, 2008.
2. Ned Mohan, Tore Undeland & William Robbins, Power Electronics : converters Applications and Design-John Willey and sons, 3rd Edition, 2003.
3. P.S. Bimbra, Power Electronics- Khanna Publishers, 3rd Edition, 2004.
4. Daniel W.Hart, Introduction to power Electronics – Prentice Hall International Inc., 1997.
5. L. Umanand, Power Electronics: Essentials and Applications- Wiley India, 2009.
6. Marty Brown, Power Sources and Supplies, ELSEVIER, 2008.
   https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/

Course Contents and Lecture Schedule

S.No.	Topic	Lectures
1.	**Magnetic Components**	
1.1	Characteristics of power semiconductor devices	1
1.2	Magnetic components in power converters	1
1.3	Design of magnetic components	3
2.	**AC to DC Converter**	
2.1	Review of Uncontrolled Rectifiers	1
2.2	Single Phase controlled Rectifiers	3
2.3	Three Phase controlled Rectifiers	3
3.	**DC to AC converter**	
3.1	Single Phase, three Phase Voltage Source Inverters	3
3.2	Current source inverters	1
3.3	PWM Schemes, Frequency and Voltage Control	3
3.4	Harmonic Distortion Analysis	3
3.5	Introduction to Multilevel Converters	1
4.	**DC-DC & AC-AC Converters**	
4.1	Buck converters	1
4.2	Boost converters	2
4.3	SMPS topology	3
4.4	AC voltage controllers	1
5.	**Applications**	
5.1	Uninterruptible Power Supply, Static Circuit Breakers	2
5.2	HVDC Transmission, FACTs, Custom Power Devices	2
5.3	Distributed Generation	1

Course designers

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- Dr. S. Arockia Edwin Xavier - saexeee@tce.edu

14EE630	TRANSMISSION AND DISTRIBUTION	Category	L	T	P	Credit
		PC	3	0	0	3

Preamble

The objective of any power system is to generate electrical energy in sufficient quantity at various locations, to transmit it as a bulk to various load centres and to distribute it with different voltage levels to various consumers with good quality and reliability. To maintain the quality and reliability of supply, the voltage and frequency are to be maintained at specified values, with minimum voltage drop and power loss. Hence the transmission and distribution network consists of various types of towers, overhead lines with different configurations, insulators, underground cables and compensators. The calculation of network performance indices such as voltage regulation and transmission efficiency and the study of sag and tension for designing the towers and conductors are essential.

Prerequisite

14EE240: Electromagnetic Fields

14EE270: Electric Circuit Analysis

14EE440: AC Machines

Course Outcomes

On the successful completion of the course, students will be able to

CO No.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Calculate the transmission network parameters for various configurations.	Apply	85	60
CO2	Calculate the performance characteristics of the given transmission line using nominal-T,π, rigorous methods and Power circle diagram.	Apply	85	60
CO3	Explain the effect of corona and sag on overhead transmission lines.	Understand	95	85
CO4	Calculate the Sag of a overhead line for various conditions	Apply	85	60
CO5	Explain the various types of insulators, cables and their construction.	Understand	95	85
CO6	Calculate string efficiency of the suspension type insulators	Apply	85	60
CO7	Compute the insulation resistance, capacitance and grading of cables	Apply	85	60
CO8	Calculate the voltage at a point on the given type of distribution System	Apply	85	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	L	L								
CO2	S	M	L	L								
CO3	S	M	L	L								
CO4	M	L	L									
CO5	S	M	L	L								
CO6	S	M	L	L								
CO7	S	M	L	L								
CO8	S	M	L	L								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember (K1)	20	20	20	20
Understand (K2)	40	40	40	40
Apply (K3)	40	40	40	40
Analyse (K4)	0	0	0	0
Evaluate (K5)	0	0	0	0
Create (K6)	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the effect of earth on capacitance of lines?
2. What is the need of transposition?
3. Find the inductance and capacitance per phase per km of double circuit 3-phase line shown in Fig.1. The line is completely transposed and operates at a frequency of 50Hz. The radius of the conductor is 7mm.

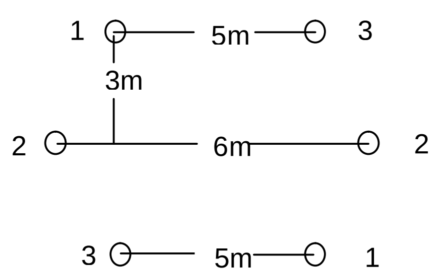


Fig. 1

Course Outcome 2 (CO2)**:**

1. What are the classifications of transmission line?
2. With neat phase diagram obtain the voltage regulation of a transmission line using nominal-π network.
3. A three phase 50Hz overhead transmission line is 100km long with 132kV as line voltage at the receiving end. The line has the following constants. R = 0.17ohm/km/phase, L= 1.1mH/km/Phase and C = 0.0082 microfarad/km/phase. Using nominal T –method find voltage, current at the sending end when 70MW at 0.8 power factor lagging load is connected at receiving end.

Course Outcome 3 (CO3):

1. What are the advantages and disadvantages of Corona?
2. Explain the terms i) critical disruptive voltage ii) Power loss due to corona
3. Derive the expression for determination of sag when the supports at unequal levels.

Course Outcome 4 (CO4):

1. **What is meant by sag template?**
2. **Explain the effect of ice loading on transmission lines.**
3. A transmission line conductor at river crossing is supported from two towers at heights of 45 metres and 75 metres above water level. The span length is 300metres.
   Weight of the conductor is 0.85 kg/metre. The tension in the conductor is 2050 kg.
   Determine the clearance between the conductor and water at a point midway between
   towers.

Course Outcome 5 (CO5):

1. Compare the various types of overhead insulators with respect to construction, characteristics and applications.
2. Name the various types insulating materials used in cables.
3. With neat sketch explain the construction of three core cable. .

Course Outcome 6 (CO6):

1. Define string efficiency.
2. Describe the methods of improving the string efficiency.
3. In a 33KV overhead line, there are three units in the string insulators. If the capacitance between each insulator pin and earth is 11% of self capacitance of each insulator, find the distribution of voltage over 3 insulators and string efficiency.

Course Outcome 7 (CO7):

1. What is meant insulation resistance of cables?
2. Explain the methods of grading of cables.
3. A single core cable has a conductor diameter of 1 cm and internal sheath diameter of 1.8 cm. If impregnated paper of relative permittivity 4 is used as the insulation, calculate the capacitance for a 1 km length of the cable.

Course Outcome 8 (CO8):

1. Define the following: service main, Feeder and distributor
2. Compare and contrast the radial and ring main distribution systems.
3. A 2 wire distributor 1200m long is loaded as shown in Fig.2. B is the mid-point. The Power factors at the two load points refer to the voltage at C. The impedance of each line is (0.15 + j 0.2) ohms. Calculate the sending end voltage and current. The voltage at C is 220V.

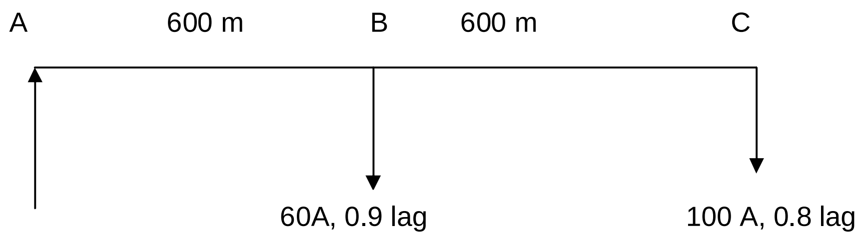
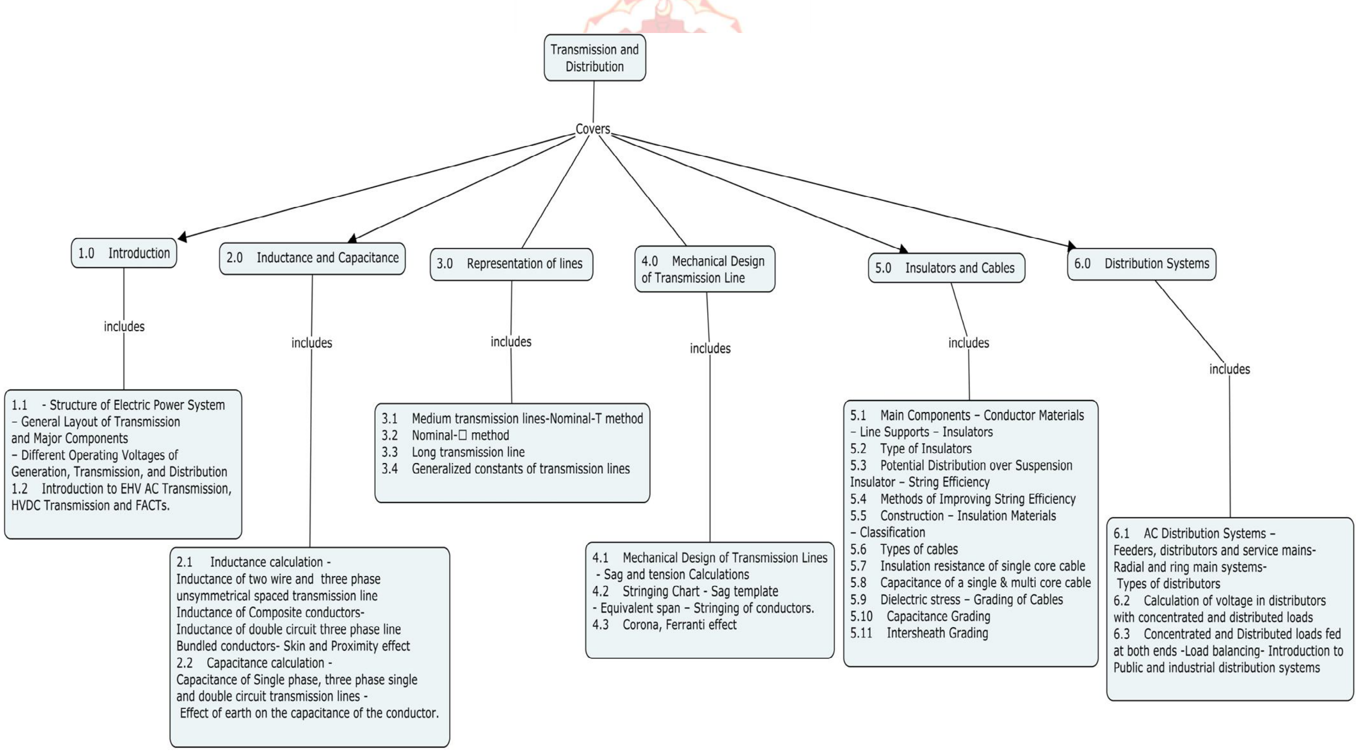


Fig.2.

Concept Map



Syllabus

Introduction - Structure of Electric Power System – General Layout of Transmission and Major Components – Different Operating Voltages of Generation, Transmission, and Distribution, Introduction to EHV AC Transmission, HVDC Transmission and FACTs.

Inductance and Capacitance of lines- Inductance of two wire - three phase unsymmetrical spacing transmission lines- Transposition of Power lines- Inductance of Composite conductors- Inductance of double circuit three phase line – Bundled conductors- Skin and Proximity effects- Capacitance of Single phase and three phase transmission lines- Capacitance of double circuit line- Effect of earth on the capacitance of the conductor.

Representation of lines – Performance characteristics of Short, Medium and Long transmission lines – ABCD constants – Power Circle diagram.

Mechanical Design of Transmission Lines - Sag and tension Calculations- Effect of wind and ice loading- Stringing Chart - Sag template- Equivalent span – Corona and loss, Ferranti effect.

Insulators and Cables - Main Components – Conductor Materials – Line Supports – Insulators- Types of Insulators – Potential distribution over a string of suspension insulators – String Efficiency -Methods of Improving String Efficiency - Extra High Voltage cables- Construction and types of Cables- Insulation resistance of single core cable- Capacitance of single and multi core cables- Dielectric stress – Grading of Cables - Capacitance Grading - Intersheath Grading

Distribution systems -AC Distribution Systems – Feeders, distributors and service mains- Radial and ring main systems- Types of distributors - Calculation of voltage in distributors with concentrated and distributed loads – Concentrated and Distributed loads fed at both ends -Load balancing- Introduction to Public and industrial distribution systems.

Text Book

1. C.L. Wadwa - Electrical Power system – New Age International-6th Edition – 2010.
2. C.L. Wadhwa, “Generation, Distribution and Utilization of Electrical Energy”, New Age International Publishers, Second Edition, 2006

Reference Books

1. H. Cotton and H. Barber - Transmission and distribution of electrical energy – BI, NewDelhi -1992.
2. S.L. Uppal - Electrical power, Khanna Publishers, 1996.
3. Soni ML and Gupta PV - A Textbook on Power Systems Engineering – Dhanpath Rai 1st Edition-1998.
4. IS 12360:1988 - Voltage Bands For Electrical Installations Including Preferred Voltages And Frequency
5. T.S.M. Rao - Principles and practice of electric power transfer systems, 1994.
6. 141-1993 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.
7. S.N. Singh, Electric Power Generation, Transmission and Distribution, Prentice Hall of India, ISBN – (978-81-203-36508), Second edition 2008.
8. http://nptel.ac.in/courses

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.0	**Introduction**	
1.1	Structure of Electric Power System – General Layout of Transmission and Major Components – Different Operating Voltages of Generation, Transmission, and Distribution	2
1.2	Introduction to EHV AC Transmission, HVDC Transmission and FACTs.	1

Module No.	Topic	No. of Lectures
2.0	**Inductance and Capacitance of lines**	
2.1	**Inductance calculation** -Inductance of two wire and three phase unsymmetrical spacing transmission line- Transposition of Power lines - Inductance of Composite conductors- Inductance of double circuit three phase line – Bundled conductors- Skin and Proximity effects.	4
2.2	**Capacitance calculation** - Capacitance of Single phase and three phase single and double circuit transmission lines - Effect of earth on the capacitance of the conductor.	3
3.0	**Representation of lines**	
3.1	Medium transmission lines-Nominal-T method	2
3.2	Nominal-π method	2
3.3	Long transmission line, ABCD constants	1
3.4	Power Circle diagram	1
4.0	**Mechanical Design of Transmission Line**	
4.1	Sag and tension Calculations - Effect of wind and ice loading	3
4.2	Stringing Chart - Sag template- Equivalent span	2
4.3	Corona and loss, Ferranti effect	1
5.0	**Insulators and Cables**	
5.1	Main Components – Conductor Materials – Line Supports – Insulators	1
5.2	Type of Insulators	1
5.3	Potential Distribution over Suspension Insulator – String Efficiency	2
5.4	Methods of Improving String Efficiency	1
5.5	Extra High Voltage cables Construction – Insulation Materials – Classification	1
5.6	Types of cables	1
5.7	Insulation resistance of single core cable	1
5.8	Capacitance of a single and multi core cables	1
5.9	Dielectric stress – Grading of Cables	1
5.10	Capacitance Grading	1
5.11	Intersheath Grading	1
6.0	**Distribution Systems**	
6.1	AC Distribution Systems – Feeders, distributors and service mains- Radial and ring main systems- Types of distributors	2
6.2	Calculation of voltage in distributors with concentrated and distributed loads	2
6.3	Concentrated and Distributed loads fed at both ends -Load balancing- Introduction to Public and industrial distribution systems	2
	Total	**40**

Course Designers:

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14EE670	**PROFESSIONAL COMMUNICATION**	Category	L	T	P	Credit
		HSS	1	0	2	2

Preamble

This course provides opportunities to students to develop and demonstrate basic communication skills in technical, professional and social contexts effectively.

Prerequisite

14EG141: English

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes		Bloom's Level	Expected proficiency (%)	Expected attainment level (%)
CO1:	Plan, organise, write, and present project reports, and technical papers in the frame of the scientific method	Apply	70	75
CO2:	Establish themselves through communication skills in corporate environment	Apply	80	90
CO3:	Solve verbal aptitude questions related to placement and higher studies	Apply	80	90
CO4:	Apply their interpersonal skills in technical, professional and social contexts	Apply	80	90

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1.								**M**	**M**	**M**	**L**	**M**
CO2.								**M**	**M**	**M**	**L**	**M**
CO3.								**M**	**M**	**M**	**L**	**M**
CO4.								**M**	**M**	**M**	**L**	**M**

S- Strong; M-Medium; L-Low

Assessment Pattern

Internal

No Common Continuous Assessment Test (CAT) will be conducted.

Students' performance will be continuously assessed in various classroom activities in Listening, Speaking, Reading and Writing for 50 marks as detailed below

Project Report Preparation and Technical Presentation through PPT	-	15
Listening Test	-	10
Spoken Task – Group Discussion / Mock Job Interview	-	10
Writing – Verbal Aptitude for Placement and Higher studies (The test will be conducted for 50 marks and reduced to 15)	-	15

External (Practical)

Listening Test	-	20
Group Discussion	-	25
Personal Interview / Situational Conversation	-	25
Technical Presentation	-	20
Resume Submission	-	10

List of Experiments

Sl. No.	Topic	No. of Hours	
		Theory	Practical
1	**Literature Survey / Project Title Selection**	**1**	
2	**Characteristics of Technical Paper and Project Report**	**1**	
3	**Abstract / Data Presentation**	**1**	
4	**Common Errors in Technical Writing**	**1**	
5	**Bibliography and References**	**1**	
6	**Vocabulary Development**	**1**	
7	**Sentence Completion**	**1**	
8	**Error Spotting**	**1**	
9	**Interpretation of Verbal Analogy**	**1**	
10	**Interpretation of Reading (Comprehension - Conception)**	**1**	
11	**Interpretation of Reading (Comprehension - Reasoning)**	**1**	
12	**Practice for writing E-mails**	**1**	
13	**PPT Preparation /Demonstration of Technical Presentation**		**4**
14	**Preparation of Resume**		**2**
15	**Preparation for Job Interviews**		**4**
16	**Demonstration of Group Discussion Skills**		**4**
17	**Developing Listening Skill (Comprehension)**		**3**
18	**Practice for Short Speeches / Situational Conversation**		**4**
19	**Development of Employability Skills**		**2**
20	**Non-Verbal Communication**		**1**
	Total Hours	**12**	**24**

Reference Books:

1. Courseware on “Technical Communication for Scientists and Engineers”, IIT Bombay, 2015.
2. Cappel, Annette and Sharp, Wendy, Cambridge English: Objective First, 4th Ed., CUP, New Delhi, 2013.
3. Sue Prince, Emma, The Advantage: The 7 Soft Skills You Need to Stay One Step Ahead, Pearson; 1 Edition, 2013.
4. Cusack, Barry. Improve Your IELTS Listening and Speaking Skills (With CD) Paperback, Macmillan, 2007.
5. Bates, Susan TOEFL iBT Exam Paperback – oxford, 2012 .
6. Hart, Guy Brook. Cambridge English Business Benchmark: 2 Ed., CUP 2014

Course Designers:

1.	Dr. S.Rajaram	sreng@tce.edu
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			Category	L	T	P	Credit
14EE680	**POWER SYSTEMS LABORATORY**		PC	0	0	2	1

Preamble

The aim of this course is to train the students for solving the power system problems using MATLAB coding. The formation of bus admittance matrix followed by power flow solutions using various numeri
cal methods is introduced. Students get the exposure in short circuit analysis and stability analysis under steady state and transient state. Economic load dispatch problem is also performed using MATLAB coding. Also, understanding different types of power system protection modules are introduced using protective relay test benches.

Prerequisite

14EE510: Numerical Methods

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	**Blooms level**	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Analyze the performance of direct inspection and singular transformation methods for determining Y-bus matrix of the given system	Analyze	90	75
CO2	Analyse the computational performance of Gauss-Seidel and Newton Raphson methods for solving non linear power flow problems.	Analyze		
CO3	Calculate the fault current for various types of faults both symmetrical and unsymmetrical on the given power system.	Apply		
CO4	Analyze the transient stability by applying different fault clearing time to the circuit breakers of the given problem	Analyze		
CO5	Compute the optimal dispatch of the given power system using Lagrange Multiplier method	Apply		
CO6	Explain the concept of power system protection using various types of relays such as negative sequence phase relay, overvoltage and differential relay by conducting suitable experiments	Understand		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	S	M	M	S				S	S		
CO2.	S	S	M	M	S				S	S		
CO3.	S	M	L	L	S				S	S		
CO4.	S	M	L	L	S				S	S		
CO5.	S	S	M	M	S				S	S		
CO6.	M	L							S	S		

S- Strong; M-Medium; L-Low

List of Experiments

Part –A – Simulation

1. Formation of bus admittance matrix by direct inspection method and singular transformation method (CO1).
2. Analysis of Gauss-Seidal and Newton Raphson methods for solving non linear power flow equation (CO2).
3. Symmetrical and unsymmetrical fault analysis in Power System (CO3).
4. Power System Transient Stability problem (CO4).
5. Economic load dispatch (CO5).

Part – B – Realization with Power system Protection Modules

6. Performance of overvoltage and under voltage relays (CO6).
7. Performance of differential relay and negative sequence relay (C06).

Course Designers

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		Category	L	T	P	Credit
14EE690	**POWER ELECTRONICS AND DRIVES LAB**	PC	0	0	2	1

Preamble

This laboratory gives a practical exposure to the students to learn the power electronics and drives. The students will be able to design and analyze power converters such as AC-DC converters, DC-DC converters, DC-AC converters, AC- to AC converters and their control circuits for real world applications.

Prerequisite

- **14EE250: Analog devices and circuits**
- **14EE520: Power electronics**

Course Outcomes

CO No.	**Course outcomes**	**Blooms level**	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Analyze the performance of driver circuits for SCR/MOSFET/IGBT	Analyze	80	80
CO2	Analyze the performance of commutation circuits for the given specifications	Analyze		
CO3	Analyze the performance of controlled rectifiers with 'R' and 'RL' loads experimentally	Analyze		
CO4	Construct DC choppers and static circuit breakers for the given specifications experimentally	Apply		
CO5	Analyze the performance characteristics of the given DC drive by conducting suitable experiments	Analyze		
CO6	Analyze the performance characteristics of the given PLC and DSP based AC drive by conducting suitable experiments	Analyze		
CO7	Analyze the performance characteristics of the given SRM drive by conducting suitable experiments	Analyze		
CO8	Evaluate the performance of the given Power electronic circuit using PSIM/ MATLAB-Simulink/ PSPICE/ PLECS/ VSIM/ PSCAD	Evaluate		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	M	M					S	S		
CO2	S	S	M	M					S	S		
CO3	S	S	M	M					S	S		
CO4	S	M	L	L					S	S		
CO5	S	S	M	M	S				S	S		
CO6	S	S	M	M	S				S	S		
CO7	S	S	M	M	S				S	S		
CO8	S	S	S	S	S				S	S		

S- Strong; M-Medium; L-Low

List of Experiments:

1. 'R' and RC triggering circuits for half wave controlled rectifiers (CO1)
2. UJT triggering circuit for half wave controlled rectifier (CO1)
3. MOSFET/IGBT/SCR Driver circuits (CO1)
4. Voltage, current and complementary commutation techniques(CO2)
5. Half controlled and fully controlled rectifier with 'R' and 'RL' loads(CO3)
6. Static DC and AC circuit breakers(CO4)
7. Single quadrant DC chopper(CO4)
8. Half controlled rectifier fed DC motor(CO5)
9. Voltage commutated chopper fed DC motor(CO5)
10. AC voltage controller fed single phase induction motor(CO6)
11. PLC/DSP based 3 phase induction motor drive(CO6)
12. V/F control of Induction motor(CO6)
13. Switched reluctance motor drive(CO7)
14. Simulation of power electronic converter circuits using PSIM/ MATLAB-Simulink/ PSPICE/PLECS/VSIM/PSCAD (CO8)

Course designers

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- Dr. S. Arockia Edwin Xavier - saexeee@tce.edu

14EE710	PROJECT MANAGEMENT	Category	L	T	P	Credit
		HSS	3	0	0	3

Preamble

Project management has been proven to be the most effective method of delivering products within cost, schedule, and resource constraints. It provides the skills to ensure that the projects are completed on time and on budget while giving the user the product, they expect. This course gives strong working knowledge of the basics of project management and be able to immediately use that knowledge to effectively manage work projects.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Cos	**Course outcomes**	**Blooms Level**	Expected Proficiency (%)	Expected attainment Level (%)
CO1	Explain the organizational structure for managing projects to develop a product with a given specification	Understand	75	80
CO2	Estimate the cost required to complete a given project	Apply	75	80
CO3	Construct a work breakdown structure for a given business cases	Apply	75	80
CO4	Identify the critical path in scheduling a set of project-activities	Apply	75	80
CO5	Outline the importance and various activities performed for resource management, risk assessment and project closure.	Understand	75	80

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1.											**S**	
CO2.											**S**	
CO3											**S**	
CO4											**S**	
CO5.											**S**	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	60	30	30	30
Apply	30	60	60	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Identify suitable organizational structure for an Engineering college.
2. Explain the need of structure in managing projects.
3. Define organizational structure.

Course Outcome 2 (CO2):

1. Estimate the cost associated with the project using bottom up technique
2. Why is the implementation of projects important to strategic planning and the project manager?
3. What is meant by an integrative approach to project management? Why is this approach important in today‟s environment?

Course Outcome 3 (CO3)

1. Develop a work breakdown structure for a wedding function.
2. How does the WBS differ from the project network.
3. What is the difference between free slack and total slack?

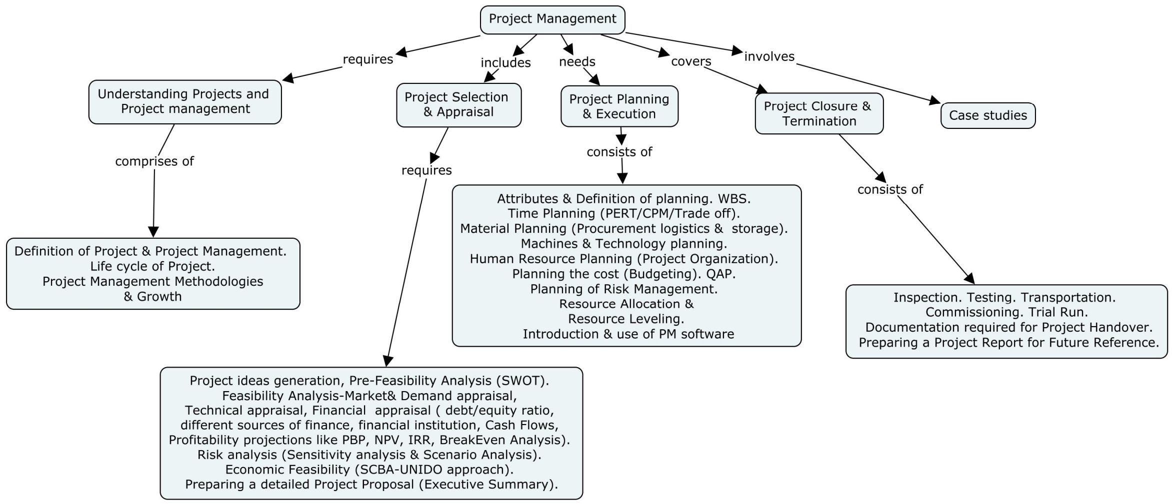
Course Outcome 4 (CO4)

1. Create a customer database for the Modesto league baseball team. Draw a project network Complete the forward and backward pass, compute activity slack, and identify the critical path. How long will this project take? How sensitive is the network schedule? Calculate the free slack and total slack for all noncritical activities.
2. List the steps in identifying the critical path in scheduling a set of project-activities.
3. Explain a method used in the determination of critical path.

Course Outcome 5 (CO5)

1. What is the difference between avoiding a risk and accepting a risk?
2. What is the difference between mitigating a risk and contingency planning?
3. Explain the difference between budget reserves and management reserves.

Concept Map



Syllabus

Understanding Projects and Project management: Definition of Project & Project Management. Life cycle of Project. Project Management Methodologies & Growth

Project Selection & Appraisal: Project ideas generation, Pre-Feasibility Analysis (SWOT). Feasibility Analysis-Market& Demand appraisal, Technical appraisal, Financial appraisal (debt/equity ratio, different sources of finance, financial institution, Cash Flows, Profitability projections like PBP, NPV, IRR, BreakEven Analysis). Risk analysis (Sensitivity analysis & Scenario Analysis). Economic Feasibility (SCBA-UNIDO approach). Preparing a detailed Project Proposal (Executive Summary).

Project Planning & Execution: Attributes & Definition of planning. WBS. Time Planning (PERT/CPM/Trade off). Material Planning (Procurement logistics & storage). Machines & Technology planning. Human Resource Planning (Project Organization). Planning the cost (Budgeting). QAP. Planning of Risk Management. Resource Allocation & Resource Leveling. Introduction & use of PM software.

Project Closure & Termination: Inspection. Testing. Transportation. Commissioning. Trial Run. Documentation required for Project Handover. Preparing a Project Report for Future Reference.

Case Studies

Text Book

1. Project Management & Appraisal, Sitangshu Khatua, Pub. Oxford University
2. Project Preparation , Appraisal, Budgeting & Implementation by Prasanna Chandra(TMH)
3. Project Management & Control by Narendra Singh, Himalaya Pub.

Reference Books

1. Project Management- a Managerial Approach to Planning, Scheduling, and Controlling Harold Kerzner, 10th edition John Wiley & Sons, Inc.
2. Project Management - a Managerial Approach : Jack R. Meredith & Samuel J Mantel, Jr., 7 th Edition John Wiley & Sonns, Inc.
3. Project Management Institute (PMBOK)â Guide, 5th Edition

Lecture Schedule

S.No.	Topic	No. of Lectures
1	**Understanding Projects and Project management**:	
1.1	Definition of Project & Project Management.	1
1.2	Life cycle of Project.	1
1.3	Project Management Methodologies & Growth	1
2	**Project Selection & Appraisal:**	
2.1	Project ideas generation, Pre-Feasibility Analysis (SWOT).	2
2.2	Feasibility Analysis-Market& Demand appraisal, Technical appraisal	3
2.3	Financial appraisal (debt/equity ratio, different sources of finance, financial institution, Cash Flows, Profitability projections like PBP, NPV, IRR, BreakEven Analysis).	3
2.4	Risk analysis (Sensitivity analysis & Scenario Analysis).	2
2.5	Economic Feasibility (SCBA-UNIDO approach).	2
2.6	Preparing a detailed Project Proposal (Executive Summary).	1
3	**Project Planning & Execution**:	
3.1	Attributes & Definition of planning. WBS.	1
3.2	Time Planning (PERT/CPM/Trade off).	3
3.3	Material Planning (Procurement logistics & storage).	1
3.4	Machines & Technology planning.	1
3.5	Human Resource Planning (Project Organization).	1
3.6	Planning the cost (Budgeting). QAP.	2
3.7	Planning of Risk Management.	1
3.8	Resource Allocation & Resource Leveling.	1
3.9	Introduction & use of PM software.	2
4	**Project Closure & Termination:**	
4.1	Inspection. Testing. Transportation.	1
4.2	Commissioning. Trial Run.	1
4.3	Documentation required for Project Handover.	1
4.4	Preparing a Project Report for Future Reference.	1
5	**Case Studies**	3
	Total	36

Course Designers

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		Category	L	T	P	Credit
14EE720	**DRIVES AND CONTROL**	PC	3	0	0	3

Preamble

Electric Drives, both ac and dc types, come in many shapes and sizes. Some are standardized versions for general-purpose applications. Others are intended for specific tasks. In any case, motors should be selected to satisfy the dynamic requirements of the machines on which they are applied without exceeding rated motor temperature. Thus, the first and most important step in motor selection is determining load characteristics, torque and speed versus time. Selection is also based on mission goals, power available, and cost.

Prerequisite

14EE250- Analog devices and circuits/ 16EE250 – Electronic devices and circuits
14EE620- Power Electronics/ 15EE520- Power Electronics
14EE330 - DC machines / 16EE330 - DC machines and transformers
14EE440- AC machines/16EE440- AC machines

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's level	Expected Proficiency in %	Expected Attainment Level in %
CO1	Explain the basics and advantages of electric drives	**Understand**	**60**	**70**
CO2	Design 1 phase and 3 phase controlled rectifier based dc drive	**Apply**	**60**	**70**
CO3	Design various dc to dc converter topology based dc drive	**Apply**	**60**	**70**
CO4	Explain the operation of VSI and CSI drive in induction motor drives	**Understand**	**60**	**70**
CO5	Describe the working of stepper motor, SRM and BLDC motor drive system	**Understand**	**60**	**70**
CO6	Learn the role of electrical drives in industrial applications and simulation of drives using simulation software such as MATLAB/Simulink, PLECS and PSIM	**Understand**	**60**	**70**

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**M**	**L**										
CO2.	**S**	**M**	**L**									
CO3	**S**	**M**	**L**									
C04	**M**	**L**										
CO5	**M**	**L**										
CO6	**M**	**L**										

S- Strong; M-Medium; L-Low

Assessment pattern

S.No.	Bloom's Category	Test 1	Test 2	Test 3 /End-semester examination
1	Remember	30	30	30
2	Understand	40	40	40
3	Apply	30	30	30
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. What are the basic elements of Electric Drives?
2. What are the advantages of electric drive over mechanical drive?
3. Draw the block diagram of Electric Drive.

Course Outcome 2 (CO2)**:**

1. A 220V shunt Motor has an armature resistance of 0.062 Ω and with full field has an emf of 215V at a speed of 960 rpm, the motor is driving an overhauling load with a torque of 172 Nm. Calculate the minimum speed at which the motor can hold the load by means of regenerative braking.
2. A 500V series motor having armature resistance and field resistance of 0.2 Ω and 0.3 Ω respectively runs at 500 rpm when taking 70A. Assuming unsaturated field, find out its speed when field diverter of 0.684 Ω is used constant load torque.
3. A 250V DC Series Motor takes 40A of current when developing a full load torque at 1500 rpm. Its resistance is 0.5 Ω. If the load torque varies as the square of the speed determine the resistance to be connected in series with the armature to reduce the speed to 122 rpm. Assume the flux is proportional to the field current.

Course Outcome 3 (CO3):

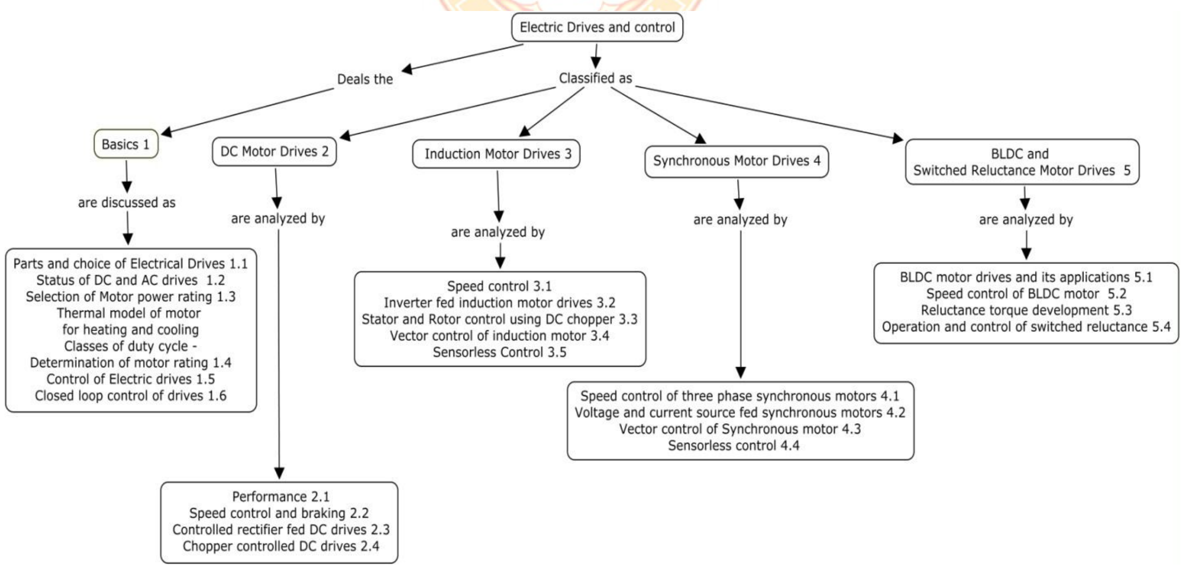
1. The input to a chopper is from a 100V dc source. The chopper is switched at a frequency of 100KHz with a pulse width of 4□s. What is the average output voltage of the chopper?
2. Discuss the effect of the output voltage, duty ratio and the load current in the determination of the inductor and capacitor value of the filter used in buck converter based DC drives.

Course Outcome 4 (CO4):
1. What is meant by vector control of IM?
2. Discuss the operation of 3 phase VSI fed IM.
3. Discuss the operation of 3 phase CSI fed IM.

Course Outcome 5 (CO5):
1. List the advantages and applications of BLDC motor.
2. Evaluate the effect of closed loop speed control of BLDC motor.
3. Explain the operation of 4 phase stepper motor.
4. Describe the working of sensorless control of SRM.
5. Discuss the effect of harmonics in an inverter fed IM drives.

Course Outcome 6 (CO6):
1. **Mention the drive used in paper industries**
2. **List out the different types of drives used in industries**
3. Simulate a VSI inverter fed IM using simulink.
4. Simulate a buck converter fed DC motor using PLECS.
5. Simulate a full converter fed DC motor using PSIM.
6. Explain the effect of harmonics on PWM inverters fed IM drives in industries

Concept Map



Syllabus

Electric Drives - Advantage of solid state electric drives - Parts and choice of electrical drives – Status of DC and AC drives - Torque-speed characteristics of motor and load - Selection of Motor power rating - Thermal model of motor for heating and cooling - Classes of duty cycle - Determination of motor rating - Control of Electric drives - Modes of operation - Speed control and drive classifications - Closed loop control of drives.

DC Motor Drives - DC motor and their performance - Speed control - Braking Controlled rectifier fed DC drives - Chopper controlled DC drives.

Induction Motor Drives - Speed control – Stator control-Inverter fed induction motor drives - Rotor resistance control and slip power recovery schemes - Static control of rotor resistance - Vector control of induction motor- Speed Estimation methods – Slip calculation – Direct Synthesis from state equations – Direct Vector control without Speed signal.

Synchronous Motor Drives - Speed control - Inverter fed synchronous motors – Vector control of Synchronous motor – Sensorless control – Trapezoidal SPM machine – Sinusoidal PM Machine.

BLDC Motor and SRM Drives - Operation and control of BLDC motor and switched reluctance motor drives.

Simulation Of Electrical Drive Systems: DC motor drive- Induction motor drive

Text Book

1. G. K. Dubey: Fundamental of Electrical Drives - Narosa Publishing House, Chennai, 2004.

Reference Books

1. Bimal K.Bose – Modern Power Electronics and AC Drives – Pearson Education Asia Publication, 2003.
2. R.Krishnan - Electric motor drives – Modeling, analysis and control, Pearson Education, New Delhi, 2003.
3. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications - Pearson Education India Publication, New Delhi, II Edition, 2007.
4. Ned Mohan, Tore Undeland & William Robbins, Power Electronics : converters Applications and Design-John Willey and sons 2003.

Course Contents and Lecture Schedule

S.No.	Topic	Duration (Hours)
1.	**Electric Drives**	
1.1	Advantage of Electric Drives - Parts and choice of Electrical Drives	1
1.2	DC and AC drives	1
1.3	Torque-speed characteristics of motor and load - Selection of Motor power rating	1
1.4	Thermal model of motor for heating and cooling - Classes of duty cycle - Determination of motor rating	2

1.5	Control of Electric drives - Modes of operation - Speed control and drive classifications	2
1.6	Closed loop control of drives	1
2.	**DC Motor Drives**	
2.1	DC motor and their performance	1
2.2	Speed control and Braking methods	2
2.3	Controlled rectifier fed DC drives	2
2.4	Chopper controlled DC drives	2
3.	**Induction Motor Drives**	
3.1	Speed control	2
3.2	Inverter fed induction motor drives	2
3.3	Rotor resistance control and slip power recovery scheme - Static control of rotor resistance using DC chopper	3
3.4	Vector control of induction motor	1
3.5	Speed Estimation methods – Slip calculation – Direct Synthesis from state equations – Direct Vector control without Speed signal	1
4.	**Synchronous Motor Drives**	
4.1	Speed control of three phase synchronous motors	1
4.2	Voltage and current source inverter fed synchronous motors	2
4.3	Vector control of Synchronous motor	2
4.4	Sensorless control - Trapezoidal SPM machine – Sinusoidal PM Machine	1
5.	**BLDC and Switched Reluctance Motor Drives**	
5.1	BLDC motor drives and its applications	1
5.2	Speed control of BLDC motor	1
5.3	Reluctance torque development	1
5.4	Operation and control of switched reluctance motor	1
6	**Simulation Of Electrical Drive System**	
6.1	DC motor drive	1
6.2	Induction motor drive	1
		36

Course designers

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		Category	L	T	P	Credit
14EE730	**INDUSTRIAL AUTOMATION**	PC	3	0	0	3

Preamble

The word 'Automation' is derived from ancient Greek words of Auto (means self) and Matos (means moving). Thus, a mechanism move by itself or self dictated is called automation. As compared with manual systems, automation systems provides superior performance in terms of precision, power and speed of operation. Industrial automation is the use of control devices such as PC/PLCs/PACs etc. to control industrial processes and machinery by replacing as much as possible labour intervention and dangerous assembly operations with automated ones.

In industrial control a wide number of process variables such as temperature, flow, pressure, distance, and liquid levels can be sensed simultaneously. All these variables are acquired, processed and controlled by complex microprocessor systems or PC based data processing controllers.

Control Systems are the essential parts of an automation system. The various types of closed loop control techniques ensure the process variables to follow the set points. In addition to this basic function, automation system employs different other functions such as computing set points for control systems, plant start up or shutdown, monitoring system performance, equipment scheduling, etc. The control systems along with monitoring adapted to the operating environment in an industry for flexible, efficient and reliable production system. The automated system needs special dedicated hardware and software products for implementing control and monitoring systems.

Prerequisite

14EE340 Measurement Systems, 14EE420 Instrumentation Systems, 14EE430 Control Systems

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome no.	Course Outcomes	Bloom's level	Expected Proficiency	Expected Attainment Level
(CO1)	Explain the architecture of Industrial Automation Systems	Understand	80%	80%
(CO2)	Distinguish between sequence control, Digital and Numeric control	Understand	80%	80%
(CO3)	Develop Ladder Logic/ Functional Block based PLC program for a given industrial application	Apply	70%	70%
(CO4)	Explain the components and operation of Hydraulic Actuator Systems & Pneumatic control systems	Understand	70	70%
(CO5)	Calculate the energy savings with Electric motor drives	Apply	70%	70%
(CO6)	Explain the working principle of Distributed Control and SCADA	Understand	70%	70%

Assessment Pattern

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	M										
CO2.	M	L									
CO3.	S	M	L		S						
CO4.	M	L									
CO5.	S	M	L	L							
CO6.	M	L									

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	20
Understand	50	50	80	50
Apply	20	30	0	30

Course Level Assessment Questions

Course Outcome 1(CO1):
1. Illustrate the architecture of Industrial Automation Systems.
2. Mention the need of data acquisition system in Industrial automation systems.
3. List a few final control elements in Industries.

Course Outcome 2(CO2):
1. Provide examples for Sequential control in Industries.
2. Distinguish between Sequential control and Digital control.
3. Enlist the differences between Digital control and Numeric control.

Course Outcome 3(CO3):
1. When the lights are turned off in a building (assume 2 lights inside the building), an exit door light is to remain ON for additional 2 minutes. Then parking lot lights should remain on for additional 3 minutes after the door light goes out. Develop a PLC program to implement this process
2. A pump is to be used to fill two storage tanks. The pump is manually started by the operator from a station. When the first tank is full, the control logic must be able to automatically stop flow to the first tank and direct flow to the second tank through the use of sensors and electric solenoid valves. When the second tank is full, the pump must shut down automatically. Indicator lamps are to be included to signal when each tank is full. Develop a PLC program to implement this process
3. Write a program to operate a light according to the following sequence:
   a) A momentary pushbutton is pressed to start the sequence.
   b) The light is switched on and remains on for 2 s.
   c) The light is then switched off and remains off for 2 s.

d) A counter is incremented by 1 after this sequence.
e) The sequence then repeats for a total of 4 counts.
f) After the fourth count, the sequence will stop and the counter will be reset to zero.

4. Two part conveyor lines, A and B, feed a main conveyor line M. A third conveyor line, R, removes rejected parts a short distance away from the main conveyor. Conveyors A, B, and R have parts counters connected to them. Construct a PLC program to obtain the total parts
5. Write a program that uses the COP instruction to copy 128 bits of data from the memory area, starting at 83:0, to the memory area, starting at 83:8.
6. The temperature reading from a thermocouple is to be read and stored in a memory location every 5 min for 4 h. The temperature reading is brought in continuously and stored in address N7:150. File #7:200 is to contain the data from the last full 4-hour period.

Course Outcome 4 (CO4):

1. **Explain the components of Pneumatic control systems.**
2. **Describe the components of Hydraulic control systems.**

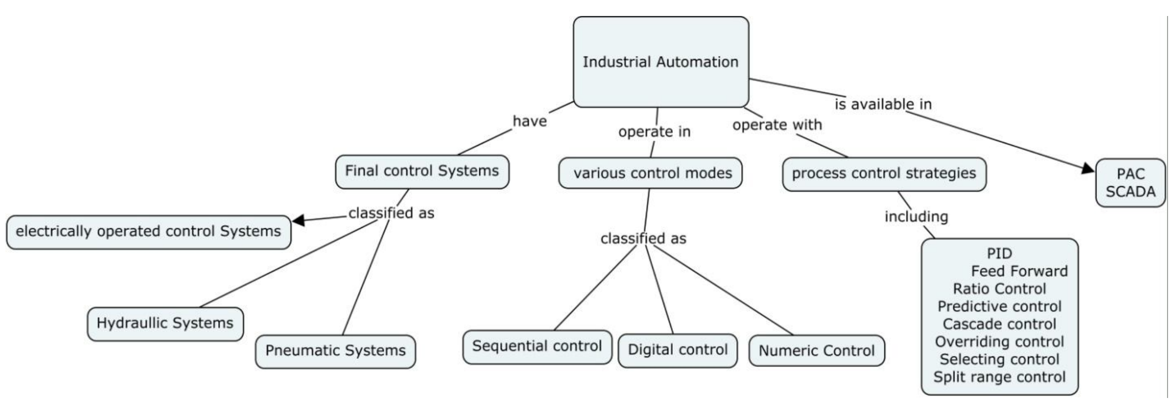
Course Outcome 5 (CO5):

1. **What are variable frequency drives ?. Mention their benefits over other drives.**
2. A 7.5 kW, 415 V, 15 A, 970 RPM, 3 phase rated induction motor with full load efficiency of 86% draws 7.5 A and 3.23 kW of input power. Calculate the percentage loading of the motor.

Course Outcome 6 (CO6):

1. List the advantages of distributed control architecture over centralized control architecture
2. Define control complexity ratio
3. Explain about various types of approaches in designing a LCU control architecture
4. Discuss about the input and output devices used for high level operator interface.
5. How is the concept of DCS applicable to Water Treatment Plant? Discuss in detail.

Concept Map



Syllabus

Introduction to Industrial Automation and Control - Architecture of Industrial Automation Systems.

Introduction to Actuators: Flow Control Valves
Hydraulic Actuator Systems: Principles, Components and Symbols - Pumps and Motors, Proportional and Servo Valves

Pneumatic Control Systems: System Components - Controllers and Integrated Control Systems
Electric Drives: Introduction, Energy Saving with Adjustable Speed Drives

Introduction to Process Control - P-- I -- D Control - Controller Tuning.
Implementation of PID Controllers - Special Control Structures : Feed forward and Ratio Control.
Predictive Control, Control of Systems with Inverse Response - Cascade Control, Overriding Control, Selective Control, Split Range Control

Introduction to Sequence Control, PLCs and Relay Ladder Logic, Scan Cycle, RLL Syntax - Structured Design Approach - Advanced RLL Programming - Functional Block diagram - The Hardware environment

Distributed Digital Control, Networking of Sensors, Actuators and Controllers: The Fieldbus - The Field bus Communication Protocol - Profibus

Control of Machine tools: Introduction to CNC Machines - Analysis of a control loop

Introduction to Production Control Systems - Programmable Automation Controller - Supervisory Control and Data Acquisition

Reference Books / Resource Materials

1. Frank.D.Petruzella – Programmable Logic Controllers, Tata McGraw Hill Publishing company Ltd.,
2. Lukcas M P, “Distributed Control Systems”, Van Nostrand Reinhold Co., New York, 1986.
3. Krishna Kant, “Computer based Industrial Control”, 2nd Edition, Prentice Hall of India, 2010
4. Bill Hollifield "High Performance HMI Handbook"
5. Seborg, Edgar, Mellichamp, Doyle, Process Dynamics and Control, 3ed, Wiley India Publications, 2015
6. George Stephanopoulos, "Chemical Process Control: An Introduction to Theory and Practice", Prentice Hall of India, 2008
7. B.G. Liptak,"Instrument Engineers Handbook" Vol.1 to Vol.3, Butterworth Hienemann Limited, 2005
8. Bill Hollifield, "The Principles of Alarm Management"
9. 6. http://www.nptelvideos.in/2012/11/industrial-automation-and-control.html

Course Designer

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V.Prakash vpeee@tce.edu

		Category	L	T	P	Credit
14EE780	**AUTOMATION LAB**	PC	0	0	2	1

Preamble

Automation is one of the basic requirement of modern day industries. Industries and Academia are focussing on totally integrated automation systems. This course will introduce the students with basics of integrated automation systems.

Prerequisite

- 14EE590 Control and Instrumentation Lab

Course Outcomes

On the successful completion of the course, students will be able to:

Sl.No	Outcomes	Bloom's Level	Expected Proficiency	Expected Attainment Level
CO1	Develop plant model in IT tools	Apply	80%	80%
CO2	Develop ladder logic program and sequential functional charts for a given sequential process	Apply		
CO3	Develop a human machine interface for a given automation system	Apply		
CO4	Use Profibus and Profinet to acquire data from remote I/O	Apply		

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	M	M	M	S							
CO2	S	M	M	M	S							
CO3	S	M	M	M	S							
CO4	S	M	M	M	S							

S-Strong; M-Medium; L-Low

List of Experiments

1. Plant Simulation in SIMIT software
2. Closed loop control and simulation in SIMIT software
3. PLC based control of industrial processes using ladder logic & Sequential Functional Charts
4. HMI development using WinCC
5. Data Acquisition using Profibus and Profinet protocols
6. Servo motor and stepper motor control using DCS
7. Development of Power and Automation system layout in COMOS

Course Designers:

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2. Mr.M.VARATHARAJAN varatharajan@tce.edu

14EE7C0	CAPSTONE II

Category	L	T	P	Credit
PC	0	0	4	2

Preamble

The purpose of this course is to apply the concept of mathematics, science and engineering fundamentals and an engineering specialization to solve complex engineering problems.

Syllabus

Electrical energy systems & Power electronics and drives
Electrical circuit analysis, DC and AC machines, Transformers, Energy resources and utilization, Power electronics, Drives and control

Analog and Digital electronics & Control and Automation
Analog devices and circuits, Digital systems, Microcontrollers, Digital signal processing, Measurement and instrumentation systems, control system and design

Assessment Pattern

(Common to B.E./B.Tech Programmes)

Comprehensive Test (30 Marks)

Test 1: Electrical energy systems & Power electronics and drives
Group 1 (60 Marks) **Duration: 90 Minutes**
Objective Type Questions : 30
Fill up the blanks : 30

Test 2: Analog and Digital electronics & Control and Automation
Group 2 (60 Marks) **Duration: 90 Minutes**
Objective Type Questions : 30
Fill up the blanks : 30

TEST	MARKS OBTAINED	CONVERTED TO
TEST1	60 MARKS (MAX)	15 MARKS (MAX)
TEST 2	60 MARKS (MAX)	15 MARKS (MAX)
		30 MARKS (MAX)

No re-test will be conducted at any circumstances

Complex Engineering Problem Solving (70 Marks):

- Selection of a complex engineering problem (Batch size: 2-4) : 5 Marks
- Literature Survey : 5 Marks
- Problem Formulation : 10 Marks
- Solution Methodology : 15 Marks
- Results and Discussion : 15 Marks
- Technical Report : 10 Marks
- Viva Voce : 10 Marks

Course Designers:

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Dr.B.Ashok Kumar ashokudt@tce.edu

Passed in BOS meeting held on 26-11-2016 Approved in 53rd AC meeting held on 22-12-2016

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

Phone: 0452 – 2482240, 41
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Web: www.tce.edu

B.E. Electrical and Electronics Engineering Degree Programme

LIST OF PROGRAMME ELECTIVE COURSES

(For the students admitted from 2014-15)

S.No.	Course Code	Course Title	Credits
Electrical Energy Systems			
1.	14EEPA0	Modeling of Electrical Machines	3
2.	14EEPB0	Power system Analysis	3
3.	14EEPC0	Design of Electrical Installations	3
4.	14EEPD0	Smart Grid	3
5.	14EEPE0	Power System Operation and Control	3
6.	14EEPF0	Power System Stability	3
7.	14EEPG0	Switchgear and Protection	3
8.	14EERC0	Principles of Energy conservation	3
9.	14EERD0	Operation and Maintenance of Electrical equipment	3
10.	14EERG0 (For the students admitted from 2016-17)	Electrical Machine Design	3

S.No.	Course Code	Course Title	Credits
Analog & Digital Electronic Systems			
1.	14EEPH0	VLSI design	3
2.	14EEPN0	Embedded Systems Design	3
3.	14EEPJ0	FPGA based System Design	3
4.	14EEPK0	Digital Signal Processors	3
5.	14EEPL0	Biomedical Instrumentation	3
6.	14EEPM0	Real Time Operating System	3

S.No.	Course Code	Course Title	Credits
Control and Automation			
1.	14EEPT0	Virtual Instrumentation	3
2.	14EEPP0	Robotics	3
3.	14EEPQ0	Automotive Electronics	3
4.	14EEPR0	Automotive Fundamentals and Manufacturing	3
5.	14EEPS0	Soft Computing	3
6.	14EERE0	Autonomous Vehicles	3
7.	14EERF0	Industrial Instrumentation	3
8.	14EEPU0	Data Structures	3

S.No.	Course Code	Course Title	Credits
Power Electronics and Drives			
1.	14EEPV0	FACTS and Custom Power Devices	3
2.	14EEPW0	HVDC Transmission	3
3.	14EEPY0	Power Quality	3
4.	14EEPZ0	Special Machines and Drives	3
5.	14EERA0	Power Electronics for Renewable Energy Systems	3
6.	14EERB0	Simulation of Power Electronic Systems	3

List of ONE credits Courses offered by Experts from Industry

S.No.	Course Code	Course Title	Credits
1.	14EE1C0	IoT in EEE	1
2.	14EE1E0	Solar Power Plant	1
3.	14EE1H0	Design of LV Robust Distribution System	1
4.	14EE1J0	Lead Acid Battery Technology	1
5.	14EE1K0	Design of Power Supplies	1
6.	14EE1L0	Micro Grid	1
7.	14EE1M0	Safety Engineering	1
8.	14EE1N0	Power Grid Operation	1
9.	14EE1P0	Indian Electrical Standards	1
10.	14EE1Q0	EEE Applications in Missile Technology	1
11.	14EE1s0	Power Quality in Industries	1
12.	14EE1T0	Electrical Substation Engineering	1
13.	14EE1U0	Management of Power Sector in India	1
14.	14EE1V0	Industrial Drives and Automation	1

List of General Elective courses proposed and it will be offered to other Branch students

S.No.	Course Code	Course Title	Credits
1.	14EEGA0	Renewable Energy Sources	3
2.	14EEGB0	Domestic and Industrial Electrical Installations	3
3.	14EEGC0	Industrial Safety and Environment	3
4.	14EEGD0	Soft Computing	3
5.	14EEGE0	Sensors and Transducers	3
6.	14EEGF0	Energy Conservation Practices	3
7.	14EEGG0	System Approach for Engineers	3

14EEPW0	HVDC TRANSMISSION	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

High voltage direct current transmission has advantages over ac transmission in special situations. With the advent of thyristor valve converters, HVDC transmission became even more attractive. This course deals with the operation, modelling and control of HVDC link in power system. Also, trends for HVDC applications and practical examples are discussed in this course.

Prerequisite

- 15EE520 : Power Electronics
- 14EE630 : Transmission and Distribution

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain the significance and necessity of HVDC system	Understand	90	80
CO2	Discuss the power converters and harmonic filters used in HVDC system	Understand	80	70
CO3	Explain the requirement of appropriate control strategies and stability techniques used for HVDC system	Understand	80	70
CO4	Design suitable controller for HVDC converter to obtain desired output	Apply	80	70
CO5	Select suitable protection scheme by identifying the fault in the system	Apply	80	70
CO6	Explain the application of HVDC system with practical examples	Understand	80	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	M	L										
CO3	S	M										
CO4	S	M	L									
CO5	S	M	L									
CO6	M	L										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	

Remember	20	20	20	20
Understand	60	40	40	40
Apply	20	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Differentiate AC and DC transmission systems.
2. Explain modern trends in DC transmission system.
3. Explain the specifications and concepts used DC transmission system.
4. List the advantages of DC transmission

Course Outcome 2 (CO2):

1. In what way should the firing angle and extinction be controlled to minimize reactive power consumption?
2. Explain the types of power converters.
3. Explain the characteristics of a twelve pulse converter used in HVDC.
4. Explain about current and extinction angle control.

Course Outcome 3 (CO3):

1. Explain the advantages of per unit quantities in DC system.
2. Compare the solution of DC power flow over AC power flow in DC system.
3. Perform power flow analysis using substitution of power injection method.

Course Outcome 4 (CO4):

1. Model and control DC LINK in a power system.
2. Prove that for same power transmitted and same percentage loss, the insulation level in DC transmission is only87% of that AC transmission.
3. An existing 400 kV 3-phase AC line transmitting a power 100 MW is converted in to bipolar DC line. Evaluate the voltage/pole and DC line losses, if the resistance of each conductor is 0.01 ohm. Assume pf=0.90.
4. Compare the dynamic interactions between DC and AC systems.
5. Design controller parameters to obtain desired output
6. Construct an energy efficient controller for the HVDC system.

Course Outcome 5 (CO5):

1. Illustrate the intensity of the fault
2. Select appropriate fault clearance techniques.
3. Design suitable protection circuits
4. A 400 kV 3-phase AC line of 800 km length transmitting 1000MW is converted in to DC line. If the surge impedance pf the line is 320 ohm, calculate the number of conductors required and surge impedance loading of 3-phase AC system.
5. A 400 kV 3-phase AC line of 800 km length transmitting 1000MW is converted in to a DC line. If the surge impedance pf the line is 320 ohm, calculate voltage per pole as DC line power losses, as percentage of AC power losses. Consider pf =0.90.

Course Outcome 6 (CO6):

1. Identify the type of system given in Figure 6.1 and discuss the merits compare to other types.

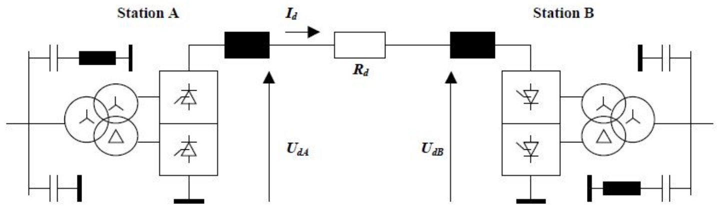
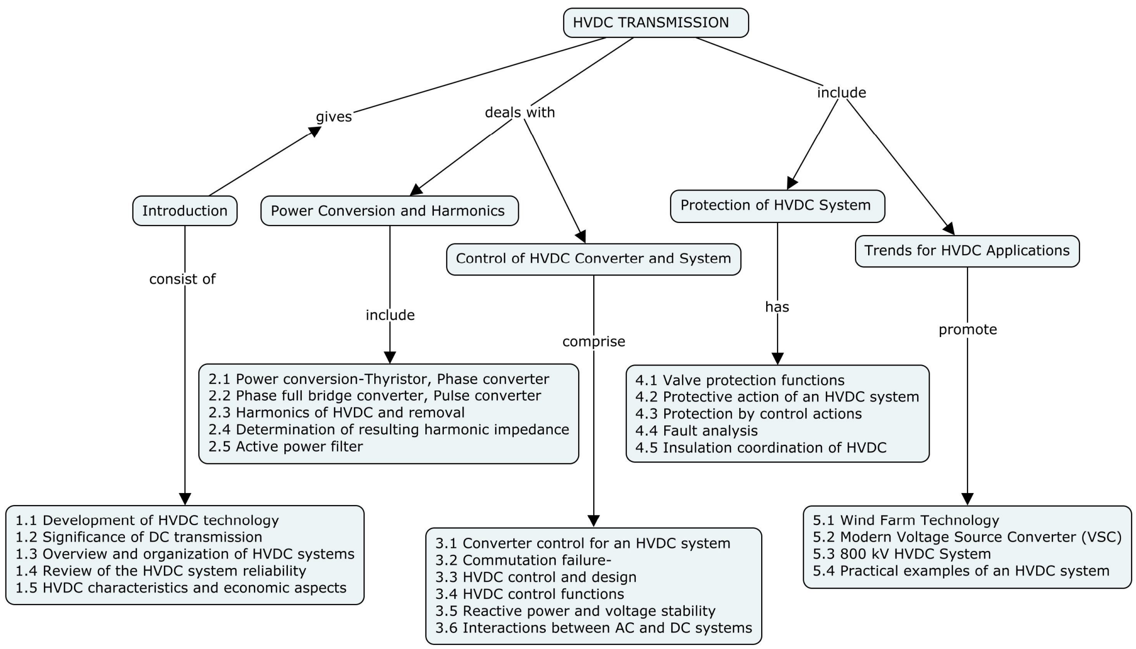


Figure 6.1

2. Illustrate the significance of DC system with a suitable example
3. Explain the importance of DC transmission in wind power generation system

Concept Map



Syllabus

Introduction

Development of HVDC technology-Significance of DC transmission-Overview and organization of HVDC systems-Review of the HVDC system reliability-HVDC characteristics and economic aspects

Power Conversion and Harmonics

Power conversion - Thyristor, Phase converter, Phase full bridge converter, Pulse converter-Harmonics of HVDC and removal-Determination of resulting harmonic impedance-Active power filter

Control of HVDC Converter and System

Converter control for an HVDC system-Commutation failure- HVDC control and design-HVDC control functions- Reactive power and voltage stability- Interactions between AC and DC systems

Protection of HVDC System

Valve protection functions- Protective action of an HVDC system-Protection by control actions-Fault analysis-Insulation coordination of HVDC

Trends for HVDC Applications

Wind Farm Technology- Modern Voltage Source Converter (VSC)- 800 kV HVDC System- Practical examples of an HVDC system

Text Book

1. Chan-Ki Kim, "HVDC TRANSMISSION Power Conversion Applications in Power Systems", John Wiley & Sons Pvt. Ltd., 2009

Reference Books

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993
2. K.R.Padiyar, "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
3. J.Arrillaga, "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4. Erich Uhlmann, "Power Transmission by Direct Current", BS Publications, 2004.
5. V.K.Sood, "HVDC and FACTS controllers – Applications of Static Converters in Power System", APRIL 2004, Kluwer Academic Publishers.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Development of HVDC technology	1
1.2	Significance of DC transmission	1
1.3	Overview and organization of HVDC systems	1
1.4	Review of the HVDC system reliability	2
1.5	HVDC characteristics and economic aspects	1
2.	**Power Conversion and Harmonics**	
2.1	Power conversion- Thyristor converter, Phase converter	2
2.2	Phase full bridge converter, Pulse converter	2
2.3	Harmonics of HVDC and removal	1
2.4	Determination of resulting harmonic impedance	1
2.5	Active power filter	2
3	**Control of HVDC Converter and System**	
3.1	Converter control for an HVDC system	1
3.2	Commutation failure	1
3.3	HVDC control and design	2
3.4	HVDC control functions	2
3.5	Reactive power and voltage stability	2
3.6	Interactions between AC and DC systems	1
4	**Protection of HVDC System**	
4.1	Valve protection functions	1
4.2	Protective action of an HVDC system	2
4.3	Protection by control actions	2
4.4	Fault analysis	1
4.5	Insulation coordination of HVDC	2
5	**Trends for HVDC Applications**	
5.1	Wind Farm Technology	1
5.2	Modern Voltage Source Converter (VSC)	2
5.3	800 kV HVDC System	1
5.4	Practical examples of an HVDC system	1

Course Designers:

1. Dr. V. Suresh Kumar vskeee@tce.edu
2. Dr. G. Sivasankar qsiva@tce.edu

14EERA0	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course will cover the applications of power electronics for the control and conversion of electrical power with emphasis on renewable energy systems.

Prerequisite

- 16EE440 : AC Machines
- 15EE520 : Power Electronics

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	**Course Outcomes**	Bloom's Level	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Explain contribution and impact of renewable energy sources	Understand	90	80
CO2	Describe the features of power electronics and their role in renewable energy system	Understand	80	70
CO3	Design appropriate converter for renewable energy systems	Apply	80	70
CO4	Categorize various issues experienced during grid connection of wind generators	Analysis	80	70
CO5	Categorize various issues experienced during grid connection of PV systems	Analysis	80	70
CO6	Demonstrate the control aspects of converters used in wind generators and PV systems	Apply	80	70

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**M**	**L**										
CO2	**M**	**L**										
C03	**S**	**M**	**L**	**L**								
CO4	**S**	**S**	**M**	**M**								
CO5	**S**	**S**	**M**	**M**								
CO6	**S**	**M**	**L**	**L**								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	30	30	30
Apply	40	40	40	40
Analyse	0	10	10	10
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is global warming?
2. List the various types of renewable energy sources.
3. Write the merits of renewable energy sources.

Course Outcome 2 (CO2):

1. What is the need for power converters in wind energy system?
2. Discuss the role of power electronics in renewable energy system.
3. Explain the merits and demerits of power electronics.

Course Outcome 3 (CO3)

4. Develop the design procedure of soft switching AC-link universal power converter,
5. Figure 3.1 shows a boost (up) converter supplying 12 V to a load of 5 Ω from a 5 V source having an internal resistance of 0.2 Ω. Determine the duty ratio D at which the converter operates. (You may neglect semiconductor device drops in your calculations.

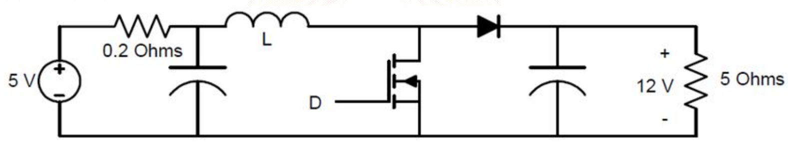


Figure 3.1 Boost converter

6. Compare hard and soft switching converters.

Course Outcome 4 (CO4)

7. Figure 4.1 shows a circuit model for the utility supplying one phase of an ac induction motor. The motor system parameters are Rs = 0.08 Ω, Lls = 1 mH, Lm = 40 mH, Llr = 1 mH, Rr = 0.1 Ω, and Rx = 33 Ω. If the utility voltage is 170·cos(377t), i) what is the current into the motor? and ii) At what power factor is the motor operating?

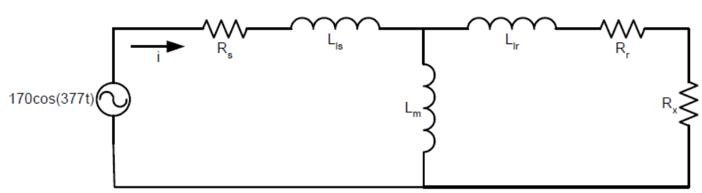


Figure 4.1 A Circuit model for one phase of an induction motor being driven by the utility

8. Consider a induction machine based wind energy conversion system. If induction machine is replaced by synchronous machine, what are the expected changes in the performance indices?

9. Consider synchronous machine based wind energy conversion system. If it is replaced by induction machine, analyse change in reactive power scenario.

Course Outcome 5 (CO5)

10. Which converter is best suitable for interfacing the PV array? Why?
11. Identify the issues related to grid connection of PV system.
12. Compare the issues related to grid connected mode and islanding mode operation of solar power system.
13. Compare the performance of various DC-DC converter topologies used in solar power conversion system.

Course Outcome 6 (CO6)

14. Demonstrate the role of pq theory in converter control.
15. Consider the circuit given in Figure 6.1. V_d = 250V, Switching frequency is 30 kHz. The bridge is connected to a speed controlled dc machine. The armature inductance L_a=0.2mH. The armature resistance is negligible.

a) The bridge may be controlled by the use of unipolar or bipolar PWM. Describe the advantages and disadvantages of these control algorithms.

b) The bridge is controlled to provide an average output voltage, V_o=200V. Find the duty ration D_1 and D_2 and the ripple frequency of the two control principles Sketch $V_o(t)$ for the two control principles.

At the given speed, the back –emf E_a=200V. Unipolar PWM is used.

c) The armature current, I_a, is 1A, find the maximum and the minimum instantaneous armature current.

d) Sketch the armature current, $i_a(t)$.Inductance which of the power semiconductors are conducting, Also sketch $i_d(t)$.

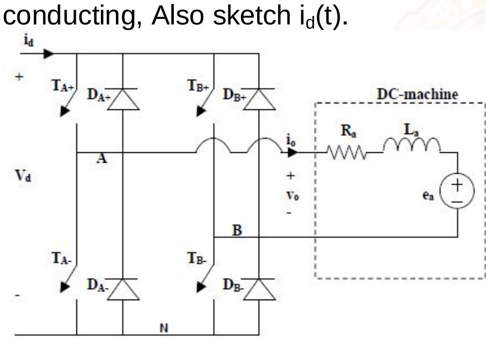
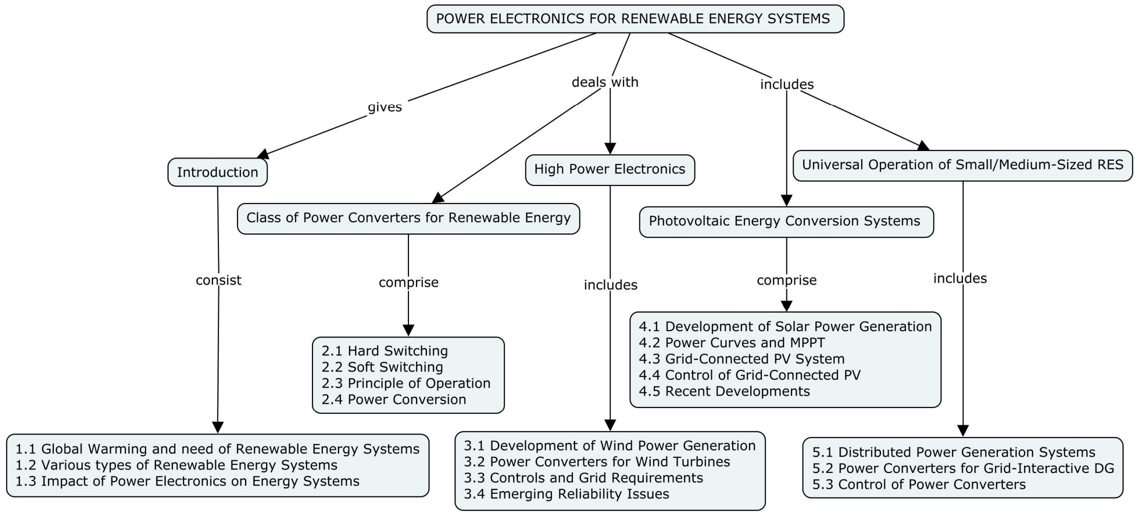


Figure 6.1

Concept Map



Syllabus

Introduction

Environmental Pollution: Global Warming Problem, Impact of Power Electronics on Energy Systems, Challenges of the Current Energy Scenario: The Power Electronics Contribution, Renewable Energy Systems

Class of Power Converters for Renewable Energy

Introduction, Hard Switching AC-Link Universal Power Converter, Soft Switching AC-Link Universal Power Converter, Principle of Operation of the Soft Switching AC-Link Universal Power Converter -

High Power Electronics: Key Technology for Wind Turbines

Introduction, Development of Wind Power Generation, Power Converters for Wind Turbines, Controls and Grid Requirements for Modern Wind Turbines, Emerging Reliability Issues for Wind Power System.

Photovoltaic Energy Conversion Systems

Introduction, Power Curves and Maximum Power Point of PV Systems, Grid-Connected PV System Configurations, Control of Grid-Connected PV Systems – Converters for domestic applications

Hybrid Renewable Energy System

Converters for hybrid renewable energy system - Recent Developments in Multilevel converters

Text Book

1. Haitham Abu-Rub, Mariusz Malinowski & Hamal Al Haddad, “Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications”, IEEE Press and John Wiley Publications, First Edition, 2014.

Reference Books

1. Muhammad H.Rashid, “Power Electronics Circuits, Devices & Applications”, Pearson Education India Publication, New Delhi, 7th Impression, 2009.
2. Ned Mohan, Tore Undeland & William Robbins, “Power Electronics: converters Applications and Design”, John Willey and sons, 3rd Edition, 2003.
3. Ali Keyhani, M.N.Marwali & Min Dai, “Integration of green and renewable energy in electrical power systems”, Wiley and sons, 2010.
4. Ewald F. Fuchs & Mohammad A.S. Masoum, “Power Conversion of Renewable Energy Systems” Springer New York Dordrecht Heidelberg London, 2011.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Introduction**	
1.1	Global Warming and need of Renewable Energy Systems	1
1.2	Various types of Renewable Energy Systems	2
1.3	Impact of Power Electronics on Energy Systems	1
2.	**Class of Power Converters for Renewable Energy**	
2.1	Hard Switching AC-Link Universal Power Converter	2
2.2	Soft Switching AC-Link Universal Power Converter	1
2.3	Principle of Operation of the Soft Switching AC-Link Universal Power Converter	2
2.3.1	Design Procedure and Analysis	2
2.4	AC–AC,DC–AC and AC–DC Power Conversion	2
3.	**High Power Electronics: Key Technology for Wind Turbines**	
3.1	Development of Wind Power Generation	2
3.2	Wind Generator Technologies	1
3.3	Power Converters for Wind Turbines	2
3.4	Controls and Grid Requirements for Modern Wind Turbines	2
3.5	Emerging Reliability Issues for Wind Power System	2
4.	**Photovoltaic Energy Conversion Systems**	
4.1	Development of Solar Power Generation	1
4.2	Power Curves and Maximum Power Point of PV Systems	2
4.3	Grid-Connected PV System Configurations	2
4.4	Control of Grid-Connected PV Systems	2
4.5	Recent Developments in PV Systems	1
4.6	Converters for domestic applications	1
5.	**Hybrid Renewable Energy System**	
5.1	Converters for hybrid renewable energy system	2
5.2	Recent Developments in Multilevel converters	2

Course Designers:

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2. Dr. G.Sivasankar qsiva@tce.edu

14EERB0	SIMULATION OF POWER ELECTRONIC SYSTEMS	Category	L	T	P	Credit
		PE	2	0	2	3

*Maximum strength of students per class is 40.

Preamble

This Course enhances the students to analyse on various aspects of Power Electronic systems. The simulation of fundamental Power electronic circuits using Matlab-PLECS and PSPICE software is discussed. Using various simulation techniques, the output response of the systems for different conditions can be easily analysed. The real power, reactive power, power factor & efficiency calculations are simplified using the simulation software. The Static, dynamic models and performance analysis of power electronics rectifier, inverter, chopper circuits and AC and DC motor drives are dicussed.

Prerequisite

- 15EE520: POWER ELECTRONICS
- 16EE330: DC MACHINES AND TRANSFORMERS
- 16EE440: AC MACHINES

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain the concept of Matlab, PLECS and PSPICE simulation	Understand	90	80
CO2	Analyse the Linear, Nonlinear, Sinusoidal, Nonsinusoidal circuits, Diode rectifiers, Phase Controlled Rectifiers using Matlab, PLECS and PSPICE simulation	Analyze	80	70
CO3	Analyse the DC-DC converters using Matlab, PLECS and PSPICE simulation	Analyze	80	70
CO4	Analyse the DC-AC converters using Matlab, PLECS and PSPICE simulation	Analyze	80	70
CO5	Analyse the State space models using Matlab, PLECS and PSPICE simulation	Analyze	80	70
CO6	Analyse the DC and AC motor drives using Matlab, PLECS and PSPICE simulation.	Analyze	80	70

Mapping with Programme Outcomes

S- Strong; M-Medium; L-Low

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3.	**S**	**L**	**L**		**S**							**L**
CO4.	**S**	**S**	**S**	**M**	**S**							**L**
CO3	**S**	**S**	**S**	**M**	**S**							**L**
CO4	**S**	**S**	**S**	**M**	**S**							**L**

Assessment Pattern

Bloom's Category	Continuous Assessment Test*	Practical test	# Terminal Examination
Remember	10	0	0
Understand	50	0	0
Apply	40	40	40
Analyse	0	60	60
Evaluate	0	0	0
Create	0	0	0

***** One theory test for 20 marks will be conducted. Practical test carries 30 marks including 10 marks for observation and record work

Practical Exam

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Write any four general commands in Matlab.
2. Compare PLECS stand alone and PLECS block set.
3. What are the platforms for PSpice?
4. Explain the MATLAB While Structures.
5. Discuss the different types of analysis in PSpice.

Course Outcome 2 (CO2):

1. Draw a linear circuit with a nonsinusoidal source.
2. A 250V, 100W rated light bulb is connected to a 230V, 50Hz single phase supply. Plot the bulb voltage and current using PSpice.
   A linear circuit supplied by a nonsinusoidal source is shown in Fig.1.

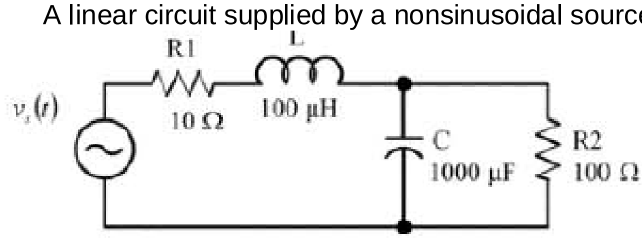


Fig.1

Find the average power absorbed by the circuit if the source voltage is expressed as $v_s(t)=100+50\cos(120\pi t)+25\cos(240\pi t)+15\cos(360\pi t)$.Write Matlab Script file.

6. Using PSpice simulate a three phase diode rectifier with source inductance. For RLE load plot the load voltage and current.The rectifier is supplied from a balanced three phase star connected 440V, 50Hz supply and the filter capacitance

C_f=1µF,R=10Ω,L=5mH,E=2V and Source inductance is 0.5mH. Using transient analysis determine the fourier coefficients of the load current and input current under the following cases: (a) with out source inductance (b) with source inductance Ls=0.5mH (c) with source inductance Ls=1.5mH. Analyse the effect of source inductance.

7. Explain the simulation of the single phase PWM inverter using PSpice and Matlab-PLECS.
8. A buck converter has an inductance of 30µH, a load resistance of 5Ω and a source voltage of 24V DC and operates with a duty ratio 0.6. Plot the output voltage if the PWM switching frequency is 10kHz. Analyse the output voltage and current for RL load under continuous current mode and discontinuous current mode using PSpice and Matlab-PLECS.

Course Outcome 3 (CO3)

1. Develop a state space model for the following circuit shown in Fig.2

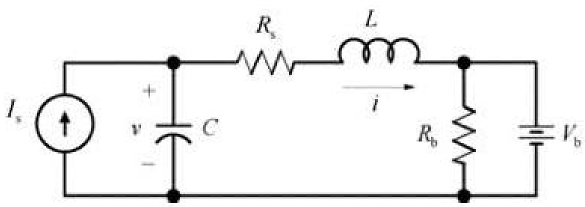


Fig.2

2.For the circuit shown in Fig.2, C=10µf, L=5mH, Is=10A and Rb=100Ω with proper time interval, simulate and plot the capacitor voltage.

3.Find out the state space model equation for the buck - boost converter.

4.Simulate a boost converter with the circuit parameter Vs=12V, Vo=28V, R=8Ω, L=150µH, C=100µF and f=5kHz using PSpice and Matlab-PLECS.

Course Outcome 4 (CO4)

1. Determine the transient response of a separately excited DC motor fed from a buck converter with respect to step change in load torque.Using PSpice and Matlab-PLECS plot the following:
(a)Armature current (b)Motor Speed (c)Developed motor torque.

2. Determine the PSpice schematic of the induction motor represented by its equivalent circuit as shown in Fig.3 and analyse the torque-speed characteristics for various slip values and various rotor resistance values.

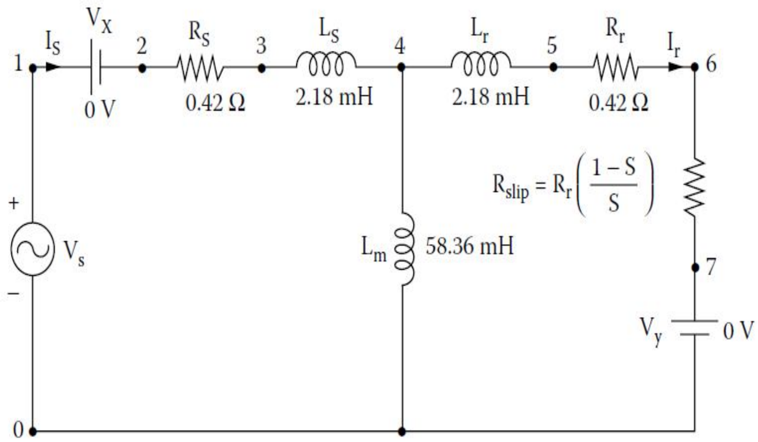
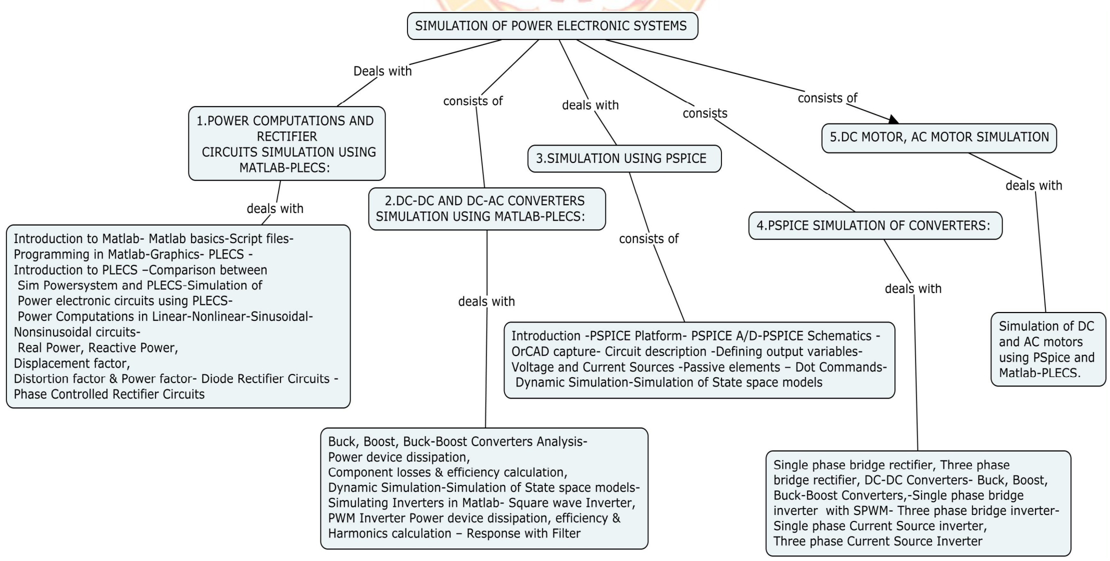


Fig.3

3. Analyse the torque-speed characteristics of the induction motor represented by its equivalent circuit as shown in Fig.3 for various slip values and various rotor resistance values using Matlab-PLECS.

Concept Map



Syllabus

POWER COMPUTATIONS AND RECTIFIER CIRCUITS SIMULATION USING MATLAB-PLECS: Introduction to Matlab- Matlab basics-Script files-Programming in Matlab-Graphics.

PLECS -Introduction to PLECS –Comparison between Sim Powersystem and PLECS-Simulation of Power electronic circuits using PLECS- Power Computations in Linear-Nonlinear-Sinusoidal-Nonsinusoidal circuits- Real Power, Reactive Power, Displacement factor, Distortion factor & Power factor- Diode Rectifier Circuits - Phase Controlled Rectifier Circuits

(4)

DC-DC AND DC-AC CONVERTERS SIMULATION USING MATLAB-PLECS: Buck, Boost, Buck-Boost Converters Analysis- Power device dissipation, Component losses & efficiency calculation, Dynamic Simulation-Simulation of State space models-Simulating Inverters in Matlab- Square wave Inverter, PWM Inverter Power device dissipation, efficiency & Harmonics calculation – Response with Filter (4)

SIMULATION USING PSPICE : Introduction -PSPICE Platform- PSPICE A/D-PSPICE Schematics -OrCAD capture- Circuit description -Defining output variables- Voltage and Current Sources -Passive elements – Dot Commands- Dynamic Simulation-Simulation of State space models. (6)

PSPICE SIMULATION OF CONVERTERS: Single phase bridge rectifier, Three phase bridge rectifier, DC-DC Converters- Buck, Boost, Buck-Boost Converters,-Single phase bridge inverter with SPWM- Three phase bridge inverter- Single phase Current Source inverter, Three phase Current Source Inverter. (4)

DC MOTOR, AC MOTOR DRIVES SIMULATION: Simulation of DC and AC motor drives using PSpice and Matlab-PLECS. (2)

Total L : 20

Text Books

1. 1.Muhammad H. Rashid and Hasan M. Rashid., “SPICE for Power Electronics and Electric Power” CRC Press 2006.
2. Randall Shaffer., “Fundamentals of Power Electronics with MATLAB” Charles River Media Boston Massachusetts, 2007.

Reference Books

1. Rao V.Dukkipati,."Analysis and Design of Control Systems using MATLAB" New age international, 2006.
2. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery : Using MATLAB/ Simulink", Prentice Hall PTR, New Jersey, 1998.
3. Ned Mohan, "Power Electronics: Computer Simulation Analysis and Education using PSPICE", Minnesota Power Electronics Research and Education, USA, 1992.
4. Ramshaw E., Schuuram D. C., “PSpice Simulation of Power Electronics Circuits – An Introductory Guide”, Springer, New York, 1996.
5. http://www.plexim.com/plecs.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**POWER COMPUTATIONS AND RECTIFIER CIRCUITS SIMULATION USING MATLAB-PLECS**	
1.1	Introduction to Matlab- Matlab basics-Script files-Programming in Matlab-Graphics	1
1.2	PLECS -Introduction to PLECS –Comparison between Sim Powersystem and PLECS	1
1.3	Simulation of Power electronic circuits using PLECS- Power Computations in Linear-Nonlinear-Sinusoidal- Nonsinusoidal circuits	1
1.4	Real Power, Reactive Power, Displacement factor, Distortion factor & Power factor- Diode Rectifier Circuits - Phase Controlled Rectifier Circuits	1
2.	**DC-DC AND DC-AC CONVERTERS SIMULATION USING MATLAB-PLECS**	
2.1	Buck, Boost, Buck-Boost Converters Analysis- Power device dissipation,	1

Module No.	Topic	No. of Lectures
2.2	Component losses & efficiency calculation, Dynamic Simulation-Simulation of State space models-Simulating Inverters in Matlab-	1
2.3	Square wave Inverter, PWM Inverter Power device dissipation	1
2.4	Efficiency & Harmonics calculation – Response with Filter	1
3	**SIMULATION USING PSPICE**	
3.1	Introduction -PSPICE Platform- PSPICE A/D-PSPICE Schematics -OrCAD capture	1
3.2	Circuit description -Defining output variables	1
3.3	Voltage and Current Sources -Passive elements	2
3.4	Dot Commands	1
3.5	Dynamic Simulation-Simulation of State space models.	1
4	**PSPICE SIMULATION OF CONVERTERS**	
4.1	Single phase bridge rectifier, Three phase bridge rectifier,	1
4.2	DC-DC Converters- Buck, Boost, Buck-Boost Converters,	1
4.3	Single phase bridge inverter with SPWM-	1
4.4	Three phase bridge inverter- Single phase Current Source inverter Three phase Current Source Inverter.,	1
5	**DC MOTOR, AC MOTOR SIMULATION**	
5.1	Simulation of DC and AC motors using PSpice and Matlab-PLECS.	2

Tentative List of Experiments (20 Hours)

Simulation using PSpice and Matlab-PLECS

1.Simulation of Diode Rectifier Circuits: Half wave, Full wave circuits with R, RL, RC loads &Battery charger applications.

2. Simulation of Phase Controlled Rectifier Circuits:Half wave phase controlled, Full wave phase controlled circuits with R, RL, RC loads &Battery charger applications.

3.Performance Analysis and Thermal Analysis of Single phase and Three phase Diode Rectifier Circuits, Phase Controlled Rectifier Circuits with filter –Analysis of Fourier coefficients of output voltage- Effects of Filter Capacitance.

4.Dynamic Simulation, Performance Analysis and Thermal Analysis :Simulation of State space models-Simulating Buck,Boost,Buck-Boost chopper circuits, Square wave Inverters-Single phase bridge inverter -Three phase bridge inverter- Single phase Current Source Inverter, Three phase Current Source Inverter, PWM Inverters with SPWM - Power device dissipation, efficiency & Harmonics calculation – Response with Filter.

5.Transient response analysis of DC motor and Induction motor drives.

Course Designers:

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3	Mr.M.Ramkumar	mjayaramkumar@tce.edu

14EEPU0	DATA STRUCTURES	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

This course will cover data structures and the operations for manipulating them. Students will learn how to organize data so that data can be accessed and updated efficiently by a computer program.

Prerequisite

- 14ES370 : Problem solving using Computers

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Illustrate how arrays, stacks, queues, linked lists, trees, heaps, Graphs and Hash Tables are used in various applications.	Remember	75	75
CO2	Explain how arrays, stacks, queues, linked lists, trees, heaps and Hash Tables are represented or used by different operations.	Understand	75	75
CO3	Construct algorithms for performing operations on a data structure, with an understanding of the trade-off between the time and space complexity	Apply	70	70
CO4	Analyze the computational efficiency of key searching, sorting and hashing algorithms.	Analyze	70	70
CO5	Evaluate the suitability of different data structures for solving computing problems.	Evaluate	65	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	M											
CO3	S	L	L									
CO4	S	S	M									
CO5	S	S	M									

S- Strong; M-Medium; L-Low

Assessment Pattern

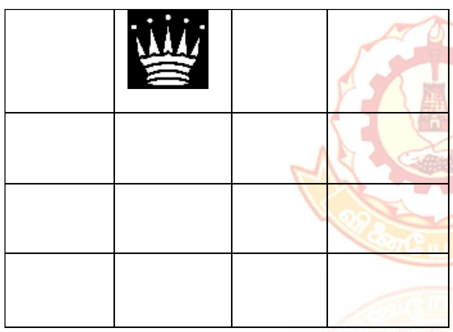
Bloom's Category	Continuous Assessment Tests	Terminal Examination

	1	2	3	
Remember	10	10	10	20
Understand	10	10	10	20
Apply	20	20	20	40
Analyse	10	10	10	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Assume that a backtracking algorithm which uses a stack has been designed to find a solution to the 4-Queen's problem on a 4x4 chess board. The algorithm has already completed an unknown number of iterations say 'k'. After these 'k' iterations, the chess board state and the state of the stack are as shown in Fig. 2 and Fig. 3 respectively. Infer the sequence of chess board configurations and the sequence of stack states for each of the iterations from 1 to k.



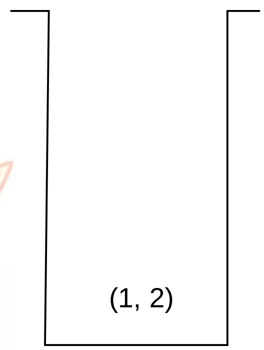


Fig. 2 Fig. 3

2. Outline a pseudo-code to multiply two polynomials. Assume that the polynomials are stored in the form of a singly linked list in memory. Make sure that the output polynomial is sorted by exponent and has at most one term of any power.
3. Assume that a goal-seeking application is being written whose job is to find a path from the source city '1' to the destination city '12' in the map [Fig 1] given below:

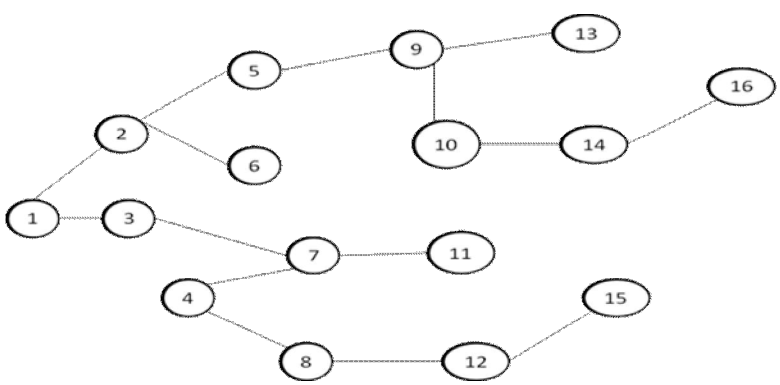


Fig. 4

In Fig. 4, nodes represent cities and lines represent roads between the cities. Assume that this application has a stack to implement the goal seeking function using backtracking. Illustrate the sequence of steps involved in the backtracking algorithm to trace a path from the source city to the destination city. Infer the various states in which the stack would have been during an execution of this algorithm.

Course Outcome 2 (CO2):

1. Outline the ways to implement three stacks in a single array.
2. Demonstrate the result of inserting the keys 10111101, 00000010, 10011011, 10111110, 01111111, 01010001, 10010110, 00001011, 11001111, 10011110, 11011011, 00101011, 01100001, 11110000, 01101111 into an initially empty extendible hash table with M = 4.
3. Infer the performance of the following two splaying strategies in terms of the amortized cost incurred over a sequence of M insert, delete and search operations.
    - Strategy 1: Keep on rotating the key accessed with its parent by using a simple rotation strategy, till the key accessed reaches the root of the splay tree.
    - Strategy 2: Depending upon the structure of the sub-tree in which the key accessed is located, apply either zig-zig or zigzag rotation operation till the key accessed reaches the root.

Course Outcome 3 (CO3):

1. Given two sorted linked lists L1 and L2, construct a pseudo-code snippet to compute L1 ∩ L2 and to store the result in a third linked list L3. (Assume ascending ordering)
2. Construct a pseudo code for performing preorder traversal of a binary tree without using recursion.
3. Construct a pseudo code for inserting an element into a d-Heap and compute its time complexity.
4. Construct a pseudo-code to check if a linked list is circular. Assume that you are given with a pointer to an arbitrary node of the list and this pointer need not necessarily be the pointer to the head node of the list

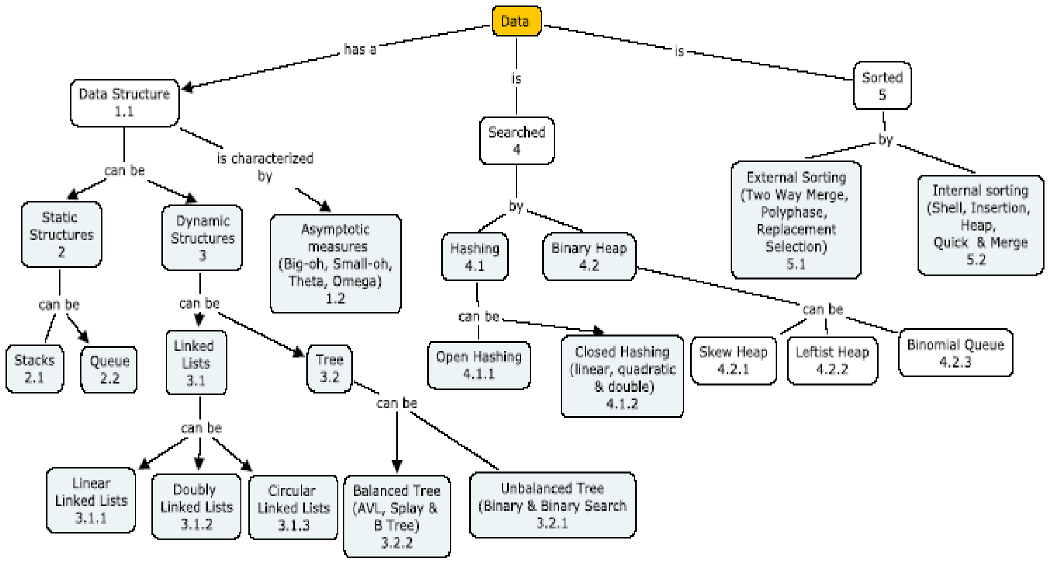
Course Outcome 4 (CO4):

1. Examine the running time of insertion sort for i) Sorted input, ii) Reverse ordered input.
2. Evaluate the best-case, average-case and worst-case time complexity of the quick sort algorithm with the help of a pseudo-code snippet and recurrence equations.
3. Defend through a precise mathematical argument that the height of an AVL tree is $O(\log_2 n)$, where n is the number of nodes in the AVL tree.

Course Outcome 5 (CO5):

1. Assume that a spell-checker program needs to be written so that it prints out all words not in some online dictionary. Suppose the dictionary contains 30,000 words and the file is large, so that the algorithm can make only one pass through the input file. Analyze which data structure will be suitable for implementing this spell-checker application in terms of time and space complexities.
2. Recommend a suitable data structure to evaluate prefix expressions and depict the sequence of steps to be followed in evaluating a prefix expression using your recommendation.
3. Recommend an efficient data structure to add two polynomials (having M and N terms). You must make sure that the output polynomial is sorted by exponent and has at most one term of any power. Assume that the polynomials are of the form $a_1x^m + a_2x^{m-1} + \ldots + a_m$ and $b_1x^n + b_2x^{n-1} + \ldots + b_n$
4.

Concept Map



Syllabus

Data: Data Structure, Asymptotic Measures **Static Data Structures:** Stacks, Queues **Dynamic Data Structures:** Linked Lists: Linear Linked Lists, Doubly Linked Lists and Circular Linked Lists, Trees: Unbalanced and Balanced Trees, **Data Search:** Hashing: Open Hashing and Closed Hashing; Heap: Skew Heap, Leftist Heap, Binomial Queue **Data Sorting:** Internal Sorting: Insertion sorting, Shell sorting, Quick sorting, Merge sorting and Heap sorting; External Sorting

Text Book

1. Mark Allen Weiss: Data Structures and Algorithms in C, Addison-Wesley, 2006

References

1. Richard F. Gilberg , Behrouz A. Forouzan: Data Structures: A Pseudocode Approach With C, 2nd Edition, Thomson Learning, 2003

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1	**Data (3)**	
1.1	Data Structure	1
1.2	Asymptotic Measures	2
2	**Static Data Structures (5)**	
2.1	Stacks	3
2.2	Queues	2
3	**Dynamic Data Structures(15)**	
3.1	Linked Lists	1

3.1.1	Linear Linked Lists	2
3.1.2	Doubly Linked Lists	2
3.1.3	Circular Linked Lists	1
3.2	Trees	1
3.2.1	Unbalanced Trees	3
3.2.2	Balanced Trees	5
4	**Data Search (9)**	
4.1	Hashing	1
4.1.1	Open Hashing	1
4.1.2	Closed Hashing	2
4.2	Heap	2
4.2.1	Skew Heap	1
4.2.2	Leftist Heap	1
4.2.3	Binomial Queue	1
5	**Data Sorting (8)**	
5.1	Internal Sorting	
5.1.1	Insertion sorting	1
5.1.2	Shell sorting	1
5.1.3	Quick sorting	1
5.1.4	Merge sorting	1
5.1.5	Heap sorting	2
5.2	External Sorting	2

Course Designer:

1. S.Prasanna sprcse@tce.edu

14EERG0	ELECTRICAL MACHINE DESIGN	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

This course is to impart in students a good understanding of fundamental design principles in electrical machine design. This course imparts knowledge about the design of magnetic circuits, main dimensions, armature circuit and field circuit of electrical machines.

Prerequisite

- 16EE330 DC Machines and Transformers
- 16EE440 AC Machines

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain about different materials used in electrical machines	Understand	90	90
CO2	Calculate the mmf required for air gap and armature teeth.	Apply	80	80
CO3	Design the main dimensions and cooling tubes arrangement of transformers.	Analyze	80	80
CO4	Design the main dimensions, winding details and field parameters of DC and AC machines for given specifications.	Analyze	80	80

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	S	S							
CO2	S	S	M	S	S							
CO3	S	S	S	S	S							
CO4	S	S	S	S	S							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's	Continuous	Terminal

Category	Assessment Tests			Examination
	1	2	3	
Remember	10	10	10	10
Understand	30	30	30	30
Apply	60	60	40	40
Analyze	0	0	20	20
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1

1. Name the various class of insulating materials with its maximum temperature limit.
2. What is S4 duty?
3. Mention some of the insulating materials used in electrical machines
4. Classify the Insulating materials with respect to temperature and give examples for each.

Course Outcome 2

1. Predict the change in eddy current loss if the flux reversal frequency doubles.
2. Calculate the apparent flux density at a section of the teeth of an armature of a D.C. machine from the following data: Slot pitch = 24 mm; Slot width = 12 mm; Length of armature including 5 ducts of 10 mm width each = 0.38 Mt; Iron stacking factor = 0.92; true flux density in the teeth of that section = 2.2 Tesla for which the MMF is 70,000 Amps. / Mt.
3. Find the MMF required for air gap of a d.c. machine with the following data: Flux density at the pole centre = 0.82 Wb/m^2; length of air gap = 6 mm; width of slot = 13 mm; width of tooth = 18 mm; length of core = 120 mm ; width of duct = 10 mm ; no. of duct = 1; Carter's coefficient for slots and ducts are 0.3 and 0.25 respectively.

Course Outcome 3

1. Derive the output equation of 3 phase core type transformer.
2. Show that equal current densities to be assumed for HV and LV conductors in the transformer design, to have minimum copper loss.
3. Show that, for a cruciform core the ratio of net core area to area of circum scribing circle is 0.71.
4. Two single phase transformers having linear dimensions ratio x:1 are designed to work with same current density, flux density and frequency. Compare the relative ratings, losses nd total weights per KVA of the two transformers.

Course Outcome 4

1.. Design a shunt field coil from the following data:

Field MMF per pole	= 9000
Mean length of turn	= 1.4 mt.

Depth of coil = 35 cm

Voltage across each field coil = 40

Resistivity of wire = 2.1×10^{-8} Ohm-mt.

Thickness of insulating varnish on the wire = 0.2 mm

Power dissipation from total surface of the coil should not exceed 700 Watts/ m^2

Check your design for power dissipation.

2..Design a 10 H.P., 415 Volts, 3-Phase, 50 Hz, 140 r.p.m., squirrel cage Induction motor. The machine is to be started by Star-Delta starter. Consider the following design data:

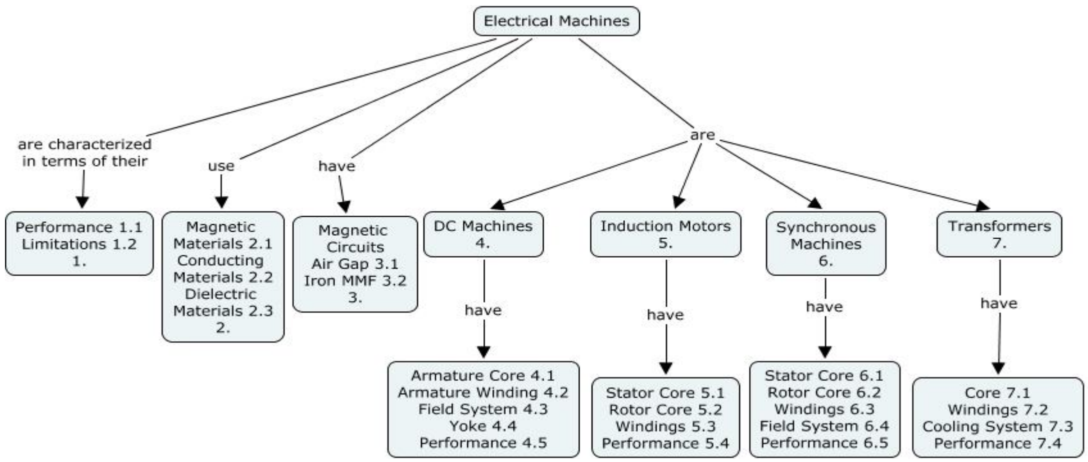
Specific Magnetic loading	=	0.45 Tesla
Specific electric loading	=	23000 A/Mt.
Winding factor	=	0.955
Power factor & Efficiency at full load	=	0.87 (each)
Core length to Pole pitch ratio	=	to obtain overall good design
Iron stacking factor	=	0.9
Slot pitch should not exceed 15 mm		
Space factor	=	0.4
Max. allowable flux density in tooth	=	1.7 Tesla
Flux density in the stator core	=	1.25 Tesla
Current density – Stator winding	=	4 A/Sq.mm
Current density – Rotor bars	=	5 A/Sq.mm
Current density – End ring.	=	6 A/Sq.mm
Length of Air gap	=	$0.2 + 2 (D * L)^{½}$; mm
Copper resistivity	=	0.021 Ohm Mt/Sq.mm
Gap contraction factor	=	1.2
MMF for Iron parts	=	20% of air gap MMF
Friction &Windage loss	=	2% of rated output
Iron Loss	=	150 Watts
Stator winding resistance	=	2.05 Ohms per phase

The answers should include complete dimensions of the stator and rotor stampings, Stator and rotor winding details, end ring dimensions, No load current, No load power factor and Efficiency & Slip at full load

3. Find the main dimensions and number of poles and of a D.C. machine having the following data: 500 KW; 400 Volts; 220 rpm; 90 % efficiency; Average flux density in the gap = 0.7 Tesla; Ampere conductor per metre = 37000; Frequency of flux reversal should lie between 25 to 50 Hz; Current per brush arm should not exceed 100 Amps; Armature MMF per pole should not exceed 5250 Amps. Take ratio of Length of armature to Pole pitch as 0.6.

4. Estimate the KVA rating of a 3 phase, 50 Hz, 2 pole Turbo machine having L = 160 cm; V_a = 140 m/Sec.; ac = 525 per cm; B_{av} = 0.52 Tesla and having uniformly distributed winding.

Concept Map



Syllabus

Introduction: Performance Specifications, Standard specifications, Duty Cycle, Design factors and Limitations, Thermal and mechanical design aspects.

Materials: Properties, selection and applications of Magnetic materials, conducting materials and insulating materials.

Design of Magnetic Circuits: MMF calculation for Air gap and Teeth. Performance Calculation of Iron losses and Magnetizing current.

Design of Transformers: Design of Core and Overall dimensions. Types of Windings.Design of Tank and cooling tubes. Performance calculations of No load current, Losses and Efficiency.

Design of DC machines: Design of Armature Core. Design of Armature windings. Design of Pole and field windings.Design of Yoke.

Design of Three Phase & Single Phase Induction Motors: Design of Stator core & Rotor core. Design of Stator & Rotor windings, Insulation specifications, Performance calculations of No load current, Losses and Efficiency.

Design of Synchronous machines: Design of Stator core & Rotor core. Design of Stator and Rotor windings.

Text Book

A.K.Sawhney. Electrical machine Design, DhanpatRai& Sons, 6th Edition, 2006

Reference Books

1. H.M.Rai, Electrical machine design – SathiyaPrakashan Publication, 5th edition 2008
2. R.K.Agarwal, Electrical machine design, S.Kataria& Sons, 5th edition 2007
3. S.K.Sen, Principles of Electrical machine design, Oxford & IBH pu. Co. Pvt. Ltd. 3rd edition 2005.
4. Balbir Singh, Electrical Machine Design, Vikas Pub. Co. 1982

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures

1.0	**Introduction**	
1.1	Performance Specifications Design Factors, Duty Cycle,	1
1.2	Limitations	1
1.3	Thermal and mechanical design aspects	1
2.0	**Materials**	
2.1	Magnetic materials	1
2.2	Conducting materials	1
2.3	Insulating materials	1
3.0	**Design of Magnetic Circuits**	
3.1	MMF calculation for Air gap	2
3.2	MMF calculation for Teeth	1
3.3	Performance: Iron losses and Magnetizing current	1
4.0	**Design of Transformers**	
4.1	Design of Core and Overall dimensions	2
4.2	Types of Windings	1
4.3	Design of Tank and cooling tubes	2
4.4	Performance: No load current , Losses and Efficiency	1
5.0	**Design of DC machines**	
5.1	Design of Armature core	2
5.2	Design of Armature windings	2
5.3	Design of Poles and filed windings	2
5.4	Design of Yoke	1
5.5	Performance: Voltage Regulation, losses and Efficiency	1
6.0	**Design of Three Phase & Single Phase Induction Motors**	
6.1	Design of Stator core	2
6.2	Design of Rotor core	2
6.3	Design of Stator & Rotor windings	2
7.0.	**Design of Synchronous machines**	
7.1	Design of Stator core	2
7.2	Design of Rotor core	2
7.3	Design of stator & rotor windings	1
7.4	Design of field systems	1
	Total	36

Course Designers:

1. Dr.S.Latha sleee@tce.edu
2. Dr.V.Mahesh maheshv@tce.edu

		Category	L	T	P	Credit
14EEPA0	**MODELLING OF ELECTRICAL MACHINES**	PE	3	0	0	3

Preamble

The use of reference frame theory is to analyse the complete drive system (machine, converter and control). The module is directed towards advanced electromagnetic machine analysis for dynamic modelling. Therefore after completion of this syllabus students have an appreciation of the simplifying assumptions associated with the various reference frames and itsmodeling techniques.

Prerequisite

ACMachines- 14EE440/16EE440, Electric circuit analysis – 14EE270

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome no.	Course Outcomes	Bloom's level	Expected Proficiency	Expected Attainment Level
CO1	Calculate machine inductances for distributed windings by make use of winding functions.	Apply	80%	70%
CO2	Illustrate reference frame theory	Understand	80%	70%
CO3	Develop dynamic electromechanical model of synchronous and induction machine	Apply	80%	70%
CO4	Illustrate the behaviour of machines under transient and steady state conditions	Understand	80%	70%
CO5	Develop control methods using transient model.	Analyze	80%	70%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**M**	**L**	**L**	**S**							
CO2	**M**	**L**										
CO3	**S**	**M**	**L**	**L**	**S**							
CO4	**M**	**L**										
CO5	**S**	**S**	**M**	**M**	**S**							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	30	30

Apply	40	40	40	40
Analyze	0	0	10	10

Course Level Assessment Questions

Course Outcome1 (CO1):

1. In a doubly excited cylindrical rotary system which inductance takes part in the development of torque? Justify it.
2. Derive expressions for the winding inductances for an elementary 2-pole, 2 phase symmetrical induction machine.
3. From the principle of co-energy deduce the expression for developed torque in a singly excited system.

Course Outcome2 (CO2):

1. Show that for a symmetrical 2-phase circuit the average power expressed in as and bs variables is equals to the average power expressed in qs and ds variables.
2. If A is one reference frame and B another, show that $({}^{A}K^{B})^{-1}={}^{B}K^{A}$
3. Devise a transformation that yields only constants when $\boldsymbol{\omega}=\boldsymbol{\omega}_e$ for a balanced three phase set with a phase sequence of acb.

Course Outcome3 (CO3):

1. Derive voltage equations in machine variables for a 2-pole, 2 phase symmetrical induction machine.
2. Derive an expression for the torque between the as and bs windings of the 2-pole, 2-phase induction machine.
3. Derive the steady state voltage equation for the synchronous machine using the stator voltage equations expressed in arbitrary reference frame.

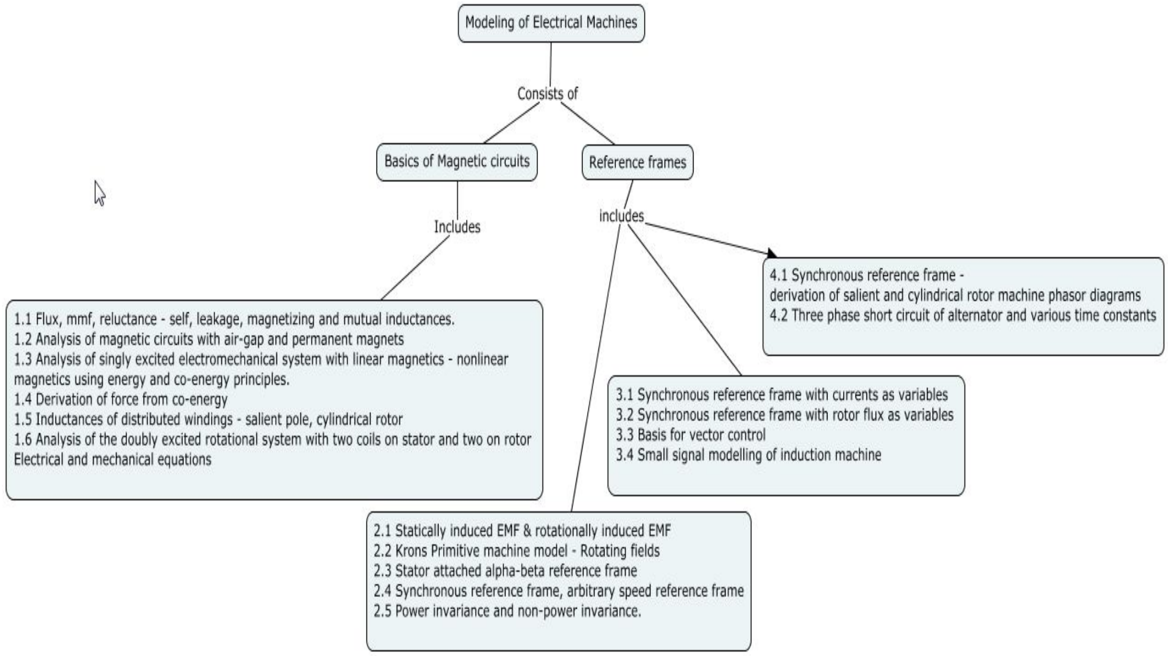
Course Outcome4 (CO4):

1. Calculate the maximum steady state torque (Motor and generator action) for the 500-hp induction machine.
2. Use the steady state torque-speed characteristics and graphically integration to determine the time required for the 3- and 2250 hp machines to slow from synchronous speed to the new operating speed when the base load torque is applied.
3. Determine the critical clearing time and critical clearing angle for the hydro and steam units using only the sin δ terms of the approximate transient torque-angle curve.

Course Outcome5 (CO5):

1. Why is it that the variable frequency requirement is always accompanied by a variable voltage requirement in ac machines?
2. PWM voltages eliminate lower-order harmonics but increase higher order harmonics, how does this fact affect motor losses?
3. Devise a control scheme to maximize the efficiency of motor drive operating with a vector-control strategy.

Concept Map



Syllabus

Introduction to Magnetic Circuits- Analysis of singly excited electromechanical system with linear magnetics - nonlinear magnetic using energy and co-energy principles. Derivation of force from co-energy.

Inductances of distributed windings - salient pole, cylindrical rotor.

Analysis of the doubly excited rotational system with two coils on stator and two on rotor – Electricaland mechanical equations.

Reference frames - Statically induced EMF & rotationally induced EMF - Krons Primitive machinemodel - Rotating fields

Stator attached alpha-beta, synchronous reference frame, arbitrary speed reference frame – powerinvariance and non-power invariance.

Analysis of induction machine - synchronous reference frame - with currents as variables - with rotorflux as variables - basis for vector control - small signal modelling of induction machine.

Analysis of the alternator - synchronous reference frame - derivation of salient and cylindrical rotormachine phasor diagrams - three phase short circuit of alternator and various time constants.

Reference Books

1 Sengupta D.P. & Lynn J.B., .Electrical Machine Dynamics., The Macmillan Press Ltd, 1980

2 Jones C.V., The Unified Theory of Electrical Machines., Butter worthPublications, 1968

3 Woodson & Melcher, Electromechanical Dynamics. Volume I, John Wiley,1968

4 Kraus P.C., Analysis of Electrical Machines., McGraw Hill BookCompany,1987

5 Boldia I. & Nasar S.A., Electrical Machine Dynamics., The Macmillan Publishing company, 1986

6 Mukhopadhyay, Asok Kumar. Matrix Analysis of Electrical Machines. New Age International,2007.

Web sources
Modelling and Analysis of ElectricMachines - Video course - Krishna Vasudevan

Course contents andLecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**Introduction**	
1.1	Introduction to Magnetic Circuits	2
1.2	Analysis of singly excited electromechanical system with linear magnetics - nonlinear magnetics using energy and co-energy principles.	2
1.3	Derivation of force from co-energy	2
1.4	Inductances of distributed windings - salient pole, cylindrical rotor	2
1.5	Analysis of the doubly excited rotational system with two coils on stator and two on rotor - Electrical and mechanical equations	2
2	**Reference frames**	
2.1	Statically induced EMF & rotationally induced EMF	2
2.2	Krons Primitive machine model - Rotating fields	2
2.3	Stator attached alpha-beta reference frame	2
2.4	Synchronous reference frame, arbitrary speed reference frame	4
2.5	Power invariance and non-power invariance.	1
3	**Analysis of induction machine**	
3.1	Synchronous reference frame with currents as variables	3
3.2	Synchronous reference frame with rotor flux as variables	2
3.3	Basis for vector control	3
3.4	Small signal modelling of induction machine	2
4	**Analysis of the alternator**	
4.1	Synchronous reference frame - derivation of salient and cylindrical rotor machine phasor diagrams	6
4.2	Three phase short circuit of alternator and various time constants	3
	Total	**40**

Course Designers:

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2 Mr.P.Vairaprakash vairaprakash@tce.edu

		Category	L	T	P	Credit
14EEPBO/ 15EE620	**POWER SYSTEM ANALYSIS**	PE/PC	3	0	0	3

Preamble

Mathematical modeling and solutions on digital computers constitute an extremely viable approach to system analysis and planning studies for a modern-day power system with its large size, complex and integrated nature. A stage has, therefore, been reached where an under-graduate must be trained in the latest techniques of analysis of large scale power systems. This course has been designed to fulfill this need by integrating the basic principles of power system analysis illustrated through a simplest system structure with analysis techniques. This course provides an exposure of representation of power system, formulation of network matrices, power flow analysis, symmetrical fault analysis, and symmetrical component method of unsymmetrical fault analysis and stability studies.

Prerequisite

- 14EE270: Electric Circuit Analysis
- 14EE440: AC Machines

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Blooms level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Develop a mathematical model of a power system under steady state operating condition by single line diagram and per unit notations.	Apply	90	75
CO2	Apply direct inspection and singular transformation methods to determine Y-bus matrix of the given system.	Apply	90	75
CO3	Describe the concept of load flow problem formulation and the various numerical methods of solution.	Understand	75	85
CO4	Calculate the fault current for various types of faults both symmetrical and unsymmetrical on the given power system.	Apply	90	75
CO5	Explain the role of stability, swing equation and equal area criterion	Understand	80	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	M	L	L								
CO2.	S	M	L	L								
CO3.	M	L										

CO4.	S	M	L	L								
CO5.	M	L										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	10	10
Understand	40	40	40	40
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Per unit value
2. What are the advantages of Per Unit Value System?
3. Draw the reactance diagram for the power system shown in fig. Neglect resistance and use a base of 50MVA and 13.8KV on generator G_1

   G_1: 20MVA, 13.8KV, X''=20% ; G_2: 30MVA, 18.0KV, X''=20%

   G_3: 30MVA, 20.0KV, X''=20% ; T_1: 25MVA, 220/13.8 KV, X =10%

   T_2:3Single phase unit each rated 10MVA, 127/18 KV, X =10%

   T_3: 35MVA, 220/22 KV, X =10%

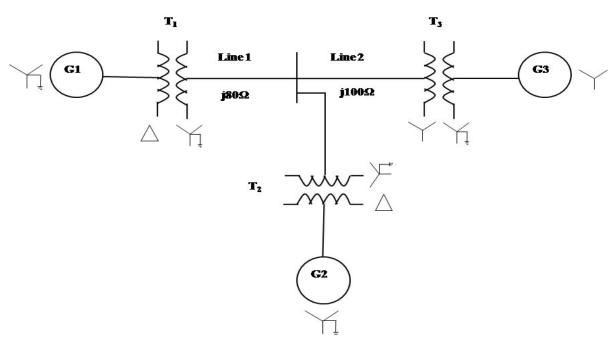


Fig. 1

Course Outcome 2 (CO2):

1. Define bus incidence matrix.
2. Develop the relation between bus admittance matrix, bus incidence matrix and primitive admittance matrix.
3. Form Y_{bus} by inspection method for the 4 bus system with line series impedances in per units as given below:

<u>Line (bus to bus)</u> <u>Impedance</u>

1 - 2	0.15 + j0.6 p.u
1 - 3	0.01 + j0.4 p.u
1 - 4	0.15 +j0.6 p.u
2 - 3	0.05 +j0.2 p.u
3 - 4	0.05 +j0.2 p.u

Course Outcome 3 (CO3):

1. State the load flow problem.
2. What are the three types of buses used to define the power flow problem? Is it possible to solve the power flow problem without such definition?
3. The following is the system data for a load flow solution. Determine the voltages at the end of first iteration using Gauss-Seidel method. Take α=1.6.

The line admittances:

Bus code	***Admittance***
1-2	2-j8.0
1-3	1-j4.0
2-3	0.666-j2.664
2-4	1-j4.0
3-4	2-j8.0

The schedule of active and reactive powers:

Bus code	**P in p.u**	**Q in p.u**	**V in p.u**	**Remarks**
1	-	-	1.06	Slack
2	0.5	0.2	1+j0.0	PQ
3	0.4	0.3	1+j0.0	PQ
4	0.3	0.1	1+j0.0	PQ

Course Outcome 4 (CO4):

1. What are the uses of symmetrical components?
2. A 50 MVA, 11kV, three phase synchronous generator is subjected to different types of faults. The fault currents are as follows:
   LG fault: 4200 A

   LL fault: 2600 A

   LLG fault: 2000A

   The generator neutral is solidly grounded. Find the p.u values of the three sequence reactance of the generator.

3. Compare the impacts of symmetrical and unsymmetrical faults in a power system.
4. A 30MVA, 11KV, 3Φ synchronous generator has a direct subtransient reactance of 0.25 p.u. The negative and zero sequence reactance are 0.35 and 0.1 p.u

respectively. The neutral of the generator is solidly grounded. Determine the sub transient current in the generator and the line to line voltages for subtransient conditions when a single line to ground fault, line to line fault and double line to ground fault occurs at the generator terminals with the generator operating unloaded at rated voltage

5. Two synchronous machines are connected through three-phase transformers to the transmission line as shown in Figure 2. The ratings and reactance of the machines and transformers are:

   Machine 1 and 2: 100MVA, 20 kV; $X_d'' = X_1 = X_2 = 20$ %

   $X_0 = 4\%$, $Xn = 5\%$

   Transformer T_1 and T_2 : 100MVA, 20Δ/345 Y kV; X=8%

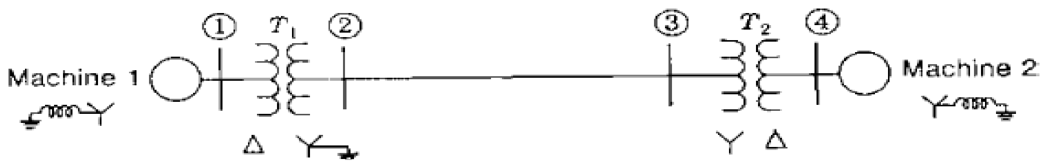


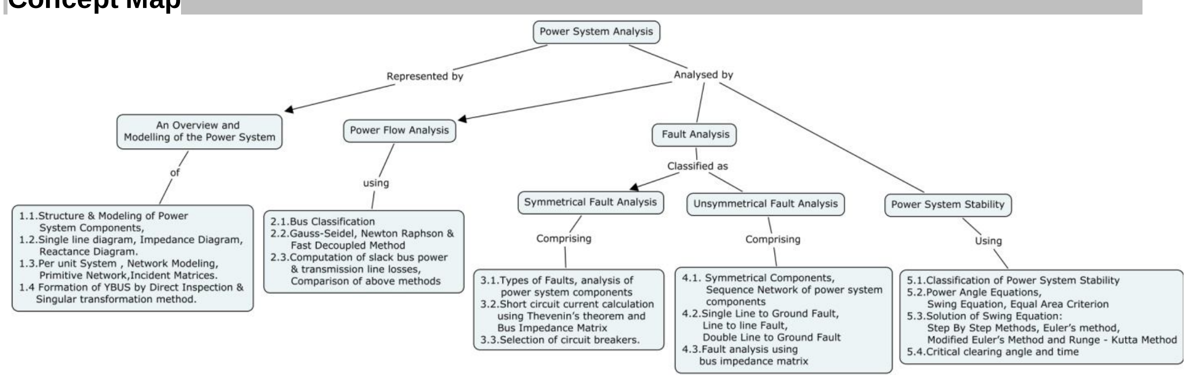
Fig.2

   Find the sub transient current in the machine 1 and 2 for a fault at machine 1.

Course Outcome 5 (CO5):

1. Explain the significant differences between direct axis transient reactance and direct axis sub transient reactance of alternator.
2. Distinguish between steady state and transient state stabilities.
3. A generator is delivering 1p.u power to an infinite bus system through a purely reactive network when the occurrence of a fault reduces the generators output power to zero. The maximum power that could be delivered is 2.5p.u. When the fault is cleared, original network conditions again exist. Determine critical clearing angle. If H=6 MJ/MVA, Calculate critical clearing time.

Concept Map



Syllabus

An Overview and Modelling of the Power System: Introduction - Structure of Electric Power System - Modeling of Power System Components - Single line diagram - Impedance Diagram - Reactance Diagram - Per unit System - Network Modeling - Bus Frame Network - Primitive Network - Incident Matrices - Formation of bus admittance matrix (Y_{BUS}) - Direct Inspection method and Singular transformation methods - Formation of bus impedance matrix (Z_{BUS}) without mutual coupling.

Power Flow Analysis: Introduction – Bus Classification – Load Flow Equations – Load flow methods – Gauss-Seidel Method – Newton-Raphson Method – Fast Decoupled Method – Computation of slack bus power and transmission line losses – Comparison of above methods.

Symmetrical Fault Analysis: Introduction – Types of Faults – Short circuit analysis of power system components: Synchronous Machine and Transmission Line – Short circuit current calculation using Thevenin's theorem and Bus Impedance Matrix – Short circuit capacity – Selection of circuit breakers.

Unsymmetrical Fault Analysis: Introduction – Symmetrical Components – Sequence Impedances – Sequence Network of power system components: Synchronous Machines, Transmission Line, Transformer and Loads – Single Line to Ground Fault – Line to line Fault – Double Line to Ground Fault – Unsymmetrical fault analysis using bus impedance matrix. Indian Standards for Short Circuit analysis IS-13234.

Power System Stability: Introduction – Classification of Power System Stability – Power Angle Equations – Swing Equation – Transient Stability – Assumptions in transient stability analysis – Equal Area Criterion – Solution of Swing Equation: Step By Step Methods, Euler's method, Modified Euler's Method and Runge – Kutta Method – Critical clearing angle and time.

Text Book

1. John J. Grainger and Stevenson Jr. W.D., 'Power System Analysis', McGraw Hill International Edition, Fourth Edition, 1994.
2. Nagarath.I.J, Kothari.D.P, 'Modern Power System Analysis', Tata McGraw Hill Pub. Co. Ltd., Third Edition, 2004.
3. P. Venkatesh, B. V. Manikandan, S. Charles Raja and A. Srinivasan, 'Electrical Power Systems: Analysis, Security and Deregulation', PHI Learning Pvt. Ltd., First Edition, 2012.

Reference Books

1. Hadi Saadat., 'Power System Analysis' Tata McGraw Hill Publishing Company, New Delhi, 2002.
2. E.W.Kimbark, Power system stability, Vol I & III, John Wiley & Sons, 2006
3. Stagg*, G.W. and* El-Abiad*,* A.H., Computer Methods in *Power System* Analysis", McGraw-Hill *Book* Co. 1968
4. K.A. Gangadhar., 'Electric Power Systems (Analysis, Stability and Protection)', Khanna Publishers Second Edition, 1992.
5. J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma,'Power System Analysis and Design' Cengage learning, 5th edition, 2016.
6. www.schneider-electric.com
7. NPTEL courses web: nptel.ac.in/courses/108105067/
8. MOOCs course link:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**An Overview and Modelling of the Power System**	
1.1	Structure of Electric Power System – Modeling of Power System Components.	1
1.2	Single line diagram – Impedance Diagram – Reactance Diagram.	1
1.3	Per unit System – Network Modeling – Bus Frame Network – Primitive Network – Incident Matrices.	2
1.4	Formation of bus admittance matrix (Y_{BUS}) – Direct Inspection method and Singular transformation method.	2
1.5	Formation of bus impedance matrix (Z_{BUS}) without mutual coupling	1
2.	**Power Flow Analysis**	
2.1	Bus Classification, Load Flow Equations	2
2.2	Load flow methods: Gauss-Seidel Method, Newton Raphson Method and Fast Decoupled Method	4
2.3	Computation of slack bus power and transmission line losses, Comparison of above methods	2
3	**Symmetrical Fault Analysis**	
3.1	Types of Faults, Short circuit analysis of power system components: Synchronous Machines and Transmission Line	2
3.2	Short circuit current calculation using Thevenin's theorem and Bus Impedance Matrix	2
3.3	Short circuit capacity, Selection of circuit breakers.	2
4	**Unsymmetrical Fault Analysis**	
4.1	Symmetrical Components, Sequence Impedances, Sequence Network of power system components: Synchronous Machines, Transmission Line, Transformer and Loads	2
4.2	Single Line to Ground Fault, Line to line Fault, Double Line to Ground Fault	3
4.3	Unsymmetrical fault analysis using bus impedance matrix. Indian Standards for Short Circuit analysis IS-13234.	2
5	**Power System Stability**	
5.1	Classification of Power System Stability, Power Angle Equations, Swing Equation.	2
5.2	Transient Stability, Assumptions in transient stability analysis, Equal Area Criterion	2
5.3	Solution of Swing Equation: Step By Step Methods, Euler's method, Modified Euler's Method and Runge - Kutta Method	3
5.4	Critical clearing angle and time	1
	Total	**36**

Course Designers:

1. Dr. P. Venkatesh pveee@tce.edu
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3. Dr. S. Charles Raja charlesrajas@tce.edu

		Category	L	T	P	Credit
14EEPD0	**SMART GRID**	PE	3	0	0	3

Preamble

The course content is designed to study about smart grid technologies, distribution automation, information and communication Technologies, and operation of transmission system operation. It is used to get familiarized with smart metering and demand side integration.

Prerequisite

14EE630 Transmission and Distribution

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Blooms level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1.	Explain the fundamentals of smart power grids and its international & Indian scenarios.	Understand	75	90
CO2.	Calculate voltage and power loss for the given distribution system.	Apply	90	75
CO3.	Explain advanced metering infrastructure and demand side management.	Understand	80	95
CO4.	Describe the operation of transmission system with synchrophasor measurement.	Understand	75	90
CO5.	Explain the data communication and technology used in smart grid.	Understand	80	95
CO6.	Explain the communication standard protocols used in smart grid.	Understand	80	90

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	S	M	L	L								
CO3.	M	L										
CO4.	M	L										
CO5.	M	L										

CO6.	M	L										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	80	60	80	60
Apply	0	20	0	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

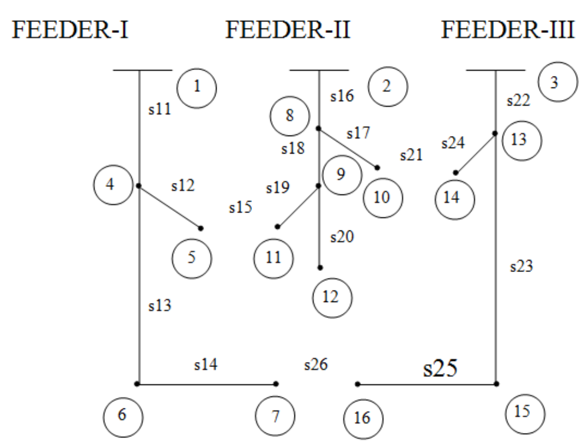
Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the need for smart grid?
2. Explain smart Grid with definitions?
3. Describe the benefits of smart grid with respect to utility and consumer?

Course Outcome 2 (CO2):

1. Explain the components used in substation with a neat sketch?
2. Determine the voltage drop and power loss for the basic configuration of 16 bus distribution network under half load condition?



3. Explain distribution network section and automation involved in it with necessary diagram?

Course Outcome 3 (CO3):

1. Give the comparison of conventional and smart metering with a neat sketch?
2. Explain the functional block diagram of a smart meter with a neat sketch?

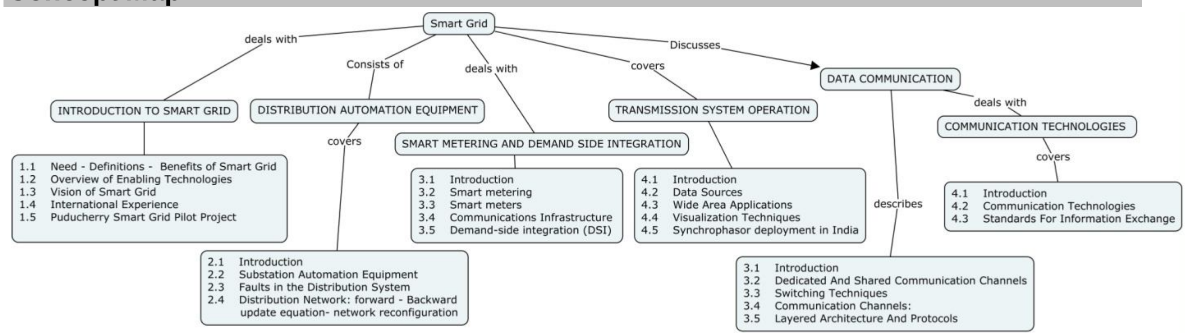
3. What are the services provided by DSI and explain in detail with a neat sketch?

Course Outcome 4 (CO4):
1. What is meant by PMU?
2. Explain phasor measurement unit device and an example of PMU connection?
3. Explain a typical EMS system configuration with a neat sketch?

Course Outcome 5 (CO5):
1. Explain data transmission devices for Ethernets and transmission path with a neat sketch in detail.
2. Explain various data communication technology used in smart grid.
3. Explain in detail about ISO/OSI model.

Course Outcome 6 (CO6):
1. Write short notes on modbus.
2. Explain IEEE 802 series standard, different technologies specified under this standard and architecture in detail.
3. Draw a basic ANSI C 12.22 smart metering architecture and explain in detail.

Concept Map



Syllabus

INTRODUCTION TO SMART GRID

Need for smart grid - Smart Grid definitions - Benefits of smart grid - Overview of enabling technologies in smart grid - vision of smart grid - International experience - smart grid demonstration and deployment efforts - Puducherry smart grid pilot project

DISTRIBUTION AUTOMATION EQUIPMENT

Introduction – Substation automation equipment: Current Transformers - Voltage Transformers - Intelligent Electronic Devices - Faults in the distribution system: Components for fault isolation and restoration – Fault location, isolation and restoration - Distribution network: forward update equation-Backward update equation- Determination of voltage, power loss, network reconfiguration for 16 bus standard distribution system

SMART METERING AND DEMAND SIDE INTEGRATION

Introduction –Smart metering: Evolution - Key components – Smart meters: over view of the hardware used - Communications infrastructure and protocols for smart metering- Demand-side integration (DSI): services - Implementations - Hardware support – Flexibility.

TRANSMISSION SYSTEM OPERATION

Introduction – Data sources: IEDs and SCADA- Phasor measurement units - Wide area applications: On-line transient stability controller-Pole-slipping preventive controller - Visualization techniques: Visual 2-D presentation-Visual 3-D presentation - Synchrophasor deployment in India

DATA COMMUNICATION

Introduction-Dedicated and shared communication channels - switching techniques: circuit switching - Message Switching- Packet switching - Communication channels - wired communication - Optical fibre- Radio communication – Cellular mobile communication - Satellite communication - Layered architecture and protocols: The ISO/OSI model-TCP/IP

COMMUNICATION TECHNOLOGIES FOR THE SMART GRID

Introduction- Communication technologies: IEEE 802 series – Mobile communications- Multi protocol label switching - Standards for information exchange: Standards for smart metering -Modbus-DNP3-IEC 61850

Text Book

1. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, Wiley & Sons Ltd., February 2012.

Reference Books

1. “Smart Grid primer”, Published by Power grid Corporation of India limited, September 2013
2. Stuart Borlase, “Smart Grid: Infrastructure, Technology and Solutions”, CRC Press 2012.
3. James Momoh, “Smart Grid Fundamentals of Design and Analysis”, IEEE Press, 2012.
4. Tony Flick, Justin morehouse, “Securing the smart grid: Next generation power grid security”, Elsevier, 2010.
5. MOOCs course link: https://www.edx.org/course/smart-grids-electricity-future-ieeex-smartgrid-x-0

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**INTRODUCTION TO SMART GRID**	
1.1	Need For Smart Grid - Smart Grid Definitions - Benefits of Smart Grid	1
1.2	Overview of Enabling Technologies In Smart Grid	1
1.3	Vision of Smart Grid	1
1.4	International Experience: Smart Grid Demonstration And Deployment Efforts - Tailoring Smart Grids to Developing Countries and Emerging Economies	1
1.5	Puducherry Smart Grid Pilot Project	1
2.0	**DISTRIBUTION AUTOMATION EQUIPMENT**	
2.1	Introduction	1
2.2	Substation Automation Equipment: Current Transformers-Voltage Transformers- Intelligent Electronic Devices	2
2.3	Faults in the Distribution System: Components for fault isolation and restoration – Fault location, isolation and restoration	2
2.4	Distribution Network: forward update equation-Backward update equation- Determination of voltage, power loss, network reconfiguration	2

	for 16 bus standard distribution system	
3.0	**SMART METERING AND DEMAND SIDE INTEGRATION**	
3.1	Introduction	1
3.2	Smart metering: Evolution - Key components	1
3.3	Smart meters: over view of the hardware used	2
3.4	Communications Infrastructure And Protocols For Smart Metering	1
3.5	Demand-side integration (DSI): services - Implementations - Hardware support – Flexibility	2
4.0	**TRANSMISSION SYSTEM OPERATION**	
4.1	Introduction	1
4.2	Data Sources: IEDs and SCADA- Phasor measurement units	1
4.3	Wide Area Applications: On-line transient stability controller-Pole-slipping preventive controller	1
4.4	Visualization Techniques: Visual 2-D presentation-Visual 3-D presentation	1
4.5	Synchrophasor deployment in India	1
5.0	**DATA COMMUNICATION**	
5.1	Introduction	1
5.2	Dedicated And Shared Communication Channels	1
5.3	Switching Techniques: circuit switching-Message Switching- Packet switching	1
5.4	Communication Channels: wired communication- Optical fibre- Radio communication – Cellular mobile communication- Satellite communication	1
5.5	Layered Architecture And Protocols: The ISO/OSI model-TCP/IP	1
6.0	**COMMUNICATION TECHNOLOGIES FOR THE SMART GRID**	
6.1	Introduction	1
6.2	Communication Technologies: IEEE 802 series – Mobile communications- Multi protocol label switching	2
6.3	Standards For Information Exchange: Standards for smart metering - Modbus-DNP3-IEC 61850	1
	Total	**36**

Course Designers:

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14EEPE0	POWER SYSTEM OPERATION AND CONTROL	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The primary aim of a power system is to provide adequate uninterrupted supply of power of certain quality to meet all the demands of customers. The quality of the supply depends on the constancy of frequency and voltage and continuity of supply. This means that the generation must be adjusted, in real time, to match prevailing demand. The second objective, to be achieved as long as it is consistent with continuity of service and dependable operation, is to generate the required total output at minimum overall cost.

Prerequisite

14EE270 – Electric Circuit Analysis

14EE440/16EE440 – AC Machines

14EE430 – Control Systems

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level	Expected Proficiency	Expected Attainment Level
CO1	State the concept of AGC and analysis of multi area system	**Apply**	70 %	70 %
CO2	Describe the various voltage control methods	Understand	80 %	80 %
CO3	Find the optimum unit commitment for a power system	**Apply**	60 %	60 %
CO4	Calculate the economic load dispatch for a system comprising of ‘n’ thermal plants	Apply	70 %	70 %
CO5	Illustrate various operating states of a power system and control actions required to obtain secured operation	**Understand**	75 %	75 %

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**S**	**M**	**L**	**L**								
CO2	**M**	**L**										
CO3	**S**	**M**	**L**	**L**								
CO4	**S**	**M**	**L**	**L**								

CO5	**M**	**L**										

S- Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is meant by primary ALFC loop?
2. Draw the dynamic response of change in frequency for a step load change.
3. What are the components of speed governor system of an alternator? Derive the mathematical model of speed governor system with aid of block diagram.
4. Two generators rated 2000 MW and 4000 MW are operating in parallel. The drop characteristics of their governors are 4% and 5% respectively from no load to full load. Assuming the the generators are operating at 50Hz at no load, how would a load of 600MW be shared between them? What will be the system frequency at this load? Assume free governor operation. Also find the load sharing if both governors have a droop of 4%.

Course Outcome 2 (CO2):

1. What are the merits of synchronous compensator?
2. What are the various methods of voltage control in transmission system?
3. State the difference between P-F and Q-V control.
4. What are the methods to improve the voltage profile in the power system?
5. What are the different types of reactive power compensation?
6. Discuss generation and absorption of reactive power..
7. A 414 KV line is fed through 132/415 KV transformer from a constant 132 KV supply. At the load end of the line, the voltage is reduced by another transformer of 415/132 KV. The total impedance of line is (20+j40) ohms. Both transformers are equipped with tap-changing. The product of the two off-nominal setting is unity. The load on the system is 250 MW at 0.8 p.f. lagging. Calculate the settings of the tap changer required to maintain the voltage at 132KV.

Course Outcome 3 (CO3):

1. Write a few constraints in unit commitment problem.
2. Define spinning reserve constraint in unit commitment problem.
3. Explain various constraints in UC and indicate the steps involved in solving UC by DP method.

Course Outcome 4 (CO4):

1. What is meant by incremental cost curve?
2. Write the equality and inequality constraints considered in the economic dispatch problem.

3. The fuel inputs per hour of plants 1 and 2 are given as

   F1 = 0.2 p12 + 40 P1 + 120 Rs/hr.

   F2 = 0.2 p22 + 40 P2 + 150 Rs/hr.

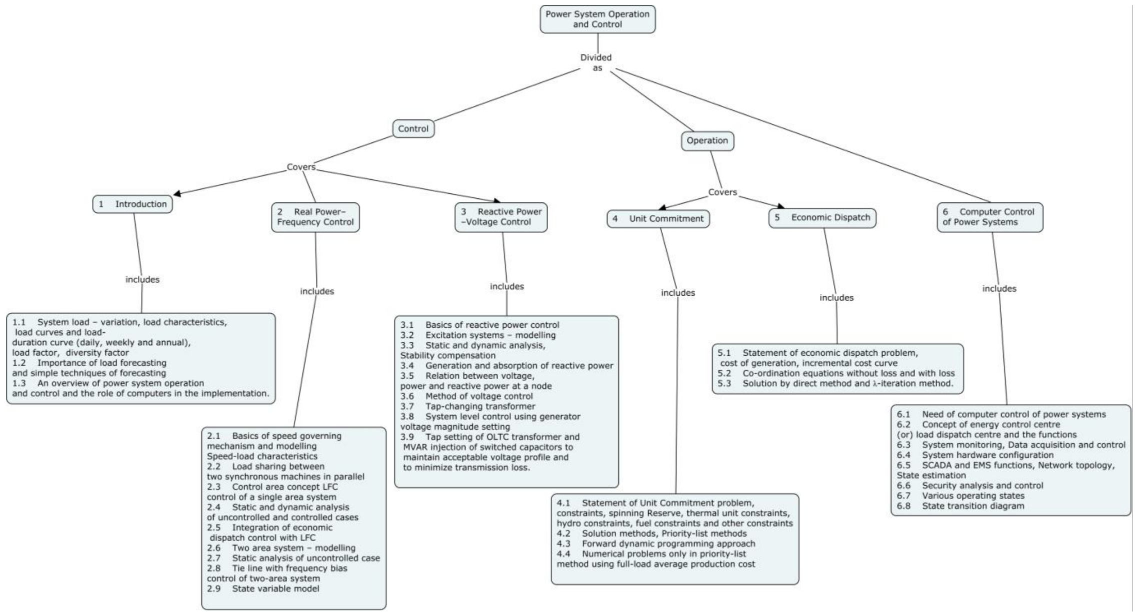
   Determine the economic operating schedule and the corresponding cost of generation if the maximum and minimum loading on each unit is 100 MW and 25 MW. Assume the transmission losses are ignored and the total demand is 180 MW. Also determine the saving obtained if the load is equally shared by both the units.

4. Formulate the co-ordination equations with losses neglected and also explain the algorithmic steps of iterative method to find the solution of co-ordination equations.

Course Outcomes 5 (C05):

1. Define the EMS system.
2. What are the function of load dispatch center?
3. What is “SCADA” ?
4. Write any two functions of load dispatch center.
5. Define ‘network topology’ in a power system.
6. Discuss the functions of ‘SCADA’ in power system operation.
7. Explain the various operating states of power system. Also discuss the state transitions and control strategies.

Concept Map



Syllabus

Introduction: System load – variation - load characteristics - load curves and load-duration curve (daily, weekly and annual) - load factor - diversity factor - Importance of load forecasting and simple techniques of forecasting - An overview of power system operation and control and the role of computers in the implementation. (Qualitative treatment with block diagram).

Real Power – Frequency Control: Basics of speed governing mechanism and modelling - speed-load characteristics – load sharing between two synchronous machines in parallel - Control area concept LFC control of a single area system - Static and dynamic analysis of uncontrolled and controlled cases - Integration of economic dispatch control with LFC - Two-area system – modelling - static analysis of uncontrolled case - tie line with frequency bias control of two-area system - state variable model.

Reactive Power – Voltage Control: Basics of reactive power control - Excitation systems – modelling - Static and dynamic analysis - stability compensation - generation and absorption of reactive power - Relation between voltage, power and reactive power at a node - method of voltage control - tap-changing transformer - System level control using generator voltage magnitude setting - tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.

Unit Commitment: Statement of Unit Commitment problem – constraints – spinning Reserve - thermal unit constraints - hydro constraints, fuel constraints and other constraints - Solution methods - Priority-list methods - forward dynamic programming approach - Numerical problems only in priority-list method using full-load average production cost.

Economic Dispatch: Statement of economic dispatch problem – cost of generation – incremental cost curve co-ordination equations without loss and with loss - solution by direct method and λ-iteration method. (No derivation of loss coefficients).

Computer Control of Power Systems: Need of computer control of power systems - Concept of energy control centre (or) load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADA and EMS functions - Network topology - state estimation - security analysis and control - Various operating states (Normal, alert, emergency, in-extremis and restorative) - State transition diagram showing various state transitions and control strategies.

Text Books

1. Allen. J. Wood and Bruce F. Wollenberg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2003.
2. V.Ramanathan, P.S.Manoharan, 'Power System Operation and Control' Third Edition, 2015, Charulatha Publications, Chennai.
3. Chakrabarti & Halder, "Power System Analysis: Operation and Control", Prentice Hall of India, 2004 Edition.

Reference Books

1. P.Kundur, 'Power System Stability and Control' MC Craw Hill Publisher, USA, 1994.
2. Olle.I.Elgerd, 'Electric Energy Systems theory an introduction' Tata McGraw Hill Publishing Company Ltd. New Delhi, Second Edition 2003.
3. Leon K. Kirchmayer, 'Economic operation of power systems' Wiley, 2008.
4. D.P. Kothari and I.J. Nagrath, 'Modern Power System Analysis', Third Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.

Course Contents and Lecture Schedule

Module No	Topic	No. of Lecture Hours
1	**Introduction**	
1.1	System load – variation, load characteristics, load curves and load-duration curve (daily, weekly and annual), load factor, diversity factor	1
1.2	Importance of load forecasting and simple techniques of forecasting	1
1.3	An overview of power system operation and control and the role of computers in the implementation.	1
2	**Real Power–Frequency Control**	
2.1	Basics of speed governing mechanism and modelling Speed-load characteristics	1
2.2	Load sharing between two synchronous machines in parallel	1
2.3	Control area concept LFC control of a single area system	1
2.4	Static and dynamic analysis of uncontrolled and controlled cases	1
2.5	Integration of economic dispatch control with LFC	1
2.6	Two area system – modelling	
2.7	Static analysis of uncontrolled case	1
2.8	Tie line with frequency bias control of two-area system	1
2.9	State variable model	1
3	**Reactive Power–Voltage Control**	
3.1	Basics of reactive power control	1
3.2	Excitation systems – modelling	1
3.3	Static and dynamic analysis, Stability compensation	1
3.4	Generation and absorption of reactive power	1
3.5	Relation between voltage, power and reactive power at a node	1
3.6	Method of voltage control	1

3.7	Tap-changing transformer	1
3.8	System level control using generator voltage magnitude setting	1
3.9	Tap setting of OLTC transformer and MVAR injection of switched capacitors to maintain acceptable voltage profile and to minimize transmission loss.	1
4	**Unit Commitment**	
4.1	Statement of Unit Commitment problem, constraints, spinning Reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints	1
4.2	Solution methods, Priority-list methods	1
4.3	Forward dynamic programming approach	1
4.4	Numerical problems only in priority-list method using full-load average production cost	1
5	**Economic Dispatch**	
5.1	Statement of economic dispatch problem, cost of generation, incremental cost curve	1
5.2	Co-ordination equations without loss and with loss	1
5.3	Solution by direct method and λ-iteration method. (No derivation of loss coefficients).	1
6	**Computer Control of Power Systems**	
6.1	Need of computer control of power systems	1
6.2	Concept of energy control centre (or) load dispatch centre and the functions	1
6.3	System monitoring, Data acquisition and control	1
6.4	System hardware configuration	1
6.5	SCADA and EMS functions, Network topology, State estimation	1
6.6	Security analysis and control	1
6.7	Various operating states (Normal, alert, emergency, in-extremis and restorative)	1
6.8	State transition diagram showing various state transitions and control strategies	1
	TOTAL	36

Course Designers:

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2. Dr.P.S.Manoharan psmeee@tce.edu

		Category	L	T	P	Credit
14EEPF0	**POWER SYSTEM STABILITY**	PE	3	0	0	3

Preamble

The largest man made system in the world is the power system. It is challenging to maintain and operate the power system against failure. This course is aimed for understanding the basic modelling requirement of various power system components and operation, different types of stability problems and analytical methods for assessment.

Prerequisite

- 14EE270 Electric circuit analysis
- 14EE330 DC Machines
- 14EE440 AC Machines

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome No.	Course Outcomes	Bloom's Level	Expected Proficiency %	Expected Attainment Level %
CO1	Explain the modelling of power system components in stability studies	Understand	80	70
CO2	Describe the concept of transient, steady state and dynamic stability	Understand	70	70
CO3	Assess the stability of the power system by Point by point, Modified Euler's and Runke-Kutta methods	Apply	60	60
CO4	Find the critical clearing angle and time from equal area criterion	Apply	70	70
CO5	Explain the modelling of excitation system	Understand	60	60
CO6	Describe small signal stability of SMIB and multi machine system.	Understand	60	60
CO7	Explain voltage collapse and voltage stability assessment methods	Understand	60	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	M	L										

CO3.	S	M	L	L									
CO4.	S	M	L	L									
CO5.	M	L											
CO6.	M	L											
CO7.	M	L											

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	30	30
Apply	50	50	50	50
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Name various types of load models used in power system
2. How medium transmission lines are represented?
3. Define steady state stability limit.
4. How power system stability is classified?
5. What are the deleterious effects of instability?
6. Explain the incorporation of stability to system design and operation.
7. Derive the power angle equation of a two machine system.
8. Discuss in detail how the following power system components are modeled in power system stability studies. (i) Induction machine (ii) Synchronous machine (iii) Loads

Course Outcome 2 (CO2):

1. How the transient stability of the power system can be improved? Discuss the traditional and new approaches to the problem.
2. Distinguish between transient, steady state and dynamic stability of a power system.
3. A two-pole, 50 Hz, 11 kV turbo alternator has a rating o f 100 MW, power factor 0.85 lagging. The rotor has a moment of inertia of a 10,000kg-m^2. Calculate H and M.
4. A 50 Hz, four pole turbo generator rated 100 MVA, 11 kV has an inertia constant of 8MJ/MVA. (a) Find the stored energy in the rotor at synchronous speed. (b) If the mechanical input is suddenly raised to 80 MW for an electrical load of 50 MW, find rotor acceleration, neglecting mechanical and electrical losses. (c) If the acceleration calculated in part (b) is maintained for 10 cycles, find the change in torque angle and rotor speed in revolutions per minute at the end of this period.

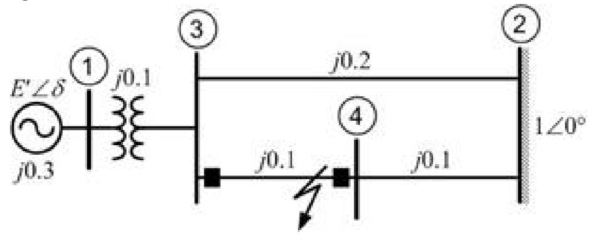
Course Outcome 3 (CO3):

1. Discuss the procedure of solving swing equation using point by point method.
2. Why swing equation is non linear?
3. Write the swing equation.
4. What is inertia constant H?
5. Establish the relation between M and H.
6. List the assumptions made in solving swing equation.

7. Derive the swing equation from basic principle.
8. Develop an algorithm and the flowchart for the solution of swing equation by modified Euler's method.
9. A 50 Hz, 500 MVA, 400 kV generator (with transformer) is connected to a 400 kV infinite bus bar through an interconnector. The generator has H = 2.5 MJ/MVA, voltage behind transient reactance of 450 kV and is loaded 460 MW. The transfer reactances between generator and bus bar under various conditions are: prefault, during and post fault are 0.5 p.u., 1.0 p.u. and 0.75 p.u. respectively. Calculate the swing curve using intervals of 0.05 sec and assuming that the fault is cleared at 0.15 sec.

Course Outcome 4 (CO4):

1. Mention the assumptions made in the equal area criterion.
2. Define: Infinite bus.
3. Explain the concept of equal area criterion.
4. Derive an expression for the critical clearing angle and clearing time using equal area criterion.
5. Consider the system in which a generator is connected to an infinite bus through a double circuit transmission line as shown in Fig. 9.5. The per unit system reactances that are converted in a common base, are also shown in this figure. Let us assume that the infinite bus voltage is 1< 0° . The generator is delivering 1.0 per unit real power at a lagging power factor of 0.9839 to the infinite bus. While the generator is operating in steady state, a three-phase bolted short circuit occurs in the transmission line connecting buses 2 and 4 - very near to bus 4. The fault is cleared by opening the circuit breakers at the two ends of this line. Find the critical clearing time for various values of *H.*



6. Figure shows transmission network. The p.u. reactances of the equipments are as shown. The voltage behind transient reactance of generator is 1.1 pu. The infinite bus voltage is 1+j0 p.u. The system is transmitting 1 p.u. power when fault occurs at the middle of the line. Determine (i) transfer reactance for pre fault, during and post fault condition and (ii) critical clearing angle.

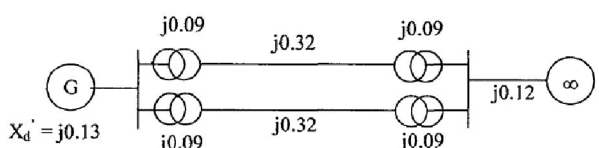


Fig 15a

7. A power deficient area receives 50 MW over a tie line from another area. The maximum steady state capacity of the tie line is 100 MW. Find the allowable sudden load that can be switched on without loss of stability.

Course Outcome 5 (CO5):

1. Define exciter response.
2. List the factors affect exciters response.
3. What is meant by nominal exciter response?
4. With the help of block diagram, explain the working of any two excitation system.
5. What are the elements of good excitation system? Explain.
6. State the functions of line drop compensator.
7. Describe the large signal performance measure of excitation system.

8. Draw the block diagram of excitation control system and drive the transfer function of each block.

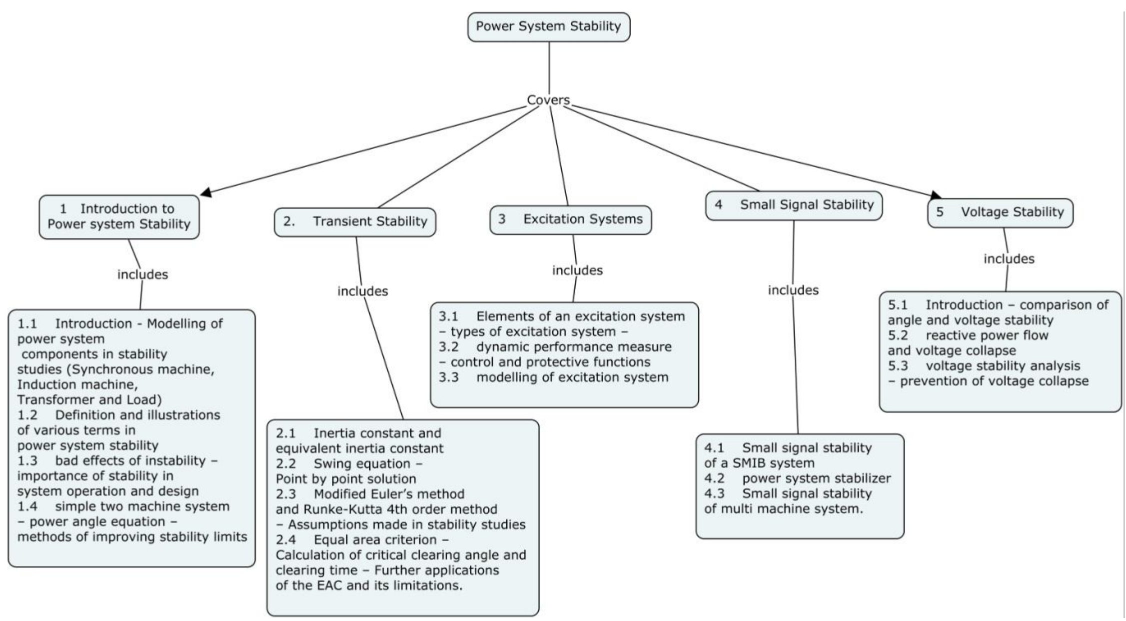
Course Outcome 6 (CO6):

1. Explain the small signal stability analysis of SMIB system.
2. Draw a neat diagram of a power system stabilizer and explain its working.
3. Name the input signal given to the power system stabilizer.

Course Outcome 7 (CO7):

1. Define: Voltage stability.
2. Compare: Angle and voltage stability.
3. Draw a sample PV curve.
4. What is voltage collapse?
5. List the factors leading to voltage collapse
6. Explain the voltage collapse phenomenon.
7. Explain the importance of reactive power in maintaining voltage stability.
8. List the methods used for voltage stability analysis.

Concept Map



Syllabus

Introduction to Power system Stability

Modelling of power system components in stability studies (Synchronous machine, Induction machine, Transformer and Load) – definition and illustrations of various terms in power system stability – bad effects of instability – importance of stability in system operation and design – simple two machine system – power angle equation – methods of improving stability limits

Transient Stability

Inertia constant and equivalent inertia constant – Swing equation – Point by point solution, numerical methods (Modified Euler's method and Runke-Kutta 4th order method) – Assumptions made in stability studies- Equal area criterion to test the transient stability of power systems – Calculation of critical clearing angle and clearing time – Further applications of the equal area criterion and its limitations.

Excitation Systems

Elements of an excitation system – types of excitation system – dynamic performance measure – control and protective functions – modelling of excitation system

Small Signal Stability

Small signal stability of a SMIB system – power system stabilizer – small signal stability of multi machine system.

Voltage Stability

Introduction – comparison of angle and voltage stability – reactive power flow and voltage collapse – voltage stability analysis – prevention of voltage collapse

Text Book

1. E.W.Kimbark, Power System Stability, Vol.1, John Wiley, 1995.
2. Prabha Kundur, Power System Stability and Control, Tata McGraw Hill, 2006.
3. B.R.Gupta, Power System Analysis and Design, S.Chand Ltd., 2008
4. D.P.Kothari and I.J.Nagrath, Modern Power System Analysis, 4th Edition, Tata McGraw Hill, 2011

Reference Books

1. P.M.Anderson and A.A.Fouad, Power System Control and Stability, 2nd Edition, Wiley India Pvt.Ltd., 2008
2. P.W.Sauer and M.A.Pai, Power System Dynamics and Stability, Pearson Education, 2007

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**Introduction to Power system Stability**	
1.1	Introduction - Modelling of power system components in stability studies (Synchronous machine, Induction machine, Transformer and Load)	3
1.2	Definition and illustrations of various terms in power system stability	2
1.3	bad effects of instability – importance of stability in system operation and design	2
1.4	simple two machine system – power angle equation – methods of improving stability limits	2
2.	**Transient Stability**	
2.1	Inertia constant and equivalent inertia constant	2
2.2	Swing equation – Point by point solution	2
2.3	Modified Euler's method and Runke-Kutta 4th order method – Assumptions made in stability studies	3

2.4	Equal area criterion – Calculation of critical clearing angle and clearing time – Further applications of the EAC and its limitations.	3
3	**Excitation Systems**	
3.1	Elements of an excitation system – types of excitation system –	2
3.2	dynamic performance measure – control and protective functions	2
3.3	modelling of excitation system	2
4	**Small Signal Stability**	
4.1	Small signal stability of a SMIB system	2
4.2	power system stabilizer	2
4.3	Small signal stability of multi machine system.	2
5	**Voltage Stability**	
5.1	Introduction – comparison of angle and voltage stability	2
5.2	reactive power flow and voltage collapse	2
5.3	voltage stability analysis – prevention of voltage collapse	1
	Total	**36**

Course Designers:

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		Category	L	T	P	Credit
14EEPGO	**SWITCHGEAR AND PROTECTION**	PE	3	0	0	3

Preamble

The importance of electric supply has constructed such circumstances that we must secure the Power system from large faults and provide protection to the machineries and devices used and to ensure maximum continuity of the power supply. For this purpose, machines such as generators and motors are needed to be switched on and off many times. Means provided to achieve this are called ‘Switch Gear’. Power system switchgear and protection is a subject which touches our lives every day, in a very non-intrusive manner. Reliable protection of electric energy systems against faults like short circuits is in fact, the cornerstone of power system reliability.Based on this, the course aims at giving an adequate exposure in Switchgear equipment and protection schemes for various apparatus.

Prerequisite

14EEPBO/ 15EE620 :Power System Analysis

Course Outcomes

On the successful completion of the course, students will be able to

S.No.	Description	Bloom’s Level	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Explain the layout of a typical substation and discuss its components	understand	70%	70%
CO2	Select Fuses and Circuit breakers for a given situation	apply	60%	60%
CO3	Discuss the principles of different types of protective relays	understand	70%	70%
CO4	Select different types of protective schemes for generator, transformer, bus bars and feeders	apply	60%	60%
CO5	Explain the various protection methods against over voltage in Power Systems	understand	70%	70%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**M**	**L**										
CO2.	**S**	**M**	**L**	**L**								
CO3	**M**	**L**										
CO4	**S**	**M**	**L**	**L**								

CO5.	**M**	**L**										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyze	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Compare indoor and outdoor substations.
2. Draw a layout of a typical outdoor type 230KV substation and explain its major components.
3. Discuss the significance of instrument transformers in protective schemes.

Course Outcome 2(CO2):

1. Outline high resistance interruption in Circuit Breakers.
2. Distinguish the operation between the over-current relay and a fuse.
3. Demonstrate how breaking capacity and making capacity of a circuit breaker are tested in a laboratory type testing system.
4. Calculate the natural frequency of transient overvoltage when circuit breaker is opened on fault. Assume L=0.5 Henry and C=5000pF.Also determine the natural frequency if a deliberate resistance of 10 kilol-ohms is added across the circuit breaker contacts?
5. Select the type of circuit breaker to be used for each of the following applications:
   i) Circuit breaker for the high voltage arc furnace
   ii) 415 volts circuit breaker for industrial application(load current=1000 A)

Course Outcome 3(CO3):

1. Define 'pick-up' and 'reset level' of relay.
2. Discuss the essential qualities of a protective relay
3. Explain the construction and operation of a static overcurrent relay with a neat block diagram.
4. Show how an overcurrent relay can be realized with microprocessor.
5. Discuss the role of negative sequence relay.

Course Outcome 4(CO4):

1. Explain the concept of carrier-aided distance protection schemes.
2. Explain why distance protection schemes are preferred than over current protection for the transmission lines.

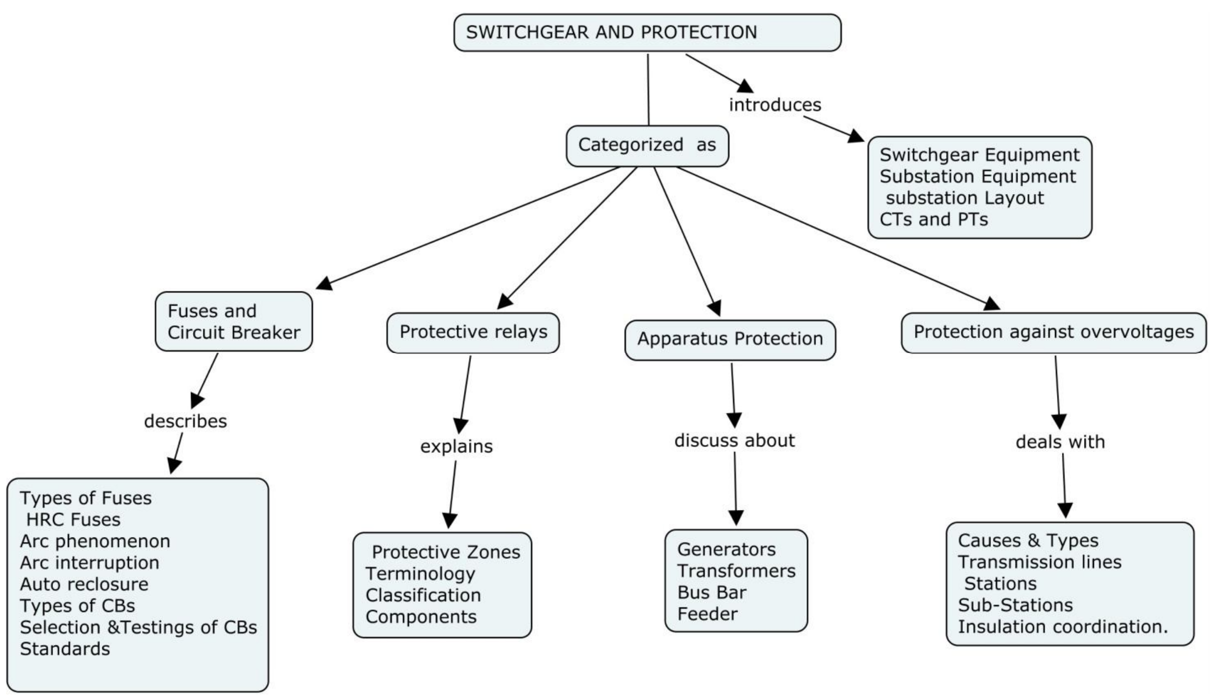
3. Explain why the first ground fault on the rotor of Alternator does not cause any damage while a second fault can be catastrophic.

4. List the various types of faults and protection schemes against them in synchronous generators.

5. Explain why conventional differential protection cannot detect interturn faults on the same phase.
6. A 11kV, 100 MVA generator is grounded through a resistance of 6Ω. The C.T.s have a ratio of 1000/5. The relay is set to operate when there is an out of balance current of 1A. Calculate the percentage of the generator winding that will be protected by the percentage differential scheme of protection.

Course Outcome 5(CO5):
1. List the causes of over voltages arising in Power System
2. Interpret how the magnitude of overvoltages due to direct and indirect lightning strokes on overhead lines be calculated.
3. A 132kV, 3-phase, 50Hz transmission line 200km long contains three conductors of effective diameter 2.2 cm, arranged in a vertical plane with 4.5 m spacing and regularly transposed. Find the inductance and kVA rating of the Peterson coil in the system.
4. Define insulation co-ordination.
5. Interpret the term “Insulation coordination” and show how to fix B.I.L.in a power system with a suitable example.

Concept Map



Syllabus

Introduction

Switchgear - essential features - Substations – Types – Equipment - Layout of a typical substation- Current and voltage transformers for protection.

Fuses and Circuit Breaker

Fuses -Types - HRC Fuses – Characteristics and applications.
Circuit Breakers **-** Arc phenomenon - restriking and recovery voltage – resistance switching- auto re-closure. Types – air, oil, SF6 and vacuum circuit breakers – ELCB - Selection - testing of circuit breakers according to IS/IEC codes[60947 Standards for Low voltage Switchgear and Control Gears- Part II].

Protective relays

Need for protective systems– Protection Zones– Essential qualities of protection – Basic relay terminology - classification of protective relays based on technology and their operating principles - components of a protection system- classification of protective schemes.

Apparatus Protection

Generator - stator and rotor protection - Transformer –protection against internal faults - Bus bar protection - differential current protection -Feeder protection – Over-current, distance, pilot wire and carrier current protection.

Protection against over-voltages

Causes of over voltages – Protection of Transmission lines, Stations and Sub-Stations against direct lightning stroke - Protection against travelling waves - Peterson coil - insulation coordination.

Text Books

1. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switch Gear”, Tata McGraw Hill 2nd edition - 2007.
2. Sunil S. Rao, “Protection and Switch Gear”, Khanna Publishers 4th edition, New Delhi, 1992.

Reference Books

1. B. Ravindranath and N.Chander, “Power System Protection and Switch Gear”, New Age International Ltd., New Delhi, Reprint 2005.
2. Uppal, “Electrical Power” Khanna Publisher, 8th edition, 1981.
3. Y.G Paithankar and S.R Bhide, “Fundamentals of power system protection”, Prentice-Hall of india, 2003.
4. Oza, Nair, Mehta and Makwana, — “Power System Protection and Switchgear”, Tata McGraw- Hill.
5. T.S. Madhava Rao “Digital/Numerical Relays”, Tata McGraw Hill 1st edition - 2005.
6. ABB Electrical installation handbook volume 2 – Electrical devices 3rd edition, June 2005 published by ABB SACE via Baioni, 35-24123, Bergamo (Italy)

Course Contents and Lecture Schedule

Sl.No.	Topic	No. of Lectures
1.0	**Introduction**	
1.1	Introduction to Switchgear - essential features	1
1.2	Substations –Types of substations - Equipment- Layout of a typical substation	3
1.3	Importance of Current and Potential Transformers in protection schemes	1
2.0	**Fuses and Circuit Breaker**	
2.1	Fuses-Types of Fuses - HRC Fuses – Characteristics and applications	2
2.2	Arc phenomenon and principles of arc interruption - restriking voltage and recovery voltage – resistance switching– auto re-closure	3
2.3	Types of Circuit breakers – air blast, air break, oil, SF6 and vacuum circuit breakers – ELCB (Earth Leakage circuit breaker)	3
2.4	Selection and testing of circuit breakers IEC 60947 Standards for Low voltage Switchgear and Control Gears (Part II circuit breakers).	1
3.0	**Protective relays**	
3.1	Need for protective systems– Protection Zones– Essential qualities of protection – Basic relay terminology	2
3.2	classification of protective relays based on technology and their operating principles	3
3.3	Components of a protection system- classification of protective schemes.	2
4.0	**Apparatus Protection**	
4.1	Generator - stator and rotor protection Transformer – protection against internal faults	4
4.2	Bus bar protection - differential current protection -Feeder protection – Over-Current, distance, pilot wire and carrier current protection.	5
5.0	**Protection against over-voltages**	
5.1	Causes of over voltages	2
5.2	Protection of Transmission lines, Stations and Sub-Stations against direct lightning stroke	2
5.3	Protection against travelling waves-Peterson coil	2
5.4	Insulation coordination.	1
	Total	**35**

Course Designers

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M.Geethanjali mgeee@tce.edu

		Category	L	T	P	Credit
14EEPJ0	**FPGA BASED SYSTEM DESIGN**	PE	2	0	2	3

Preamble

A decade back SSI, and MSI circuits were used largely to build digital systems. With advent of VLSI devices most of the designs moved to ASIC domain. Also, at the same time Filed Programmable devices started to evolve. As time progressed these devices has taken up the space of SSI and MSI devices and started to even replace ASICs at lowest end. Presently Field programmable devices are able to match the functional complexity of ASIC Devices.

This course is appropriate for all introductory-to-intermediate level courses in FPGAs, Digital designs once built in custom silicon are increasingly implemented in field programmable gate arrays (FPGAs), but effective FPGA system design requires a understanding of new techniques developed for FPGAs. This course deals FPGA fabrics, introduces essential FPGA concepts, and compares multiple approaches to solving basic problems in programmable logic.

Prerequisite

- **14EE350 Digital systems**

Course Outcomes

On the successful completion of the course, students will be able to

Cos	**Course outcomes**	**Blooms Level**	Expected Proficiency	Expected attainment Level
CO1	Design digital circuits using PROMs and SPLDs such as PLA,PAL	Apply	70%	70%
CO2	Describe the architecture and features of CPLD ICs	Understand	70%	70%
CO3	Explain architecture and features of SRAM, Flash and antifuse based FPGA	Understand	70%	70%
CO4	Explain the concept of synchronous design, and how to redesign an asynchronous circuit to be synchronous.	Understand	70%	70%
CO5	Develop the given digital circuits in Xilinx FPGA processor using Hardware description Language.	Apply	60%	60%
CO6	Develop the specific digital applications in Xilinx FPGA processor using Hardware description Language.	Apply	60%	60%

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1.	**S**	**M**	**L**	**L**								
CO2.	**M**	**L**										
CO3	**M**	**L**										
CO4	**M**	**L**										

CO5.	**S**	**M**	**L**	**L**	**S**							
CO6	**S**	**M**	**L**	**L**	**S**							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	
Remember	20	20	0	20
Understand	40	60	0	40
Apply	40	20	100	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

CAT 3 (compulsory) marks are based on the performance in lab experiments.
Assignment Marks are based on the lab observations.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the architecture of PLA.
2. Show the logic arrangement of both a PROM and a PLA required to implement a binary full adder.
3. Implement the following two Boolean functions with a PLA:

   $F1(A, B, C) = \sum(0,1,2,4)$

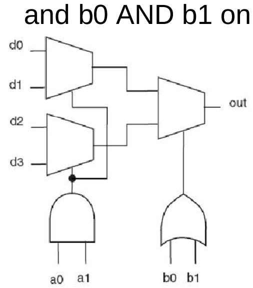
   $F2(A, B, C) = \sum(0,5,6,7)$.

Course Outcome 2 (CO2):

1. Explain the type of packages used in CPLDs
2. Describe the architecture of XILINX XC9500.
3. List the features of XILINX XC9500.

Course Outcome 3 (CO3)

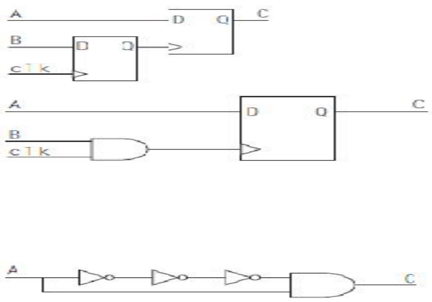
1. Define Design Abstraction of FPGAs.
2. Explain the Methodology for evaluating FPGA fabrics.
3. Redesign the logic element of Figure to be controlled by a0 OR a1 in the first stage and b0 AND b1 on the second stage. Draw the schematic and write the truth table.



Course Outcome 4 (CO4)

1. Define One-Hot State Encoding .
2. With an example explain Bus contention and how it can be avoided.

3. Determine the design problems associated with given asynchronous circuits and find its solution.



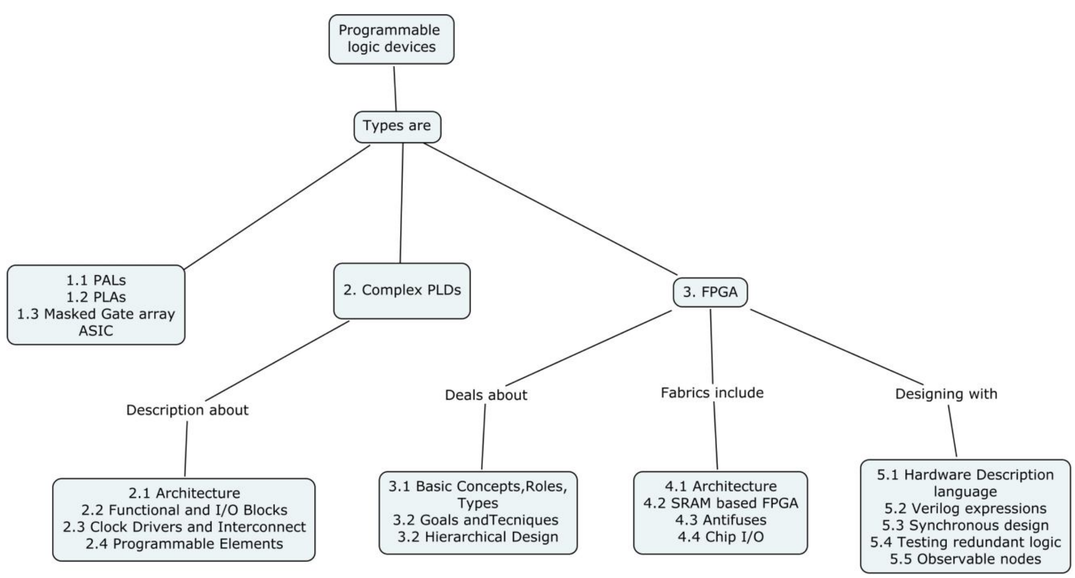
Course Outcome 5 (CO5)

1. Write Verilog code using functional modeling to design a counter to count 0 to F. And display the counter output in seven segment display.
2. How many two-input LUTs would be required to implement a four-bit ripple-carry adder?
3. Design a four-input multiplexer that uses a combination of pass transistors and static gates. The first stage of multiplexing should be performed by pass transistors while the remaining multiplexing should be performed by static gates.

Course Outcome 6 (CO6)

1. **Compare FPGA and DSP processor.**
2. **Write Verilog code for stepper motor controller.**
3. Design of FIR Filter Using Verilog HDL.(Lab)

Concept Map



Syllabus

Programmable Logic to ASICs: Programmable Read Only Memories (PROMs), Programmable Logic Arrays (PLAs), Programmable Array Logic (PALs), the Masked Gate Array ASIC, CPLDs and FPGAs.

Complex Programmable Logic Devices (CPLDs): CPLD Architectures, Function Blocks, I/O Blocks, Clock Drivers, Interconnect CPLD Technology and Programmable Elements.

FPGA-Based Systems: Introduction: Basic Concepts (Boolean algebra and karnaugh map), Digital Design and FPGAs, The roles of FPGAs, FPGA types, FPGA-Based System: Design, Goals & techniques, Hierarchical design, Design abstraction, Methodologies.

FPGA Fabrics: FPGA Architectures, SRAM-Based FPGAs, Characteristics of SRAM-Based FPGAs, Logic elements & Interconnections networks, Permanently Programmed FPGAs , Antifuse, Flash configuration, Logic blocks and interconnections, Antifuse programming,Chip I/O, Circuit Design of FPGA Fabrics.

Hardware Description Language: VHDL and Verilog programming.

Design Techniques, Rules, and Guidelines : Top-Down Design, Synchronous Design, Floating Nodes, Bus Contention, One-Hot State Encoding, Design For Test (DFT) , Testing Redundant Logic, Initializing State Machines, Observable Nodes.

Text Book

1. Wayne Wolf "FPGA –Based System Design" Pearson Education, 2004.
2. Bob Zeidman, "Designing with FPGAs and CPLDs", Elsevier, CMP Books, 2002.

Reference Books

1. M. Morris Mano and Michael D. Ciletti, "Digital Design", PHI, fourth edition, 2008
2. R.F.Tinder: Engineering Digital Design, (2/e), Academic Press, 2000
3. Digital Electronics Principles, Devices and Applications Anil K. Maini – Wiley 2007
4. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition, 2004.
5. Stephen Brown Zvonko Vranesic "Fundamentals of Digital Logic with VHDL Design" Tata McGraw- Hill Edition.
6. www.xilinx.com
7. www.acctel.com

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1	**Programmable Logic to ASICs**	
1.1	Programmable Read Only Memories (PROMs).	1
1.2	Programmable Logic Arrays (PLAs)	2
1.3	Programmable Array Logic (PALs)	2
1.4	The Masked Gate Array ASIC	1
2	**Complex Programmable Logic Devices (CPLDs)**	
2.1	CPLD Architectures, Function Blocks, I/O Blocks	1
2.2	Clock Drivers, Interconnect, CPLD Technology and Programmable Elements	1
3	**FPGA-Based Systems**	
3.1	Introduction- Basic Concepts, Digital Design and FPGAs, The roles of FPGAs and FPGA types	1
3.2	FPGA Based System Design- Design, Goals & techniques, Hierarchical design, Design abstraction, Methodologies	1
4	**FPGA Fabrics**	
4.1	FPGA Architectures	1
4.2	SRAM-Based FPGAs	1
4.2.1	Characteristics of SRAM-Based FPGAs	1
4.2.2	Logic elements & Interconnections networks	1

4.3	Permanently Programmed FPGAs	1
4.3.1	Antifuses, Flash configuration	1
4.3.2	Logic blocks and interconnections, Antifuse programming	1
4.4	Chip I/O, Circuit Design of FPGA Fabrics	1
5	**Design Techniques, Rules,and Guidelines**	
5.1	Basics of Hardware Description Language (Verilog) and Expressions	1
5.2	Top-Down Design	1
5.3	Synchronous Design	1
5.4	Floating Nodes, Bus Contention and One-Hot State Encoding	1
5.5	Design For Test and Testing Redundant Logic.	1
5.6	Initializing State Machines, Observable Nodes	1
	Total	24

Tentative List of Experiments (24 Hours)

1. Construct digital circuits such as,
    a. Synchronous Counters
    b. Ripple counters
    c. 4 –Bit adder and Subtractor
    d. Code Converters
    e. MUX, DEMUX, Encoder and decoder

2. Design FPGA based
    a. Digital signal processing
    b. Motor Control
    c. Real time applications

Course Designers:

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		L	T	P	Credit
14EEPK0	**DIGITAL SIGNAL PROCESSORS**	2	0	2	3

Preamble

A digital signal processor is a specialized microprocessor with its architecture optimized for the operational needs of digital signal processing. The goal of DSPs is usually to measure, filter and/or compress continuous real-world analog signals. Most general-purpose microprocessors can also execute digital signal processing algorithms successfully, but dedicated DSPs usually have better power efficiency thus they are more suitable in portable devices such as mobile phones because of power consumption constraints. DSPs often use special memory architectures that are able to fetch multiple data and/or instructions at the same time.

Prerequisite

14EE550 – Digital Signal Processing

Course Outcomes

Cos	Course outcomes	Blooms Level	Expected Proficiency	Expected Attainment Level
CO1	Explain the fundamentals of fixed and floating point architectures of various DSPs.	Understand	80 %	80 %
CO2	Describe the architecture details and instruction sets of floating point DSPs	Understand	70 %	70 %
CO3	Demonstrate the control instructions, interrupts, and pipeline operations.	Understand	70 %	70 %
CO4	Illustrate the features of on-chip peripheral devices and its interfacing along with its programming details.	Understand	70 %	70 %
CO5	Design and implement signal processing modules in DSPs for specific applications using TMS320C6X processor.	Apply	60 %	60 %

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	M	L										
C03	M	L										
C04	M	L										
C05	S	M	L	L	S							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	0	20
Understand	50	30	0	30
Apply	30	50	100	50

CAT 3 (compulsory) marks are based on the performance in lab experiments.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What are the factors that influence selection of DSPs?
2. Compare fixed and floating Point Digital signal Processors.
3. List the applications of DSPs.

Course Outcome 2 (CO2):

1. What are the different stages in pipelining?
2. With help of block diagram explain the architecture of TMS320C6X DSP.
3. Explain the various addressing modes in TMS320C6X DSP.

Course Outcome 3 (CO3)

1. Explain arithmetic and logical instructions of TMS320C6X DSP.
2. Explain Control operations and interrupts of TMS320C6X DSP.
3. Explain interrupts of TMS320C6X DSP.

Course Outcome 4 (CO4)

1. List the on-chip peripherals in C6x.
2. Explain the A/D and D/A converter interfacing along with its programming.
3. Define DMA.

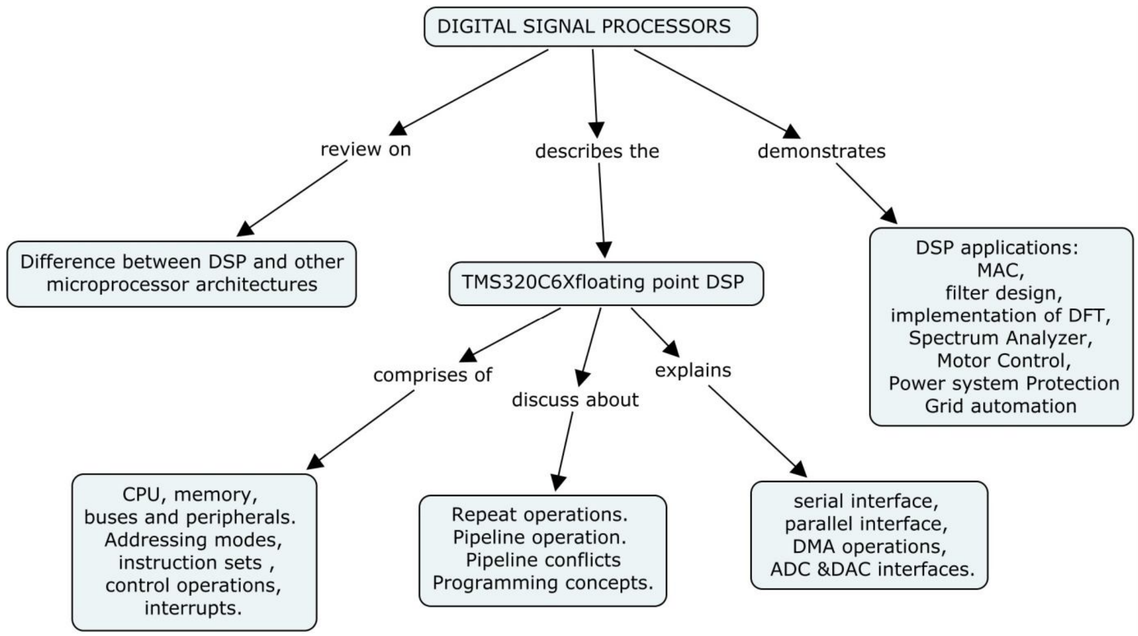
Course Outcome 5 (CO5)

1. Using a rectangular window technique design and implement a LPF with pass band gain of unity, cutoff frequency of 1000Hz and working sampling frequency of 5kHz. The length of impulse be 7.
2. Design a Digital butterworth LPF satisfying the specification
   Fp=0.10KHz;αp=5dB

   Fs=0.15Khz ;αs=20dB;F=1KHz

3. Design an adaptive echo cancellation technique.

Concept Map



Syllabus

Introduction: Difference between DSP and other microprocessor architectures, fundamentals of fixed and floating point architectures

Architecture: TMS320C6X floating point DSP architectures, CPU, memory, buses and peripherals. Addressing modes, instruction sets, control operations, interrupts.

Operations: Repeat operations. Pipeline operation. Pipeline conflicts and programming concepts.

Interfacing: serial interface, parallel interface, DMA operations, A/D and D/A converter interfaces, DSP tools.

DSP applications: MAC, Digital filter design, implementation of DFT, spectrum analyzer, Motor control andGrid Automation.

Text Book

1. B. Venkataramani & M. Bhaskar, Digital Signal Processor, Architecture, Programming and Applications,(2/e), McGraw- Hill,2010
2. S. Srinivasan & Avtar Singh, Digital Signal Processing, Implementations using DSP Microprocessors with Examples from TMS320C54X, Brooks/Cole, 2004.

Reference Books

1. Sen M. Kuo & Woon-Seng S. Gan, Digital Signal Processors: Architectures, Implementations, and Applications, Prentice Hall, 2004
2. C. Marven & G. Ewers: A Simple approach to digital signal processing, Wiley Inter science, 1996.
3. R.A. Haddad & T.W. Parson: Digital Signal Processing: Theory, Applications and Hardware, Computer Science Press NY, 1991.
4. http://www.ti.com/lit/wp/spry226/spry226.pdf

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1	**Introduction**	
1.1	Difference between DSP and other microprocessor architectures.	1
1.2	Fundamentals of fixed and floating point architectures	1
2	**TMS320C6X floating point DSP architectures**	
2.1	CPU, memory	1
2.2	Buses and peripherals.	1
2.3	Addressing modes	2
2.4	Instruction sets	2
2.5	Control operations & interrupts.	2
3	**Operations and Interfacing**	
3.1	Repeat operations. Pipeline operation.	2
3.2	Pipeline conflicts and programming concepts.	2
3.3	Serial interface, parallel interface,	2
3.4	DMA operations, A/D and D/A converter interfaces.	2
3.5	DSP tools	1
4	**DSP applications**	
4.1	MAC &Spectrum Analyzer	1
4.2	implementation of DFT &Digital Filter Design	1
4.3	Motor Control	1
4.4	Power system Protection	1
4.5	Grid Automation	1
	Total	24

Tentative List of Experiments using TMS320C6748 DSP Processor (22-24 Hours)

- Filter design
- Implementation of DFT
- Spectrum Analyzer
- Motor Control
- Power system Protection
- Grid Automation

Course Designers:

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2. Dr.R.Helen rheee@tce.edu
3. Mr.Seetharaman vseetharaman@tce.edu

		Category	L	T	P	Credit
14EEPL0	**BIO-MEDICAL INSTRUMENTATION**	PE	3	0	0	3

Preamble

Biomedical instrumentation is the application of engineering principles and design concepts to medicine and biology. This field seeks to close the gap between engineering and medicine: It combines the design and problem solving skills of engineering with medical and biological sciences to improve healthcare diagnosis, monitoring and therapy. Recent advances in medical field have been fuelled by the instruments developed by the Electronics and Instrumentation Engineers. Pacemakers, Ultrasound Machine CAT, Medical diagnostic systems are few names which have been contributed by engineers. Now health care industry uses many instruments which are to be looked after by instrumentation engineers. This subject will enable the students to learn the basic principles of different instruments/equipment used in the health care industry.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

Cos	**Course outcomes**	**Blooms Level**	Expected Proficiency	Expected outcome Level
CO1	Explain the principles of biomedical measurement systems and its characteristics.	Understand	70%	70%
CO2	Describe the medical standards, safety and regulation	Understand	70%	70%
CO3	Discuss the origin and acquisition of bio potentials and bioelectric signals. Like ECG, EEG.	Understand	70%	70%
CO4	Select suitable Instrumentation systems to measure Blood Flow, Blood Pressure, and Heart sound, and Blood cell counters for specific situation.	Apply	60%	60%
CO5	Select suitable therapeutic devices for specific situation.	Apply	60%	60%
CO6	Explain the construction and operation of medical imaging systems(X ray machine, computer tomography, MRI, Ultrasound)	understand	70%	60%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	**L**										
CO2.	**M**	**L**										
C03	**M**	**L**										
C04	**S**	**M**	L	L								

C05	**S**	**M**	L	L								
C06	**M**	**L**										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	80	40	40	40
Apply	0	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss various constraints in design of medical instrumentation systems.
2. Classify the medical instrumentation systems.
3. Explain the generalized medical instrumentation systems.

Course Outcome 2 (CO2):

1. Define micro and macro shock.
2. Explain the impact of leakage current in cardiac patient and how it can be avoided?
3. List the standards followed in medical instrumentation systems.

Course Outcome 3 (CO3)

1. Explain the electrical activity of Excitable cells with necessary sketches.
2. Describe 10-20 electrode placement system and explain the working of a multichannel EEG recording machine.
3. Classify and explain biopotential electrodes with neat diagram.

Course Outcome 4 (CO4)

1. Select and Justify the Blood flow meters which is used to measure pulsative blood flow.
2. Explain ausculatory and oscillometric blood pressure Measurement.
3. With neat sketch explain the principle of Coulter counter.

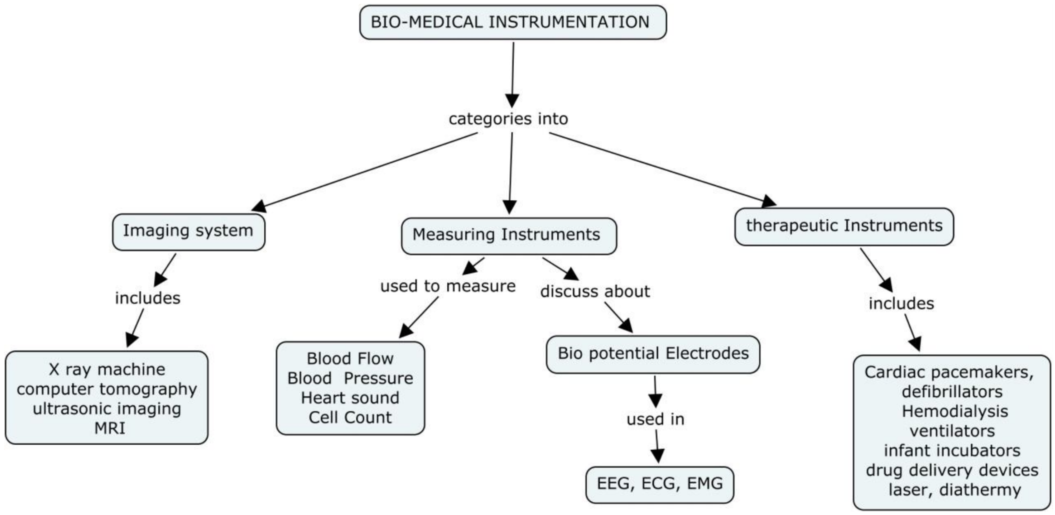
Course Outcome 5 (CO5)

1. Explain the short wave diathermy with neat diagram.
2. Give the need for Pacemakers and explain different types of implantable pacemakers.
3. Select suitable therapeutic device for abnormal heart rhythms.

Course Outcome 6 (CO6)

1. Explain the principles of Nuclear Magnetic Resonance imaging systems and gives its advantages.
2. Classify the X-rays and With neat diagram explain X-Ray machine?
3. Describe the various scanning methods in ultrasonic imaging system.

Concept Map



Syllabus

BASIC CONCEPTS OF BIO MEDICAL INSTRUMENTATION

Terminology – Generalised medical instrumentation system – Measurement constrains – Bio statistics – Regulation of medical devices – Electrical safety in medical environment.

BIO POTENTIALS AND MEASUREMENTS

Electric activity and excitable cells – Functional organization of peripheral nervous system. EMG, ECG, EEG and recording systems – Bio-potential electrodes – Electrolyte interface. Polarization – Body surface recording electrodes -microelectrodes– Electrodes for electric simulation of tissues – Practical hints for using electrodes.

BLOOD FLOW, PRESSURE, SOUND, CELL COUNTERS MEASUREMENT

Blood Flow- Electromagnetic blood flow meter, ultrasonic blood flow meter, Doppler blood flow meter, NMR blood flow meter, cardiac output measurement – indicator dilution methods and impedance technique. Blood pressure and heart sound measurement: Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound, indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques. Heart sound measurement – stethoscope, phonocardiograph. Blood cell counters: Different methods for cell counting, Coulter Counters, automatic recognition and differential counting of cells.

THERAPEUTIC DEVICES

Cardiac pacemakers, defibrillators, Hemodialysis, ventilators, infant incubators, drug delivery devices, therapeutic applications of the laser, diathermy

MEDICAL IMAGING SYSTEMS

X ray machine, computer tomography, ultrasonic imaging system, magnetic resonance imaging system.

Text Book

1. 1. R. S. Khandpur “Handbook of Bio-Medical Instrumentation”, second edition Tata McGraw Hill 2005.

Reference Books

1. J.Webster, “Medical Instrumentation application and design”, third edition Wiley & Sons 2001.

2. Carr & Brown, "Introduction to Biomedical Equipment Technology" Pearson Education, Asia.
3. Leslie Cromwell, " Biomedical Instrumentation and Measurements"

Course Contents and Lecture Schedule

SL. No.	Topics	No of lectures
1	**BASIC CONCEPTS OF BIO MEDICAL INSTRUMENTATION**	
1.1	Terminology, Generalized medical instrumentation system	1
1.2	Measurement constrains	1
1.5	Regulation of medical devices & Electrical safety in medical environment	2
2	**BIO POTENTIALS AND MEASUREMENTS**	
2.1	Electric activity and excitable cells – Functional organization of peripheral nervous system	2
2..2	ENG, EMG, ECG	2
2.3	EEG & MEG and recording systems – Bio-potential electrodes – Practical hints for using electrodes	2
2.4	Electrolyte interface. Polarization – Body surface recording electrodes	1
2.5	Microelectrodes, Electrodes for electric simulation of tissues	1
3	**BLOOD FLOW, PRESSURE, SOUND, CELL COUNTERS MEASUREMENT**	
3.1	**Blood Flow**	
3.1.1	Electromagnetic blood flow meter, ultrasonic blood flow meter.	2
3.1.2	Doppler blood flow meter, NMR blood flow meter.	1
3.1.3	Cardiac output measurement – indicator dilution methods and impedance technique	2
3.2	**Blood pressure and heart sound measurement**	
3.2.1	Measurement of blood pressure using sphygmomanometer instrument based on Korotkoff sound	1
3.2.2	Indirect measurement of blood pressure, automated indirect measurement, and specific direct measurement techniques.	2
3.2.3	Heart sound measurement – stethoscope, phonocardiograph.	1
3.3	**Blood cell counters**	
3.3.1	Different methods for cell counting, Coulter Counters,	1
3.3.2	Automatic recognition and differential counting of cells.	1
4	**THERAPEUTIC DEVICES**	
4.1	Cardiac pacemakers, defibrillators	1
4.2	Hemodialysis, ventilators,	2
4.4	Therapeutic applications of the laser	1
4.5	Diathermy	2
5	**MEDICAL IMAGING SYSTEMS**	
5.1	X ray machine	1
5.2	computer tomography	1
5.3	Ultrasonic imaging system	2
5.4	magnetic resonance imaging system	2
Total		36

Course Designers:

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14EEPM0	**REAL TIME OPERATING SYSTEM**	L	T	P	Credit
		2	0	2	3

Preamble

Real-time systems are complex embedded systems that operate with real time constraints. Real time systems include automotive electronics, air traffic control, nuclear power plants, telecommunications, and robotics and they use a real time operating system (RTOS) that determines which applications should run in what order and how much time should be allowed for each application before giving processor access to another process. The functions of the RTOS are to manage the sharing of internal memory among multiple tasks, to handle input and output to and from attached hardware devices such as serial ports, buses, and I/O device controllers and to send messages about the status of operation and any errors that may have occurred.

Prerequisite

- 14EEPI0 – Embedded System Design

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level	Expected Proficiency	Expected Attainment Level
CO1	Explain the concepts of real-time systems	Understand	80 %	80 %
CO2	Describe the various functional blocks of real-time operating systems	Understand	80 %	70 %
CO3	Explain the RTOS µCOS-II Programming concepts	Understand	80 %	70 %
CO4	Develop RTOS program for an automatic chocolate vending machine and digital camera using µCOS-II	Apply	80 %	70 %
CO5	Analyse the developed embedded ‘C’ program with RTOS for the given applications	Analyse	80%	70%

Mapping with Programme Outcomes

COs	PO 1	PO2	PO3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	M	L										
CO2	M	L										
CO3	M	L										

CO4	S	M	L	L								
CO5	S	S	M	M	M				S	S		

S- Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			Terminal Examination*
	1	**2**	**3***	
Remember	20	20	0	0
Understand	50	30	0	0
Apply	30	50	60	60
Analyse	0	0	40	40

*CAT-3 and Terminal Examination are to be conducted as practical sessions and marks are allocated based on the performance of the students in doing the lab experiments.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. What is the role of RAM in an embedded system?
2. What are the different steps in the design process an embedded system?
3. Define critical section of a task?
4. What is the advantage and disadvantage of disabling interrupts during running of a critical section of a process?
5. Write the operation done when the function OSSemPend ( ) is executed.
6. How is an anonymous object denoted in UML?

Course Outcome 2 (CO2):

1. Explain the different hardware components in embedded system.
2. Explain the DFG model of programming with an example.
3. Why RTOS is required in an embedded system?
4. Why polled waiting loop method is not preferred in many applications?
5. How semaphore is used to execute critical section of a task in a multitasking system?
6. Describe any three task related functions in µCOS-II.

Course Outcome 3 (CO3):

1. Show how the timer functions can be applied
   a) to reduce the light level in a mobile phone with full brightness

   b) to switch off the LCD display in a mobile phone after 15 seconds from the time

   it was switched on.

2. Write exemplary codes for using the μCOS-II functions for time delay and semaphore.
3. How will you create, remove, open, close a device by applying RTOS functions? Take an example of a pipe delivering an I/O stream from a network device.
4. How will you create and display SMS message in T9 keypad of a mobile phone? Use the states, FSM model and state tables for all keys 0, 1 to 9 with T9 keypad. Use suitable templates.

Course Outcome 4 (CO4):

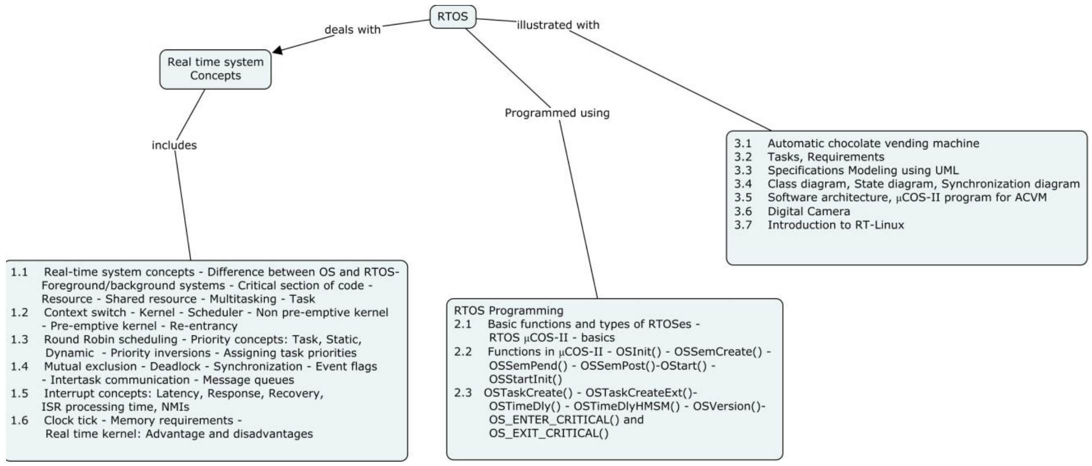
1. Draw an FSM model of an automatic chocolate-vending machine program. The machine permits only one type of coin, Rs. 1, one chocolate at a time and one chocolate cost is Rs. 8.
2. Illustrate the class diagram and state diagram for the automatic chocolate vending machine.

3. Develop RTOS program for the digital camera using μCOS-II. Illustrate the class diagram and state diagram for the digital camera.

Course Outcome 5 (CO5):

1. Write and execute the program using μCOS-II for speed measurement of a DC motor.
2. Write and execute the program using μCOS-II for elevator control.

Concept Map



Syllabus

Introduction: Real-time system concepts – Difference between OS and RTOS - Foreground/background systems - Critical section of code - Resource - Shared resource - Multitasking - Task - Context switch - Kernel - Scheduler - Non preemptive kernel - Preemptive kernel - Reentrancy - Round Robin scheduling - Priority concepts: Task, Static, Dynamic - Priority inversions - Assigning task priorities - Mutual exclusion - Deadlock - Synchronization - Event flags - Intertask communication - Message queues - Interrupt concepts: Latency, Response, Recovery, ISR processing time, Non-maskable Interrupts (NMIs) - Clock tick - Memory requirements - Real time kernel: Advantage and disadvantages.

RTOS programming: Basic functions and types of RTOSes - RTOS μCOSII: basics - Functions in μCOSII - OSInit() - OSSemCreate() - OSSemPend() - OSSemPost() - OStart()- OSStartInit()-OSTaskCreate()-OSTaskCreateExt()-OSTimeDly()-OSTimeDly HMSM() - OSVersion() - OS_ENTER_CRITICAL() and OS_EXIT_CRITICAL().

Design examples with μCOS-II: Automatic chocolate vending machine - Tasks - Requirements - Specifications Modeling using UML - Class diagram - State diagram - Synchronization diagram - Software architecture - μCOS-II program- Digital Camera- Introduction to RT-Linux.

Text Books

4. Jean J. Labrosse, ‘Embedded Systems Building Blocks’, Second Edition, CMP Books, USA, 1999.
5. Raj Kamal, “Embedded Systems- Architecture, Programming and Design” Second edition , Tata McGraw Hill, 2008.

Reference Books

1. David E.Simon, “An Embedded Software Primer”, Pearson Education, 2006
2. C.M. Krishna, Kang, G.Shin, “Real Time Systems”, McGraw Hill, 1997.
3. Phillip A. Laplante, Real Time Systems Design and Analysis, An Engineer’s Handbook, Second Edition, PHI India, 1997.
4. Introduction to RT-Linux (https://www.cis.upenn.edu/~lee/06cse480/lec-RTOS_RTlinux.pdf)

Course Contents and Lecture Schedule

S.No.	Topics	No. of Lectures
1.	**Introduction**	
1.1	Real-time system concepts - Difference between OS and RTOS- Foreground/background systems - Critical section of code - Resource - Shared resource - Multitasking - Task	2
1.2	Context switch - Kernel - Scheduler - Non pre-emptive kernel - Pre-emptive kernel - Re-entrancy	2
1.3	Round Robin scheduling - Priority concepts: Task, Static, Dynamic - Priority inversions - Assigning task priorities	2
1.4	Mutual exclusion - Deadlock - Synchronization - Event flags - Intertask communication - Message queues	2
1.5	Interrupt concepts: Latency, Response, Recovery, ISR processing time, NMIs	2
1.6	Clock tick - Memory requirements - Real time kernel: Advantage and disadvantages	1
2	**RTOS programming**	
2.1	Basic functions and types of RTOSes, RTOS µCOS-II – basics	1
2.2	Functions in µCOS-II - OSInit() - OSSemCreate() - OSSemPend() - OSSemPost()-OStart() - OSStartInit()	1
2.3	OSTaskCreate() - OSTaskCreateExt()-OSTimeDly() - OSTimeDlyHMSM() - OSVersion() - OS_ENTER_CRITICAL() and OS_EXIT_CRITICAL()	2
3	**Design examples with µCOS-II**	
3.1	Automatic chocolate vending machine	1
3.2	Tasks, Requirements	1
3.3	Specifications Modeling using UML	1
3.4	Class diagram, State diagram, Synchronization diagram	2
3.5	Software architecture, µCOS-II program for ACVM	1

3.6	Digital Camera	2
3.7	Introduction to RT-Linux	1
	Total	**24**

Tentative List of Experiments (24 hours)

Develop embedded "C' program with RTOS for the following applications:

- Elevator control
- Motor control
- Real time power and energy measurement
- Temperature measurement
- Speed measurement
- PWM generation
- Sensor interfacing

Course Designers:

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		Category	L	T	P	Credit
14EEPSO	**SOFT COMPUTING**	PE	3	0	0	3

Preamble

The objective of this course is to introducebasic concepts and applications of soft computing tools such as neural networks, fuzzy logic systems, and genetic algorithms. Also it covers soft computing based solutions for real-world Electrical Engineering problems.

Prerequisite

Prior knowledge of MATLAB software is required.

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Blooms level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Describe the role of various soft computing techniques in building intelligent systems	Understand	75	85
CO2	Explain fuzzy logic operations, relations and inference system	Understand	75	85
CO3	Apply fuzzy logic control techniques for the given Electrical engineering problem	Apply	90	75
CO4	Explain the architecture and learning methodologies of perceptron, and back propagation neural networks	Understand	90	75
CO5	Apply back propagation neural network for modelling and control of the given electrical engineering problem	Apply	90	75
CO6	Apply genetic algorithm to solve the given optimization problem using hand calculations	Apply	90	75

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	M	L										
CO3.	S	M	L	L								

CO4.	M	L										
CO5.	S	M	L	L								
CO6.	S	M	L	L								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the role of soft computing tools in building intelligent systems.
2. Explain the architecture of perceptron neural network.
3. Contrast between conventional logic and fuzzy logic
4. Compare the performance of conventional optimization technique and GA in solving real-world optimization problem.
5. Explain where fuzzy logic can be used with a suitable example.
6. Compare the performances of soft computing tools.

Course Outcome (CO2)

1. Define fuzzification and defuzzification
2. Explain the working of fuzzy logic controller with a neat block diagram
3. List the steps involved in the design of fuzzy logic controller
4. Compare the two types of fuzzy logic controller
5. The relationship between temperature and maximum operating frequency R depends on various factors for a given electronic circuit. Let ~ be a fuzzy set (in degrees Fahrenheit) and ~represent a frequency fuzzy set (in MHz) on the following universes of discourse:

$$\underset{\sim}{T} = \{-100, -50, 0, 50, 100\} \quad \text{and} \quad \underset{\sim}{F} = \{8, 16, 25, 33\}.$$

$$\underset{\sim}{S} = \begin{array}{c} \\ -100 \\ -50 \\ 0 \\ 50 \\ 100 \end{array} \begin{array}{c} \begin{array}{ccccc} 1 & 2 & 4 & 8 & 16 \end{array} \\ \begin{bmatrix} 1 & 0.8 & 0.6 & 0.3 & 0.1 \\ 0.7 & 1 & 0.7 & 0.5 & 0.4 \\ 0.5 & 0.6 & 1 & 0.8 & 0.8 \\ 0.3 & 0.4 & 0.6 & 1 & 0.9 \\ 0.9 & 0.3 & 0.5 & 0.7 & 1 \end{bmatrix} \end{array}$$

Suppose a Cartesian product between ~and ~is formed that results in the following relation~ The reliability of the electronic circuit is related to the maximum operating temperature. Such a relation ~can be expressed as a Cartesian product between the reliability index, ~= {1, 2, 4, 8, 16} (in dimensionless units), and the temperature:Find a relationship between frequency and the reliability index, use (a) max–min composition (b) max–product composition.

Course Outcome (CO3)

1. How will you control the temperature and pressure in a thermal power plant by the control of throttle action using the concept of fuzzy logic? Assume the triangular membership functions for input and output.
2. Consider the speed control of induction motor problem, apply fuzzy logic to exercise this. Let change in speed and error in change in speed as inputs and output as switching frequency of the inverter.

Course Outcome (CO4)

1. Explain supervised and unsupervised learning
2. List the different types of activation functions used in ANN
3. Describe BPN architecture with a neat sketch and explain the steps involved in the training of the network
4. Develop a suitable perceptron neural network model to perform the following classification problem. The vectors (1,1,1,1) and (-1,1,-1,-1) for belonging to the class (target value 1) vectors (1,1,1,-1) and (1,-1,-1,1) for not belonging to the class (target value -1).

Course Outcome (CO5)

1. Apply the concept of neural network to model and control the speed of an induction motor.
2. Apply the concept of neural network to model and control the speed of an DC Motor

Course Outcome (CO6)

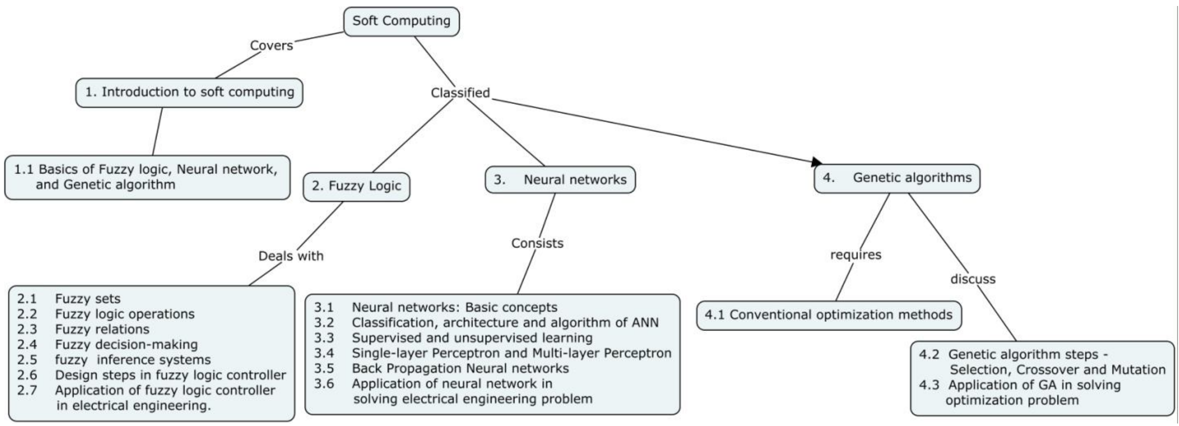
1. List the various operators used in GA
2. Explain the importance of selection operator in GA.
3. Explain the role of reproduction operator in GA
4. Perform two generations of simple binary coded genetic algorithm to solve the following optimization problem. Maximize $f(x) = x^2$ $0 \leq x \leq 31$, x is an integer.
   Use proportionate selection, single point crossover, binary mutation and population size of six.

5. Perform simple binary coded and real coded genetic algorithm to solve the following optimization problem.
   Maximize $f(x) = |x| \sin(x)$ $-5 \leq x \leq 5$, x is real number.

   Use proportionate selection, single point crossover, and binary mutation for simple GA and proportionate selection, Arithmetic crossover, and Gaussian mutation for

RGA. Evaluate the performance of SGA and RGA after a fixed number of generations with equal population size.

Concept Map



Syllabus

Introduction to soft computing - Fuzzy logic, Neural Network and Genetic algorithm

Fuzzy Logic: Fuzzy sets, logic operations, and relations; Fuzzy decision-making; fuzzy inference systems; design steps in fuzzy logic controller; application of fuzzy logic controller in Electrical engineering.

Neural networks: Basic concepts and major classes of neural networks, supervised and unsupervised learning, Single-layer perceptron, Multi-layer perceptron, Back Propagation Neural network, Application of neural network modelling / control problems in Electrical engineering

Genetic algorithms: Introduction - genetic algorithm steps-Selection, Crossover and Mutation; Application of GA to Electrical engineering problems.

Reference Books

1. George J.Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic, Second Edition, PHI, 2006
2. J.M.Zurada, Introduction to artificial neural systems, Jaico Publishing House, 2006
3. D.E. Goldberg, Genetic algorithms in search, optimization, and machine learning, Addison-Wesley.1989.
4. S.N.Sivanandam, and S.N.Deepa, Principles of Soft computing, Second Edition, Wiley India Pvt. Ltd, 2013.
5. N.P.Padhy and S.P.Simon, Soft computing with MATLAB programming, Oxford publishers, 2015.
6. http://nptel.ac.in/courses/106106046/41
7. https://www.coursera.org/learn/neural-networks
8. http://www.iitk.ac.in/kangal/deb.shtml

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Introduction to soft computing**	
1.1	Basics of Fuzzy logic, Neural network, and Genetic algorithm	2
2.	**Fuzzy Logic**	
2.1	Fuzzy sets	2
2.2	Fuzzy logic operations	2
2.3	Fuzzy relations	2
2.4	Fuzzy decision-making	2
2.5	fuzzy inference systems	2
2.6	Design steps in fuzzy logic controller;	1
2.7	Application of fuzzy logic controller in electrical engineering.	1
3.	**Neural networks**	
3.1	Neural networks: Basic concepts	2
3.2	Classification, architecture and algorithm of ANN	3
3.3	Supervised and unsupervised learning	2
3.4	Single-layer Perceptron and Multi-layer Perceptron	3
3.5	Back Propagation Neural networks	2
3.6	Application of neural network in solving electrical engineering problem	2
4.	**Genetic algorithms:**	
4.1	Conventional optimization methods	2
4.2	Genetic algorithm steps - Selection, Crossover and Mutation	3
4.3	Application of GA in solving optimization problem	3
	Total	**36**

Course Designers:

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2. Dr. P. Venkatesh pveee@tce.edu
3. Dr.C.K.Babulal ckbeee@tce.edu

14EEPV0	FACTS AND CUSTOM POWER DEVICES	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

FACTS are power electronics based system that provides control of AC transmission system parameters to enhance controllability and increase power transfer capability. Rising energy costs and a greater sensitivity to environmental impact of new transmission lines necessitated the application of FACTS controllers to minimize losses and maximize the stable power-transmission capacity of existing lines.

Power distribution networks have always been exposed to traditional factors such as voltage sag, voltage swell, harmonics and capacitor switching which destruct sinusoidal waveforms and decrease power quality as well as network reliability. A reliable power of acceptable quality can be achieved by applying power electronic devices, called Custom Power devices, in power distribution networks. The present study tries to introduce and compare different types of FACTS & custom power devices and explain their applications.

Prerequisite

14EE620 / 15EE520 : Power Electronics
14EE630 : Transmission and Distribution

Course Outcomes

On the successful completion of the course, students will be able to:

Course Outcome No.	Course Outcomes	Bloom's level	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Explain the necessity of FACTS and custom power devices	Understand	70	70
CO2	Describe the performance and applications of various shunt and series type FACTS controllers	Understand	70	70
CO3	Explain the performance and applications of hybrid FACTS devices	Understand	70	70
CO4	Explain the functioning of custom power devices	Understand	70	70
CO5	Analyze the performance characteristics of the given power network with FACTS controllers	Analyze	60	70
CO6	Analyze the stability of the given power network with custom power devices	Analyze	60	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	M	L										
CO3	M	L										
CO4	M	L										
CO5	S	S	M	M	S							
CO6	S	S	M	M	S							

Assessment Pattern

S. No.	Bloom's Category	Test 1	Test 2	Test 3	End-semester examination
1.	Remember	10	10	0	20
2.	Understand	40	40	0	80
3.	Apply	0	0	0	0
4.	Analyze	0	0	50	0
5.	Evaluate	0	0	0	0
6.	Create	0	0	0	0

* CO5 & CO6: Only for internal assessment

Third Internal Test: The third internal test mark will be given based on a mini software project. A mini-project has to be done by every student individually using PLECS /PSPICE / MATLAB /PSCAD/PSIM/ETAB software. The assessment will be based on design, modelling and simulation of the project.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1 Explain the concept of transmission network.
2 What is passive reactive compensation?
3 What is the need for FACTS controllers?
4 Discuss the merits and demerits of FACTS devices.

Course Outcome 2 (CO2):

1 Explain the characteristics of TCSC.
2 Compare SVC and STATCOM.
3 Distinguish between SSSC and TCSC.
4 Compare TSSC and TCSC.

5 Discuss the application of STATCOM in Power System Damping.
6 How TCSC is used to mitigate SSR?

Course Outcome 3 (CO3) :

1 Explain the working of UPFC.
2 Explain the application of UPFC in power flow control.
3 Draw the UPFC model used for power flow studies.
4 Draw the phasor diagram of UPFC.

Course Outcome 4 (CO4) :

1 Differentiate active and passive filters.
2 Explain the role of custom power devices.
3 Discuss the issues related to voltage, current, power, energy and power factor measurements.
4 Explain working principle and construction of D-STATCOM and also discuss how it is used for load compensation and voltage regulation in power system.
5 Describe the operation of UPQC and DVR. Also discuss how UPQC and DVR are used to mitigate power quality problems.
6 Compute the expression for power transfers and reactive power requirement with diagram to increase the power transfer capability of transmission line using shunt compensator.
7 Design a filter to attenuate the 5th, 7th, and 11th harmonics. Also design such that each filter section is tuned 4 percent below the filtered harmonic.

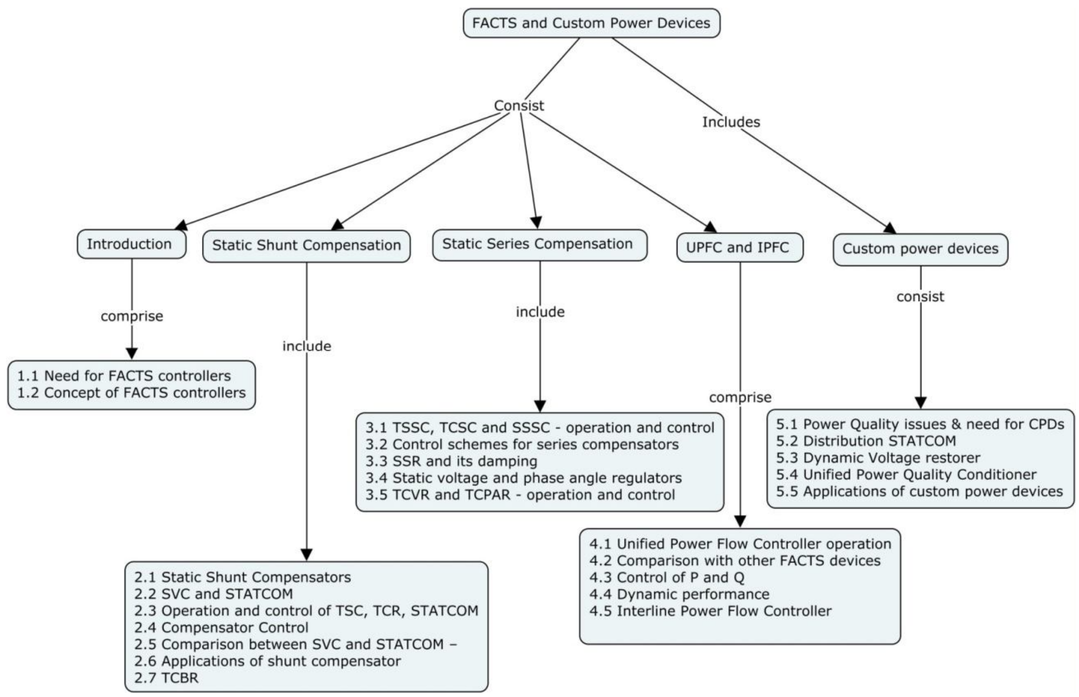
Course Outcome 5 (CO5) :

1. Design and illustrate the reactive power handling capability of a STATCOM using SPICE software.
2. Design and compare the performance of TSC & TCR.
3. Design and compare the performance of SVC & STATCOM.
4. Simulate a suitable controlling device for power factor compensation using Matlab software.
5. Simulate and demonstrate various compensation aspects of a UPFC

Course Outcome 6 (CO6) :

1. Design simulation model of a DSTATCOM for harmonic reduction using Matlab software.
2. Design and illustrate the voltage sag handling capability of DVR using SPICE software.
3. Simulate a UPQC model and demonstrate various control aspects.
4. Simulate a suitable CPD to simultaneously control harmonics, power factor and voltage sag.

Concept Map



Syllabus

Introduction - Need for FACTS controllers- Concept of FACTS controllers

Static Shunt Compensation - Static Shunt Compensators - SVC and STATCOM - operation and control of TSC, TCR, STATCOM - Compensator Control - Comparison between SVC and STATCOM – Applications of shunt compensators and TCBR.

Static Series Compensation - TSSC, TCSC and SSSC - operation and control - Control schemes for series compensators - SSR and its damping - static voltage and phase angle regulators - TCVR and TCPAR - operation and control

UPFC and IPFC - The Unified Power Flow Controller - operation, comparison with other FACTS devices - control of P and Q - dynamic performance - Interline Power Flow Controller

Custom power devices: Power Quality issues & custom power devices – Distribution STATCOM – Dynamic Voltage restorer – Unified Power Quality Conditioner – Applications of custom power devices.

Reference Books

1. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age InternationalPublishers, 2 nd Edition, 2016.

2. R. Mohan Mathur, Rajiv K. Varma. Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Wiley & IEEE Press, 2002.
3. N.G. Hingorani & L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Wiley & IEEE Press, 1999.
4. T.J.E Miller, Reactive Power Control in Electric Systems, New Age International, New Delhi, 1994.
5. Dr Ashok S & K S Suresh Kumar “FACTS Controllers and applications” course book for STTP, 2003.
6. G.T.Heydt: Electric Power Quality, 2nd edition, Stars in a Circle Publications, 1994.
7. Sankaran C, “Power Quality”, CRC press special Indian edition 2009.
8. Arindam Ghosh and Gerald Ledwich: Power Quality Enhancement using Custom Power Devices, Kluwer Academic Publishers, 2002.

Course Contents and Lecture Schedule

Sl No.	Topic	No. of lectures
1	**Introduction**	
1.1	Need for FACTS controllers	1
1.2	Concept of FACTS controllers	1
2	**Static Shunt Compensation**	
2.1	Static Shunt Compensators	1
2.2	SVC and STATCOM	2
2.3	Operation and control of TSC, TCR, STATCOM	2
2.4	Compensator Control	1
2.5	Comparison between SVC and STATCOM –	1
2.6	Applications of shunt compensator	1
2.7	TCBR	1
3	**Static Series Compensation**	
3.1	TSSC, TCSC and SSSC - operation and control	2
3.2	Control schemes for series compensators	2
3.3	SSR and its damping	1
3.4	Static voltage and phase angle regulators	1
3.5	TCVR and TCPAR - operation and control	2
4	**UPFC and IPFC**	
4.1	Unified Power Flow Controller operation	2
4.2	Comparison with other FACTS devices	1
4.3	Control of P and Q	2
4.4	Dynamic performance	1
4.5	Interline Power Flow Controller	2
5	**Custom power devices**	
5.1	Power Quality issues & need for CPDs	2
5.2	Distribution STATCOM	1
5.3	Dynamic Voltage restorer	1
5.4	Unified Power Quality Conditioner	1
5.5	Applications of custom power devices	3
	Total	**35**

Course Designers

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		Category	L	T	P	Credit
14EEPYO	**POWER QUALITY**	PE	3	0	0	3

Preamble

This course imparts knowledge about various electrical power quality issues and their origin and address the effects of power quality problems on electrical power system. It also emphasis need for PQ monitoring and measurement. The study on transient and power factor enables students to understand the characteristics and performance of the real system. The topic on introduction to mitigation devices gives solution for solving various PQ issues.

Prerequisite

14EE330 : DC Machines / 16EE330 : DC Machines and Transformers
14EE440 : AC Machines / 16EE440 : AC Machines
14EE630 : Transmission and Distribution
14EE620 / 16EE520 : Power Electronics

Course Outcomes

On the successful completion of the course, students will be able to :

Course Outcome No.	Course Outcomes	Bloom's level	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Explain various power quality problems	Understand	70	70
CO2	Discuss the root cause of power quality problems	Understand	70	70
CO3	Explain the impact of PQ issues on various electrical components	Understand	70	70
CO4	Discuss the need for PQ monitoring and measurement	Understand	60	70
CO5	Compute the harmonics distortion in the given electical drive	Apply	60	70
CO6	Analyze various power quality issues and their solutions in residential / commercial / industrial facilities	Analyze	60	70

Mapping with programme outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	M	L										
CO2	M	L										
CO3	M	L										
CO4	M	L										
CO5	S	M	L	L								
CO6	S	S	M	M								

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	10	10	30	20
Understand	30	20	50	50
Apply	10	10	10	20
Analyze	0	10	0	10
Evaluate	0	0	0	0
Create	0	0	0	0

Third Internal Test: The third internal test will be based on Multiple Choice Question.

Course Level Assessment Question

Course Outcome 1 (CO1) :

1. What is Power Quality?
2. What is the most common power quality Problem? Why has power quality only become an issue in recent years?
3. What are harmonics?
4. Define DC offset, Inter harmonics
5. Define voltage unbalance
6. What are the major power quality issues? Explain in detail

Course Outcome 2 (CO2) :

1. What are the root cause of voltage sag ?
2. List few sources that cause harmonics.
3. Name any two IEEE standards that define power quality.
4. Discuss about long and short duration voltage variations.
5. Discuss in detail about transients
6. Explain the following: a) Total harmonic distortion b) Total demand distortion

Course Outcome 3 (CO3) :

1. Why noise or transients on the power line causing problems now?
2. Explain the various types of power quality disturbances and impacts of power quality.
3. What are transient over voltages? Explain the different types of transient over voltages.
4. Illustrate the impact of different voltage sag on electrical components.

5. List the impacts of harmonics on the performance of various electrical components.
6. Illustrate the impacts of harmonics on power factor of the industrial loads.

Course Outcome 4 (CO4) :

1. What are the importance of power quality monitoring?
2. Discuss the functioning of power quality analyzer.
3. Write the working principle and applications of harmonics analyzer.

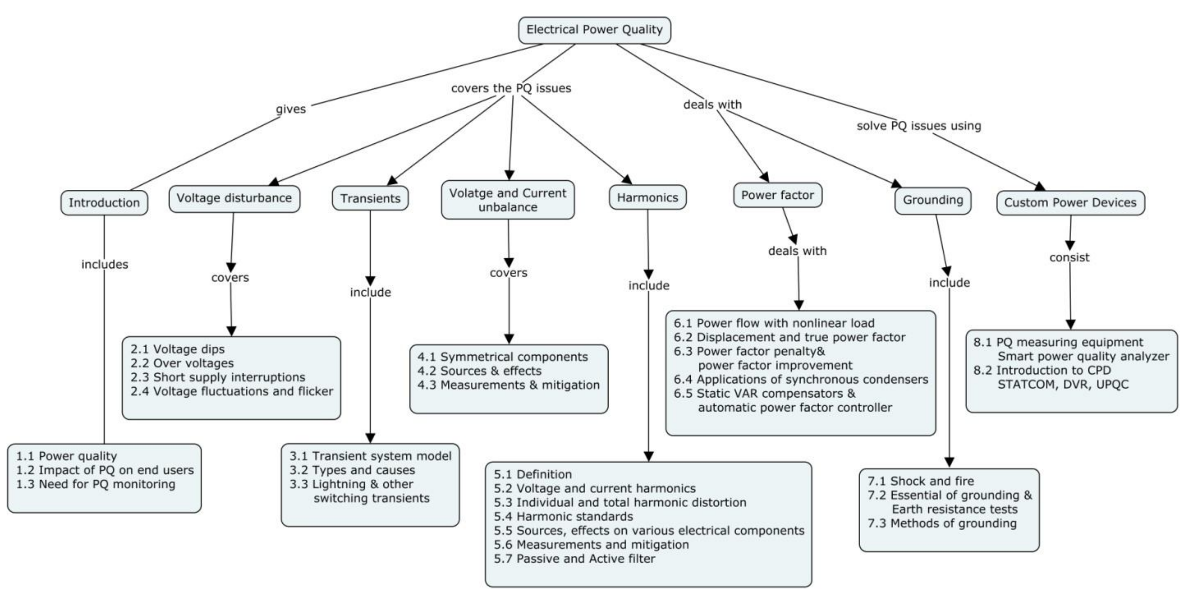
Course Outcome 5 (CO5) :

1. Suppose that a capacitor bank installed for reactive power compensation at a six pulse power converter applications to be tuned to fifth harmonic. Compute the required reactor size and verify whether capacitor bank operation fall within IEEE limits.
2. A waveform contains 50 Hz fundamental, plus 5^{rd}, 9^{th}, 11^{th}, 13^{th} harmonics with their magnitudes 0.3, 0.1, 0.05 and 0.01respectively. CalculateTHD.
3. Calculate the *k* rating of a transformer required to carry a load consisting of 1000 A of fundamental, 120 A of third harmonics, 80 A of fifth harmonics, and 40 A of seventh harmonics.

Course Outcome 6 (CO6) :

1. Investigate the filter requirement to attenuate the 5th, 7th, and 11th harmonics. Also design such that each filter section is tuned 4 percent below the filtered harmonic.
2. Examine the harmonic currents drawn from the line and design a filter to comply with IEEE-519, where the source is 277 V, line-to-neutral. The fundamental load current at 50 Hz is 100 A. This load also draws fifth-harmonic current I_5 = 20 A and seventh-harmonic current I_7 = 15 A.
3. Examine the capacitor bank requirement to improve the power factor from the present level to typically 0.9 to 0.95. Determine whether capacitor operating parameters fall within IEEE maximum recommended limits.

Concept Map



Syllabus

Introduction

Power quality - Impact of PQ on end users, Need for PQ monitoring, Various PQ problems

Voltage disturbances
Voltage dips, over voltages, short supply interruptions, voltage fluctuations and flicker - sources, effects, measurement and mitigation

Transients
Transient system model, examples of transient models and their response, power system transient model, types and causes of transients, lightning, other switching transients.

Voltage and Current Unbalance
Symmetrical components of currents and voltages, sources, effects, measurements and mitigation

Harmonics
Definition, odd and even harmonics, harmonic phase sequence, voltage and current harmonics, individual and total harmonic distortion, harmonic standards, sources, effects on various electrical components, measurements and mitigation, passive and active filters (Case Studies)

Power factor
Active and reactive power flow with nonlinear load, displacement and distortion power factor, power factor penalty, power factor improvement, applications of synchronous condensers and static VAR compensators, automatic power factor controller (Case Studies)

Grounding
Shock and fire hazards, essential of a grounded system, earth resistance tests, methods of grounding.

Solving power quality problems using CPD
Power quality measuring equipment-Smart power quality analyzers, Introduction to custom power devices (CPD) – STATCOM, DVR, UPQC.

Text Book

1. Sankaran C,"Power Quality", CRC Press special Indian edition 2009.

Reference Books

1. Angelo Baggini, "Handbook of Power Quality" John Wiley & Sons Ltd, 2008.
2. Roger .C. Dugan, Mark F.Mcgranaghan & H.Wayne Beaty," Electrical power system Quality" McGraw-Hill Newyork Second edition 2003.
3. Barry W.Kennedy, "Power Quality Primer", McGraw-Hill, New York, 2000.
4. Math H.J.Bollen, « Understanding Power Quality Problems : Voltage Sags and Interruptions », IEEE Press, New York, 2000.
5. Arrillaga.J, Watson.N.R and Chen.S, « Power System Quality Assessment », John Wiley & Sons Ltd., England, 2000
6. Bhim Singh, Ambrish Chandraand Kamal Al-Haddad: Power Quality: Problems and Mitigation Technique, Wiley Publications, 2015
7. Arindam Ghosh and Gerald Ledwich: Power Quality Enhancement Using Custom Power Devices, Kluwer Academic Publishers, 2002.
8. G.T.Heydt: Electric Power Quality, 2nd edition, Stars in a Circle Publications, 1994.

9. Math H.J.Bollen, "Understanding Power Quality Problems: Voltage Sags and Interruptions", IEEE Press, New York, 2000.

Course contents and Lecture schedule

Sl No.	Topic	No.of lectures
1	**Introduction**	
1.1	Power quality	1
1.2	Impact of PQ on end users	1
1.3	Need for PQ monitoring	1
2	**Voltage disturbances**	
2.1	Voltage dips	1
2.2	Over voltages	1
2.3	Short supply interruptions	1
2.4	Voltage fluctuations and flicker	1
3	**Transients**	
3.1	Transient system model, examples of transient models and their response, power system transient model	2
3.2	Types and causes of transients	1
3.3	Lightning, other switching transients	1
4	**Voltage and Current Unbalance**	
4.1	Symmetrical components of currents and voltages,	1
4.2	Sources & effects	1
4.3	Measurements and mitigation	1
5	**Harmonics**	
5.1	Definition, odd and even harmonics, harmonic phase sequence	1
5.2	Voltage and current harmonics	1
5.3	Individual and total harmonic distortion	1
5.4	Harmonic standards	1
5.5	Sources, effects on various electrical components	1
5.6	Measurements and mitigation	1
5.7	Passive and Active filter	1
6	**Power factor**	
6.1	Active and reactive power flow with nonlinear load	1
6.2	Displacement and distortion power factor	1
6.3	Power factor penalty, power factor improvement	1
6.4	Applications of synchronous condensers	1
6.5	Static VAR compensators, automatic power factor controller	2
7	**Grounding**	
7.1	Shock and fire	1
7.2	Essential of grounding, Earth resistance tests	1
7.3	Methods of grounding	1
8	**Solving power quality problems using CPD**	
8.1	Power quality measuring equipment, Smart power quality analyzer	2
8.2	Introduction to custom power devices –STATCOM, DVR, UPQC	3
	Total	**35**

Course Designers

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		Category	L	T	P	Credit
14EEPZ0	**SPECIAL MACHINES AND DRIVES**	PE	3	0	0	3

Preamble

This course aims to impart in students, a good understanding of fundamental principles of different types of special machines. The course includes constructional details, operating principles, motor characteristics, microprocessor based controllers and applications of various types of special machines.

Prerequisite

- 14EE330- DC Machines /16EE330 - DC Machines and Transformers
- 14EE440/16EE440 - AC Machines

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome No.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1.	Illustrate the basic construction and operating principle of Synchronous Reluctance Motor, SRM, Stepper motor, PMSM, PMBLDC Motor and Linear Induction Motor.	Understand	80	70
CO2.	Explain the motor characteristics, power input and torque developed for Synchronous Reluctance Motor, SRM, Stepper motor, PMSM and PMBLDC Motor.	Understand	70	60
CO3.	Develop the drive systems and control schemes for Stepper motors, SRM,PMSM and PMBLDC Motor.	Apply	70	60
CO4.	Select the suitable special purpose motor for the specific application	Apply	60	50
CO5.	Explain the Microprocessor/ DSP based control of Stepper motors, SRM,PMSM and PMBLDC Motor.	Understand	70	60
CO6.	Analyse the performance of a drive system using Matlab-Simulink	Analyse	60	50

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**M**	**L**										
CO2.	**M**	**L**										
CO3.	**S**	**M**	**L**									
CO4.	**S**	**M**	**L**									
CO5.	**M**	**L**										
CO6.	**S**	**S**	**M**	**M**	**S**							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	50	50	50
Apply	20	30	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Note:Assignment topics are based on analysis of the performance of special purpose motor drives using Matlab-Simulink.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Illustrate the construction and working principle of a synchronous reluctance motor.
2. Explain the working principle of Linear Induction motor.
3. Explain the various operating modes of SR motor with neat diagrams.

Course Outcome 2 (CO2):

1. How do you obtain the current-flux linkage characteristics of a SRM?
2. Explain the torque-speed characteristics of a BLDC motor.
3. Derive the expression for power input and torque of a PMSM.

Course Outcome 3 (CO3)

1. Design an open loop controller for a four phase VR stepper motor.
2. Explain the closed loop speed control system for a SRM drive.
3. Illustrate a low cost three phase BLDC motor drive.

Course Outcome 4 (CO4)

1. Select the suitable special purpose motor drive for the following applications:
   (a) PC based scanning equipment (b) Traction (c) Fan and also justify your choice.
2. Find a suitable special purpose motor drive system for optical disk drive head driving mechanism. Illustrate the schematic of the motor drive.
3. Illustrate the closed loop drive system suitable for industrial process control where variable speed, precise motion control and stable operation are critical.

Course Outcome 5 (CO5)

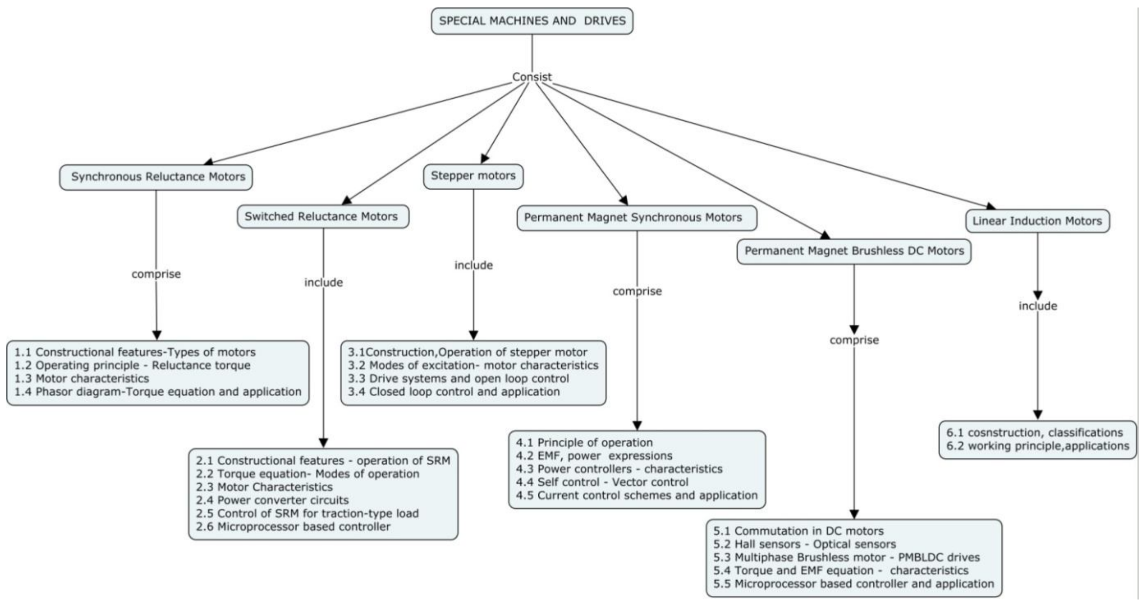
1. Explain the role of microprocessor in the design of closed loop variable reluctance stepper motor drive.
2. Discuss the implementation of vector control in PMSM using DSP.
3. Illustrate the microprocessor based BLDC motor drive.

Course Outcome 6 (CO6)

1. Model and Analyse a closed loop speed controlled SRM drive for the following cases:
   (a) Increase the reference speed (b) Increase the load torque. Use Matlab-Simulink.

2. Develop a Matlab-Simulink model for analysing the current and torque waveforms of a variable speed BLDC motor drive.
3. Design a self controlled PMSM using Matlab-Simulink.

Concept Map



Syllabus

Synchronous Reluctance Motors

Constructional features-Types-Cage rotor-Cageless rotor-Axial and Radial air gap Motors - Operating principle - Reluctance torque- Motor characteristics-Torque-angle characteristics-Speed-torque characteristics - Phasor diagram-Torque equation-Applications.

Switched Reluctance Motors

Constructional features - Principle of operation and control requirements- Torque equation - Modes of operation - Motor Characteristics –Current-Flux linkage Characteristics-Torque-Speed Characteristics-Power converter circuits – Control of SRM for traction-type load-Microprocessor based controller- Applications.

Stepper motors

Constructional features - Principle of operation - Torque production in Variable Reluctance (VR) stepper motor - Modes of excitation - Dynamic characteristics - Drive systems and Circuit for open loop control of stepper motor - Closed loop control of stepper motor-Applications.

Permanent Magnet Synchronous Motors

Principle of operation - EMF, power input and torque expressions - Phasor diagram - Power controllers - Torque speed characteristics - Self control - Vector control - Current control schemes- Applications.

Permanent Magnet Brushless DC Motors

Commutation in DC motors - Difference between mechanical and electronic commutators - Hall sensors - Optical sensors - Multiphase Brushless motor - Square wave permanent magnet brushless motor drives - Torque and EMF equation - Torque-speed characteristics – Microprocessor based controller- Applications.

Linear Induction Motors

Construction-Classifications-Working Principle-Applications.

Text Book

1. Bimal K.Bose, “Modern Power Electronics and AC Drives”, Prentice Hall, New Delhi, 2005.
2. Gopal K.Dubey, ”Fundamentals of Electrical Drives”, Narosa Publishing House Pvt. Ltd.,New Delhi, Second edition, 2015.

Reference Books

1. R. Krishnan, Permanent Magnet Synchronous and Brushless DC Motor Drives, Prentice Hall of India, 2009.
2. T.J.E.Miller ,”Brushless Permanent Magnet and Reluctance DC Motor Drives”, Clarendon Oxford Press, 1989.
3. T. Kenjo, “Stepping Motors and their Microprocessor Controls”, Clarendon Oxford Press, 1994.
4. T. Kenjo and S. Naganori, “Permanent Magnet and Brushless DC motors”, Clarendon Oxford Press,1989.
5. T. Kenjo, “Power Electronics for the Microprocessor Age”, Oxford Press Publications, 1994.
6. J R Hendershot and T.J.E.Miller, “Design of Brushless Permanent Magnet Motors”, Oxford University Press,1995.
7. K.Venkataratnam, “Special Electrical Machines”,University Press(India) Pvt. Ltd.,2009.
8. I.Boldea and S.A.Nasar, “Linear motion electromagnetic systems”, Wiley Interscience,1985.
9. Ion Boldea, “Linear Electric Machines, Drives and MAGLEVs Handbook”, CRC Press, Taylor& Francis Group, 2013.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Synchronous Reluctance Motors**	
1.1	Constructional features-Types-Cage rotor-Cageless rotor-Axial and Radial air gap Motors	1
1.2	Operating principle – Reluctance torque	1
1.3	Motor characteristics-Torque-angle characteristics- Speed-Torque characteristics	2
1.4	Phasor diagram-Torque equation- Applications	2
2.	**Switched Reluctance Motors**	
2.1	Constructional features – Principle of operation and control requirements	2
2.2	Torque equation- Modes of operation	2
2.3	Motor Characteristics –Current-Flux linkage Characteristics-Torque-speed Characteristics	2
2.4	Power converter circuits	1
2.5	Control of SRM for traction-type load	1

Module No.	Topic	No. of Lectures
2.6	Microprocessor based controller- Applications	1
3.	**Stepper motors**	
3.1	Constructional features – Principle of operation – Torque production in Variable Reluctance (VR) stepper motor	2
3.2	Modes of excitation- Dynamic characteristics	1
3.3	Drive systems and Circuit for open loop control of stepper motor	2
3.4	Closed loop control of stepper motor- Applications	1
4	**Permanent Magnet Synchronous Motors**	
4.1	Principle of operation	1
4.2	EMF, power input and torque expressions – Phasor diagram	2
4.3	Power controllers – Torque speed characteristics	1
4.4	Self control – Vector control	2
4.5	Current control schemes- Applications	1
5	**Permanent Magnet Brushless DC Motors**	
5.1	Commutation in DC motors – Difference between mechanical and electronic commutators	1
5.2	Hall sensors – Optical sensors	2
5.3	Multiphase Brushless motor – Square wave permanent magnet brushless motor drives	1
5.4	Torque and EMF equation – Torque-speed characteristics	2
5.5	Microprocessor based controller- Applications	1
6	**Linear Induction Motors**	
6.1	Construction-Classifications	1
6.2	Working Principle- Applications.	2

Course Designers:

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14EERCO	PRINCIPLES OF ENERGY CONSERVATION	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

Energy resource scarcity becomes one of the biggest issues in the world and leading to rise in cost. Effective utilization of Electrical energy is one of the key issues to minimize the rising cost of energy and to minimize the global warming. This course will educate the power system engineers on the aspect of energy conservation in electrical equipment and Electrical Installations. It will helpful to select an energy efficient electrical system for an establishment.

Prerequisite

14EE320 Transformers
14EE440 AC Machines
14EE540 Utilization of Electrical Energy
14EE630 Transmission & Distribution

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcomes	Bloom's Level	Expected Proficiency	Attainment Level
CO1.	Describe the principles of Energy Audit, Management and Conservation	Understand	80	70
CO2	Estimate the energy performance of Electrical System	Apply	70	60
CO3	Estimate the energy performance of Electrical Motors	Apply	70	60
CO4	Estimate the energy performance of Lighting System	Apply	70	60
CO5	Selection and Operation aspects of DG Set for Energy Efficiency	Apply	70	60
CO6	Identify the Energy Efficient gadgets for domestic, commercial and industrial applications	Understand	80	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	S	M	L	L								
CO3	S	M	L	L								
CO4	S	M	L	L								
CO5	S	M	L	L								

CO6	**M**	**L**											

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	
Remember	20	20	20	20
Understand	50	50	40	40
Apply	30	30	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Mention the types of Energy audit.
2. List down the objective of energy management
3. Explain the implications of part load operation of energy equipment with examples.

Course Outcome 2 (CO2):

1. Define contracted demand and billing demand.
2. A textile mill operates with a load of 1800kVA demand at 0.85 power factor lagging. If the power factor is improved from 0.85 to 0.95 lagging by adding additional capacitors, calculate the reduction in demand. The demand charge is Rs.300 per kVA demand per month. Calculate the demand cost saving per year due to the power factor improvement.
3. In a sub-station 2Nos. of identical 5000kVA 33kV / 11kV Transformers are operated parallel to meet a domestic load. The iron and full load copper loss of the above Transformer is 9.2 kW and 32.5kW respectively. Initially the two transformers are operated in parallel to meet the load. The load pattern of the domestic load is as follows:

Load in kW	6000	3500	3000	8000	1500
Power factor	0.8 Lagging	0.78 Lagging	0.75 Lagging	0.9 Lagging	0.7 Lagging
Time in 24 Hours	6.00 A.M to 9.00 A.M	9.00 A.M to 12 Noon	12 Noon to 6.00 P.M	6.00 P.M to 10.00 P.M	10.00 P.M to 6.00 A.M

Suggest the best operating practice for the sub-station to minimize the transformer loss and also quantify the transformer loss minimized due to the best transformer operating practice.

Course Outcome 3 (CO3).

1. Name three types of motors in industrial practice.
2. An 89% efficient 30HP Size standard efficiency induction motor was replaced with a 93% efficient 30HP size Premium efficiency induction motor to improve energy efficiency. Calculate the Annual energy saving potential and payback period for the above proposal, using the following data given for the above applications.

Load factor	- 90%
Operating Hours per year	- 8000 Hours
Cost per kWh of Energy	- Rs.5
Cost of Premium efficiency induction motor	- Rs.60000/-
Scrap value of old standard efficiency induction motor	- Rs.20000/-

Assume the operating efficiency is as that of designed efficiency at 90% load factor condition.

Course Outcome 4 (CO4)

1. List the types of commonly used lamps.
2. Describe the methodology of lightning energy audit in an industrial facility.
3. In a factory shop floor lighting 60Nos. of 400Watts High Pressure Mercury Vapour(HPMV) lamps are replaced with 250Watts Metal Halide Lamps to reduce energy consumption. The luminous efficacy of HPMV Lamp and Metal Halide lamp are 60 & 100 Lumens per watt. Calculate the Annual energy saving potential and payback period for the above energy saving proposal, if the lamps are used for 12 Hours daily for 330Days in a year. The cost per fitting of Metal halide lamp is Rs.6000/- and cost per kWh energy is Rs.5/-.
4. In a Textile Mill to minimize the lighting power consumption Conventional 9Watts loss Tube light Ballast was replaced with 2Watts loss Electronic Ballast and 40Watts Tube lights are replaced with 36Watts tube lights in 750Nos. of Single Lamp Tube Light Fittings. The cost of Electronic Ballast and 36Watts Tube lights are Rs. 225 and Rs.45/- per unit. Calculate the Power and Energy Saving Potential, if the mill operates for 8000 Hours in a year. Also calculate the investment required and payback period for the above ENCON Proposal, when the Energy cost is Rs. 4.50 per kWh.

Course Outcome 5 (CO5)

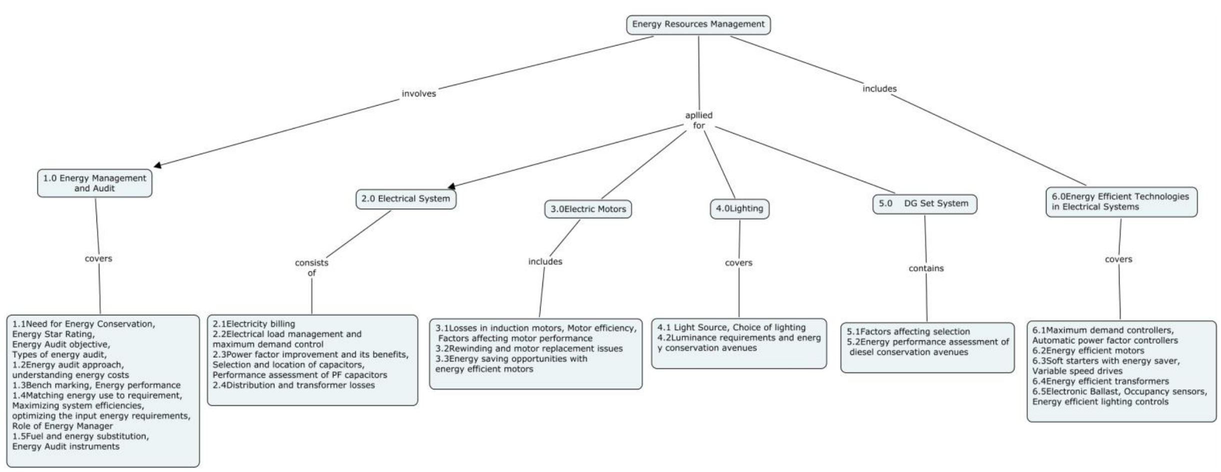
1. Specify the role of Turbo chargers.
2. List the energy savings opportunities in an industrial DG Set plant.
3. The Specific Fuel Consumption of a 500KVA Diesel Generating Set is 3.2kWh per litre of Diesel at 40% Load Factor. If the Load Factor is improved from 40% to 70%, the Specific Fuel Consumption is 3.8kWh per litre of Diesel. Calculate the fuel saving per day because of the load factor improvement.

Course Outcome 6 (CO6)

1. Specify the advantages of energy efficient motors.

2. Explain why centrifugal machines offer the greatest savings, when operating with Variable speed drives.
3. Mention the role of demand controller in industrial plants.
4. What is the function of Automatic Power factor controller?
5. A 500KVA 11KV/415V Transformer was proposed to buy for an Industrial application. The conventional Core Transformer Cost Rs. 2,50,000/-, whereas the Energy Efficient Amorphous core Transformer cost Rs.2,90,000/-. The Iron losses of Conventional and Amorphous core Transformers are 2200 Watts and 800Watts respectively. The copper losses for the both the transformers are same. Calculate the payback period for the excess investment paid for the Energy efficient Amorphous core transformer, when compared to conventional core Transformer. The cost of Electrical Energy is Rs.5 per kWh and the Transformer proposed to operate for 8760 Hours in a year.
6. A Chemical industry planned to install a Maximum Demand Controller and an Automatic Power Factor Controller to minimize the Demand Cost. The existing Contracted Demand is 4500KVA and actual demand is 4375KVA. The electricity board billing is based on 90% of contracted demand or Actual demand reached, whichever is higher. The demand charge is Rs.400 per KVA per month. The existing power factor is 0.92 lagging. After installing the Maximum Demand Controller and Automatic Power factor controller, the Actual Maximum Demand reached is 3900KVA. The investment incurred in the Demand Saving measure is Rs. 9,00,000/-. Calculate the Demand Cost saving per year and Payback period for the above Encon proposal.

Concept Map



Syllabus

Energy Management and Audit –Need of Energy Conservation, Energy Star Rating/Green Labeling, Energy Audit objective, Types of energy audit, Energy audit approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, optimizing the input energy requirements, Fuel and energy substitution, Simple Payback calculation, Energy Audit instruments, Role of Energy Manager

Electrical System – Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefits, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses. (Case Studies)

Electric Motors – Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors. (Case Studies)

Lighting – Light Source, Choice of lighting, Luminance requirements and energy conservation avenues. (Case Studies)

DG Set System – Factors affecting selection, Energy performance assessment of diesel conservation avenues. (Case Studies)

Energy Efficient Technologies in Electrical Systems – Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic Ballast, Occupancy sensors, Energy efficient lighting controls. Checklist & Tips for Energy Efficiency in Electrical System.

Text Books

1. Book I - General aspect of energy management and energy audit, Second Edition 2005, By Bureau of Energy Efficiency, Ministry of Power, India.
2. Book III - Energy efficiency in electrical utilities, Second Edition 2005, By Bureau of Energy Efficiency, Ministry of Power, India.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**Energy Management and Audit**	
1.1	Need for Energy Conservation, Energy Star Rating, Energy Audit objective, Types of energy audit,	2
1.2	Energy audit approach, understanding energy costs	2
1.3	Bench marking, Energy performance	1
1.4	Matching energy use to requirement, Maximizing system efficiencies, optimizing the input energy requirements, Role of Energy Manager	2
1.5	Fuel and energy substitution, Simple Payback calculation Energy Audit instruments	2
2.0	**Electrical System**	
2.1	Electricity billing	2
2.2	Electrical load management and maximum demand control	1
2.3	Power factor improvement and its benefits, Selection and location of capacitors, Performance assessment of PF capacitors	2
2.4	Distribution and transformer losses	2
3.0	**Electric Motors**	
3.1	Losses in induction motors, efficiency, Factors affecting motor performance	2

Module No.	Topic	No. of Lecture Hours
3.2	Rewinding and motor replacement issues	2
3.3	Energy saving opportunities with energy efficient motors	1
4.0	**Lighting**	
4.1	Light Source, Choice of lighting	1
4.2	Luminance requirements and energy conservation avenues	2
5.0	**DG Set System**	
5.1	Factors affecting selection	1
5.2	Energy performance assessment of diesel conservation avenues	1
6.0	**Energy Efficient Technologies in Electrical Systems**	
6.1	Maximum demand controllers, Automatic power factor controllers	2
6.2	Energy efficient motors	2
6.3	Soft starters with energy saver, Variable speed drives	1
6.4	Energy efficient transformers	2
6.5	Electronic Ballast, Occupancy sensors, Energy efficient lighting controls	1
6.6	Checklist & Tips for Energy Efficiency in Electrical System.	1
	Total	**35**

Course Designers:

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14EERD0	OPERATION AND MAINTENANCE OF ELECTRICAL EQUIPMENT	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course will provide the possible technical and practical information required for ensuring correct operation, maintenance and troubleshooting of electrical equipments and systems such as transformer, motor, generator, substation, switchgear & transmission and distribution system.

Prerequisite

- 14EE320: Transformers
- 14EE330: DC Machines
- 14EE440: AC Machines
- 14EE630: Transmission and Distribution

Course Outcomes

On the successful completion of the course, students will be able to

CO No	Course Outcomes	Bloom's Level	Expected Proficiency	Expected Attainment
CO1	Describe the causes of electrical accidents, safety measures and regulations.	Understand	80%	75%
CO2	Describe earthing concept, different methods of earthing, earth resistance and its measurement.	Understand	80%	75%
CO3	Discuss the fundamentals of different types of maintenance and its procedures and records.	Understand	80%	75%
CO4	Explain the operation andmaintenance practices for various electrical equipment and systems.	Understand	80%	75%
CO5	Apply suitable troubleshooting practices for various electrical equipment and systems.	Apply	70%	60%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	L										
CO2.	M	L										
CO3.	M	L										
CO4.	M	L										
CO5.	S	M	L	L								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	50	50	50
Apply	30	30	30	30
Analyse	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--

Course Level Assessment Questions

Course Outcome 1 (CO1):

1) Explain the various causes for accident and also explain the role of safety engineer.
2) List the unsafe operating conditions.
3) Specify the few safety regulations in Indian electricity act.
4) Explain the operation of different types of fire extinguishers.

Course Outcome 2 (CO2):

1) Is it necessary to run a continuous earth wire on the overhead line posts? Why?
2) Why earthing is necessary for electrical equipments?
3) Describe how an earth electrode is provided.
4) Describe the volt – ammeter method of testing earths.
5) Describe an earth loop tester.

Course Outcome 3 (CO3)

1) What are the records to be maintained for maintenance purpose?
2) Explain the Preventive Maintenance Procedure in detail.
3) List the various data to be recorded in the History card of an equipment.
4) Under which condition Production maintenance is preferred and explain its procedure?

Course Outcome 4 (CO4)

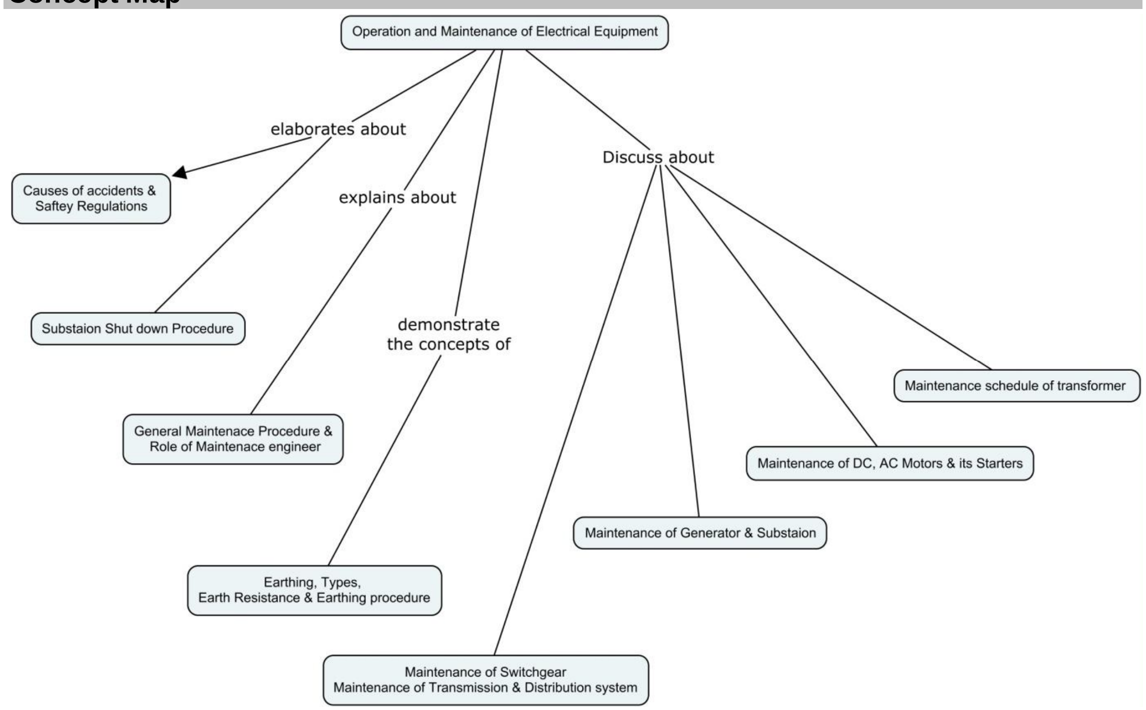
1) Illustrate the manner in which heat produced inside a transformer is dissipated.
2) How heavy a single phase load can be connected to a three phase transformer?
3) What will be the starting torque of a synchronous motor?
4) Connecting 3000 kVA and 1000 kVA transformers in parallel, each with 5.75% impedance, each with the same turn ratios, connected to a common 4000 kVA load. What is the loading on each transformer?
5) Why should the generator characteristics be similar for parallel operation?
6) What is the principle of operation of a lightning arrestor?
7) What are the safety devices used on overheadlines?

8) State the sequence of operation of isolator, C.B and earthing switch while opening and closing.
9) Summarize the substation shut down procedure.
10) Illustrate the need of reverse current protection.
11) Illustrate the calculations of most economical voltage determined for transmitting a given power over a known distance.

Course Outcome 5 (CO5)

1) Illustrate the precautions, which are necessary for resuming supply.
2) If a motor starter's overload mechanism trips frequently what action will you suggest?
3) How do you ensure proper operation of circuit breakers, in the event of fault?
4) Choose a suitable type of fire extinguisher when fire occurs near the oil tank of a transformer and explain the operation of the extinguisher.
5) Prepare an action plan, for the following complaints raised by a consumer.
   (i) Abnormal Power Consumption, (ii) Lamps Burning out frequently & (iii) Dim Light

Concept Map



Syllabus

Electrical Accidents and Safety: Causes of electrical accidents – Factors affecting severity of electrical shock - Actions to be taken when a person gets attached to live part - Safety regulations and safety measures- Indian electricity supply act 1948-1956; Factory Act -1948; Fire extinguishers- Building Electrical Installations – Annual Inspection, Safe working of Electrical Equipments

Earthing: Necessity of earthing - System earthing: advantage of neutral earthing of generator in power station; Equipment earthing: Objective - Types of earth electrodes -

Methods of earthing : plate earthing, pipe earthing and coil earthing - Earthing in extra high voltage and underground cable, Earthing resistance- factors affecting, Determination of maximum permissible resistance of the earthing system - Comparison between equipment earthing and system grounding - Earthing procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line.

Maintenance: Types and Importance of Plant maintenance, Preventive, Breakdown and Production - Preventive maintenance: need, classification, advantages, activities, Frequency of maintenance- Breakdown maintenance: concept, advantages - Maintenance Records, Role of Maintenance Engineer.

Transformer, Motors (DC and AC) and Starters: Maintenance schedule of transformer ***(***Below and above 1000kVA)**:** - Insulation co-ordination and Impulse voltage testing- Lightning arrestor. Maintenance and Troubleshooting - Oil Purification and Testing. Maintenance of DC, AC Motors and their Starters: – Operation, Routine andBreakdown Maintenance, Causes of failure, Precautions andTrouble shooting.

Generator and Substation: Maintenance of Generator: Operation, Routine and breakdown Maintenance, Causes of Failure and Precautions. Maintenance of Substation**:** Operation, Routine & breakdown Maintenance, Causes of Failure and Precautions. Sub-station shut down procedure - certificate of requisition for shut down; certificate of Permit to work and certificate of Line clear - Instruction for the safety of persons working on a job with a permit to work.

Switchgears, Transmission and Distribution system: Maintenance of Switchgear: – Operation, Routine and breakdown Maintenance, Causes of Failure and Precautions. Maintenance of Transmission and Distribution system: – Rules for Low, Medium and High voltages, Factor of safety, precautions - Minimum Clearance, Conductors, System protection.

Text Book

1. B.V.S.Rao, “Operation and Maintenance of Electrical Equipment”, Volume I & II, 2008 Edition, Media Promoters & Publishers Pvt. Ltd., Mumbai.

Reference Books

1. S. Rao, “Testing Commissioning Operation and Maintenance of Electrical Equipments”, Sixth Edition, Khanna Publishers, New Delhi, 2010.
2. Tarlok Singh, “Installation Commissioning and Maintenance of Electrical Equipments”, First Edition, S. K. Kataria & Sons, 2013.
3. Paul Gill, “Electrical Power Equipment Maintenance and Testing”, Second Edition, CRC Press, 2013.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1.	**Electrical Accidents and Safety**	
1.1	Causes of electrical accidents – Factors affecting severity of electrical shock - Actions to be taken when a person gets attached to live part	2
1.2	Safety regulations and safety measures- Indian electricity supply act 1948-1956; Factory Act -1948	2
1.3	Fire extinguishers	2

Module No.	Topic	No. of Lectures
1.4	Building Electrical Installations – Annual Inspection, Safe working of Electrical Equipments	2
2.	**Earthing**	
2.1	Necessity of earthing - System earthing: advantage of neutral earthing of generator in power station; Equipment earthing: Objective - Types of earth electrodes	2
2.2	Methods of earthing : plate earthing, pipe earthing and coil earthing - Earthing in extra high voltage and underground cable, Earthing resistance- factors affecting	2
2.3	Determination of maximum permissible resistance of the earthing system - Comparison between equipment earthing and system grounding	2
2.4	Earthing procedure - Building installation, Domestic appliances, Industrial premises, Earthing of substation, generating station and overhead line.	2
3.	**Maintenance**	
3.1	Types and Importance of Plant maintenance, Preventive, Breakdown and Production - Preventive maintenance: need, classification, advantages, activities, Frequency of maintenance-	2
3.2	Breakdown maintenance: concept, advantages - Maintenance Records, Role of Maintenance Engineer	2
4.	**Transformer, Motors (DC and AC) and Starters**	
4.1	Maintenance schedule of transformer ***(***Below and above 1000kVA)***:***	3
4.2	Insulation co-ordination and Impulse voltage testing-Lightning arrestor.	3
4.3	Maintenance and Trouble shooting-Oil Purification & Testing.	3
4.4	Maintenance of DC, AC Motors and their Starters: – Operation, Routine and Breakdown Maintenance, Causes of failure, Precautions and Trouble shooting.	3
5.	**Generator and Substation**	
5.1	Maintenance of Generator: Operation, Routine and breakdown Maintenance, Causes of Failure & Precautions.	3
5.2	Maintenance of Substation**:** Operation, Routine and breakdown Maintenance, Causes of Failure & Precautions.	2
5.3	Sub-station shut down procedure - certificate of requisition for shut down; certificate of Permit to work and certificate of Line clear - Instruction for the safety of persons working on a job with a permit to work.	2
6	**Switchgears, Transmission and Distribution system**	
6.1	Maintenance of Switchgear: – Operation, Routine & breakdown Maintenance, Causes of Failure and Precautions.	3
6.2	Maintenance of Transmission and Distribution system: – Rules for Low, Medium and High voltages,	3
6.3	Factor of safety, precautions - Minimum Clearance, Conductors, System protection	2
	Total	45

Course Designers:

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		Category	L	T	P	Credit
14EERE0	**AUTONOMOUS VEHICLES**	PE	3	0	0	3

Preamble

Today's procedural-software-driven computer controllers are limited by the amount of programming and decision-making "intelligence" passed onto it by a human programmer or engineer. The biggest challenge for the 21st century is to make robots and machines "intelligent" enough to learn how to perform tasks automatically and adapt to unforeseen operating conditions or errors in a robust and predictable manner, without the need for human guidance, instructions or programming.

The autonomous vehicle exists to apply, develop and promote technology related to the field of robotics, driverless car, Automated Guided Vehicle (AGV), underwater vehicle and unmanned aerial vehicle (UAV). It is for the students from all disciplines, particularly mechatronics engineering to apply the principles and technology of autonomous vehicle. It concerned with the principles of locomotion, kinematics, sensors, localization and navigation of autonomous vehicles like mobile robot.

Prerequisite

14EE460 Microcontrollers
14EEPP0 Robotics

Course Outcomes

On the successful completion of the course, students will be able to

Sl.No	Outcomes	Blooms Level	Expected Proficiency	Expected Outcome
CO1	Describe the structure of Automated guided and autonomous Vehicles	Understand	70	60
CO2	Explain the mobility requirements of an autonomous vehicle	Understand	70	60
CO3	Describe the mechanical system behaviour and motion control through kinematics	Understand	70	60
CO4	Select suitable sensors for mobile robot application	Apply	70	60
CO5	Implement the concept of localization and navigation for path planning through different algorithms	Apply	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	M	L									
CO2	M	L									

CO3	M	L									
CO4	S	M	L	L							
CO5	S	M	L	L							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	20	20	10
Understand	60	40	40	30
Apply	0	40	40	60
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. Describe the structure of automated guided vehicle (AGV) and its monitoring systems.
2. Explain the architecture of unmanned ground vehicle and mention any four of its applications.
3. Discuss the classification of bio-inspired robots in terms of locomotion.

Course Outcome 2 (CO2)**:**

1. Define controllability.
2. Describe four wheel types for mobile robots.
3. Explain various parameters involved in the design of wheeled locomotion.

Course Outcome 3 (CO3)**:**

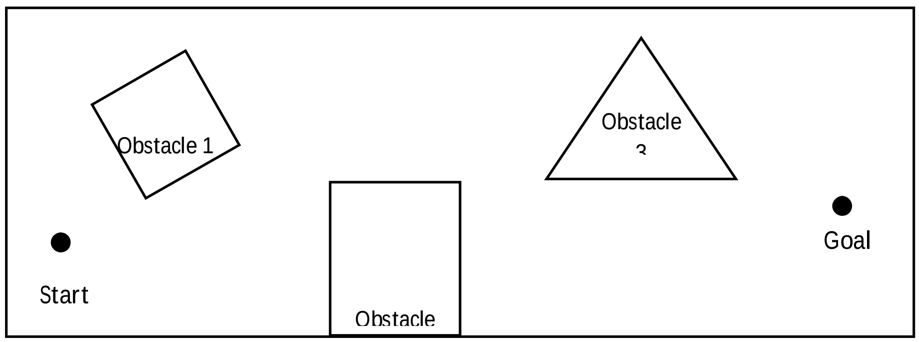
1. Explain the forward kinematic model of a wheeled mobile robot.
2. With use of simple sketches, explain the working of castor wheel for steering.
3. Describe the open loop motion control to follow a trajectory described by its position trajectory profile.

Course Outcome 4 (CO4)**:**

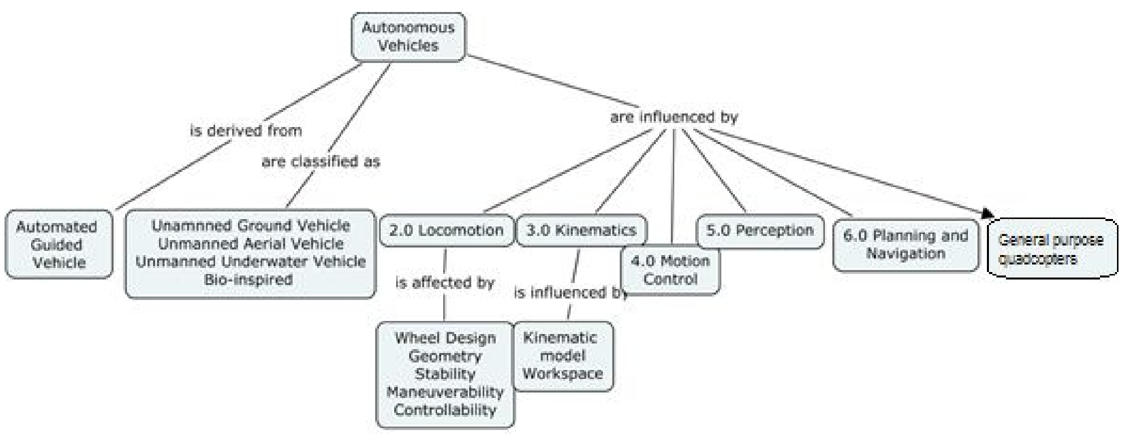
1. Explain how the sensors are classified.
2. Select suitable sensors for pick and place mobile robot to carry one kg of a component which operates within 10 meters.
3. Suggest a suitable sensor for collision avoidance between the moving vehicles in a straight line.

Course Outcome 5 (CO5):

1. Describe the general schematic for mobile robot localization.
2. Explain the architecture for behaviour-based navigation with use of block diagram.
3. Generate Voronoi diagram for determining the feasible path between destination as shown in figure 1.



Concept Map



Syllabus

Automated Guided Vehicle: Type, structure and safety aspects. **Autonomous Vehicles:** Definition of autonomy, Classification- Unmanned Ground Vehicle (UGV), Unmanned Aerial Vehicle (UAV), Unmanned Underwater Vehicle (UUWV)and Bio-inspired robots. **Locomotion**: Introduction, key issues for locomotion, wheeled locomotion-wheel design, geometry, stability, maneuverability and controllability. **Mobile Robot kinematics**: kinematic model and constraints, Mobile robot workspace-motion control. **Perception:** sensors for mobile robots-classification, characterizing sensor performance, wheel or motor sensors, heading sensors, ground-based beacons, active ranging, motion/speed sensors, introduction to vision based sensor, Global Positioning Systems (GPS) – Blue tooth interface. **Mobile robot localization:** challenges, localization based on navigation versus programmed solutions, map representation, probabilistic map-based localization. **Planning and navigation:** planning and reacting- path planning, road map path planning, cell decomposition path planning, potential field path planning, navigation architecture-techniques for decomposition, offline planning. **General purpose Quadcopters** – Selection of motors and propellers, Electronic speed controllers (ESC), Control of Quadcopters

Reference Books/Learning Resources

1. Roland Siegwart and Illah R.Nourbakhsh, "Introduction to Autonomous Mobile Robots", Prentice Hall of India (P) Ltd., 2005.
2. George A. Bekey, "Autonomous Robots – From Biological Inspiration to Implementation and control", MIT Press, 2005.
3. Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavraki and Sebastian Thrun, "Principles of Robot Motion – Theory, Algorithms and Implementation", MIT Press, 2005.
4. Mikell P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Learning, Third Edition, 2009.

Course Contents and Lecture Schedule

S.No	Topics	No. of Lectures
1	**Automated Vehicles**	
1.1	**Automated Guided Vehicle (AGV)** - Type, structure safety aspects	1
1.2	**Autonomous Vehicles:** Definition of autonomy	1
1.2.1	Classification- Unmanned Ground Vehicle (UGV), Unmanned Aerial Vehicle (UAV), Unmanned Underwater Vehicle (UUWV)and Bio-inspired robots	1
2	**Locomotion**	
2.1	Introduction, Key issues for locomotion	1
2.2	Wheeled locomotion-wheel design	2
2.3	Geometry, stability, manoeuvrability and controllability	2
3	**Mobile Robot kinematics**	
3.1	Kinematic model and constraints	2
3.2	Mobile robot workspace-motion control	2
4	**Perception**	
4.1	Classification of Sensors for mobile robots	1

S.No	Topics	No. of Lectures
4.1.1	Characterizing sensor performance	1
4.2	Wheel or motor sensors, heading sensors	1
4.2	Ground-based beacons, active ranging	1
4.3	Motion/speed sensors, introduction to vision based sensor	1
5	**Mobile robot localization**	
5.1	Introduction - challenges	1
5.2	Localization based on navigation versus programmed solutions	1
5.3	Map representation	1
5.3.1	Probabilistic map-based localization	2
6	**Planning and navigation**	
6.1	Planning and reacting - path planning	1
6.2	Road map path planning, cell decomposition path planning	2
6.3	Potential field path planning	2
6.4	Navigation architecture	1
6.4.1	Techniques for decomposition, offline planning	2
7	**General purpose Quadcopters**	
7.1	Selection of motors and propellers	2
7.1.1	Electronics speed controllers	1
7.1.2	Control of quadcopters	4
	Total	**37** Hours

Course Designers:

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		Category	L	T	P	Credit
14EERF0	**INDUSTRIAL INSTRUMENTATION**	PE	3	0	0	3

Preamble

Instrumentation is the science of automated measurement and control. It is a collective term for measuring instruments used for indicating, measuring and recording physical quantities. Applications of this science abound in modern research, industry, and even in household. From automobile engine control systems to home thermostats to aircraft autopilots to the manufacture of pharmaceutical drugs, automation surrounds us. This course covers some of the fundamental principles of industrial instrumentation.

Prerequisite

- 14EE340 : Measurement Systems
- 14EE420 : Instrumentation Systems

Course Outcomes

On the successful completion of the course, students will be able to

CO No	Course Outcome	Blooms category	Expected Proficiency (%)	Expected attainment level(%)
CO1	Explain the principle and operating characteristics of Force and torque measuring techniques (CO1)	Understand	85	70
CO2	Explain the principle and operating characteristics of Acceleration and Vibration measuring techniques (CO2)	Understand	85	70
CO3	Apply suitable technique for measurement of Flow and Level for a given application (CO3)	Apply	85	70
CO4	Explain the principle and operating characteristics of Viscosity measuring techniques (CO4)	Understand	85	70
CO5	Apply suitable technique for measurement of high temperature and Pressure for a given application (CO5)	Apply	85	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	M	**L**										
CO2.	M	**L**										

CO3	S	**M**	**L**									
CO4	M	**L**										
CO5	S	**M**	**L**									

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	
Remember	20	20	20	20
Understand	80	60	60	60
Apply		20	20	20
Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO1):

6. List the commonly used scales in force measurement.
7. Draw and explain the operation of pneumatic load cell.
8. Write the ways to measure the shaft power.

Course Outcome 2 (CO2):

1. Mention the two specific needs for measuring acceleration.
2. Draw the general block diagram of accelerometer.
3. Define vibration and write the need for measuring the same.

Course Outcome 3 (CO3):

1. Explain the principle of orifice plates.
2. Illustrate the construction and operation of Electromagnetic flow meter.
3. Distinguish between the float and displacer type liquid level gauges and justify the away the change in the density of the liquid is taken into account in these gauges.

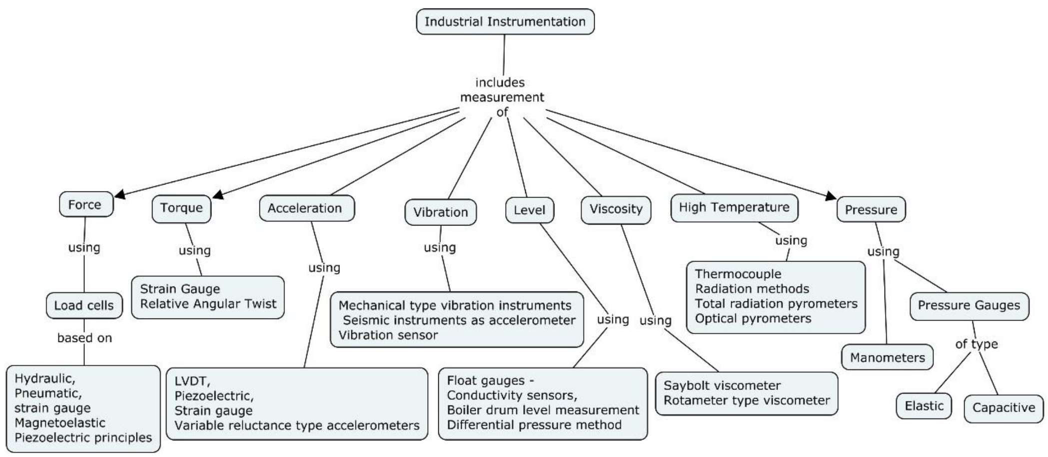
Course Outcome 4 (CO4):

1. Define viscosity.
2. Explain the operation of Saybolt viscometer.
3. List the three physical principles used in Instruments for measuring viscosity.

Course Outcome 5(CO5):

1. The liquid in a well manometer has a specific weight of 40 lb/ft3. How far will the liquid rise in the smaller leg, if the pressure in the larger leg is 1.5 lb/ft2 higher than in the smaller leg?
2. Recommend the type of manometer for measuring the pressure inside a reheating furnace. Justify the same.
3. A furnace wall 12 ft2 in area and 6-in thick has a thermal conductivity of 0.14 BTU/h ft°F. Estimate the heat loss if the furnace temperature is 1100°F and the outside of the wall is 102°F?

Concept Map



Syllabus

MEASUREMENT OF FORCE, TORQUE
Different types of load cells - Hydraulic, Pneumatic, strain gauge- Magneto-elastic and Piezoelectric load cells - Different methods of torque measurement: - Strain gauge-Relative angular twist

MEASUREMENT OF ACCELERATION, VIBRATION
Accelerometers LVDT, Piezoelectric, Strain gauge and Variable reluctance type accelerometers - Mechanical type vibration instruments - Seismic instruments as accelerometer - Vibration sensor - Calibration of vibration pickups

FLOW MEASUREMENTS
Orifice plate different types of orifice plates , Difference between area flow and mass flow meters, Venturi tube — Flow nozzle -- Principle and construction and details of Electromagnetic flow meter — Ultrasonic flow meters

LEVEL & VISCOSITY MEASUREMENT
Float gauges - Electrical types: Conductivity sensors, Boiler drum level measurement - Differential pressure method,

VISCOSITY MEASUREMENT
Viscosity — Saybolt viscometer-Rotameter type viscometer

HIGH TEMPERATURE MEASUREMENTS:
Special techniques for measuring high temperature using thermocouple -Radiation fundamentals - Radiation methods of temperature measurement - Total radiation pyrometers -Optical pyrometers

PRESSURE MEASUREMENT

Units of pressure - Manometers, different types, Elastic type pressure gauges Capacitive type pressure gauge

Case Study on application of above discussed measurement in Boiler, Furnace process.

Text Book

1. Patranabis, D. Principles of Industrial Instrumentation, 3rd Edition, Tata McGraw Hill, New Delhi, 2010.
2. Doebelin, E.O.andManik,D.N., Measurement Systems Application and Design, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.

Reference Books

1. Liptak, B.C., Instrumentation Engineers Handbook (Measurement), CRC Press, 2005.
2. Singh,S.K., Industrial Instrumentation and Control, 3rd edition, McGrawHill Education., New Delhi, 2015.
3. Jain, R.K., Mechanical and Industrial Measurements, 12th edition, Khanna Publishers, Delhi, 2011.
4. A. K. Sawhney, PuneetSawhney Course in Mechanical Measurements and Instrumentation and Control, Dhanpat Rai & Sons, New Delhi, 1997.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures
1	**MEASUREMENT OF FORCE, TORQUE:**	
1.1	Different types of load cells, Hydraulic, Pneumatic, strain gauge- Magneto-elastic and Piezoelectric load cells	3
1.3	Different methods of torque measurement:- Strain gauge-Relative angular twist	2
2	**MEASUREMENT OF ACCELERATION, VIBRATION:**	
2.1	Accelerometers: - LVDT, Piezoelectric,	1
2.2	Strain gauge and Variable reluctance type accelerometers	1
2.3	Mechanical type vibration instruments - Seismic instruments as accelerometer	2
2.4	Vibration sensor - Calibration of vibration pickups	1
3	**FLOW MEASUREMENTS:**	
3.1	Orifice plate different types of orifice plates	3
3.2	Difference between area flow and mass flow meters	1
3.3	Venturi tube — Flow nozzle	2
3.4	Principle and constructional details of Electromagnetic flow meter	2
3.5	Ultrasonic flow meters	1
4	**LEVEL MEASUREMENT :**	
4.1	Float gauges - Displacer type, DIP methods	1
4.2	Bubbler system-Load cell Electrical types: Conductivity sensors	1
4.3	Boiler drum level measurement - Differential pressure method	1
5	**MEASUREMENT OF VISCOSITY:**	
5.1	Viscosity	1
5.2	Saybolt viscometer	1

Module No.	Topic	No. of Lectures
5.3	Rotameter type viscometer	1
6.1	**HIGH TEMPERATURE MEASUREMENTS:**	
	Special techniques for measuring high temperature using thermocouple	2
6.2	Radiation fundamentals: Radiation methods of temperature measurement -	3
6.3	Total radiation pyrometers , Optical pyrometers	2
7	**PRESSURE MEASUREMENT:**	
7.1	Units of pressure - Manometers, different types,	2
7.2	Elastic type pressure gauges	1
7.3	Capacitive type pressure gauge	1
	Total	36

Course Designers:

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B.E. Electrical and Electronics Engineering Degree Programme

LIST OF PROGRAMME ELECTIVE COURSES
(For the students admitted from 2014-15)

S.No.	Course Code	Course Title	Credits
Electrical Energy Systems			
1.	14EEPA0	Modelling of Electrical Machines	3
2.	14EEPB0	Demand Side Management	3
3.	14EEPC0	Design of Electrical Installations	3
4.	14EEPD0	Smart Grid	3
5.	14EEPE0	Power System Operation and Control	3
6.	14EEPF0	Power System Stability	3
7.	14EEPG0	Power System Protection	3

S.No.	Course Code	Course Title	Credits
Analog & Digital Electronic Systems			
1.	14EEPH0	VLSI design	3
2.	14EEPN0	Embedded Systems Design	3
3.	14EEPJ0	FPGA based System Design	3
4.	14EEPK0	Digital Signal Processor	3
5.	14EEPL0	Biomedical Instrumentation	3
6.	14EEPM0	Real Time Operating System	3

S.No.	Course Code	Course Title	Credits
Control and Automation			
1.	14EEPT0	Virtual Instrumentation	3
2.	14EEPP0	Robotics	3
3.	14EEPQ0	Automotive Electronics	3
4.	14EEPR0	Automotive Fundamentals and Manufacturing	3
5.	14EEPS0	Soft Computing	3

S.No.	Course Code	Course Title	Credits
Power Electronics and Drives			
1.	14EEPU0	Design of Power Supplies	3
2.	14EEPV0	FACTS and Custom Power Devices	3
3.	14EEPW0	HVDC Transmission	3
4.	14EEPY0	Electrical Power Quality	3
5.	14EEPZ0	Special Machine Drives	3
6.	14EEP10	Power Electronics for Renewable Energy Systems	3
7.	14EEP20	Simulation of Power Electronic Systems	3

List of ONE / TWO credits proposed and it will be offered by Experts from Industry

S.No.	Course Code	Course Title	Credits
1.	14EE2A0	Electric Traction	2
2.	14EE2B0	Electric vehicle	2
3.	14EE1C0	IoT in EEE	1
4.	14EE1D0	Nuclear Power Plant	1
5.	14EE1E0	Solar Power Plant	1
6.	14EE1F0	Intelligent Sensors	1
7.	14EE1G0	GIS and SS Automation	1
8.	14EE1H0	Design of LV Robust Distribution System	1
9.	14EE1J0	Lead Acid Battery Technology	1
10.	14EE1K0	Design of Power Supplies	1
11.	14EE1L0	Micro Grid	1
12.	14EE1M0	Safety Engineering	1
13.	14EE1N0	Power Grid Operation	1
14.	14EE1P0	Indian Electrical Standards	1
15.	14EE1Q0	EEE Applications in Missile Technology	1
16.	14EE1R0	Illumination Design	1
17.	14EE1s0	Power Quality in Industries	1
18.	14EE1T0	Electrical Substation Engineering	1
19.	14EE1U0	Management of Power Sector in India	1

List of General Elective courses proposed and it will be offered to other Branch students

S.No.	Course Code	Course Title	Credits
1.	14EEGA0	Renewable Energy Sources	3
2.	14EEGB0	Domestic and Industrial Electrical Installations	3
3.	14EEGC0	Industrial Safety and Environment	3
4.	14EEGD0	Soft Computing	3
5.	14EEGE0	Sensors and Transducers	3
6.	14EEGF0	Energy Conservation Practices	3
7.	14EEGG0	System Approach for Engineers	3

14EEPCO	DESIGN OF ELECTRICAL INSTALLATIONS	Category	L	T	P	Credit
		PE	2	2	0	3

Preamble

Design of Electrical Installations course will illustrate the correct procedure for basic design of installations from initial assessment to final commissioning. The Electrical Installation must be primarily concerned with the safety of persons, property and livestock. The selection of appropriate systems and associated equipment and accessories is an integral part of the design procedure, and as such cannot be addressed in isolation. For example, the choice of a particular type of protective device may have a considerable effect on the calculation of cable size or shock risk, or the integrity of conductor insulation under fault conditions.

Prerequisite

14EE220 Material Science for Electrical Engineering
14EE270 Electric Circuits Analysis
14EE320 Transformers
14EE440 AC Machines

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course Outcomes	Blooms Level
CO1.	Describe the General rules of Electrical Installations design as per the Indian Electricity Rules	Understand
CO2	Design of Electrical Installations based on equipment ratings	Apply
CO3	Discuss the Selection of a right type of Sub-station for an Electrical System	Understand
CO4	Calculate the Size of LV Distribution System Components for a specified Electrical System	Apply
CO5	Draw the Electrical Plan and Selection of System components for the given specification of Residential Electrical Installations.	Apply
CO6	Choose the right type and Ratings of electrical safety and protective devices against electrical hazards	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M							S				

CO2	**S**	**M**	**L**									**L**
CO3	**M**	**M**	**L**	**L**								
CO4	**S**	**M**	**L**									**L**
CO5	**S**	**M**				**L**						**L**
CO6	**S**	**M**				**L**	**L**	**L**				

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse				
Evaluate	--	--	-	--
Create	--	--	-	--

Course Level Assessment Questions
Course Outcome 1 (CO1):

1. Specify the role of Cut-out on Consumer's premises
2. Explain the identification of earthed and earthed neutral conductors & position of switches and cut-outs.
3. Explain the need of periodical and testing of consumer's installation.
4. Explain in detail the points to be inspected while carry out an annual inspection in a commercial complex.
5. Discuss about the guidelines for electrical contractors for wiring and earthing.

Course Outcome 2 (CO2):

1. State the nature of starting current drawn by an induction motor.
2. Define contracted demand and maximum demand.
3. Select a Suitable Size of Transformer in KVA for an Industry has the following connected load. The recommended load factor of the transformer will be 60%. The diversity factor of the load is 1.2.

Type of Load	Rating
Induction Motors	450HP

Lighting System	25kW
Electric Oven	100kW

Course Outcome 3 (CO3).

1. List the various types of Sub-station
2. Discuss the factors to be considered, while selecting a sub-station for an Industrial power Distribution.
3. Explain the procedure for the establishment of a new sub-station.
4. Discuss the choice of selecting of Power Generation Source for an Industrial Unit.

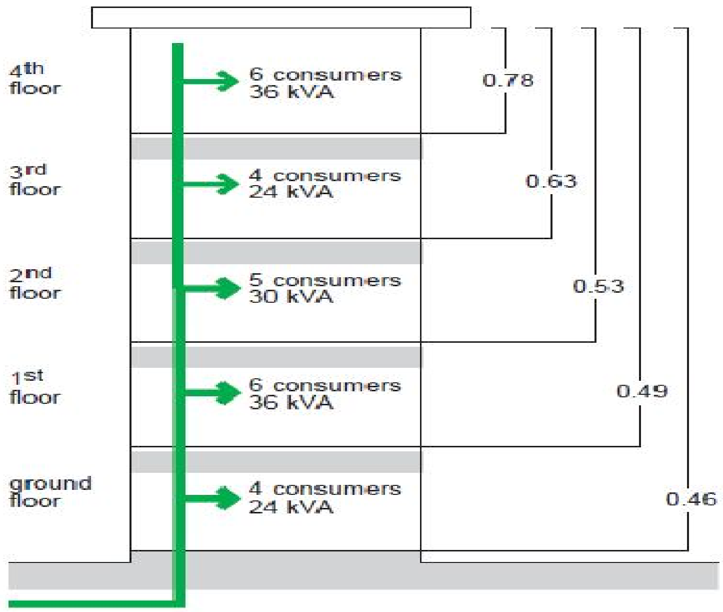
Course Outcome 4 (CO4)

1. List the basic components of a Power Distribution System.
2. Calculate the MCB Ratings of the Main Distribution Board supplying power to a workshop have the following connected loads.

Equipment Name	Apparent Power in kVA	Utilization Factor	Diversity Factor
Lathe No.1	5	0.8	0.75
Lathe No.2	5	0.8	0.75
Lathe No.3	5	0.8	0.75
Lathe No.4	5	0.8	0.75
Pedestal Drill No.1	2	0.8	0.60
Pedestal Drill No.2	2	0.8	0.60
5Nos. of Socket Outlets 16Amps	18	1	0.20
30Nos. Fluorescent Lamp	3	1	1.00

Course Outcome 5 (CO5)

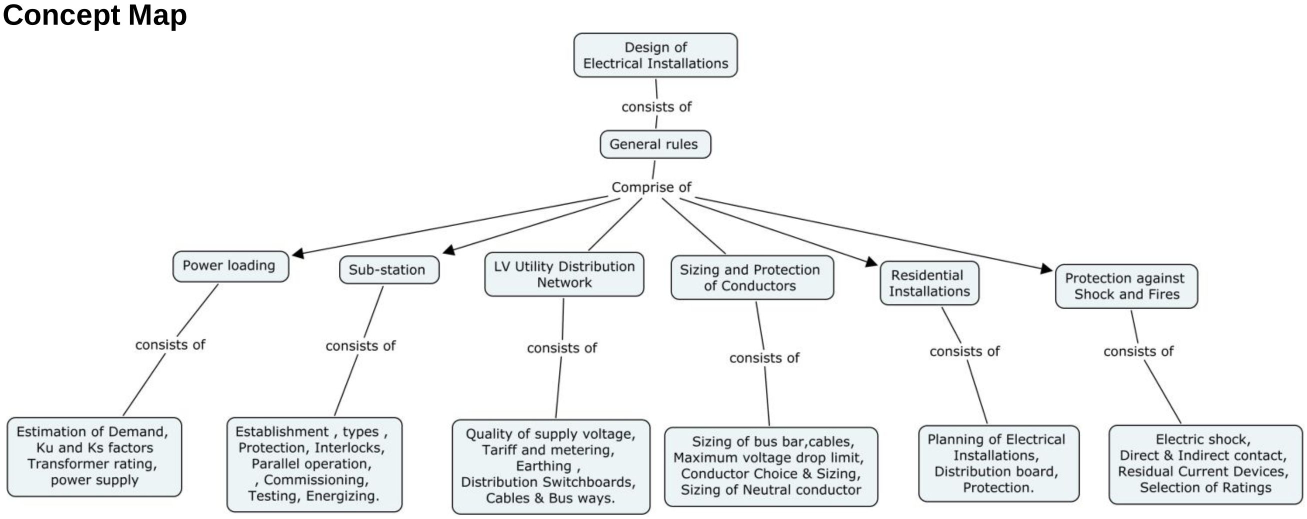
1. List the basic components of Domestic Wiring Systems.
2. State the advantages of Concealed Wiring.
3. Design a single phase power distribution system for your house and draw the single line diagram of the same.
4. 5 storey's apartment building with 25 consumers, each having 6 kVA of installed load. The total installed load for the building is: 36 + 24 + 30 + 36 + 24 = 150 kVA. The apparent-power supply required for the building is: 150 x 0.46 = 69 kVA. From the given Figure. Determine the magnitude of currents in different sections of the common main feeder supplying all floors. For vertical rising mains fed at ground level, the cross-sectional area of the conductors can evidently be progressively reduced from the lower floors towards the upper floors.



Course Outcome 6 (CO6)

1. Discuss the protective devices in electrical installations.
2. State the purpose of Interlocks and mention the condition of operation.
3. Explain the provision of Interlocks to avoid the contacts between Electricity Board Supply with the Captive Power Supply with a diagram.

Concept Map



Syllabus

General rules of electrical installation design : Methodology & Characteristics of Installed power loads - Rules and statutory regulations- Voltage Ranges, Standards, Quality & Safety of an electrical installation, Initial Testing of Installation, Periodic Check& Testing of Installation-– Induction motors, Induction Furnace, Resistive type heating applications, Lamps.

Power loading of an installation : Installed Power & Apparent Power, Estimation of Actual Maximum KVA Demand, Shunt Compensation, Automatic Power Factor Correction, Application of factors Ku and Ks, Choice of Transformer rating, Choice of power supply sources.

Sub-station : Establishment of a new sub-station, Different types of sub-station, Protection of Transformer, Interlocks & conditioned operations, information & requirement provided by utility, Parallel operation of transformers, Generators in stand-alone operation, Generators in parallel operation mode, Commissioning, Testing, Energizing.

LV Utility Distribution Network : Low voltage consumers, Low voltage networks, Consumer service connection, Quality of supply voltage, Tariff and metering, Earthing connections, Standardized earthing schemes, Installation and measurements of earth electrodes, Distribution Switchboards, Cables & Busbar.

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Sizing and Protection of Conductors : Recommended simplified approach for cables, Sizing of bus bar trunking systems, Maximum voltage drop limit, Calculation of voltage drop in steady load conditions, Short circuit current, Calculation of minimum levels of short circuit current, Conductor Choice & Sizing, Sizing of Neutral conductor, Protection & Isolation of Neutral conductor, Examples of cable calculation.

Residential Installations: Planning of Electrical Installations, Distribution board components selection, Protection of People, Circuits, Protection against over voltages & Lightning, Equi-potential Bonding.

Protection against Electric Shock and Electric Fires – Electric shock, Direct & Indirect contact, Measures of protection against direct contact, Measures of protection against indirect contact, Residual Current Devices, Arc Fault Detection Devices, Selection of Ratings.

Text Books

1. Schneider Electric "Electrical Installation Guide", Schneider Electric Industries - SAS, 2016 Year Edition, 2016.
2. BUREAU OF INDIAN STANDARDS, "National Electrical Code 2011", Government of India, 1st Revision 2011.

Reference Books

1. Siemens "Planning of Electrical Power Distribution – Technical Principles", Published by Siemens AG, Germany,2014
2. A.J.Watkins, C.Kitcher, " Electrical Installation Calculations - Basics", Elsevier Publications, 8th edition, 2009.
3. Brian Scadden," IEE Wiring Regulation : Design and Verification of Electrical Installations" Elsevier Publications, 6th edition,
4. Paul Cook, "Electrical Installation Design Guide", The Institution of Engineering & Technology, UK, 2nd Edition, 2013

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**General rules of electrical installation design**	
1.1	Methodology & Characteristics of Installed power loads, Rules and statutory regulations	3
1.2	Voltage Ranges, Standards, Quality & Safety of an electrical installation, Initial Testing of Installation, Periodic Check& Testing of Installation	2
1.3	Induction motors, Induction Furnace, Resistive type heating applications, Lamps	2
2.	**Power loading of an installation**	
2.1	Installed Power & Apparent Power, Estimation of Actual Maximum KVA Demand, Shunt Compensation, Automatic Power Factor Correction Application of factors Ku and Ks	3
2.2	Choice of Transformer rating, Choice of power supply sources.	2
3	**Sub-station**	
3.1	Establishment of a new sub-station, Different types of sub-station	2
3.2	Protection of Transformer, Interlocks & conditioned operations, information & requirement provided by utility, Parallel operation of transformers	2
3.3	Generators in stand-alone operation, Generators in parallel operation mode, Commissioning, Testing, Energizing.	2
4	**LV Utility Distribution Network**	
4.1	Low voltage consumers, Low voltage networks, Consumer service connection, Quality of supply voltage, Tariff and metering,	2
4.2	Earthing connections, Standardized earthing schemes, Installation and measurements of earth electrodes,	2
4.3	Distribution Switchboards, Cables & Busbar.	1
5.	**Sizing and Protection of Conductors**	
5.1	Recommended simplified approach for cables, Sizing of bus bar trunking systems, Maximum voltage drop limit, Calculation of voltage drop in steady load conditions	3
5.2	Short circuit current, Calculation of minimum levels of short circuit current	2
5.3	Conductor Choice & Sizing, Sizing of Neutral conductor, Protection & Isolation of Neutral conductor, Examples of cable calculation.	2
6.	**Residential Installations**	
6.1	Planning of Electrical Installations, Distribution board components,	3

Module No.	Topic	No. of Lecture Hours
	Protection of People, Circuits	
6.2	Protection against over voltages & Lightning, Equipotential Bonding.	1
7.	**Protection against Electric Shock and Electric Fires**	
7.1	Electric shock, Direct & Indirect contact, Measures of protection against direct contact, Measures of protection against indirect contact,	3
7.2	Residual Current Devices, Arc Fault Detection Devices, Selection of Ratings.	2
	Total	**39**

Course Designers:

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2. Dr.P.S.Manoharan psmeee@tce.edu

		Category	L	T	P	Credit
14EEPH0	**VLSI DESIGN**	PE	2	2	0	3

Preamble

VLSI stands for "Very Large Scale Integration". This is the field which involves packing more and more logic devices into smaller and smaller areas. This has opened up a big opportunity to do things that were not possible before. VLSI circuits are everywhere ... your computer, your car, your brand new state-of-the-art digital camera, the cell-phones, and what have you.

VLSI has been around for a long time, as a effect of advances in the world of computers, there has been a dramatic proliferation of tools that can be used to design VLSI circuits. Alongside, obeying Moore's law, the capability of an IC has increased exponentially over the years, in terms of computation power, utilisation of available area, yield. The combined effect of these two advances is that people can now put diverse functionality into the IC's, opening up new frontiers

VLSI is a technology that can be harnessed for various applications covering analog, digital and mixed signal electronics. The current trend is to reduce the entire system design to a single chip solution called as system on chip.

VLSI has become a major driving force in modern technology. It provides the basis for computing and telecommunications, and the field continues to grow at an amazing pace.

Prerequisite

14EE250 -Analog devices and circuits
14EE350- Digital Systems

Course Outcomes

On the successful completion of the course, students will be able to:

CO No.	Course outcomes	Bloom's Level
CO1	Explain the concept of MOS transistors and its characteristics	Understand
CO2	Describe the basics of CMOS fabrication techniques(n well, p well, Twin tub, SOI)	Understand
CO3	Describe the operation and applications of transmission gate and inverters	Understand
CO4	Apply layout rule in CMOS Logic circuits	Apply
CO5	Construct logic circuits using Pseudo NMOS, C^2MOS, dynamic CMOS .	Apply
CO6	Describe the I/O structure and VLSI Clocking.	Understand
CO7	Illustrate the testing of VLSI circuits.	Understand
CO8	Develop a model for given digital system using Hardware Description Language(VHDL)	Apply

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L										
CO2	M	L										
CO3	M	L										
CO4	S	M	L									
CO5	S	M	L									
CO6	M	L										
CO7	M	L										
CO8	S	M			S							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	30	40	40
Apply	20	50	40	40
Analyse	--	--	--	--
Evaluate	--	--	--	--
Create	--	--	--	--
Assignment - 3 Simulating VHDL code using ISE.				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define threshold voltage.
2. Consider the nMOS transistor in a 180nm process with a normal threshold voltage of 0.4V and doping level of 8.10^{17} cm^{-3}. The body is tied to ground with a substrate contact. How much does the threshold change at room temperature if the source is at 1.1V instead of 0. Assume $t_{ox} = 40^{o}A$.
3. Analyze the Gate capacitance effect of n-channel MOSFET

Course Outcome 2 (CO2):

1. Differentiate the positive and negative photo resist.
2. Explain N-well fabrication process with neat sketch.
3. List the advantages of SOI fabrication process.

Course Outcome 3 (CO3):

1. Illustrate 4X1 multiplexer using Transmission gate.
2. With neat diagrams and waveforms explain the DC characteristics of a complementary CMOS Inverter & also explain its various regions of operation.

3. An inverter uses FETs with $\beta n = 2.1 mA/V^2$ $\beta P = 1.8\ mA/V^2$. The threshold voltage of nFET and P FET is 0.60V and -0.70V respectively. It has a value of VDD= 4V. The parasitic capacitance at output node is 74fF.
   a) Find midpoint voltage.
   b) Find Rn and Rp
   c) Calculate rise and fall time when external load capacitance of 115fF is connected to the output.

Course Outcome 4 (CO4)

1. Sketch transistor level schematic for following logic
   a) 2:4 decoder defined by
   Y0 = A0.A1, Y1 = A0.A1, Y2 = A0.A1, Y3 = A0.A1
   b) 3:2 priority encoder
   Y0 = A0. (A1+A2), Y1 = A0.A1
2. Construct the CMOS Physical layout using Lamda rule and estimate the cell width and height for given function. Consider β n =2 β P.
   Y = ((ABC)+D)'
3. List the Layout Guidelines followed in designing CMOS logic gate.

Course Outcome 5 (CO5)

1. Draw 2 Input XOR gate using universal gate (NOR and NAND). Compare the fall time and rise time delay.
2. Draw the transistor level schematic of CMOS 3 input XOR gate.

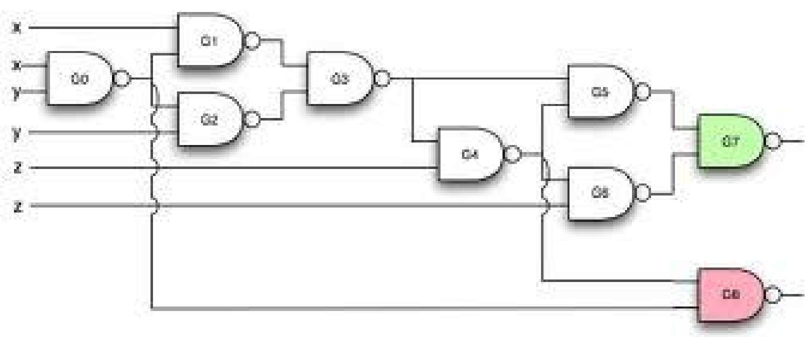
Consider a 4 input NAND Dynamic circuit (f = A.B.C.D). The input voltage is set to Vin = VDD = 5V and it is given that Vtn= 0.75V. a)Draw the circuit diagram of the function. b)Suppose that the signals are initially at (A,B,C,D) = (1,1,0,0) and switched to (A,B,C,D) = (0,1,1,1). Find the value of Vout.

Course Outcome 6 (CO6)

1. Define cycle time for pipelined system.
2. Write the advantages of bidirectional pads.
3. Explain PLL clocking technique with neat diagram and give its advantages.

Course Outcome 7 (CO7)

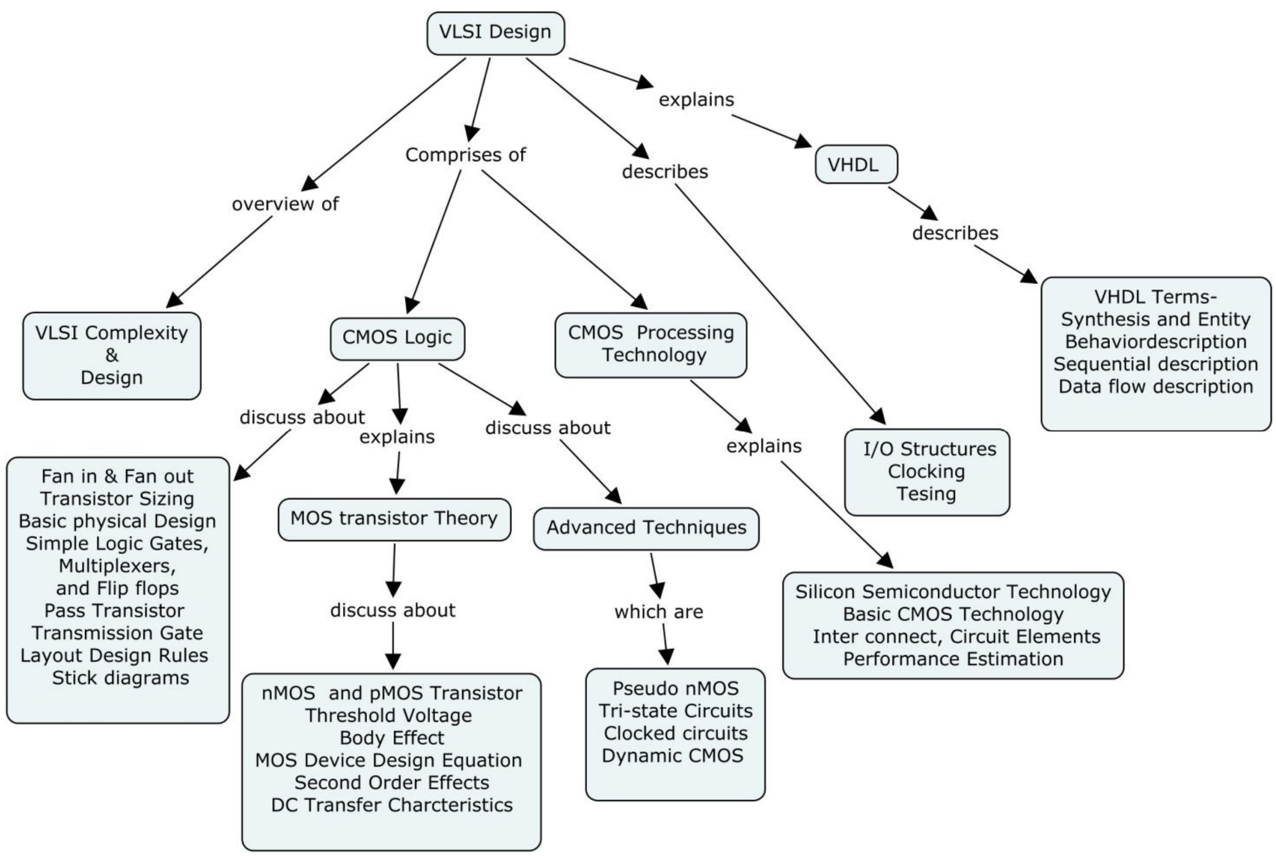
1. With an example explain fault models.
2. Define controllability.
3. For the given circuit generate test pattern using D algorithm. And also apply SCOAP for the same.



Course Outcome 8 (CO8)

1. Write VHDL code for BCD to Excess 3 converter using Structural and behavioral modeling.
2. Write VHDL Code for Ripple Counter using Dataflow modeling.
3. Mention any four capabilities of VHDL.

Concept Map



Syllabus

An overview of VLSI: Complexity and Design, Basic Concepts

CMOS Logic: Fan in & Fan out-Transistor Sizing-Basic physical Design of Simple Logic Gates: Inverter, NAND, NOR and Compound gates -Multiplexers and Flip flops-Pass Transistor and Transmission Gate-Layout Design Rules and Stick diagrams.

MOS Transistor Theory: nMOS and pMOS Enhancement Transistor-Threshold Voltage and Body Effect-MOS Device Design Equation -Second Order Effects-DC Transfer Characteristics-The Complementary CMOS Inverter-Beta Ratio- Noise Margin-Ratioed Inverter Transfer function-Pass Transistor-Tristate Inverter

CMOS Processing Technology:
Silicon Semiconductor Technology- Basic CMOS Technology (N-well, P-well, Twin Tub, SOI)-Inter connect, Circuit Elements - **Performance Estimation:** Delay Estimation-Transistor Sizing-Power Dissipation-Interconnect-Design Margin.

Advanced Techniques in CMOS Logic gates : Pseudo nMOS, Tri-state Circuits, Clocked circuits, Dynamic CMOS Logic Circuits.

VLSI I/O Structures Clocking and Testing of VLSI Circuits : I/O Structures**,** Clocked FlipFlops, CMOS Clocking Styles, Pipelined Systems, Clock Generation and Distribution. Testing of VLSI Circuits : General Concepts, CMOS Testing, Test Generation Methods.

VHDL : Introduction on VHDL & VHDL Terms - Synthesis and Entity, Behavioral description and sequential description, Data flow description.

Text Books

1. Neil H.E. Weste, David Harris & Ayan Banerjee, “CMOS VLSI Design- A Circuits and Systems Perspective”, Third Edition, Pearson education, 2008.
2. John P. Uyemura “Introduction to VLSI Circuits and systems” – John Wiley & Sons, Inc., 2008

Reference Books

1. Wayne Wolf, “Modern VLSI Design,” 2nd edition, Prentice Hall PTR, 2000.
2. Sung – Mo Kang, Yusuf Leblebici, “CMOS Digital Integrated circuits, Analysis & Design”, 3rd edition, Tata Mcgrew – Hill Publishing, 2003.
3. J. Bhaskar**,** “A VHDL Primer”, Third Edition, Addition Wesley, 1999.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1	**An overview of VLSI**	
1.1	Complexity and Design ,Basic Concepts	1
2	**CMOS Logic**	
2.1	Fan in & Fan out-Transistor Sizing	1
2.2	Basic physical Design of Simple Logic Gates: Inverter, NAND,	2

	NOR and Compound gates	
2.3	Multiplexers and Flip flops	1
2.4	Pass Transistor and Transmission Gate	1
2.5	Layout Design Rules and Stick diagrams	2
3	**MOS Transistor Theory**	
3.1	nMOS and pMOS Enhancement Transistor	1
3.2	Threshold Voltage and Body Effect	1
3.3	MOS Device Design Equation	1
3.4	Second Order Effects	1
3.5	DC Transfer Characteristics: The Complementary CMOS Inverter- Beta Ratio- Noise Margin - Ratioed Inverter Transfer function - Pass Transistor - Tristate Inverter	2
4	**CMOS Processing Technology**	
4.1	Silicon Semiconductor Technology	1
4.2	Basic CMOS Technology (N-well, P-well, Twin Tub, SOI)	2
4.3	Inter connect, Circuit Elements	1
4.4	**Performance Estimation**	
4.4.1	Delay Estimation	1
4.4.2	Transistor Sizing	1
4.4.3	Power Dissipation	1
4.4.4	Interconnect & Design Margin	1
5	**Advanced Techniques in CMOS Logic gates**	
5.1	Pseudo nMOS	1
5.2	Tri-state Circuits	1
5.3	Clocked circuits	1
5.4	Dynamic CMOS Logic Circuits	1
6	**VLSI I/O Structures, Clocking and Testing of VLSI Circuits**	
6.1	I/O Structures	1
6.1	Clocked FlipFlops & CMOS Clocking Styles	1
6.2	Pipelined Systems	1
6.3	Clock Generation and Distribution	1
6.4	Testing of VLSI Circuits - General Concepts, CMOS Testing, Test Generation Methods.	1
7	**VHDL**	
7.1	VHDL Terms- Synthesis and Entity	1
7.2	Behavioral and sequential description	2
7.3	Data flow description	1
	Total	**35**

Course Designers:

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2. Dr.R.Helen rheee@tce.edu

		Category	L	T	P	Credit
14EEPN0	**EMBEDDED SYSTEMS DESIGN**	PE	2	0	2	3

Preamble

An embedded system is a computer system with a dedicated function within a larger electrical or mechanical system, often with real-time computing constraints. An embedded system is some combination of computer hardware and software, either fixed in capability or programmable, that is specifically designed for a particular function. Industrial machines, automobiles, medical equipments, digital cameras, household appliances, airplanes, vending machines, toys, cellular phone and PDA are among the numerous possible hosts of an embedded system. Embedded systems that are programmable are provided with programming interfaces. In order to meet real time constraints, most of the embedded systems use a real-time operating system (RTOS). This course introduces the architecture, design and development process of embedded systems. The architecture and programming of ARM Cortex M4 microcontrollers (STM32407xx, TM4C123) are also covered in this course.

Prerequisite

14EE460 –Microcontrollers
14EE490 - Microcontrollers Lab

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level
CO1	Explain embedded system architecture and its building blocks.	**Understand**
CO2	Explain the embedded system software tools and design process.	**Understand**
CO3	Explain the architecture and function of on-chip peripherals (DMA, interrupt controllers, Clocks, RTC, WDT, I²C, USART, SPI,SDIO) in ARM Cortex M4 (STM32407xx) Microcontroller	Understand
CO4	Explain the architecture and function of on-chip peripherals (DMA, interrupt controllers, RTC, Timers and watchdogs, CAN, USB, PWM, QEI) in TM4C123 Microcontroller.	Understand
CO5	Design and develop the embedded systems using STM32407XX / TM4C123 microcontroller such as DC motor / stepper motor speed control and display of speed, Temperature measurement and display, data communication using Ethernet/ USB/ CAN and wireless data communication using bluetooth and Zigbee, etc.	**Analyse**

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**S**									**M**		**M**
CO2	**S**									**M**		**M**
CO3	**S**									**M**		**S**
CO4	**S**									**M**		**M**
C05	**S**	**S**	**S**	**M**	**S**	**M**	**M**	**M**	**S**	**M**	**M**	**S**

S- Strong; **M**-Medium; **L**-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination**
	1	2	3*	
Remember	40	20	0	20
Understand	60	40	0	40
Apply	0	40	0	40
Analyse	0	0	100	0
Evaluate	0	0	0	0
Create	0	0	0	0

***Assignments and CAT 3 (compulsory) marks are based on the performance in lab experiments.**

**Terminal examination covers theory part only.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Distinguish between GPP and ASIP.
2. What are the power down modes ?
3. How the embedded systems are classified ?
4. What is the function of WDT ?
5. What is boot loader ?
6. Write the need of RTC in embedded system.

Course Outcome 2 (CO2):

1. Illustrate the various steps involved in the design process of an embedded system in detail with necessary diagram.
2. Demonstrate the layers of an embedded system.
3. Demonstrate the process of converting C program into the file for ROM image.
4. Illustrate the various types of serial communication devices.

Course Outcome 3 (CO3):

1. Explain the architecture of STM32407xx Microcontroller.
2. Explain the different interrupts in STM32407xx Microcontroller.
3. Explain the operation of RTC and WDT in STM32407xx Microcontroller.
4. With neat diagram, explain the working of SPI interface in STM32407xx Microcontroller.

Course Outcome 4 (CO4):

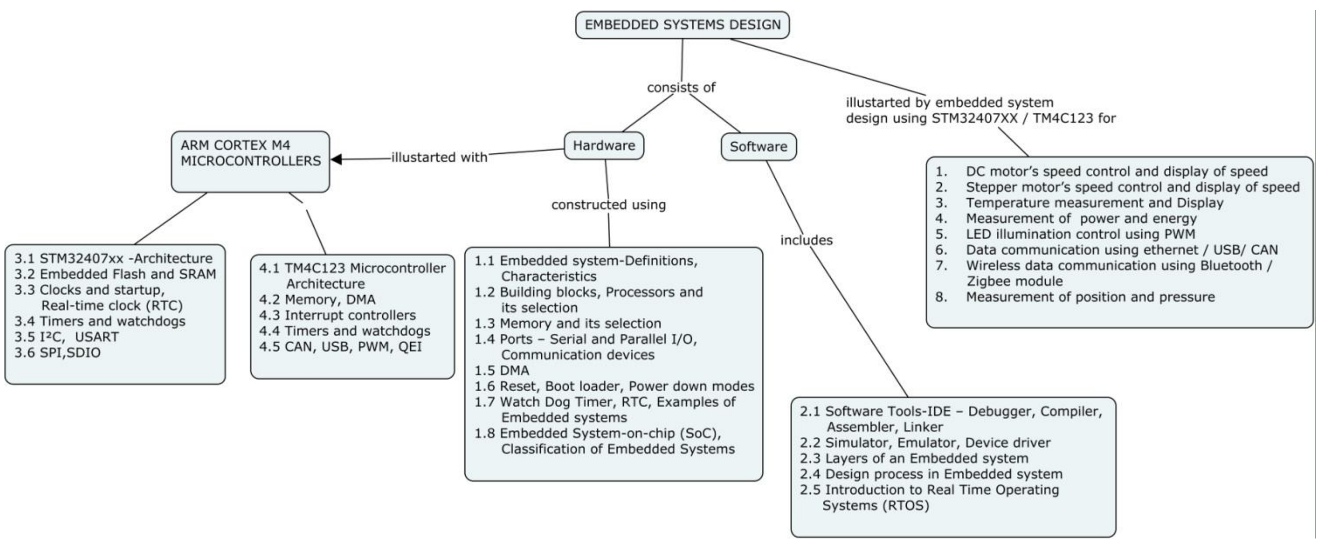
1. Explain the architecture of TM4C123 Microcontroller.
2. Explain the different interrupts in TM4C123 Microcontroller.
3. Explain the operation of USB interface in TM4C123 Microcontroller.
4. With neat diagram, explain the working of CAN interface in TM4C123 Microcontroller.

Course Outcomes 5 (C05):

The evaluation is based on the design and development of the following embedded systems using STM32407XX / TM4C123 microcontrollers in the laboratory:

1. DC motor speed control and display of speed
2. Stepper motor speed control and display of speed
3. Temperature measurement and Display
4. Measurement of power and energy
5. LED illumination control using PWM
6. Data communication using Ethernet / USB/ CAN
7. Wireless data communication using Bluetooth / Zigbee module
8. Measurement of position and pressure

Concept Map



Syllabus

Embedded Systems: Definitions – Characteristics, Building blocks – Processors and its selection - Memory and its selection - Ports - Serial and Parallel I/O Communication devices - DMA - Reset - Boot loader - Power down modes - Watch Dog Timer - RTC - Examples of Embedded systems - Embedded System-on-chip (SoC) - Classification of Embedded Systems.

Software Tools: IDE - Debugger - Compiler - Assembler - Linker - Simulator - Emulator - Device driver - Layers of an Embedded system - Design process in Embedded system - Introduction to Real Time Operating Systems (RTOS).

ARM Cortex M4 Microcontroller: STM32407xx -Architecture - Embedded Flash and SRAM- Clocks and startup - Real-time clock (RTC) - Timers and watchdogs - I²C - USART - SPI - SDIO.

TM4C123 Microcontroller: Architecture – Memory - DMA - Interrupt controllers - Timers and watchdogs – CAN - USB - PWM - QEI.

Practical Part:

Design of Embedded Systems using STM32407XX / TM4C123 microcontroller: DC motor speed control and display of speed - Stepper motor speed control and display of speed - Temperature measurement and Display - Measurement of power and energy - LED illumination control using PWM - Data communication using Ethernet / USB/ CAN - Wireless data communication using Bluetooth / Zigbee module - Measurement of position and pressure.

Text Books

1. Raj Kamal, 'Embedded Systems, Architecture, Programming and Design', Tata McGraw-Hill, second edition 2010.
2. D.P.Kothari, Shriram K.Vasudevan, Embedded Systems, New Age International Publishers, 2012.
3. ARM Cortex M4 (STM32407xx) Data sheet, ST Microelectronics.
4. ARM Cortex M4 (TM4C123) Data sheet, Texas Instruments.

Reference Books

1. Shibu K V, 'Introduction to Embedded Systems', Tata McGraw Hill Education Pvt. Ltd.,2010
2. Tammy Noergaard, Embedded systems Architecture, Second edition, Newnes-Elsevier,2013.
3. Frank Vahid and Tony Givargis, 'Embedded System Design: A Unified Hardware/Software Introduction', John Wiley & Sons, Inc. 2002.
4. Steve Heath, Embedded Systems Design, Second Edition, Elsevier, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**Embedded Systems**	
1.1	Embedded systems Definitions, Characteristics	1
1.2	Building blocks, Processors and its selection	1
1.3	Memory and its selection	1
1.4	Ports – Serial and Parallel I/O, Communication devices	1
1.5	DMA	1
1.6	Reset, Boot loader, Power down modes	1
1.7	Watch Dog Timer, RTC, Examples of Embedded systems	1
1.8	Embedded System-on-chip (SoC), Classification of Embedded Systems	1
2	**Software Tools**	
2.1	IDE – Debugger, Compiler, Assembler, Linker	1

2.2	Simulator, Emulator, Device driver	1
2.3	Layers of an Embedded system	1
2.4	Design process in Embedded system	1
2.5	Introduction to Real Time Operating Systems (RTOS)	1
3.	**ARM Cortex M4 Microcontrollers**	
3.1	STM32407xx -Architecture	1
3.2	Embedded Flash and SRAM	1
3.3	Clocks and startup, Real-time clock (RTC)	1
3.4	Timers and watchdogs	1
3.5	I^2C, USART	1
3.6	SPI,SDIO	1
4	**TM4C123 Microcontroller**	
4.1	Architecture	1
4.2	Memory, DMA	1
4.3	Interrupt controllers	1
4.	Timers and watchdogs	1
4.5	CAN, USB, PWM, QEI	1
	Total	**24**

Tentative List of Experiments (12 -14 Hours)

Design of Embedded Systems using STM32407XX / TM4C123 microcontroller:

1. DC motor speed control and display of speed
2. Stepper motor speed control and display of speed
3. Temperature measurement and Display
4. Measurement of power and energy
5. LED illumination control using PWM
6. Data communication using Ethernet / USB/ CAN
7. Wireless data communication using Bluetooth / Zigbee module
8. Measurement of position and pressure

Course Designers:

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2. Dr.P.S.Manoharan psmeee@tce.edu

		Category	L	T	P	Credit
14EEPT0	**VIRTUAL INSTRUMENTATION**	PE	2	0	2	3

Preamble

The rapid adoption of the PC in the last 20 years catalyzed a revolution in instrumentation for test, measurement, and automation. One major development resulting from the ubiquity of the PC is the concept of virtual instrumentation, which offers several benefits to engineers and scientists who require increased productivity, accuracy, and performance.
A virtual instrument consists of an industry-standard computer or workstation equipped with powerful application software, cost-effective hardware such as plug-in boards, and driver software, which together perform the functions of traditional instruments. Virtual instruments represent a fundamental shift from traditional hardware-centred instrumentation systems to software-cantered systems that exploit the computing power, productivity, display, and connectivity capabilities of popular desktop computers and workstations.
This course is designed to impart knowledge of fundamentals of Virtual instrumentation. The course exposes the students to data acquisition (direct data acquisition, instrument control and networked data acquisition).

Prerequisite

14EE420 - Instrumentation Systems

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level
CO1	Describe the fundamental components of Digital and virtual instrumentation.	Understand
CO2	Compare the difference between sequential programming and data flow programming / Graphical programming	Understand
CO3	Choose the components of Data Acquisition for the given application.	Apply
CO4	Explain the interfacing of RS232, RS 422, RS 485 and USB standards - IEEE 488 standard with PC	Understand
CO5	Analyze the developed VI program involving controls, indicators, arrays, cluster, bundle, loops, case structures, math script, graph & charts, sub-VI, digital I/O, analog I/O, counter/timers for given applications	Analyze, Precision

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**M**					**M**					
CO2	**M**	**M**	**L**		**M**		**M**		**M**			
CO3	**S**	**M**	**M**						**M**			
CO4	**M**	**M**	**M**		**M**				**L**			
CO5	**S**	**M**	**M**	**L**	**S**				**S**			**M**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3*	
Remember	20	20	0	20
Understand	60	60	0	60
Apply	20	20	0	20
Analyse	0	0	100	0
Evaluate	0	0	0	0
Create	0	0	0	0

***Note:** CAT 3 (compulsory) marks based on development and execution of a Virtual Instrument programme for a given application in the laboratory.

Course Level Assessment Questions

Course Outcome 1 (CO 1):
1. Distinguish between a traditional instrument and virtual instrument.
2. Explain for which applications, the virtual instrumentation will be very much suitable.

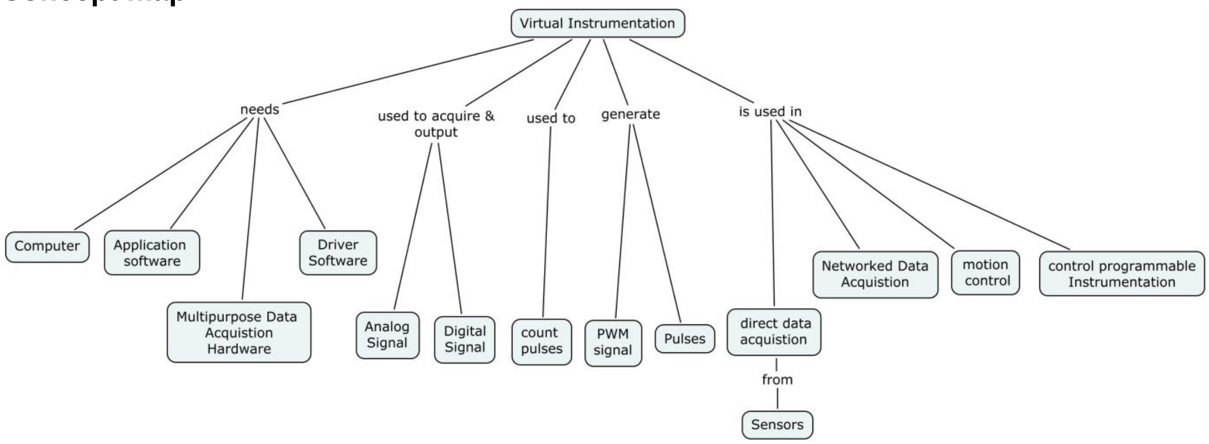
Course Outcome 2 (CO2):
1. Define G – programming.
2. Distinguish between text based languages and data flow programming.

Course Outcome 3 (CO3):
5. Define Aliasing
6. Choose the minimum sampling frequency in a PC based data acquisition system when the highest component of a pure test signal is 500 Hz.

Course Outcome 4 (CO4):
1. Distinguish between RS 232 and RS 485 standard of interfacing a programmable instrument to a PC.
2. Distinguish between USB standard and IEEE 488 standard.

Course Outcome 5 (CO5):
(Sample Programmes)
1. Develop a password security system using VI techniques.
2. Acquire the data from a thermocouple and determine the average temperature**.**
3. Develop a networked instrumentation system for remote measurement of power.
4. Develop an image acquisition system

Concept map



Syllabus

OVERVIEW OF DIGITAL INSTRUMENTATION
Representation of analog signals in the digital domain – Review of quantization in amplitude and time axes, sample and hold, sampling theorem, ADC and DAC

FUNDAMENTALS OF VIRTUAL INSTRUMENTATION
Historical perspective - Concept of virtual instrumentation – Advantages of VI – Define VI – lock diagram & Architecture of VI – Data flow techniques – Graphical programming in data flow – Comparison with conventional programming

PC BASED DATA ACQUISITION – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card- Wiresless data acquisition

CLUSTER OF INSTRUMENTS IN VI SYSTEM
Interfacing of external instruments to a PC – RS232, RS 422, RS 485 and USB standards - EEE 488 standard-Converters

PROGRAMMING ENVIRONMENT IN VI
Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O.

SIMPLE APPLICATIONS IN VI (Practical sessions):
Experiments demonstrating direct data acquisition for analog and digital signals, concept of aliasing and its remedy, Programmable gain instrumentation Amplifier, calibration and range, resolution & accuracy of instruments, Interfacing various sensors, instrument control, networked data acquisition and signal generation, Image acquisition.

Text Books

1. Jeffrey Travis, Labview for Everyone, Second Edition, Prentice Hall PTR, 2002
2. Robert H. Bishop, 'Learning with Lab-view', Prentice Hall, 2003.

Reference Books/Web sources

1. S. Gupta and J.P Gupta, 'PC Interfacing for Data Acquisition and Process Control', Instrument society of America, 1994.
2. Peter W. Gofton, 'Understanding Serial Communications', Sybex International.
3. www.ni.com.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.	**OVERVIEW OF DIGITAL INSTRUMENTATION**	
1.1	Representation of analog signals in the digital domain	1
1.2	Review of quantization in amplitude and time axes	1
1.3	sample and hold, sampling theorem	1
1.4	ADC and DAC	1
2.	**FUNDAMENTALS OF VIRTUAL INSTRUMENTATION**	
2.1	Historical perspective - Concept of virtual instrumentation	1
2.2	Advantages of VI – Define VI – Block diagram & Architecture of VI	2
2.3	Data flow techniques	1
2.4	Graphical programming in data flow – Comparison with conventional programming	1
2.5	PC based data acquisition – Typical on board DAQ card	1
2.6	Resolution and sampling frequency - Multiplexing of analog inputs	1
2.7	Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs.	1
2.8	Concept of universal DAQ card	1
2.9	Use of timer-counter and analog outputs on the universal DAQ card - Wireless Data acquisition	1
3.	**CLUSTER OF INSTRUMENTS IN VI SYSTEM**	
3.1	Interfacing of external instruments to a PC	1
3.2	RS232, RS 422	1
3.3	RS 485 and USB standards	1
3.4	IEEE 488 standard, Converters	1
4.	**PROGRAMMING ENVIRONMENT IN VI**	
4.1	Lab-view software – Concept of VIs and sub VI	1
4.2	Display types – Digital – Analog – Chart	1
4.3	Oscilloscopic types – Loops	1
4.4	Case and sequence structures - Types of data	1
4.5	Arrays – Formulae nodes –Local and global variables	1
4.6	String and file I/O	1

5	**SIMPLE APPLICATIONS IN VI (Laboratory Sessions)**	
5.1	Experiments demonstrating direct data acquisition for analog and digital signals	4
5.2	concept of aliasing and its remedy, Programmable gain instrumentation Amplifier, calibration and range, resolution & accuracy of instruments, and signal generation	12
5.3	Interfacing various sensors, instrument control, networked data acquisition - Image acquisition	8
	Total	**48**

Course Designers:

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		Category	L	T	P	Credit
14EEPP0	**ROBOTICS**	PE	3	0	0	3

Preamble

The field of Robotics finds many applications nowadays. This course mainly discusses about robot anatomy, coordinate frames, mapping and transforms, direct kinematic modelling of robots and inverse kinematics, dynamic modelling, trajectory planning, control of manipulators, robotic sensors and vision. 2-D planar robot alone is considered for quantitative analysis.

Prerequisite

- Differential Equations, and Laplace Transform.
- 14EE430 Control systems

Course Outcomes

On the successful completion of the course, students will be able to:

CO1	Explain the applications of robotics in Industries, Home appliances, Defense, Aerospace and Medicine	Understand
CO2	Explain the anatomy of robot, coordinate frames, mapping and transformations	Understand
CO3	Construct forward & inverse kinematic model and dynamic model for a given Robotic manipulator	Apply
CO4	Use Joint Space techniques and Cartesian space techniques for trajectory planning	Apply
CO5	Illustrate the role of sensors and control systems in Robotics	Understand
CO6	Use roboanalyser software to simulate the dynamics of given manipulator	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	L											
CO2	L	L	L									
CO3	S	M	L	L								
CO4	S	M	L	L								
CO5	L	L	L									
CO6	S	S	S	S	S							

S-Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	40	40	40	40
Apply	40	40	40	40
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

CO6 SHALL BE EVALUATED THROUGH ASSIGNMENTS

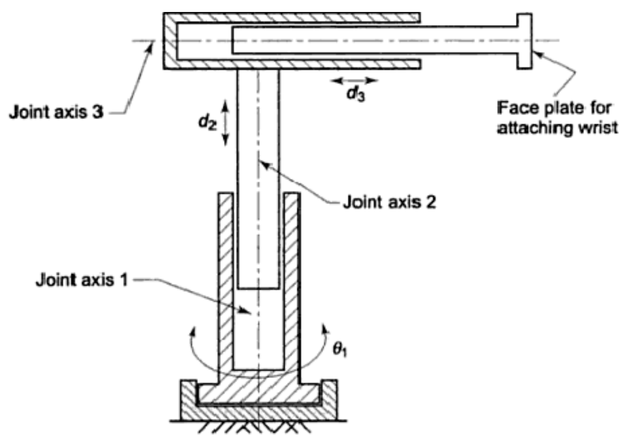
Course Level Assessment Questions

Course Outcome 1 (CO1):

1. When a robot is preferred than human being to do a specific task?(Remember)
2. State the laws of robots (Remember)
3. Explain the applications of robots (Understand)

Course Outcome 2 (CO2):
1. Write the rotation matrix w.r.t. z axis (Remember)
2. Explain about degrees of freedom and dexterous robots(Understand)
3. A vector OP defined in the reference frame {0} is [1 2 3]T. Origin of frame is displaced by +2units along y axis and +3 units along z axis. Frame {0} is then rotated about z axis by 90 degree and about x axis by -90 degree. Find the vector OP w.r.t the transformed frame. (Understand)

Course Outcome 3 (CO3):
1. Define forward kinematics and inverse kinematics (Remember)
2. Write a short note on DH notation. (Understand)
3. Calculate the forward and inverse kinematics model of the cylindrical arm shown below. (Apply)

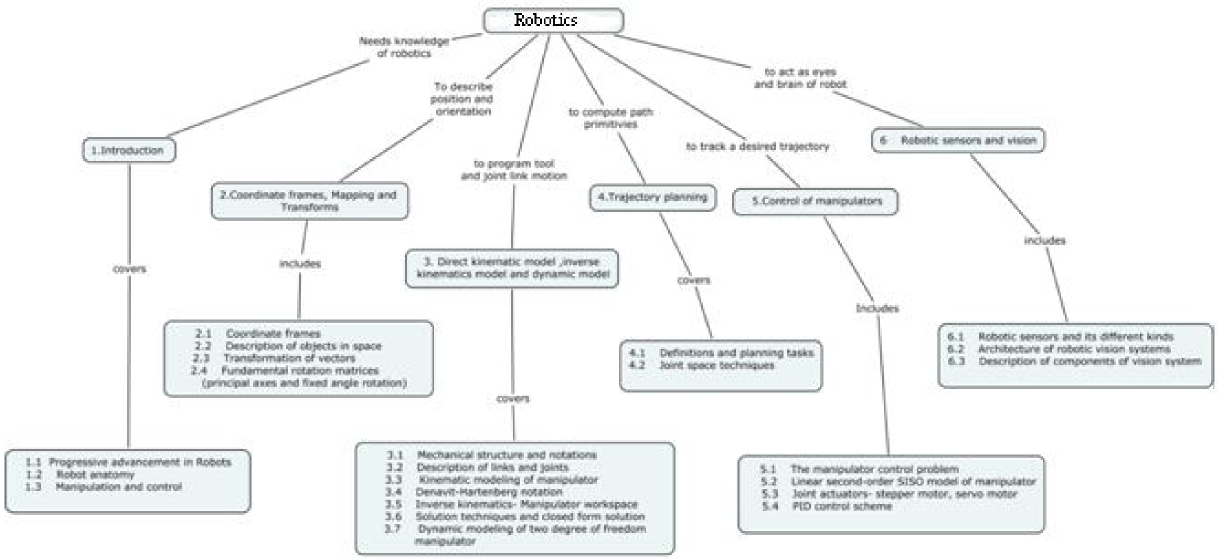


Course Outcome 4 (CO4):
1. Define trajectory planning. (Remember)
2. Explain about Cartesian space techniques (Understand)
3. Determine the trajectory of pick and place robot which has to pass through three via-points using piecewise linear interpolation with parabolic blends for each segment. The path points are [0 10 45 30 5] degrees and travel times for the segments are [0.5 1.5 2.0 1.0] seconds respectively. Assume the magnitude of acceleration at each parabolic blend is 25 degree / sec^2 (Apply)

Course Outcome 5 (CO5):
1. Derive the transfer function of single manipulator (Understand)

2. Write any four factors to be considered in selection of robotic sensor (Remember)
3. Consider a manipulator with linear, second order dynamic model $\tau = I\ddot{\theta} + B\theta$, where I is the total inertia and B is the total friction.
    - Design suitable partitioned control scheme to achieve the error dynamics $\ddot{e} + 4\dot{e} + 4e = 0$
    - Assuming that there is a constant disturbance torque τ_d, design suitable control scheme to eliminate the effect of disturbance and achieve the error dynamics $\dddot{e} + 3\ddot{e} + 4\dot{e} + 4e = 0$ (Apply)

Concept Map



Syllabus

Introduction to Robotics: Basics of Robots, Progressive advancement in Robots, ApplicationsRobot anatomy, Manipulation and Control, Introduction to mobile robots
Coordinate frames, Mapping and Transforms: Coordinate frames, Description of objects in space, Transformation of vectors, Fundamental rotation matrices (principal axes and fixed angle rotation)
Direct kinematic model & inverse kinematics (Limited to 3DOF robots) and dynamic modeling (Limited to 2DOF robots):
Mechanical structure and notations, Description of links and joints, Kinematic modeling of manipulator, Denavit-Hartenberg notation, Inverse kinematics- Manipulator workspace, Solution techniques and closed form solution, Dynamic modeling of two degree of freedom manipulator
Trajectory planning: Definitions and planning tasks, Joint space techniques, Cartesian space techniques

Control of manipulators: The manipulator control problem, Linear second-order SISO model of manipulator, Joint actuators- stepper motor, servo motor, PID control scheme, Force control
Robotic sensors and vision: Robotic sensors and its different kinds, Architecture of robotic vision system, Description of components of vision system.
Robot Software: Introduction to robot programming languages. Computer aided analysis of robots (using roboanalyzer software)

Text Books

1. R.K. Mittal, I.J. Nagrath, Robotics and control, Tata McGraw-Hill, 2003.
2. John J.Craig, Introduction to Robotics, Mechanics and control, third edition, Pearson education, 2005

Reference Books

1. Mark W.Sponge, M.Vidyasagar, Robot dynamics and control, Wiley India, 2009.
2. KS **Fu,** Ralph Gonzalez CSG Lee, Robotics, John wiley, 2002.
3. http://www.roboanalyzer.com/tutorials.html

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture hours
1.0	**Introduction**	
1.1	Basics of Robotics, Progressive advancement in Robots	1
1.2	Robot anatomy	1
1.3	Manipulation and control, Introduction to mobile robots	1
2.0	**Coordinate frames, Mapping and Transforms**	
2.1	Coordinate frames	1
2.2	Description of objects in space	1
2.3	Transformation of vectors	2
2.4	Fundamental rotation matrices (principal axes and fixed angle rotation)	2
3.0	**Direct kinematic model, inverse kinematics and dynamic modeling**	
3.1	Mechanical structure and notations	1
3.2	Description of links and joints	2
3.3	Kinematic modeling of manipulator	3
3.4	Denavit-Hartenberg notation	2
3.5	Inverse kinematics- Manipulator workspace	2
3.6	Solution techniques and closed form solution	2
3.7	Dynamic modeling of two degree of freedom manipulator	2
4.0	**Trajectory planning**	
4.1	Definitions and planning tasks	1

4.2	Joint space techniques	2
4.3	Cartesian Space techniques	1
5.0	**Control of manipulators**	
5.1	The manipulator control problem	1
5.2	Linear second-order SISO model of manipulator	1
5.3	Joint actuators- stepper motor, servo motor	1
5.4	PID control scheme	1
6.0	**Robotic sensors and vision**	
6.1	Robotic sensors and its different kinds	1
6.2	Architecture of robotic vision system	1
6.3	Description of components of vision system	1
7.0	**Robot software**	
7.1	Introduction to robot programming languages	1
7.2	Computer aided analysis of robots (using roboanalyzer software)	1
	Total	**36**

Course Designers:

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		Category	L	T	P	Credit
14EEPQ0	**AUTOMOTIVE ELECRTONICS**	PE	3	0	0	3

Preamble

This course covers the fundamentals of vehicle electrical and electronic system, components and sub systems. It discusses working principle of sensors and actuators, concepts of diagnostics and communication protocols, and gives exposure to Quality, Reliability and Safety aspects**.**

Prerequisite

1. 14EE340 - Measurement Systems.
2. 14EE350 - Digital Systems.
3. 14EE420 - Instrumentation systems.

Course Outcomes

On successful completion of the course, students will be able to:

COs No.	Course Outcomes	Blooms level
CO1	Explain the vehicle electrical and Electronic systems and their components	Understand
CO2	Explain the working of electrical and electronic subsystems	Understand
CO3	Explain the working principles of sensors and actuators in automotive	Understand
CO4	Calculate sensors and actuator outputs under given operating conditions	Apply
CO5	Explain the concepts of diagnostics and communication protocols	Understand
CO6	Explain the Quality, Reliability and Safety aspects of automotive electrical and electronic system requirements	Understand

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**M**	**L**	**L**									
CO2	**M**	**L**	**L**									
CO3	**M**	**L**	**L**									
CO4	**S**	**M**	**L**						**M**			**L**
CO5	**M**	**L**										**L**
CO6	**M**	**L**										**L**

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	60	60	60
Apply	20	20	20	20

Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain working of ignition system with neat diagram.
2. Describe the operation of Anti-lock Braking System in an automotive.
3. Explain the functions of engine management system in detail.

Course Outcome 2 (CO2):

1. Discuss the automobile headlamp electric circuit with all possible modes.
2. Explain the function of starting system with neat diagram.
3. Discuss the requirement of wiring harness in an automobile.

Course Outcome 3 (CO3):

1. Explain the working of oil pressure sensor with neat diagram.
2. Describe the working principle of Hall Effect sensor to measure the crankshaft position.
3. Explain the operation of fuel injector with neat diagram.

Course Outcome 4 (CO4):

1. Assume that the temperature of the coolant in an automotive is increasing and it is measured by thermistor. The sensor is supplied with 12 V. Determine the fixed resistance used, if the sensor variable resistance decreases from 8 ohm to 2 ohm for an output voltage increase from 4V to 8V.
2. Determine the engine load of a vehicle when the fuel injector pulse timing is 30 msec and the duty cycle is 10%.
3. Determine the pulse counter output of an engine speed sensor for 4 minutes when an eight cylinder engine is running at 5000 rpm..

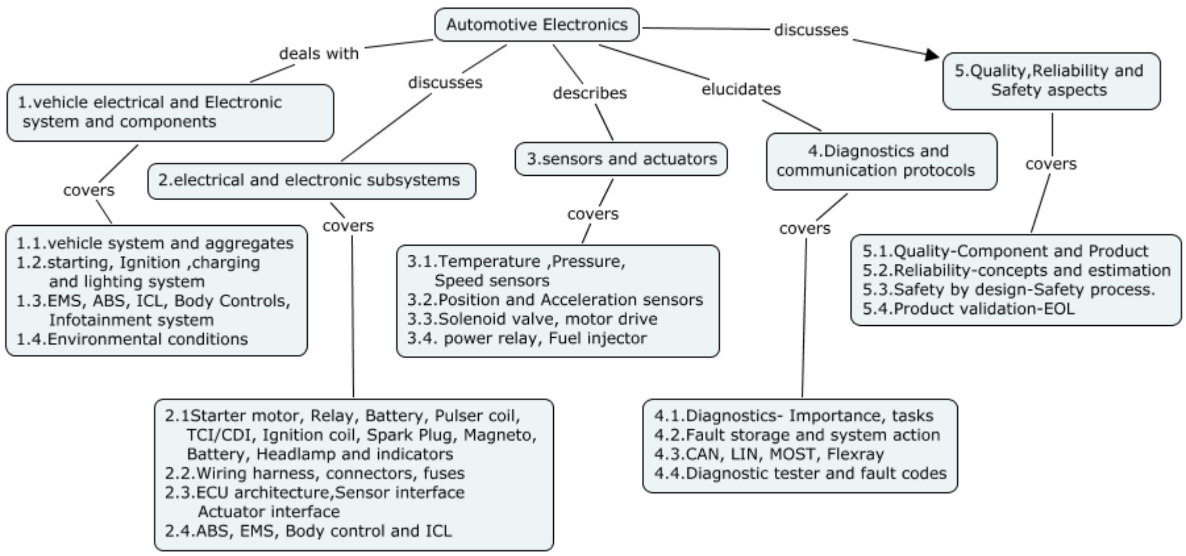
Course Outcome 5 (CO5):

1. Discuss the features of On Board Diagnostics II (OBD-II) in detail.
2. Define freeze frame parameters.
3. Explain the CAN bus in detail.

Course Outcome 6 (CO6):

1. Define - MTBF.
2. Describe the process of Failure Mode and Effects Analysis.
3. Discuss the five phases of Product Quality Planning.

Concept Map



Syllabus

Vehicle Electrical and Electronic system and components: Overview of vehicle system and aggregates, Schematic diagram of automotive electrical system - function of starting system, Ignition system, charging system and lighting system -Schematic diagram of electronic system-Function of EMS, ABS, ICL, Body Controls, Infotainment system-Environmental conditions: Electrical and operating-key requirements of automotive systems.

Electrical and Electronic Subsystems : Starter motor, Relay, Battery, Pulser coil, TCI/CDI, Ignition coil, Spark Plug, Magneto, Battery, Headlamp and indicators- Requirements of Wiring harness, connectors, fuses-ECU architecture-Sensor interface-Actuator interface-Automotive Electronic Application - ABS, EMS, Body control and ICL.

Sensors and Actuators: sensors-Temperature, Pressure, Speed, Position and Acceleration-actuator-Solenoid valve, motor drive, power relay, Fuel injector.

Diagnostics and Communication protocols : Diagnostics- Importance, tasks, Fault storage and system action-Communication networks-CAN, LIN, MOST, Flexray-communication protocols- KWP2000, OBD-II-Diagnostic tester and fault codes

Quality, Reliability and Safety aspects: Quality-Component and Product-Reliability-concepts and estimation-Safety by design-Safety process-Product validation-EOL.

Reference Books

1) Ronald K Jurgen, “Automotive Electronics Handbook”, Tata McGraw Hill, 1999.
2) Robert Bosch , “Automotive Electrics and Automotive Electronics”, GmbH, 2007.
3)Tom Denton, ”Automobile Electrical and Electronics Systems” ,Elsevier Publications,2004

4) Ronald K Jurgen, "Automotive Microcontrollers", Progress in technology,2008.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture hours
1.0	**Vehicle Electrical and Electronic system and components**	
1.1	Overview of vehicle system and aggregates, Schematic diagram of automotive electrical system	2
1.2	function of starting system, Ignition system, charging system and lighting system	3
1.3	Schematic diagram of electronic system- Function of EMS, ABS, ICL, Body Controls, Infotainment system	2
1.4	Environmental conditions: Electrical and operating - key requirements of automotive systems.	1
2.0	**Electrical and Electronic Subsystems**	
2.1	Working principle of Starter motor, Relay, Battery, Pulser coil, TCI/CDI, Ignition coil, Spark Plug, Magneto, Battery, Headlamp and indicators	3
2.2	Requirements of Wiring harness, connectors, fuses	1
2.3	ECU -Sensor interface-Actuator interface	2
2.4	Automotive Electronic Application - ABS, EMS, Body control and ICL	2
3.0	**Sensors and Actuators**	
3.1	Working principle of sensors-Temperature ,Pressure, Speed	3
3.2	Position and Acceleration sensors	1
3.3	Working principle of actuator-Solenoid valve, motor drive,	2
3.4	power relay, Fuel injector	2
4.0	**Diagnostics and Communication protocols**	
4.1	Diagnostics- Importance, tasks	1
4.2	Fault storage and system action	2
4.3	Communication networks-CAN, LIN, MOST, Flexray- communication protocols- KWP2000, OBD-II	3
4.4	Diagnostic tester and fault codes	1
5.0	**Quality, Reliability and Safety aspects**	
5.1	Quality-Component and Product	2
5.2	Reliability-concepts and estimation	2
5.3	Safety by design-Safety process.	2
5.4	Product validation-EOL	1
	Total	**38**

Course Designer:

1 Dr.R.Medeswaran medes@tce.edu

14EEPR0	**AUTOMOTIVE FUNDAMENTALS AND MANUFACTURING**	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Knowledge on vehicle performance calculations, working of sub-systems such as braking, suspension, steering and manufacturing of automobile components are desirable for an engineering graduate seeking employment in automotive industries. This course covers modules on vehicle performance calculations, working of various subsystems such as transmission, steering, suspension, braking and automotive electrical systems and manufacturing of automobile components.

Prerequisite

14PH120 – Physics
14ES160 - Basics of Electrical and Electronics Engineering.

Course Outcomes

On the successful completion of the course, students will be able to:

COs No.	Course outcomes	Blooms level
CO1	Determine vehicle performance parameters such as acceleration, gradability and draw-bar pull.	Apply
CO2	Explain construction and working of various subsystems such as transmission, steering, suspension, braking, automotive electrical and electronics systems.	Understand
CO3	Explain working of fluid power drives, circuits and process flow in manufacturing.	Understand

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S									
CO2	S	L	L				M				M	L
CO3	M										M	L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	30	30	20
Understand	30	70	70	60

Apply	50	0	0	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define “Gradability” and “Draw-bar pull”.
2. A motor car with wheel base 2.75 m with a centre of gravity 0.85 m above the ground 1.15 m behind the front axle has a coefficient of adhesion 0.6 between the tyre and the ground. Calculate the maximum possible acceleration when the vehicle is
   (a) Driven on four wheels
   (b) Driven on the front wheels only
   (c) Driven on rear wheels only
3. A car weighing 21336.75 N, has a static weight distribution on the axles 50:50. The wheel base is 3 m and the height of the centre of gravity above ground is 0.55 m. If the coefficient of friction on the highway is 0.6, prove that rear wheel drive offers higher gradability than front wheel drive, if engine power is not a limitation.

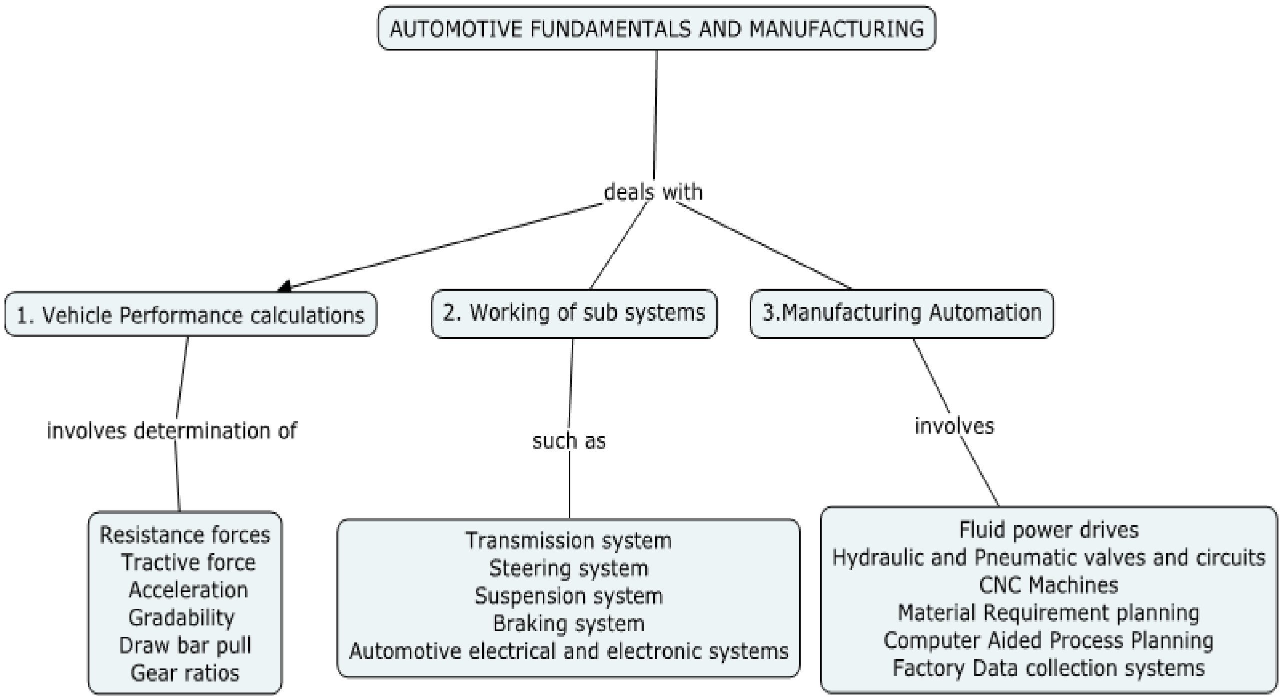
Course Outcome 2 (CO2):

1. With neat diagrams, explain the construction and working of limited slip differential.
2. With a neat sketch, explain the working of McPherson strut type suspension.
3. Explain the working of starter motor of an automobile with a neat sketch.

Course Outcome 3 (CO3):

1. Discuss on the various aspects of material requirement planning.
2. Explain the role of hydraulics in manufacturing automation.
3. How are Factory Data collection systems classified? How do they help to improve quality?

Concept Map



Syllabus

Vehicle performance – Various Resistance forces, tractive force, engine power, acceleration, gradability and draw bar pull, Selection of gear ratios – Theory and Problems.
Transmission system: Clutch – Working of Centrifugal type, Diaphragm clutch, Torque converter. **Gear Box** – Double de-clutching, working of synchromesh gear box - planetary gear box - Continuously Variable Transmission (CVT). **Differential –** working of limited slip differential and centre differential. **Axles -** Types of front and rear axles – working of joints used in live front axle.
Steering system: True rolling, links in steering system, recirculating ball and nut, rack and pinion steering gears, working of power steering.
Suspension system: Functions, construction of leaf spring and coil spring suspension, Independent suspension. Working of telescopic shock absorber.
Braking system: Types, working of drum and disc brakes, Hydraulic brake system, Power brake system.
Automotive electrical and electronics: Lighting and signaling systems – Working of head light, Horns, indicators - Ignition system-Battery ignition system, Magneto ignition system, Electronic ignition system. Starter motor- Principle of operation, construction - Working of automotive electronic systems such as MPFI, CRDI and ABS.
Fluid power drives in manufacturing: Selection & Application range of Industrial drives-Comparison of fluid power and electric drives-advantages of electrical drives- Energy saving-motor/mechanical load match-Motion/time profile match.

Hydraulic Motors and Pumps-Hydraulic valves-Hydraulic cylinders & cushioning, Pneumatic actuators - pneumatic valves and control circuits-Multiple actuator circuits **-** Hydraulic and Pneumatic circuits.
Automation: Definition, Benefits and types, **CNC Machines:** Construction, Working and applications in various types of Manufacturing process (Turning, Milling, Welding and Forming). **Material Requirement Planning (MRP)**: Inputs to MRP, Working of MRP and MRP output reports. **Computer Aided Process Planning:** Retrieval type and Generative type CAPP, Benefits. **Factory Data collection systems**: Automatic Identification methods, automated data collection systems.

Text Books

1. N.K.Giri, "Automobile Mechanics", 8th Edition, Khanna Publishers, Delhi, 2008.
2. Kirpal Singh, "Automobile Engineering", Volume-1&2, 13th Edition, Standard Publishers Distributers, Delhi, 2012.
3. Anthony Esposito, "Fluid power with applications", Pearson 7th edition, 2014.
4. Mikell P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Learning, Third Edition, 2009.

Reference Books

1. William Crouse, "Automobile Engineering Series ", McGraw-Hill, 1988.
2. Newton and Steeds, "Motor Vehicles ", ELBS, 1985.
3. Richard Stone and Jeffrey K. Ball, "Automotive Engineering Fundamentals" SAE International, 2011.
4. Joseph Heitner, "Automotive Mechanics, Principle and practices", East West Press, (Second Edition), 2001.
5. Vajpayee S. Kant, "Principles of Computer Integrated Manufacturing", Prentice Hall of India Learning, 2009.

Course Contents and Lecture Schedule

Module No.	Topics	No. of lecture hours
1	**Vehicle Performance Calculations**	
1.1	Various Resistance forces and factors affecting.	1
1.2	Tractive force, engine power, acceleration, gradability and draw bar pull, Selection of gear ratios – Theory.	2
1.3	Tractive force, engine power, acceleration, gradability and draw bar pull, Selection of gear ratios - Problems	2
2	**Automotive sub-systems**	
2.1	**Transmission system**	
2.1.1	Clutch – Working of Centrifugal type, Diaphragm clutch	1.5
2.1.2	Construction and working of torque converter.	1
2.1.3	Gear Box – Double de-clutching, working of synchromesh gear box	1.5
2.1.4	Planetary gear box – Continuously Variable Transmission (CVT)	1

2.1.5	Differential – working of limited slip differential and centre differential	1.5
2.1.6	Axles – Types of front and rear axles – working of joints used in live front axle	1
2.2	**Steering system**	
2.2.1	True rolling, links in steering system, recirculating ball and nut, rack and pinion steering gears	1.5
2.2.2	Construction and working of power steering	1
2.3	**Suspension system**	
2.3.1	Functions, construction of leaf spring and coil spring suspension, Independent suspension. Working of telescopic shock absorber	1.5
2.4	**Braking system**	
2.4.1	Types, working of drum and disc brakes, self energization	1
2.4.2	Hydraulic brake system, power brake system	1.5
2.5	**Automotive electrical and electronics**	
2.5.1	Lighting and signaling systems – Working of head light, Horns, indicators	1
2.5.2	Ignition system-Battery ignition system, Magneto ignition system, Electronic ignition system.	1
2.5.3	Starter motor- Principle of operation, construction	1
2.5.4	Working of MPFI, CRDI, ABS	2
3	**Manufacturing Automation**	
3.1	Selection & Application range of Industrial drives-Comparison of fluid power and electric drives-advantages of electrical drives- Energy saving-motor/mechanical load match-Motion/time profile match.	2
3.2	Hydraulic Motors and Pumps - Hydraulic valves - Hydraulic cylinders & cushioning.	2
3.3	Pneumatic actuators-pneumatic valves and control circuits-Multiple actuator circuits-Hydraulic and Pneumatic circuits.	2
3.4	**Automation:** Definition, Benefits and types, **CNC Machines:** Construction, Working and applications in various types of Manufacturing process (Turning, Milling, Welding and Forming).	2
3.5	**Material Requirement Planning (MRP)**: Inputs to MRP, Working of MRP and MRP output reports.	1.5
3.6	**Computer Aided Process Planning:** Retrieval type and Generative type CAPP, Benefits.	1.5
3.7	**Factory Data collection systems**: Automatic Identification methods, automated data collection systems.	1
	Total	**36**

Course Designers:

1. A. Samuel Raja samuel1973@tce.edu
2. M.Balamurali balacim82@tce.edu

OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

PROGRAMME ELECTIVES
(For TVS students)

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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S.No.	***Common syllabus***		***Course Title***
	Course code (2010-13 batch)	Course code (OBE 2014-15 batch)	
1.	EC1	14EEP10	Software Engineering
2.	EC2	14EEP20	Quality Engineering
3.	EC3	14EEP30	Reliability Engineering
4.	EC5	14EEP40	Industrial Electrical and Electronics
5.	EC7	14EEP60	Testing & Certification of Automotive Electrical and Electronic Systems

14EEP10	SOFTWARE ENGINEERING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

The main objective of this subject is to promote the practice of software engineering concepts at a higher level of abstraction, in a more engineering-like fashion.

Prerequisite

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Course Outcomes

On the successful completion of the course, students will be able to

Course Outcomes	Blooms level	Expected proficiency (%)	Expected attainment level (%)
Understand the various software life cycle development models and identify the ways of measuring the software. **(CO1)**	Understand	75	70
Apply the various estimation techniques and scheduling in software project development. **(CO2)**	Apply	65	65
Apply the testing tactics and strategies performed for any software. **(CO3)**	Apply	65	65
Apply the management of quality and change in the software development process. **(CO4)**	Apply	65	65

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	**M**	**L**	**L**									
CO2.	**S**	**M**	**M**	**L**								
CO3	**S**	**M**	**M**	**L**								
CO4	**S**	**M**	**M**	**L**								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	30	20	20	20
Understand	40	40	20	20
Apply	30	40	60	60
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1)**:**

1. State the important elements of CSR in SCM.
2. State the way of status reporting after S/W changes.
3. Illustrate an application where an agile process model is applicable.
4. Explain the need for measurement. What are the various classifications of measurement?

Course Outcome 2 (CO2)**:**

1. Using the Cocomo models, estimate the effort required to build a S/W for a Simple ATM that produces 24 screens, 15 reports and will require approximately 110 S/W components. Assume average complexity and average developer / environment maturity. Use the application composition model with object points.
2. Write a function of Make / Buy decision.
3. Implement the formal technical reviews for weather monitoring S/W.
4. Compute the 3D function point value for a project with the following information domain characteristics {45, 55, 20, 25, 6, 27, 5 }. The code designed for the project is reusable, all master files are updated on-line and the performance is critical. The other complexity adjustment values are considered to be average.

Course Outcome 3 (CO3)**:**

1. Illustrate the cost impact of early defect detection during the software process, assuming the following error detection percentage. Preliminary design-65%, detailed desing-45%, code/unit test-70% and others-50%. Assume your own amplification factors and error generated in each phase.
2. Draw the CFG and calculate the cyclomatic complexity for the following program.

```
int compute_gcd(x, y)
int x, y;
{
while (x! = y){
if (x>y) then
x= x – y;
else y= y – x;
 }
 return x;
}
```

Course Outcome 4 (CO4)

1. Illustrate the cost impact of software defects ((With and without reviews).) using defect amplification model. Assume % efficiency for error detection as follows. Assume the cost units for after release is 75.

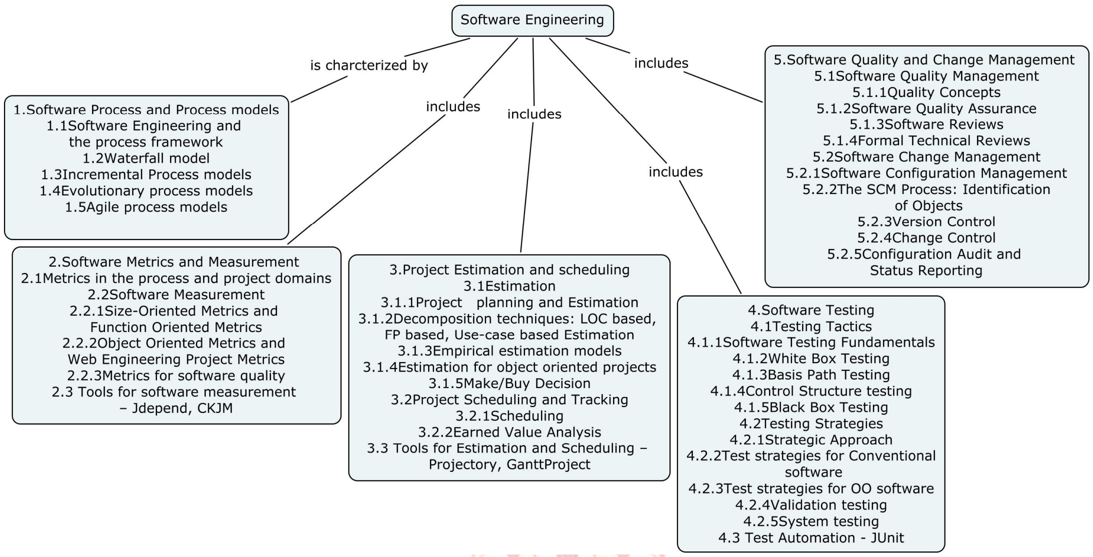
Stages	% efficiency for error detection	Amplification value	Newly generated errors	Cost units
Preliminary Design	25%	0	14	3.5
Detailed Design	60%	1.7	19	4.2
Code/Unit Test	70%	2.4	26	8.0
Other testing stages	50%	0	0	19
After Release	-			60

2. Compute Phase Index and Error Index for the following table. Given Ws=10, Wm=3, Wt=1 and Size of the product=25,500

Type of the Error	No of Errors		
	Serious	Moderate	Minor
IES	87	64	96
MCC	89	56	15
IDS	35	70	57
EDR	57	82	45
ICI	79	49	50
PLT	7	5	9
MIS	15	20	10
HCI	56	78	35

3. Design a project database (repository) system that would enable a software engineer to store, cross- reference, trace, update and change, all important software configuration items. How would the database handle different versions of the program? Would source code be handled differently than documentation? How will two developers be precluded from making different changes to the same SCI at the same time?

Concept Map



Syllabus

Software Process and Process models: Software Engineering and the process framework - Waterfall model - Incremental Process models - Evolutionary process models - Agile process models

Software Metrics and Measurement: Metrics in the process and project domains - Software Measurement - Size-Oriented Metrics and Function Oriented Metrics - Object Oriented Metrics and Web Engineering Project Metrics - Metrics for software quality - Tools for software measurement – Jdepend, CKJM

Project Estimation and scheduling: Estimation - Project planning and Estimation - Decomposition techniques: LOC based, FP based, Use-case based Estimation - Empirical estimation models - Estimation for object oriented projects - Make/Buy Decision - Project Scheduling and Tracking – Scheduling - Earned Value Analysis - Tools for Estimation and Scheduling – Projectory, GanttProject

Software Testing: Testing Tactics - Software Testing Fundamentals - White Box Testing - Basis Path Testing - Control Structure testing - Black Box Testing - Testing Strategies - Strategic Approach - Test strategies for Conventional software - Test strategies for OO software - Validation testing - System testing - Test Automation - JUnit

Software Quality and Change Management: Software Quality Management - Quality Concepts - Software Quality Assurance - Software Reviews - Formal Technical Reviews - Software Change Management - Software Configuration Management - The SCM Process: Identification of Objects - Version Control - Change Control - Configuration Audit and Status Reporting

Text Book

1. Roger S. Pressman, Software Engineering A Practitioner's Approach, sixth Edition, McGraw Hill International Edition.,2007.

Reference Books

1. Roger S. Pressman, Software Engineering A Practitioner's Approach, Fifth Edition, McGraw Hill International Edition.,2000
2. Ian Somerville-Software Engineering, John Wiley and sons,2003

Course Contents and Lecture Schedule

No.	Topic	No of Lectures
1.	**Software Process and Process models**	
1.1	Software Engineering and the process framework	1
1.2	Waterfall model	1
1.3	Incremental Process models	2
1.4	Evolutionary process models	2
1.5	Agile process models	2
2	**Software Metrics and Measurement**	
2.1	Metrics in the process and project domains	1
2.2	Software Measurement	
2.2.1	Size-Oriented Metrics and Function Oriented Metrics	2
2.2.2	Object Oriented Metrics and Web Engineering Project Metrics	2
2.2.3	Metrics for software quality	1
2.3	Tools for software measurement – Jdepend, CKJM	1
3.	**Project Estimation and scheduling**	
3.1	Estimation	
3.1.1	Project planning and Estimation	1
3.1.2	Decomposition techniques: LOC based, FP based, Use-case based Estimation	2
3.1.3	Empirical estimation models	1
3.1.4	Estimation for object oriented projects	1
3.1.5	Make/Buy Decision	1
3.2	Project Scheduling and Tracking	
3.2.1	Scheduling	2
3.2.2	Earned Value Analysis	1
3.3	Tools for Estimation and Scheduling – Projectory, Gantt Project	1
4	**Software Testing**	
4.1	Testing Tactics	
4.1.1	Software Testing Fundamentals	1
4.1.2	White Box Testing	1
4.1.3	Basis Path Testing	1

4.1.4	Control Structure testing	1
4.1.5	Black Box Testing	1
4.2	Testing Strategies	
4.2.1	Strategic Approach	1
4.2.2	Test strategies for Conventional software	1
4.2.3	Test strategies for OO software	1
4.2.4	Validation testing, System Testing	1
4.2.5	System Testing	1
4.3	Test Automation - JUnit	1
5	**Software Quality and Change Management**	
5.1	Software Quality Management	
5.1.1	Quality Concepts	1
5.1.2	Software Quality Assurance	1
5.1.3	Software Reviews	1
5.1.4	Formal Technical Reviews	1
5.2	Software Change Management	
5.2.1	Software Configuration Management	1
5.2.2	The SCM Process: Identification of Objects	1
5.2.3	Version Control	1
5.2.4	Change Control	1
5.2.5	Configuration Audit and Status Reporting	1
	Total	**45**

Course Designer:

1. Mrs.J.Jane Rubel Angelina janerubel@tce.edu

		Category	L	T	P	Credit
14EEP20	**QUALITY ENGINEERING**	PE	3	0	0	3

Preamble

This course covers the foundations of modern methods of quality control and improvement that are used in the manufacturing and service industries. Quality is the key to surviving tough competition. Consequently, business needs technically competent people who are well-versed in statistical quality control and improvement. This course starts with the philosophy and fundamentals of quality control. It then deals with the statistical foundations of quality control. Statistical Process Control and acceptance sampling are then covered. This course also deals with product and process design including quality assurance, reliability and environmental requirements and introduces experimental design techniques. This course also demonstrates the use of computer software package, Minitab, for quality control and improvement exercises.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO No	Course Outcomes	Blooms level	Expected Proficiency	Expected Attainment level
CO1	Explain the Philosophy and fundamental concepts behind Quality Engineering	Understand	90%	80%
CO2	Estimate Quality characteristics using statistical concepts and techniques	Apply	90%	80%
CO3	Select suitable control chart for a given statistical process control	Analyse	90%	80%
CO4	Illustrate the basics of product quality in terms of Electrical and Electronics systems	Understand	90%	80%
CO5	Explain the basics of process quality in terms of Electrical and Electronics systems	Understand	90%	80%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3.	**M**	**L**										
CO4.	**S**	**M**	**L**									
CO3.	**S**	**M**	**M**	**L**								
CO4.	**M**	**L**										
CO5.	**M**	**L**										

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	**Continuous Assessment Tests**			**Terminal Examination**
	1	**2**	**3**	
Remember	20	20	20	20
Understand	50	30	80	30
Apply	30	30		30

Analyse		20		20

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define Quality according to Juran and Deming's view.
2. Discuss Juran's Triology.
3. List the evaluation process of Quality control from 1920 to 1970 according to Feigenbaum.

Course Outcome 2 (CO2):

1. Construct Cause and effect diagram for Edge flaws problem.
2. The % cost of quality for 12 projects are given below. Calculate the chance that a project's % cost of quality will be within 15 ± 6 %

15.35	13.90	15.11	13.02	11.67	14.15
8.07	15.95	17.45	14.53	11.73	16.89

3. A study is undertaken to reduce the cost of quality to 0.2. During brainstorming, one of the team members suggested that wherever the rework effort / total effort < 0.07, those projects have cost of quality generally lower than 0.2. The data on cost of quality of projects with rework effort / total effort < 0.07 is given below. Validate the suggestion?

0.15	0.22	0.12	0.21	0.12	0.19	0.33
0.11	0.22	0.3	0.18	0.31	0.19	0.27

Course Outcome 3 (CO3)

4. The data given below are surface Finish values of 30 jobs after chromium plating. Construct an Individual X & Moving Range chart to monitor the process.

0.078	0.079	0.077	0.076	0.074	0.072	0.069	0.075	0.078	0.077
0.075	0.078	0.08	0.081	0.08	0.079	0.082	0.073	0.078	0.074
0.072	0.075	0.068	0.073	0.074	0.081	0.076	0.08	0.074	0.07

5. For the given data's
   - Calculate Control Limits
   - Plot Control Chart
   - Calculate Process Capability Indices (Pp/Ppk).
   - Monitor Process through plotting control chart.

Sample No.	Hour	x1	x2	x3	x4
1	8:00	5.00	5.01	4.98	5.00
2	9:00	5.01	4.98	5.00	5.00
3	10:00	5.02	5.01	5.00	5.00
4	11:00	5.00	5.00	5.00	5.00
5	12:00	4.98	4.98	5.01	4.99
6	13:00	5.02	4.99	5.00	4.98
7	14:00	4.99	4.99	4.98	4.98
8	15:00	5.00	5.01	5.02	5.00
9	16:00	4.98	5.00	5.01	4.98

6. 20 data on acid content (mm) is given in the table below. If the specification on acid content is 0.70 ± 0.2 mm. Check whether the process has the potential to meet the customer requirement.

0.85	0.75	0.80	0.65	0.75	0.60	0.80	0.70	0.75	0.60
0.80	0.75	0.70	0.70	0.75	0.75	0.85	0.60	0.50	0.65

Course Outcome 4 (CO4)

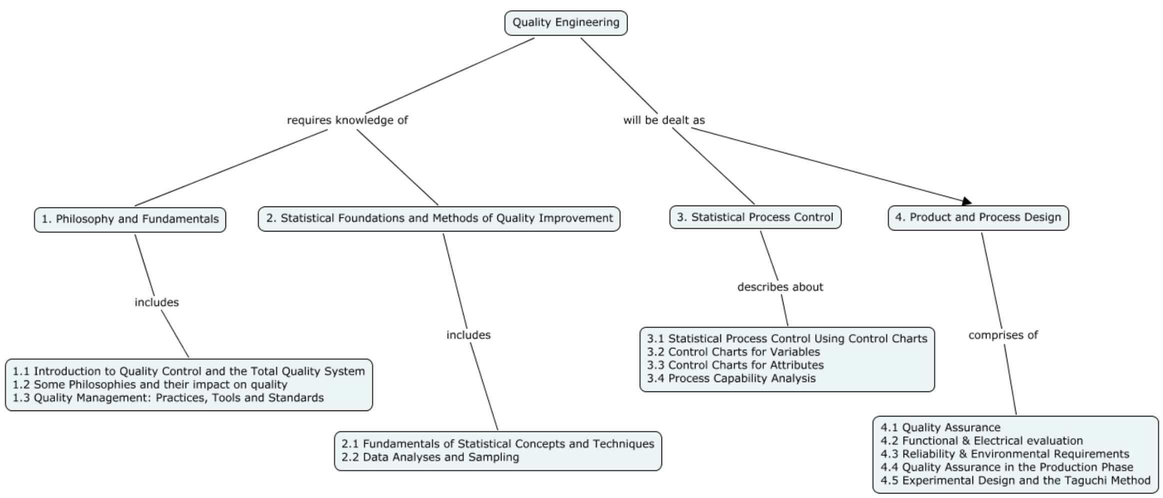
1. Write the purpose of evaluation in Product design.

2. Explain the Philosophy behind APQP
3. Explain the electrical and electronics evaluation in terms of PCB.

Course Outcome 5 (CO5)

1. Outline electrical evaluation carried out in industrial automotive field.
2. Explain the functionality of Quality Assurance team activities.
3. Write the purpose of evaluation in Process design

Concept Map



Syllabus

Philosophy and Fundamentals

Introduction to Quality Control and the Total Quality System, Some Philosophies and their impact on quality, Quality Management: Practices, Tools and Standards.

Statistical Foundations and Methods of Quality Improvement

Fundamentals of Statistical Concepts and Techniques, Data Analyses and Sampling.

Statistical Process Control

Statistical Process Control Using Control Charts, Control Charts for Variables, Control Charts for Attributes, Process Capability Analysis.

Product and Process Design

Quality Assurance, Functional & Electrical evaluation, Reliability & Environmental Requirements, Quality Assurance in the Production Phase, Experimental Design and the Taguchi Method.

Text Books

1. A.Mitra, “Fundamentals of Quality Control and Improvement”, Wiley, Third Edition, 2008
2. W.Fleischammer, “Quality by Design for Electronics”, Chapman & Hall, First Edition, 1996

Reference Books

1. H.M.Wadsworth, K.S.Stephens and A.B.Godfrey, “Modern Methods for Quality Control and Improvement”, John Wiley & Sons.2004
2. M.S. Phadke, "Quality Engineering using Robust Design", Pearson, 1989

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Philosophy and Fundamentals**	
1.1	Introduction to Quality Control and the Total Quality System	2
1.2	Some Philosophies and their impact on quality	2
1.3	Quality Management: Practices, Tools and Standards	4

No.	Topic	No. of Lectures
2.	**Statistical Foundations and Methods of Quality Improvement**	
2.1	Fundamentals of Statistical Concepts and Techniques	4
2.2	Data Analyses and Sampling	2
3	**Statistical Process Control**	
3.1	Statistical Process Control Using Control Charts	4
3.2	Control Charts for Variables	2
3.3	Control Charts for Attributes	2
3.4	Process Capability Analysis	2
4	**Product and Process Design**	
4.1	Quality Assurance	2
4.2	Functional & Electrical evaluation	4
4.3	Reliability & Environmental Requirements	2
4.4	Quality Assurance in the Production Phase	4
4.5	Experimental Design	2
4.6	Taguchi Method	2
Total		**40**

Course Designers:

1. P.S.Raghavan PS.Ragahavan@tvsmotor.co.in
2. A.Srikumar A.Srikumar@tvsmotor.co.in
3. Mr.P.Vairaprakash vairaprakash@tce.edu

14EEP30	RELIABILITY ENGINEERING	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

This course is designed to provide an introduction to reliability engineering. Reliability engineering fulfils the need for a time-based concept of quality. Competition, the pressure of schedules and deadlines, the cost of failures, the rapid evolution of new materials, methods and complex systems, the need to reduce product costs, and safety considerations all increase the risks of product development. Reliability engineering has developed in response to the need to control these risks. Understanding of reliability engineering principles and methods is now an essential ingredient of modern engineering. This course starts by explaining the fundamental concepts of reliability engineering. It demonstrates how reliability engineering methods can be applied to design and development to control the level of risk. Reliability of electrical and electronic systems is dealt in detail. This course explains reliability testing and analysis covering environmental and stress testing and the integration of reliability and other development testing. This course also demonstrates reliability prediction using failure rate database including an introduction to computer simulation tools to predict electrical and electronic product and system reliability.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

CO No	Course Outcomes	Blooms level	Expected Proficiency	Expected Attainment level
CO1	Explain the basic concepts of Reliability Engineering	Understand	90%	80%
CO2	Identify the reliability of Electrical systems	Apply	90%	80%
CO3	Illustrate the reliability prediction of Electronic systems	Understand	90%	80%
CO4	Classify reliability testing and data analysis	Apply	90%	80%
CO5	Estimate the reliability of electrical and electronic systems using failure rate database	Apply	90%	80%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO5.	**M**	**L**										
CO6.	**S**	**M**	**L**									
CO3.	**M**	**L**										
CO4.	**S**	**M**	**L**									
CO5.	**S**	**M**	**L**		**S**							

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	50	30	30	30
Apply	30	50	50	50
Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Discuss why engineering products fail.
2. Define reliability. What is its relation to probability of failure?
3. Suppose that the scores in an examination are normally distributed with mean μ= 76, standard deviation=15, the top 15% of students are A grade, bottom 10% are F grade. Find the minimum score to receive A Grade.

Course Outcome 2 (CO2):

1. In a normal domestic kitchen containing a fluorescent light fitting and a washing machine, list the EMI sources you may find and how as a designer you may mitigate these effects.
2. Write down the importance of Computer Aided Engineering and Environments in reliability design.
3. Write down the stress effects of current.

Course Outcome 3 (CO3):

1. You are designing an electronic unit that will be used on an agricultural machine. What failures might be caused by the vibration environment? What steps would you take to minimize these?
2. Describe three methods for analyzing the effects of component parameter variations on the performance of an electronic circuit. For each, describe how the variations and their effects can be minimized by the designer.
3. For a small plastic transistor operating at 120mW, estimate T_j if Θ=0.4°C mW^{-1} above 25°C, if the ambient temperature is 50°C. If the maximum junction temperature is 150°C, estimate what power the transistor will dissipate at an ambient temperature of 60°C

Course Outcome 4 (CO4)

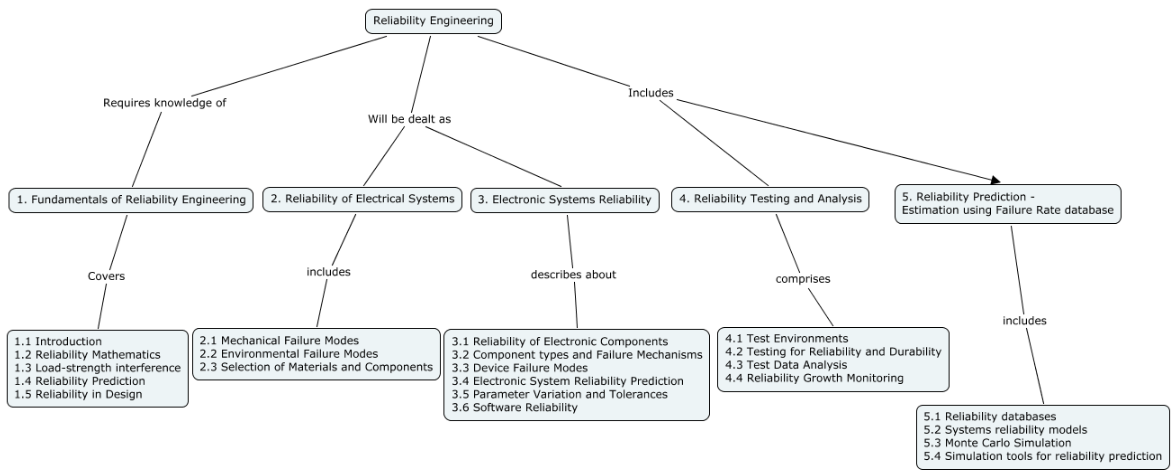
1. Explain the Highly Accelerated Life Testing.
2. Write down the main principles of effective vibration testing.
3. The first reliability qualification test on a new electronic test equipment generates 11 failures in 600h, with no one type of failure predominating. The requirement set for the production standard equipment is an MTBF of not less than 500h in service. How much more testing should be planned, assuming values for α of 0.3 and 0.5?

Course Outcome 5 (CO5)

1. Suppose that you have run a Monte Carlo analysis (*m* samples) and wish to cut the standard deviation in half. How many samples do you need to run?
2. Test the hypothesis that whenever several random variables are added together, the resulting sum tends to normal regardless of the distribution of the variables being added. Sample the sum of 10 random variables from different statistical distribution and test the normality of this sum by constructing the histogram or using other statistical tools.

3. An electric circuit current was modelled with 1000 experiments. The mean value of the outputs is 25 amps with the standard deviation of 8 amps. Estimate the number of runs required to achieve 1 % accuracy with 95 % confidence.

Concept Map



Syllabus

Fundamentals of Reliability Engineering

Introduction, Reliability Mathematics, Load-strength Interference, Reliability Prediction, Reliability in Design

Reliability of Electrical Systems

Mechanical Failure Modes, Environmental Failure Modes, Selection of Materials and Components.

Electronic Systems Reliability

Reliability of Electronic Components, Component types and Failure Mechanisms, Device Failure Modes, Electronic System Reliability Prediction, Parameter Variation and Tolerances, Software Reliability.

Reliability Testing and Analysis

Test Environments, Testing for Reliability and Durability, Test Data Analysis, Reliability Growth Monitoring.

Reliability Prediction – Estimation using Failure rate database

Reliability databases, systems reliability models, Monte Carlo Simulation, simulation tools for reliability prediction.

Text Books

3. Patrick D. T. O'Connor, "Practical Reliability Engineering", Fourth Edition, Wiley-India, 2006

Reference Books

3. E. E. Lewis, "Introduction to Reliability Engineering", Wiley, 1987
4. E. Balaguruswamy, "Reliability Engineering", Tata McGraw-Hill Publishing Co. Ltd., 1984
5. B.S. Dhillion, C. Singh, "Engineering Reliability", John Wiley & Sons, 1980

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.	**Fundamentals of Reliability Engineering**	
1.1	Introduction	1
1.2	Reliability Mathematics	4
1.3	Load-strength Interference	1

No.	Topic	No. of Lectures
1.4	Reliability Prediction	2
1.5	Reliability in Design	2
2.	**Reliability of Electrical Systems**	
2.1	Mechanical Failure Modes	2
2.2	Environmental Failure Modes	2
2.3	Selection of Materials and Components	2
3	**Electronic Systems Reliability**	
3.1	Reliability of Electronic Components	2
3.2	Component types and Failure Mechanisms	2
3.3	Device Failure Modes	2
3.4	Electronic System Reliability Prediction	2
3.5	Parameter Variation and Tolerances	1
3.6	Software Reliability	1
4	**Reliability Testing and Analysis**	
4.1	Test Environments	2
4.2	Testing for Reliability and Durability	2
4.3	Test Data Analysis	2
4.4	Reliability Growth Monitoring	2
5.	**Reliability Prediction – Estimation using Failure rate database**	
5.1	Reliability databases	2
5.2	Systems reliability models	1
5.3	Monte Carlo Simulation	1
5.4	Simulation tools for reliability prediction	2
	Total	**40**

Course Designers:

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14EEP40	INDUSTRIAL ELECTRICAL AND ELECTRONICS	Category	L	T	P	Credit
		PE	3	0	0	3

Preamble

Industrial process control and production automation requires proficiency in industrial electrical and electronics. This is achieved by linking equipment such as PCs, PLCs, SCADA, distributed control systems and simple instrument together with data communications systems that are correctly designed and implemented. This course highlights the industrial controllers, networks and communication requirement for smart instrumentation.

Prerequisite

- **14ES160- Basic Electrical and Electronics Engineering**
- **14EE350- Digital systems**

Course Outcomes

On the successful completion of the course, students will be able to

CO No	Course Outcomes	Blooms level	Expected Proficiency	Expected Attainment level
CO1	Determine the performance of manufacturing engineering systems	Understand	90%	80%
CO2	Illustrate the basic subsystems and sequence of SPM and GPM machines	Understand	90%	80%
CO3	Explain the architecture of Industrial machine controllers	Understand	90%	80%
CO4	Develop efficient industrial design for all modern requirements.	Apply	90%	80%
CO5	Select, install and maintain the industrial protocols in most cost-effective manner for the plant.	Analyse	90%	80%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO7.	**M**	**L**										
CO8.	**M**	**L**										
CO3	**M**	**L**										
CO4	**S**	**M**	**L**									
CO5	**S**	**M**	**M**	**L**								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	30	30	20	20
Apply	50	50	30	40
Analyse	0	0	30	20

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Calculate the takt time for producing 35000vehicles/month, assuming two shift operations with each shift working for 466 minutes?
2. Define Line balancing
3. Where do we use standard operation combination chart?

Course Outcome 2 (CO2):

1. Write the differences between special purpose machines and general purpose machines.
2. Explain "Through Coolant" system and its advantages.
3. Outline different components that are used in a machine tool to achieve different levels of safety.

Course Outcome 3 (CO3)

1. Draw the architecture of machine controllers for a Variable Frequency Drive.
2. Explain the operating principle of an inductive proximity sensor.
3. State the factors influencing the choice of transducer.

Course Outcome 4 (CO4)

1. Design and develop the ladder diagram for ON delay timer using PLC.
2. Develop ladder logic for semi automatic starter for starting of three phase induction motor using PLC.
3. A reamer is said to be fit for operating 5000 auto cycles. Once 4999 cycles are over PLC has to pop up an warning bit saying “Tool life over”. Write ladder logic for tool life monitoring in a machine.

Course Outcome 5 (CO5)

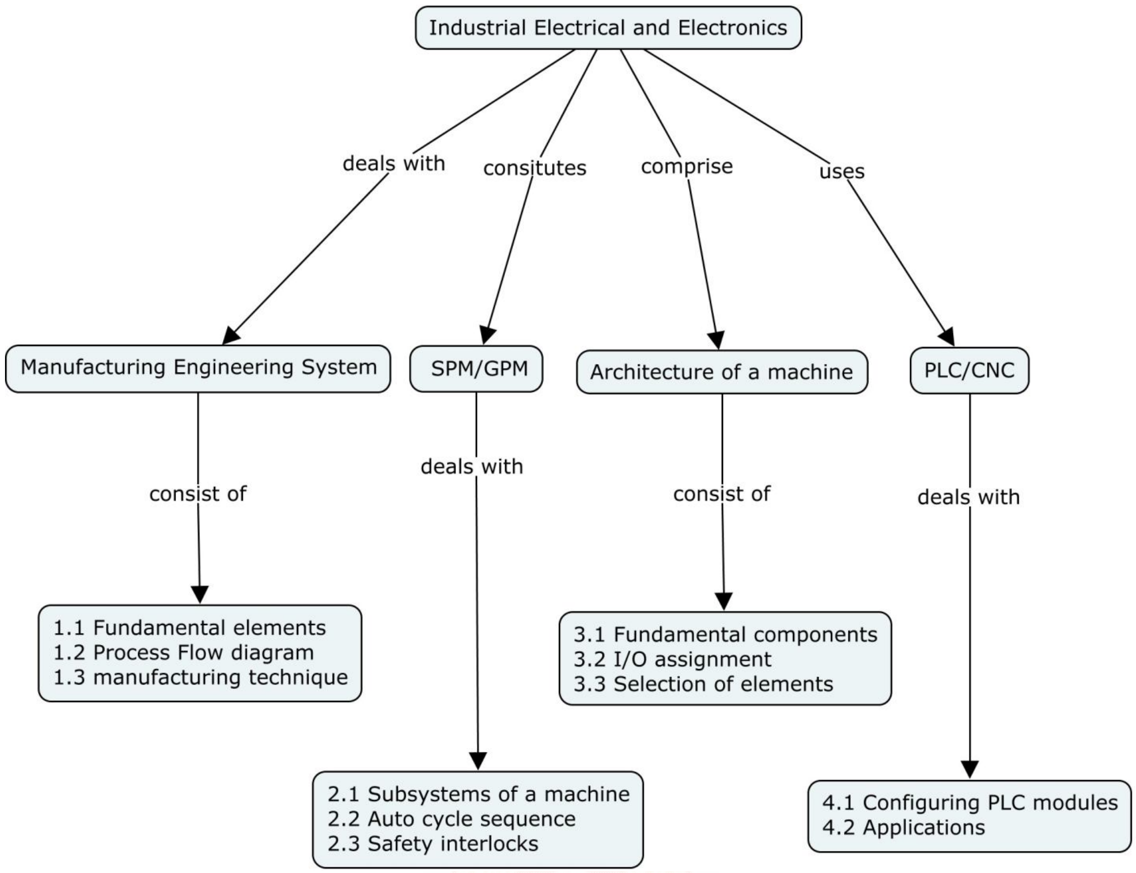
1. You have two counters counting up-to 16, built from negative edge DFF , First circuit is synchronous and second is "ripple" (cascading), Which circuit has a less propagation delay? Why?
2. Analyse what will happen if there is setup time and hold time violation, how to overcome this?
3. Prepare the I/O list and write the ladder diagram considering the following statements.

   There are two cylinders available like main and small cylinders. Initially both the cylinders are at HOME (Back) condition. User has to actuate the main cylinder first from HOME to forward. By this time small cylinder will be in HOME. Then the small cylinder should be actuated forward for 5s. Then it has to come back to HOME. Finally main cylinder should come back to Home.

   Programmer is given following elements to design the ladder.

   - Main cylinder HOME proximity for its HOME position confirmation.
   - Main cylinder FWD proximity for its FWD position confirmation.
   - Small cylinder HOME proximity for its HOME position confirmation.
   - A push button for Cycle start.
   - Main Cylinder forward & reverse solenoid (Double coil solenoid)
   - Small Cylinder forward & reverse solenoid (Double coil solenoid)
   - Indication lamp for Home condition confirmation for both the cylinders.
   - Indication Lamp for small cylinder in forward condition.

Concept Map



Syllabus

Manufacturing Engineering System: Batch, Cell concept, Individual part flow, Takt time, Process Time, Lead time, Cycle time, OEE, Process Flow diagram, Lean manufacturing technique and Six sigma overview

SPM/GPM: Basic Subsystems of a machine - Base & Columns, Fixture, Tooling's, Spindle, Slide ways, Hydraulics, Pneumatics, Lubrication, Cladding & Auto door, Coolant & Chip tray. Electrical - Control Cabinet, Servo drives, Operator console, HMI/MMI/Panel PC.

Auto cycle sequence - Auto Door movement, component clamp/de-clamp, Slide feed, Axes interpolation in a CNC machine, Automatic Tool Change, Metal cutting at regulated rpm, Cutting coolant and bed coolant. Safety interlocks- Levels of safety, redundancy levels and poka yoke used in machining process & power saving techniques

Architecture of machine controllers: Sensors & transducers, Actuators, Relays, contactor, power supply, fuse, Isolator, ELCB, MCB, MPCB, Controlling Induction motor from VFD, Servomotor& Servo drives, Encoders, Operator panel elements (Push button, Selector switch, lamp, HMI etc), PLC & CNC controllers. I/O assignment - Addressing Digital I/O, Analogue I/O & counter inputs for a machine based on application. Selection of elements for application control - PLC/CNC controller, HMI/MMI, sensors, transducers, actuators, motors, drives, Circuit breakers, power supply, relays, cables etc, Earthing/shielding of measuring equipments, Techniques of electrical noise elimination while wiring, Symbols for electrical elements, design a control panel & operator panel using selected elements

PLC/CNC: Configuring PLC modules using ladder, Bit, Byte & words, addressing digital I/O signals, Concept of NO/NC elements, coils, flags, Boolean operation, AND/OR/NOT, Pulse triggered execution, serial, parallel and latch execution sequence, Relays, Counter, Timers, Registers, Mathematical and logical instructions, building tags. Addressing analogue I/Os in Ladder, Programming an analogue I/O block, Read/Write functions, Programming an encoder using counter block, Compare functions Examples of very commonly used safety logics/techniques, building poka yoke in ladder using peripheral sensors, power saving techniques.

Reference Books

1. Srinivas Medida, "Pocket Guide on Industrial Automation For Engineers and Technicians" first edition, IDC Technologies.
2. W. Bolton, "Programmable Logic Controllers", Newnes imprint of Elsevier, 2006
3. Frank D.Petruzella, "Programmable Logic Controllers", Fourth Edition McGraw-Hill, 2011

Course Contents and Lecture Schedule

S. No.	Topics	No of lecture hours
1	**Manufacturing Engineering System**	
1.1	Batch, Cell concept, Individual part flow, Takt time, Process Time, Lead time, Cycle time, OEE	2
1.2	Process Flow diagram	2
1.3	Lean manufacturing technique and Six sigma overview	2
2	**SPM / GPM**	
2.1	Basic Subsystems of a machine : Base & Columns, Fixture, Tooling's, Spindle, Slide ways, Hydraulics, Pneumatics, Lubrication, Cladding& Auto door, Coolant & Chip tray, Electrical : Control Cabinet, Servo drives, Operator console, HMI/MMI/Panel PC	3
2.2	Auto cycle sequence : Auto Door movement, component clamp/de-clamp, Slide feed, Axes interpolation in a CNC machine, Automatic Tool Change, Metal cutting at regulated rpm, Cutting coolant and bed coolant,	4
2.3	Safety interlocks: Levels of safety, redundancy levels and poka yoke used in machining process & power saving techniques	3
3	**Architecture of machine controllers**	
3.1	Sensors & transducers, Actuators, Relays, contactor, power supply, fuse, Isolator, ELCB, MCB, MPCB, Controlling Induction motor from VFD, Servomotor & Servo drives, Encoders, Operator panel elements(Push button, Selector switch, lamp, HMI etc),PLC & CNC controllers,	5
3.2	I/O assignment: Addressing Digital I/O, Analogue I/O & counter inputs for a machine based on application.	2
3.3	Selection of elements for application control : PLC/CNC controller, HMI/MMI, sensors, transducers, actuators, motors, drives, Circuit breakers, power supply, relays, cables etc, Earthing/shielding of measuring equipments, Techniques of electrical noise elimination while wiring, Symbols for electrical elements, design a control panel & operator panel using selected elements	5
4	**PLC / CNC**	
4.1	Configuring PLC modules using ladder, Bit, Byte & words, addressing digital I/O signals, Concept of NO/NC elements, coils,	6

	flags, Boolean operation: AND/OR/NOT, Pulse triggered execution, serial, parallel and latch execution sequence, Relays, Counter, Timers, Registers, Mathematical and logical instructions, building tags, Addressing analogue I/Os in Ladder, Programming an analogue I/O block, Read/Write functions, Programming an encoder using counter block, Compare functions	
4.2	Examples of very commonly used safety logics/techniques, building poka yoke in ladder using peripheral sensors, power saving techniques	4
	Total	**40**

Course Designers:

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2. Mr.P.Vairaprakash vairaprakash@tce.edu

		Category	L	T	P	Credit
14EEP60	**TESTING & CERTIFICATION OF AUTOMOTIVE ELECTRICAL & ELECTRONIC SYSTEMS**	PE	3	0	0	3

Preamble

This course gives an exposure to Indian Test standards and Test methods for automotive Electrical & Electronic components and Test standards & Compliance requirements for EMCs. This course also focuses on the Test set-up &Test Methods for HIL testing and various environmental requirements.

Prerequisite

14EEPQ0 – Automotive Electronics

Course Outcomes

On successful completion of the course, students will be able to

No	Course Outcomes	Blooms level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain Indian Test standards for homologation of 2W/3W.	Understand	80	75
CO2	Explain Indian Test standards & Test methods for Electrical & Electronic components.	Understand	80	75
CO3	Explain Indian Test standards & Compliance requirements for EMC	Understand	80	75
CO4	Explain HIL testing	Understand	80	75
CO5	Explain Indian Test standards for Environmental requirements	Understand	80	75

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L									L
CO2	M	L	L									L
CO3	M	L	L									
CO4	M	M	L									
CO5	M	L	L									L

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	40	40	40
Understand	60	60	60	60
Apply	0	0	0	0
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Mention any two global standards for 2W Emissions
2. Mention any four parameters in Indian homologation requirements.
3. What is meant by Type approval?

Course Outcome 2 (CO2):

1. Describe the Homologation test procedure for Lighting system of 2W.
2. Explain the Homologation test procedure for Horn of 2W
3. Describe the Homologation test procedure for Emission of 2W Motor Cycle.

Course Outcome 3 (CO3):

1. What is range of frequency band for radiated emission testing?
2. Describe the EMC test procedure in Open Air Test Site.
3. Describe Bulk Current Injection Test procedure.

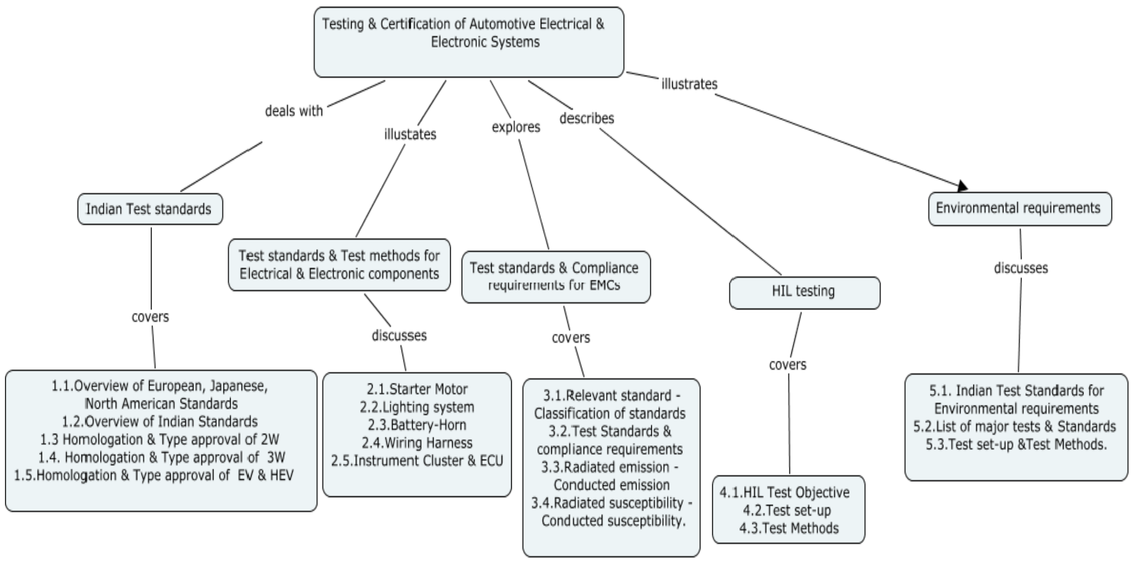
Course Outcome 4 (CO4):

1. State objective of HIL test.
2. Describe HIL test set up in detail.
3. Explain the test methods for HIL in detail.

Course Outcome 5 (CO5):

1. Mention any four standards used for environmental testing of electrical & Electronic parts.
2. Explain thermal cycle test.
3. Explain various applicable tests for wiring harness.

Concept Map



Syllabus

Indian Test standards
Overview of European, Japanese, North American Standards - Overview of Indian Standards -Homologation & Type approval of 2W & 3W, EV & HEV

Test standards & Test methods for Electrical & Electronic components : Test standards & Test methods for Electrical & Electronic components - Starter Motor, Lighting system, battery, Horn, Wiring Harness- Instrument Cluster & ECU

Test standards & Compliance requirements for EMCs: Relevant standard **-** Classification of standards – Test Standards & compliance requirements - Radiated emission - Conducted emission- Radiated susceptibility - Conducted susceptibility

HIL testing : HIL Test Objective- Test set-up - Test Methods

Environmental requirements : Indian Test Standards for Environmental requirements - List of major tests & Standards - Test set-up &Test Methods

.

Reference Books

1) Study Material supplied by 'The Automotive Research Association of India' (ARAI), Pune.

Course Contents and Lecture Schedule

Module No	Topic	No. of Lectures
1.0	**Indian Test standards**	

1.1	Overview of European, Japanese, North American Standards	1
1.2	Overview of Indian Standards	1
1.3	Homologation & Type approval of 2W	1
1.4	Homologation & Type approval of 3W	2
1.5	Homologation & Type approval of EV & HEV	2
2.0	**Test standards & Test methods for Electrical & Electronic components**	
2.1	Test standards & Test methods for Electrical components - Starter Motor	1
2.2	Lighting system	1
2.3	Battery-Horn	2
2.4	Wiring Harness	1
2.5	Test standards & Test methods for Electronic components - Instrument Cluster & ECU	3
3.0	**Test standards & Compliance requirements for EMCs**	
3.1	Relevant standard **-** Classification of standards	1
3.2	Test Standards & compliance requirements	2
3.3	Radiated emission - Conducted emission	2
3.4	Radiated susceptibility - Conducted susceptibility	2
4.0	**HIL testing**	
4.1	HIL Test Objective	2
4.2	Test set-up	2
4.3	Test Methods	3
5.0	**Environmental requirements**	
5.1	Indian Test Standards for Environmental requirements	2
5.2	List of major tests & Standards	2
5.3	Test set-up &Test Methods	3
	Total	36

Course Designer:

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OUTCOME BASED EDUCATION

CURRICULUM AND DETAILED SYLLABI

FOR

B.E. EEE DEGREE PROGRAMME

GENERAL ELECTIVES

FOR THE STUDENTS ADMITTED FROM THE

ACADEMIC YEAR 2014-15

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided ISO 9001:2008 certified Autonomous Institution affiliated to Anna University)
MADURAI – 625 015, TAMILNADU

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S.No.	Course Code	Name of the Course	Number of Hours / Week			Credit	Pre requisite if any
			L	T	P		
		THEORY					
1.	14EEGA0	Renewable Energy Sources	3	0	-	3	14BS160
2.	14EEGB0	Domestic and Industrial Electrical Installations	2	1	-	3	Nil
3.	14EEGC0	Industrial Safety and Environment	3	-	-	3	Nil
4.	14EEGD0	Soft Computing	2	1	-	3	Nil
5.	14EEGE0	Sensors and Transducers	2	1	-	3	Nil
6.	14EEGF0	Energy Conservation Practices	2	2	-	3	14BS160
7.	14EEGG0	System Approach for Engineers	3	-	-	3	Nil
8.	14EEGH0	Manufacturing of Automotive Electrical and Electronics Parts	3	-	-	3	14EE250 14EE270

14EEGA0	**RENEWABLE ENERGY SOURCES**	Category	L	T	P	Credit
		GE	3	0	0	3

Preamble

Renewable energy sources are gaining importance to minimize the global warming. Presently around 5% of total energy usage is met by Renewable Energy Sources. The renewable energy usage may be met up to 50% level in the end of this century to make the world green. Energy has become an important and one of the basic infrastructures required for the economic development of a country. Energy security is imperative for sustained growth of economy. The importance and role of renewable energy sources is stressed on the aspects of growing energy demand. The harnessing of energy through renewable resources, using efficient technologies is expected to play an important role of serving a clean energy source for mankind and for the mother earth.

The mission of the Renewable Energy Sources Course is to prepare students for the challenges of designing, promoting and implementing renewable energy solutions. Graduates will have a fundamental understanding of energy engineering and a sense of social responsibility for the implementation of sustainable energy solutions.

Prerequisite

14ES160 - Basic Electrical Engineering

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcomes	Bloom's Level	Expected Proficiency %	Expected Attainment Level %
CO1.	Describe the challenges and problems associated with the use of various energy sources, including fossil fuels, with regard to future supply and the environment.	Understand	70	60
CO2	Discuss remedies/potential solutions to the supply and environmental issues associated with fossil fuels and other energy resources.	Apply	60	50
CO3	Selection, Operation and Operation of Solar PV System for different types of applications	Apply	60	50
CO4	Selection and Operation of Wind Turbine System	Understand	70	60
CO5	Small Scale Hydroelectric Plant Selection and Design	Apply	60	50
CO6	Biomass Power Generation Types, Applicability and Limitations	Understand	70	60

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	S								S	S	
CO2.	S									S	
CO3.	S	S	S	S		M					
CO4.	S	S	S	S		M					
CO5.	S	S	S	S							
CO6.	S					L					

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	10	10
Understand	60	50	50	50
Apply	20	30	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	10	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define the term per capita Energy consumption.
2. What is meant by Global Warming? What are the various reasons for Global Warming?
3. State the objective of Kyoto Protocol.
4. Discuss the Impacts of fossil fuel usage on Environmental. Also suggest methods to overcome

Course Outcome 2 (CO2):

1. List the non-commercial energy sources as on date on earth? Also explain the strategy to make the non-commercial energy sources into viable commercial energy sources?
2. Give an outline of energy reserves of India. Also discuss the methods to bridge the gap between Demand and Supply in India by the short-term method.
3. Explain the concept of Clean Development Mechanism to save the earth and meet the sustainable energy development.

Course Outcome 3 (CO3):

1. List the three types of solar cell based on manufacturing technique.
2. With a block diagram, explain the operation of Grid-Tie Solar PV System. Also mention its advantages and limitations.
3. Explain the principle of direct solar energy to Electrical energy conversion? Specify its limitations?
4. Calculate the number of PV modules required to produce 240kW rated power Solar array operating at voltage output of 480Volts DC Supply. A solar cell gives a voltage and power output of 0.5Volts and 1.5Watts respectively. A 300Watts 24Volts rated Solar PV Modules are used. Also specify the number of modules to be connected in parallel and series to produce the rated power of 240kW Solar PV array.
5. Design a Solar PV System to meet the energy requirement of a Cafe located at remote tourist spot and operates during Daytime needs 3600Watts of AC power for 8hours a day supplied by 14% Efficient Poly-crystalline type solar PV cell along with a battery back-up system. The operating voltage of the battery storage system is 24Volts DC Supply. The

solar radiation falling on that location is equivalent to 820Wattts per square meter area. An average basis, the sun is available for 4hours daily. Design the battery size to meet the 50% energy requirement during dull sun period of every day.

Course Outcome 4 (CO4):

1. State the advantages of slow speed synchronous generator over Induction generator for wind turbine applications.
2. List the various types of Electric generator used for energy conversion in Wind turbine. Also explain the recent development in Electric generator for the above applications, along with its advantages.
3. State the various issues raised against wind turbine installation across the world. Suggest the ways and means to minimize/solving these issues.
4. Explain the need of Yaw and Pitch control in Wind turbine and specify the wind parameters to be measured to perform the above control.
5. Calculate the generated electric power, when the wind speed is 8.4 meters per second for a horizontal axis three blade wind turbine machine having rotor blade diameter of 75meter. The co-efficient of power activated in the wind turbine is 0.56. The Gear and Coupling Efficiency is 90%. The conversion efficiency of the generator is 93%. Also calculate the power generated, when the wind speed rise by 25% more than the previous case.
6. Design a suitable size electric generator for a wind turbine, where the rated wind Speed is 14 Meter/Second and Co-efficient of Power Activation is 0.52. The suggested rotor blade diameter of the wind turbine is 75meter. Assume suitable relevant data for the design.

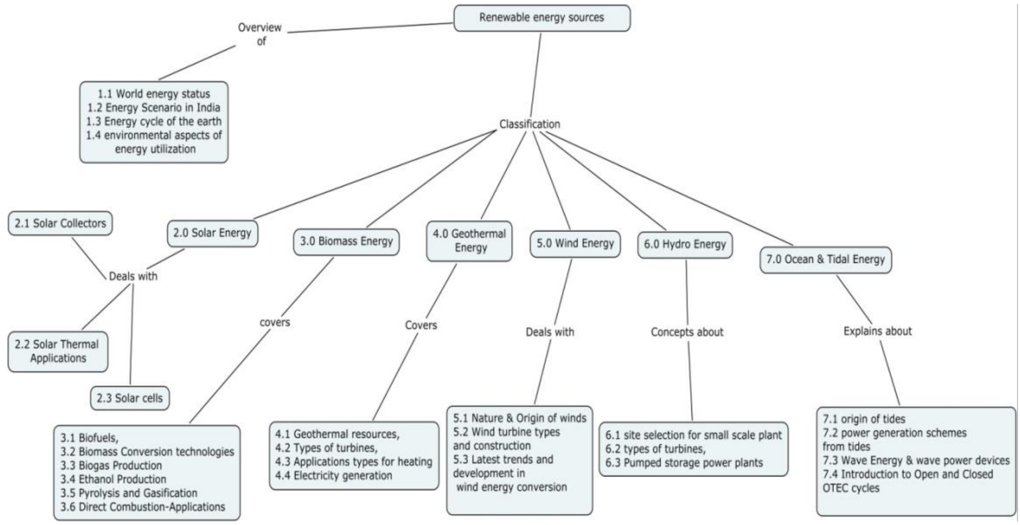
Course Outcome 5 (CO5):

1. Discuss the specific application of pumped storage hydro electric power plants. Mention its limitations.
2. A Run-off river plant with small pond is installed in a site, where the water stream flow rate is 90 cubic meter per second during daytime 12 Hours & 45 Cubic meter per second during night time 12 Hours and head availability is 45 meter. A Turbo jet turbine having 63% conversion efficiency is installed. The generator efficiency is 92%. Calculate the Energy produced form the hydro electric power plant in a day?
3. A pumped storage power plant operates for 4Hours daily to supply 90MW of power to the grid during peak hours at 94% overall plant efficiency . The net head availability is 210Meter. The same power plant operate in pump mode to pump back the water in 4Hours daily from the lower bay to upper bay during off-peak hours at 92% efficiency. The cost of power during peak hours and off-peak hours is Rs.4.50/kWh and Rs.2.50/kWh respectively. Calculate the cost saved per day. Also calculate the water discharge during power generation and quantity of water pumped back.

Course Outcome 6 (CO6):

1. What is meant by Energy Plantation?
2. List the various methods of producing power by biomass direct combustion. Also specify the limitations and method to overcome.
3. Explain the method of producing gas from Biomass using Thermo chemical process.
4. What are the advantages of biomass gasification, when compared to biomass direct combustion? Also specify the limitations of biomass gasification.

Concept Map



Syllabus

Energy Overview: Classification of Energy Resources, World energy status, Energy Scenario in India-energy cycle of the earth-environmental aspects of energy utilization-renewable energy resources and their importance, Carbon credit.

Solar Energy: Solar cells types, Characteristics, Insolation, MPPT, Standalone & Grid Connected Solar PV System Selection, Grid-Tie Inverter, Design, Operation and Maintenance.

Biomass Energy: Bio-fuels, Biomass Conversion technologies, Biogas Production-Ethanol Production-Pyrolysis and Gasification-Direct Combustion-Biomass power generation status, Applications.

Geothermal Energy: Geothermal resources, basic theory-types of turbines-applications types, applications for heating and electricity generation

Wind Energy: Nature & Origin of winds, Wind Potential Estimation, Wind Power Calculation, Wind turbine types and construction, Wind Turbine Ratings, Selection, Latest trends and development in wind energy conversion.

Hydro Energy: Basic concepts site selection and types of turbines for small scale hydropower, Run-off River plant, Role of Pumped storage power plants in Power system for the Voltage and Frequency control, Estimation of Power in Small Scale and Pumped Storage Power plants.

Ocean & Tidal Energy: origin of tides-power generation schemes-Wave Energy, wave power devices, Introduction to Open and Closed OTEC cycles

Reference Books

1. B.H. Khan, "Non-Conventional Energy Resources" Tata McGraw-Hill Publishing Company Limited, 1st Edition, 2006.
2. G.D.Roy, Non-conventional Energy Sources, Khanna Publications, New Delhi, 2001
3. Ghosh.B.Saha, S.K.Basu, Sujay, Towards Clean Energy, Tata McGraw Hill, New Delhi, 1996
4. Garg.H.P, Prakash.J, Solar Energy, Tata McGraw Hill, New Delhi, 2000

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**Energy Overview**	
1.1	Classification of Energy Resources, World energy status, Energy Scenario in India	1
1.2	Energy cycle of the earth, Environmental aspects of energy utilization	1
1.3	Renewable energy resources and their importance	1
2.0	**Solar Energy**	
2.1	Solar cells types, Characteristics, Insolation, MPPT	2
2.2	Standalone & Grid Connected Solar PV System Selection, Grid-Tie Inverter	2
2.3	Solar PV System Design	2
2.4	Operation and Maintenance	2
3.0	**Biomass Energy**	
3.1	Biofuels	1
3.2	Biomass Conversion technologies	1
3.3	Biogas Production	1
3.4	Ethanol Production	1
3.5	Pyrolysis and Gasification	2
3.6	Direct Combustion-Applications	1
4.0	**Geothermal Energy**	
4.1	Geothermal resources & basic theory	1
4.2	Types of turbines, Electric Power Generation	1
5.0	**Wind Energy**	
5.1	Nature & Origin of winds, Wind Potential Estimation,	1
5.2	Wind Power Calculation	2
5.3	Wind turbine types and construction,	1
5.3	Wind Turbine Ratings, Selection,	2
5.4	Latest trends and development in wind energy conversion	1
6.0	**Hydro Energy**	
6.1	Site selection for Small Scale Hydropower Plant, Run-off river plant	2
6.2	Turbines for Small Scale Hydro Plants	1
6.3	Role of Pumped storage power plants in Power System for Voltage and Frequency control	1
6.4	Problems in Small Scale and Pumped Storage Power Plant	1
7.0	**Ocean & Tidal Energy**	
7.1	origin of tides	1
7.2	power generation schemes from tides	1
7.3	Wave Energy & wave power devices	1
7.4	Introduction to Open and Closed OTEC cycles	1
	Total	**36**

Course Designers:

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14EEGB0	DOMESTIC AND INDUSTRIAL ELECTRICAL INSTALLATIONS	Category	L	T	P	Credit
		GE	2	1	0	3

Preamble

Electricity becomes one of the essential commodities for the human beings on day to day activities. Hence it is necessary to educate an engineer in the aspects of Domestic and Industrial Electrical Installations. The idea of this subject is to educate the non-electrical engineers on the aspect of do's and don't in Electrical Installations. It will helpful to select a best electrical system for an establishment.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

COs No.	**Course outcomes**	Blooms level	Expected Proficiency	Expected Attainment Level
CO1	State the concept of electricity	Understand	80 %	80 %
CO2	Describe the electrical installations in Domestic Building	Understand	80 %	80 %
CO3	Describe the electrical installations in industry	Understand	80 %	80 %
CO4	Develop electrical distribution design for domestic and industry	Apply	70 %	70 %
CO5	Illustrate the guidelines and specifications for electrical installation work	Understand	80 %	75 %
CO6	Describe the various types of lighting schemes	Understand	80 %	80 %
CO7	Design the lighting system for domestic, commercial and industrial applications	Apply	75%	70%

Mapping with Programme Outcomes

COs	PO1 <K3>	PO2 <k4>	PO3 <k4>	PO4 <k4>	PO5 <k3, k4, k6>
CO1 <K2>	**S**	**L**			
CO2 <K2>	**S**	**L**			
CO3 <K2>	**S**	**L**			
CO4 <K3>	**S**	**L**	**L**	**L**	
CO5 <K2>	**S**	**L**			
CO6 <K2>	**S**	**L**			
CO7 <K3>	**S**	**L**	**L**	**L**	

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	**2**	**3**	
Remember	20	20	20	20
Understand	50	50	40	40
Apply	30	30	40	40

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. When to go for a three phase power supply for domestic uses?
2. Specify the role of fuse.
3. Where to use FRLS wires?
4. Why switches should not be connected in neutral side?
5. List the points to be checked in a single phase wiring.
6. How to check the electrical wiring in flats.
7. Explain the working principle of Residual Current circuit breakers.

Course Outcome 2 (CO2):

1. What are the factors to be considered, while selecting the dimension of wire thickness for an application?
2. What are the points to be inspected, while carryout an annual inspection in a commercial complex?
3. Explain the various steps involved during planning electrical wiring for buildings.
4. Draw the electrical distribution design in multi-storied residential flat.

Course Outcome 3 (CO3):

1. List the major equipment used in a sub-station. Also specify the role of each.
2. Explain the plate earthing procedure as per the IS code of practice.
3. Explain the earthing in Power and Distribution.
4. Explain the various types of Lightning Arrestors for industrial applications.

Course Outcome 4 (CO4):

1. Design a three phase power distribution system for a bungalow and draw the single line diagram of the same.
2. A 30meter X 50meter shop floor needs to be illuminated to a light level of 250Lux. The depreciation factor and utilization factor for the lighting system is 1.2 and 0.7 respectively. 400Watts Metal halide lamp is suggested for the illuminating purpose. The luminous efficacy of the Metal halide lamp is 105 Lumens per watt. Calculate the number of lamps required and the arrangements of lamps for even light distribution.
3. Design a complete protective system for an industrial units starting from the sub-station to the load. Also specify the role of each protective system.

Course Outcome 5 (CO5):

1. Classify the different accidents
2. Mention the method of protecting electrical equipment in industry from over voltage.
3. List the safety precautions for operating high voltage equipment
4. Discuss the do's and don'ts in electrical wiring.
5. Explain the role of lightning arrestor in building and electrical systems.

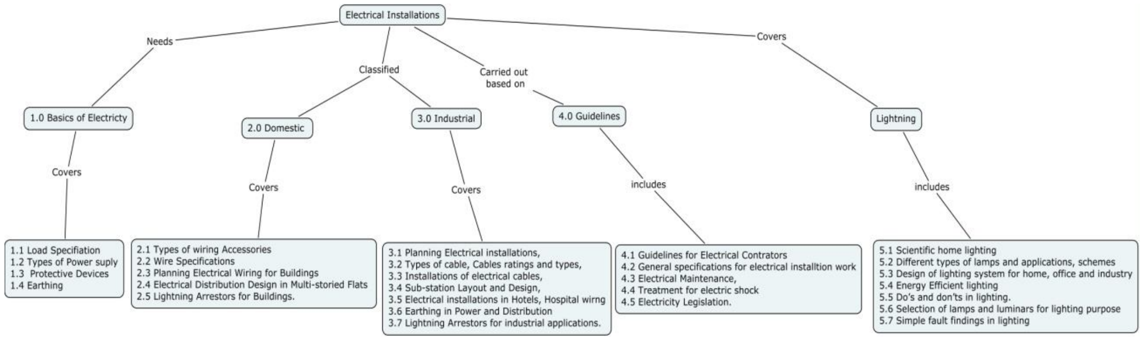
Course Outcome 6 (CO6):

1. Mention the energy efficient lamps used for domestic and industrial purpose.
2. Specify the advantages of indirect lighting schemes.
3. What are the factors to be considered while designing a lighting system for domestic purpose?
4. List the points to be inspected, while carryout an electrical inspection.

Course Outcome 7 (CO7):

1. Classify the lamps based on application. Also suggest suitable energy efficient lamps for Home and Shop floor lighting with justification.
2. Design a Distribution system for a hotel having a connected load of 100KW. The connected lighting load is 30KW and power load is 70KW. Assume other relevant data if necessary.
3. How can select the lamps and luminars for the conference hall in a office?

Concept Map



Syllabus

Introduction to Electricity –Connected load, Contracted demand, Maximum demand, Power factor, Single Phase Supply, Three phase supply, Three phase wiring, Protective devices in Electrical Installations – Fuse, MCB,MCCB's, RCCB, ELCB. Earthing for Electrical Safety.

Electrical Installations in Domestic Building - Types of wiring, Accessories used in Domestic wiring practice, wire ratings, FRLS type wires and PVC pipes, Planning Electrical Wiring for Buildings, Checking Electrical wiring in Flats, Electrical Distribution Design in Multi-storied Residential Flats and Commercial Buildings, Lightning Arrestors for Buildings.

Electrical Installation in Industry – Planning Electrical installations, Types of cable, Cables ratings and types, Installations of electrical cables, Sub-station Layout and Design, Electrical installations in Hotels, Hospital wiring, Earthing in Power and Distribution, Lightning Arrestors for industrial applications.

Do's and Don'ts in Electrical Wiring - Guidelines for Electrical Contractors. General specifications for electrical installation work, Electrical Maintenance, treatment for electric shock, Electricity Legislation. Points to be inspected, while carryout an Electrical Inspection.

Lighting – Scientific home lighting, Different types of lamps and applications, Various types of lighting schemes, design of lighting system for home, office and industrial work place, Energy Efficient lightings, Do's and don'ts in lighting. Selection of lamps and luminars for lighting purpose, Simple fault findings in lighting.

Text Book

B.Raja Rao, "Electricity for Architects, Project Consultants and Builders", B.Raja Rao Technical Books Publishers, Chennai.

Reference Books

V.S.Rao -Operation & Maintenance of Electrical Equipment - Volume I & II, 1997 Edition, Media Promoters & Publishers Pvt. Ltd., Mumbai.

Course Contents and Lecture Schedule

S.No.	Topic	No. of Lectures
1.0	**Introduction to Electricity**	
1.1	Connected load, Contracted demand, Maximum demand, Power factor	1
1.2	Single Phase Supply, Three phase supply, Three phase wiring	1
1.3	Protective devices in Electrical Installations – Fuse, MCB, MCCB's, RCCB, ELCB	1
1.4	Earthing for Electrical Safety	1
2.0	**Electrical Installations in Domestic Building**	
2.1	Types of wiring, Accessories used in Domestic wiring practice	1
2.2	wire ratings, FRLS type wires and PVC pipes	1
2.3	Planning Electrical Wiring for Buildings, Checking Electrical wiring in Flats	1
2.4	Electrical Distribution Design in Multi-storied Residential Flats and	2

	Commercial Buildings	
2.5	Lightning Arrestors for Buildings	1
3.0	**Electrical Installation in Industry**	
3.1	Planning Electrical installations	1
3.2	Types of cable, Cables ratings and types	1
3.3	Installations of electrical cables	2
3.4	Sub-station Layout and Design	1
3.5	Electrical installations in Hotels, Hospital wiring	2
3.6	Earthing in Power and Distribution	1
3.7	Lightning Arrestors for industrial applications	1
4.0	**Do's and Don'ts in Electrical Wiring**	
4.1	Guidelines for Electrical Contractors	1
4.2	General specifications for electrical installation work	2
4.3	Electrical Maintenance	2
4.4	Treatment / First Aid for electric shock	1
4.5	Electricity Legislation	2
4.6	Points to be inspected, while carryout an Electrical Inspection	
5.0	**Lighting**	
5.1	Scientific home lighting	1
5.2	Different types of lamps and applications, Various types of lighting schemes	1
5.3	Design of lighting system for home, office and industrial work place	3
5.4	Energy Efficient lightings	1
5.5	Do's and don'ts in lighting	1
5.6	Selection of lamps and luminars for lighting purpose	1
5.7	Simple fault findings in lighting	1
	Total	36

Course Designers:

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	Category	L	T	P	C
14EEGCO INDUSTRIAL SAFETY AND ENVIRONMENT	**GE**	**3**	**-**	**-**	**3**

Preamble

In India, efforts for control of major chemical plant accidents began in the aftermath of the Bhopal Gas tragedy in 1984. In 1989, the Ministry of Environment & Forest, Government of India formed the important MIHC (Manufacture & Import of Hazardous Chemicals) rules. Ministry of Labour, Government of India implemented an ILO (International Labour Organization) project to establish MAHC (Major Hazard Control) system to identify & assess hazards in MAH plants, to frame new legislation for MHC, etc. Over 1000 industrial plants have been identified as MH plants in India. Unlike natural hazards, chemical hazards can be prevented by proper planning & in case of accidents; the consequences can be minimized to the extent possible.

Within the past 10 or 15 years, the chemical & petroleum industries have undergone considerable changes. Process conditions such as pressure & temperature have become more severe. Plants have grown in size & inventory. The scale of possible fire, explosion has grown & so has the area that might be affected by such events, especially outside the work boundary.

Prerequisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to:

Outcomes	**Blooms level**	**Expected proficiency**	**Target**
Explain the basic principles of Safety practices (CO1)	Understand	80%	70%
Estimate the risk level of a given hazardous area (CO2)	Understand	75%	65%
Apply and adopt safety management and policy (CO3)	Apply	80%	70%
Carryout accident analysis (CO4)	Apply	60%	50%

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.									**S**	**S**	**L**	**S**
CO2.									**S**	**S**	**L**	**S**
CO3									**S**	**S**	**L**	**S**
CO4									**S**	**S**	**L**	**S**

S- Strong; M-Medium; L-Low

Assessment Pattern

	Bloom's Category	Test 1	Test 2	Test 3 / End-semester examination
1	Remember	30	30	20
2	Understand	50	50	30
3	Apply	20	20	50
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

8. List the salient features of 3rd factory act 1911
9. List the methods of lessoning accidents
10. List the safety precautions for operating high voltage equipment

Course Outcome 2 (CO2):

5. Explain the concept of risk tolerance matrix
6. Compare and contrast the relative ranking method of analysis and Preliminary hazard analysis (PHA)
7. Discuss the bad grounding practices

Course Outcome 3 (CO3):

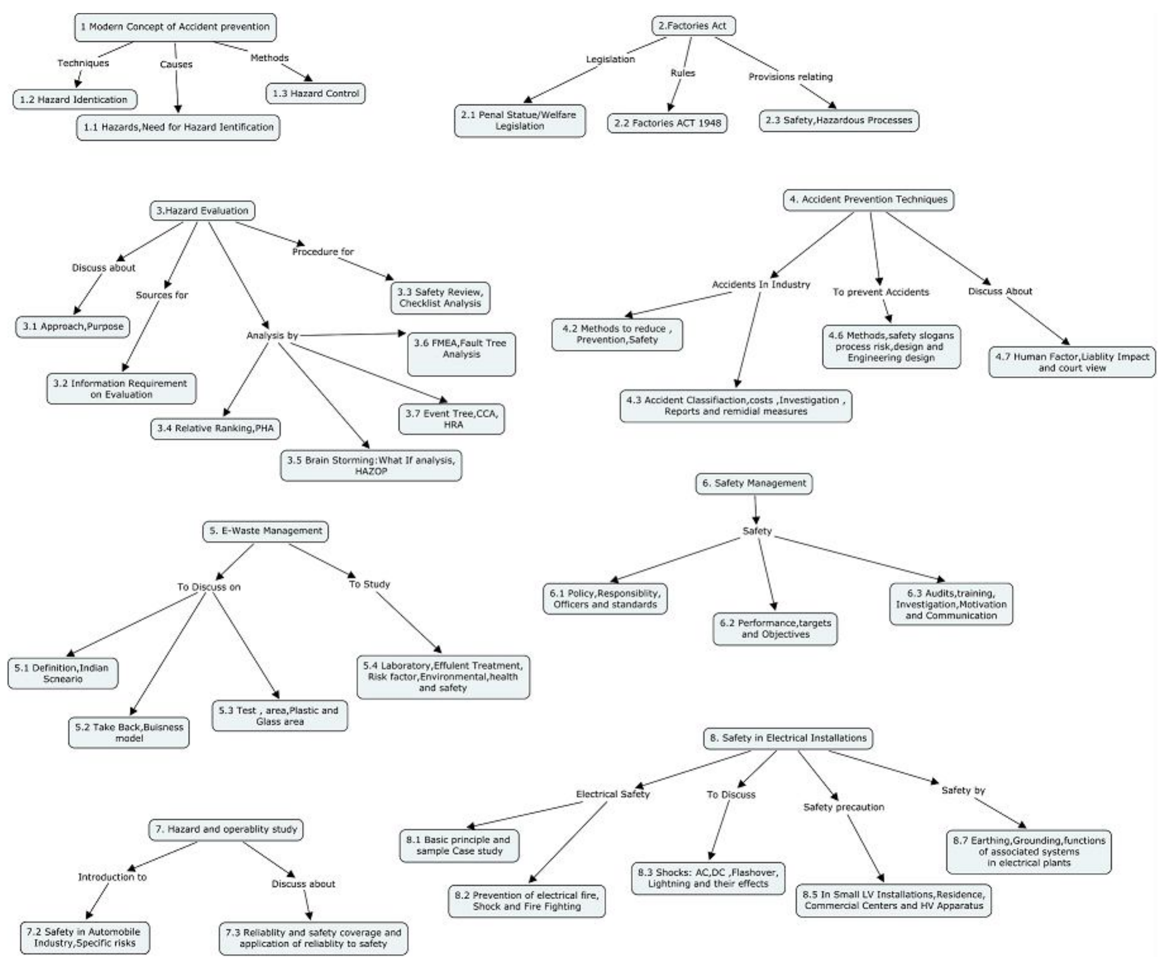
4. Specify the applications of Lockout and Tag out
5. What are the safety factors to be consider in a petrochemical industries
6. Discuss the precautionary measures to be consider in Textile industry to minimize hazards.

Course Outcome 4 (CO4):

1. With any one case study explain the cause and effect of electric accident and the remedial measures to prevent it
2. Analyze the health risks in an automobile industry and suggest techniques to minimize?

3. Classify the risk zones regarding fire accidents in petrochemical industries. Also suggest suitable fire extinguishers for each area.

Concept Map



Syllabus

Modern Concept of Accident Prevention – Hazard, Hazard causes, Need for Hazard Identification, Hazard Identification Techniques, Reactive approach, Proactive approach, Hazard Control

Factories Act – Penal Statute / Welfare Legislation, The Factories Act 1948 and Tamil Nadu Factories Rules 1950, Safety Provisions, Provisions relating to Hazardous processes

Hazard Evaluation - Hazard Evaluation approach, Purpose, Sources for information requirement on hazard evaluation, Safety Review, Advantages, Method of checklist analysis, Relative ranking method of analysis, Preliminary Hazard Analysis (PHA), Brain Storming approach: What - if – analysis, Hazard and Operability Analysis (HAZOP), Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), Cause-Consequence Analysis (CCA), Human Reliability Analysis (HRA)

Accident Prevention Techniques - safety precautions, Industrial Accidents, Methods of Lessening Accidents, Prevention of Accident, Safety Committee, Classification of Accidents, Accident Costs, Steps of Investigation, Accident Reports, Need for the analysis of accidents, Remedial Measures, Methods adopted for accident prevention, Methods of reducing accidents, Safety Slogans, Process risk, Design and engineering control, Human factor, Liability impacts of major disaster outside its premises, Court view

E-Waste Management - Suitable for Indian condition, Definition of e-waste, Indian Scenario, Take Back, Business Model, Test Area, Metals Area, Plastic Area, Glass Area, Laboratory, Effluent Treatment Plant, Risk factors, Environmental, Health and Safety

Safety Management – Introduction, Safety policy, Safety to be a Line Management Responsibility, Safety officers, Safety standards, Techniques to measure safety performance, Safety targets and objectives, Audits of safety standards and practices, Safety training, Investigation and follow up of injuries and incidents, Motivation and communication,

Hazard and Operability Study – Introduction, Principle, Procedure, Safety in Automobile Industry, Industry specific risks, Reliability & Safety - Coverage, Application of Reliability to Safety

Safety in Electrical Installations - Basic principles of electrical safety, A sample case study, Fire prevention and fire fighting, Electrical shocks and their prevention, Occurrence of shock, Shocks from AC, AC Shock versus DC shock, Effect of impulse discharge through body, Shocks due to flashover, Lightning and its effects, Safety precautions for small L-V installations, residential and commercial centers, Precautions to be taken before working on HV apparatus, Earthing and grounding, Equipment grounding, Safety systems in electrical installations, Functions of associated systems in electrical plants and substations

Text Book

B.Nedumaran, “Industrial Safety and Risk Management” Class notes,2004.

Reference Books

1. William Hammer, “Product Safety management and Engineering '', prentice Hall International Society, 1980.
2. Danier C. Peterson, “Techniques of Safety Management '', McGraw Hill Kogakisha Ltd.,Japan, 1971.
3. Check list for work place inspection for improving safety, '' health and working condition '', International Labour Organization Geneva, 1987.
4. Safety and failure of components, '' Proceedings of Mechanical Engineering '', London, Vol. 184, Part 38, 1974.

Course contents and Lecture Schedule

No.	Topic	No. of Lectures
1.0	**Modern Concept of Accident Prevention**	
1.1	Hazard, causes the hazards, Need for Hazard Identification	2
1.2	Hazard Identification Techniques	1
1.3	Hazard Control	1
2.0	**Factories Act**	
2.1	Penal Statute / Welfare Legislation	1
2.2	The Factories Act 1948 and Tamil Nadu Factories Rules 1950,	1

2.3	Safety Provisions, Provisions relating to Hazardous processes	1
3.0	**Hazard Evaluation**	
3.1	Hazard Evaluation approach, Purpose	1
3.2	Sources for information requirement on hazard evaluation,	1
3.3	Safety Review, Advantages, Method of checklist analysis	1
3.4	Relative ranking method of analysis, Preliminary Hazard Analysis (PHA)	1
3.5	Brain Storming approach: What - if – analysis, Hazard and Operability Analysis (HAZOP),	1
3.6	Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA)	1
3.7	Event Tree Analysis (ETA), Cause-Consequence Analysis (CCA), Human Reliability Analysis (HRA)	
4.0	**Accident Prevention Techniques**	
4.1	Safety precautions	1
4.2	Industrial Accidents, Methods of Lessening Accidents, Prevention of Accident, Safety Committee	1
4.3	Classification of Accidents, Accident Costs, Steps of Investigation	1
4.4	Accident Reports, Need for the analysis of accidents	1
4.5	Remedial Measures, Methods adopted for accident prevention,	1
4.6	Methods of reducing accidents, Safety Slogans, Process risk, Design and engineering control	1
4.7	Human factor, Liability impacts of major disaster outside its premises, Court view	1
5.0	**E-Waste Management**	
5.1	Definition of e-waste, Indian Scenario	1
5.2	Take Back, Business Model	1
5.3	Test Area, Metals Area, Plastic Area, Glass Area	1
5.4	Laboratory, Effluent Treatment Plant	1
5.5	Risk factors, Environmental, Health and Safety	1
6.0	**Safety Management**	
6.1	Safety policy, Safety to be a Line Management Responsibility, Safety officers, Safety standards	1
6.2	Techniques to measure safety performance, Safety targets and objectives	1
6.3	Audits of safety standards and practices, Safety training	1
6.4	Investigation and follow up of injuries and incidents, Motivation and communication	1
7.0	**Hazard and Operability Study**	
7.1	Introduction, Principle, Procedure	1
7.2	Safety in Automobile Industry, Industry specific risks	1
7.3	Reliability & Safety - Coverage, Application of Reliability to Safety	1
8.0	**Safety in Electrical Installations**	
8.1	Basic principles of electrical safety, A sample case study,	1
8.2	Fire prevention and fire fighting	1
8.3	Electrical shocks and their prevention, Occurrence of shock, Shocks from AC, AC Shock versus DC shock,	1

8.4	Effect of impulse discharge through body, Shocks due to flashover, Lightning and its effects,	1
8.5	Safety precautions for small L-V installations, residential and commercial centers,	1
8.6	Precautions to be taken before working on HV apparatus	1
8.7	Earthing and grounding, Equipment grounding, Safety systems in electrical installations,	1
8.8	Functions of associated systems in electrical plants and substations	1
	Total periods	40

Course Designers:

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14EEGD0	SOFT COMPUTING	Category	L	T	P	Credit
		GE	2	1	0	3

Preamble

Soft computing is a discipline that deals with the design of intelligent systems, which is in contrast to classical hard computing technique. A consortium of computing methodologies that provides a foundation for the conception, design, and deployment of intelligent systems and aims to formalize the human ability to make rational decisions in an environment of uncertainty, imprecision, partial truth, and approximation. The main constituents of soft computing involve fuzzy logic, neuro computing, and genetic algorithms and its applications.

Students acquire knowledge of soft computing theories, fundamentals and so they will be able to design program systems using approaches of these theories for solving various real-world problems. Students also awake the importance of tolerance of imprecision and uncertainty for design of robust and low-cost intelligent machines.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Course Outcome NO.	Course Outcomes	Bloom's Level	Expected Proficiency (%)	Expected Attainment Level (%)
CO1	Explain the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience	Understand	75	70
CO2	Explain the basics of neural networks	Understand	75	70
CO3	Derive the mathematical background for carrying out the optimization and control associated with neural network learning	Apply	70	70
CO4	Explain the use genetic algorithm to obtain global optimum solution	Understand	75	70
CO5	Illustrate the intelligent behaviour of programs based on soft computing for various case studies	Apply	70	70

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO3.	**M**	**L**										
CO4.	**M**	**L**										
CO3	**S**	**M**	**L**	**L**								
CO4	**M**	**L**	**L**									
CO5	**S**	**M**	**L**	**L**								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	10	10
Understand	40	40	30	30
Apply	40	40	60	60
Analyse				
Evaluate				
Create				

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Give some common applications of fuzzy logic?
2. What are the different methods of De-fuzzification?
3. What are the parameters to be considered for the design of membership function?
4. Explain Sugeno fuzzy model
5. Explain the construction of fuzzy model for a nonlinear equation
6. Compute the centroid defuzzifier for

$$\overline{A}=\left\{\frac{0.9}{-3},\frac{0.7}{-2},\frac{0}{-1},\frac{0.3}{1},\frac{1}{2},\frac{0.2}{3}\right\}$$

7. Let $X=\{0,1,2,3,4,5\}$ and $\overline{A}=\left\{\frac{0.9}{-3},\frac{0.7}{-2},\frac{0}{-1},\frac{0.3}{1},\frac{1}{2},\frac{0.2}{3}\right\}$, $\overline{B}=\left\{\frac{0.9}{-3},\frac{0.7}{-2},\frac{0}{-1},\frac{0.3}{1},\frac{1}{2},\frac{0.2}{3}\right\}$

Find the fuzzy max and fuzzy min of $\overline{A}$ and $\overline{B}$

8. Let A={(x1,0.2),(x2,0.7),(x3,0.4)} and B={(y1,0.5),(y2,0.6)} be two fuzzy sets defined on the universe of discourse X={x1,x2,x3} and Y={y1,y2,y3} respectively. Find the Cartesian product of the A and B and fuzzy relation R.

Course Outcome 2 (CO2):

1. Explain multilayer perceptron with its architecture. How is it used to solve XOR Problem?

2. What do you mean by supervised and unsupervised learning?
3. Mention the linear and non-linear activation functions used in ANN.
4. What is perceptron?
5. What is feed forward networks? Give example.

Course Outcome 3 (CO3)

1. How weights are initialized by BAM?
2. Mention the special features of Boltzman machine.

3. Describe the structure and operation of continuous Hopfield network. & Construct an auto associative BAM using the following training vectors. X1 = $(1,-1,-1,1,-1,1)^T$ and x2 = $(1,1,1,-1,-1,-1)^T$. Determine the output using xo =$(1,1,1,1,-1,1)^T$

4 . Find the optimal layer associative memory (OLAM) matrix M for the association given below

A1 = $(1 \quad 2 \quad 3)^T$ B1 = $(4 \quad 3 \quad 2)^T$
A2 = $(2 \quad 3 \quad 4)^T$ B2 = $(3 \quad 5 \quad 2)^T$
A3 = $(3 \quad 4 \quad 6)^T$ B3 = $(2 \quad 2 \quad 1)^T$

Determining whether Ai= M – Bi

Course Outcome 4 (CO4):

1. Mention the different methods selection.
2. What are the genetic operators used in GA?
3. Explain the various steps involved in GA in detail
4. Perform two generations of simple binary coded genetic algorithm to solve the following optimization problem. Maximize $f(x) = x^2$ $0 \le x \le 31$, x is an integer.
5. Use proportionate selection, single point crossover, binary mutation and population size of six.
   7. Perform two generations of simple binary coded and real coded genetic algorithm to solve the following optimization problem.
6. Maximize $f(x) = |x| \sin(x)$ $-5 \le x \le 5$, x is real number.
   Use proportionate selection, single point crossover, and binary mutation for simple GA and proportionate selection, Arithmetic crossover, and Gaussian mutation for RGA .Use population size of six for both SGA and RGA. Evaluate the performance of SGA and RGA after two generations

Course Outcome 5 (CO5):

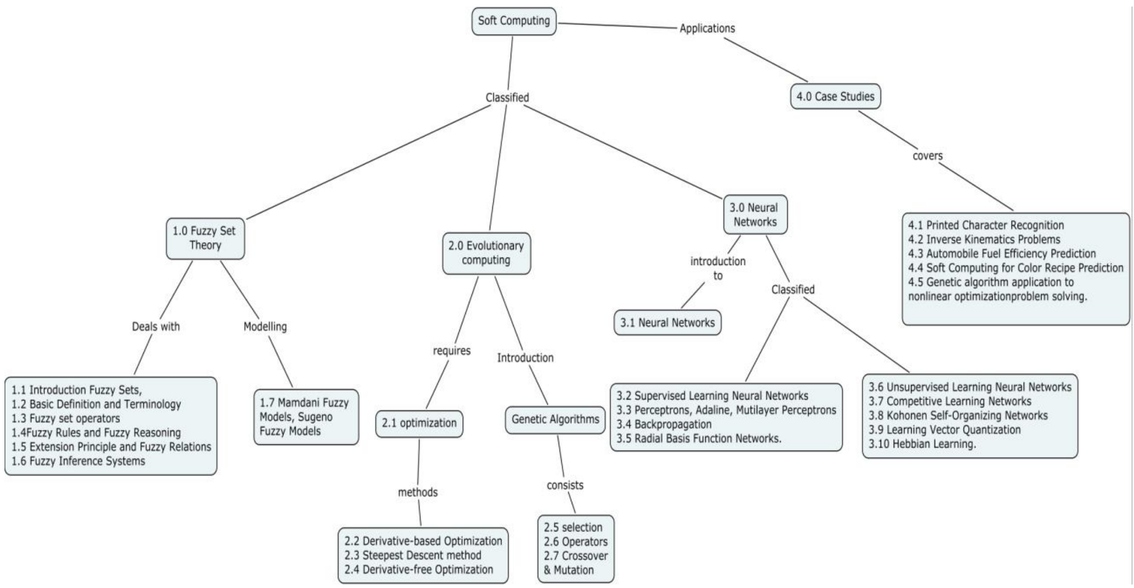
1. For the following data set, generate a suitable simple fuzzy and perceptron neuron model

```
OriginalData = {{1, 20}, {2, 12}, {3, 9}, {4, 6},
  {5, 5}, {6, 4}, {7, 5}, {8, 6}, {9, 9}, {10, 12}, {11, 20}};
```

Evaluate their performance.

2. Explain the use of soft computing in color recipe prediction.
3. Predict automobile fuel efficiency using suitable soft computing technique.

Concept Map



Syllabus

FUZZY SET THEORY

Introduction to Soft Computing – Fuzzy Sets – Basic Definition and Terminology – Fuzzy set operators – Fuzzy Rules and Fuzzy Reasoning – Extension Principle and Fuzzy Relations – Fuzzy Inference Systems – Mamdani Fuzzy Models – Sugeno Fuzzy Models – Fuzzy Modeling.

GENETIC ALGORITHMS

Introduction to optimization techniques - Derivative-based Optimization –Steepest Descent Method – Derivative-free Optimization – Genetic Algorithms - Selection, -Genetic operators-Crossover and Mutation –Simple binary coded GA-Real coded GA.

NEURAL NETWORKS

Introduction - Supervised Learning Neural Networks – Perceptrons - Adaline –Mutilayer Perceptrons – Back propagation - Radial Basis Function Networks – Unsupervised Learning Neural Networks – Competitive Learning Networks – Kohonen Self-Organizing Networks – Learning Vector Quantization – Hebbian Learning –Support vector Machines .

CASE STUDIES

Printed Character Recognition – Inverse Kinematics Problems – Automobile Fuel Efficiency Prediction – Soft Computing for Color Recipe Prediction- Genetic algorithm application to nonlinear optimization problem solving.

Text Book

1. J.S.R.Jang, C.T.Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI, 2004, Pearson Education 2004.

Reference Books

1. Timothy J.Ross, “Fuzzy Logic with Engineering Applications”, McGraw-Hill, 1997.
2. Davis E.Goldberg, “Genetic Algorithms: Search, Optimization and Machine Learning”, Addison Wesley, N.Y., 1989.
3. Simon Haykin, “Neural Networks A comprehensive foundation”, PHI, Second Edition,1999

Course Contents and Lecture Schedule

No.	Topic	No. of Lectures
1.0 FUZZY SET THEORY		
1.1	Introduction to Soft Computing	1
1.2	Fuzzy Sets, Basic Definition and Terminology	1
1.3	Fuzzy set operators	1
1.4	Fuzzy Rules and Fuzzy Reasoning	1
1.5	Extension Principle and Fuzzy Relations	1
1.6	Fuzzy Inference Systems	1
1.7	Mamdani Fuzzy Models Sugeno Fuzzy Models	2
2.0 GENETIC ALGORITHMS		
2.1	Introduction to optimization techniques	1
2.2	Derivative-based Optimization	1
2.3	Steepest Descent method and Derivative-free Optimization	1
2.4	Genetic Algorithms- Selection	1
2.5	Genetic operators	1
2.6	Crossover and Mutation schemes	1
2.7	Simple binary coded GA	2
2.8	Real coded GA	2
3.0 NEURAL NETWORKS		
3.1	Introduction	1
3.2	Supervised and unsupervised Learning Neural Networks	1
3.3	Perceptrons, Adaline, Mutilayer Perceptrons	2
3.4	Backpropagation	2
3.5	Radial Basis Function Networks	1
3.6	Competitive Learning Networks	1

3.7	Kohonen Self-Organizing Networks	1
3.8	Learning Vector Quantization	1
3.9	Hebbian Learning.	1
3.10	Support vector machines	2
4.0 CASE STUDIES		
4.1	Printed Character Recognition	1
4.2	Inverse Kinematics Problems	1
4.3	Automobile Fuel Efficiency Prediction	1
4.4	Soft Computing for Color Recipe Prediction	1
4.5	Genetic algorithm application to nonlinear optimization problem solving.	2

Course Designers:

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14EEGE0	SENSORS AND TRANSDUCERS	Category	L	T	P	Credit
		GE	2	1	0	3

Preamble

Sensors and transducers form an indispensible part in Industrial automation today. With the competition in industries there is a necessity that down time need to be contolled as well as the process parameters be monitored accurately for making quality products. Digitalisation of the automation process also requires new sensors. This course address the important aspects of Sensors/Transducers.

Prerequisite

Nil

Course Outcomes

On the successful completion of the course, students will be able to

Cos	**Course outcomes**	**Blooms Level**	Expected Proficiency (%)	Expected attainment Level (%)
CO1	Explain the static and dynamic characteristics of transducers	Understand	80	70
CO2	Explain the operation of electrical, magnetic, piezoelectric, fiber optic transducers	Understand	80	70
CO3	Explain the operation of digital transducers and their application	Understand	80	70
CO4	Explain the application of smart sensors	Understand	80	70
CO5	Identify a sensor for a particular industrial application	Apply	80	70

Mapping with Programme Outcomes

COs	**PO1 K3**	**PO2 K4**	**PO3 K4**	**PO4 K4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1.	**M**	**L**										
CO2.	**M**	**L**										
CO3.	**M**	**L**										
CO4.	**M**	**L**										
CO5.	**S**	**M**	**L**	**L**								

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	40	20	20
Understand	40	40	60	60
Apply	20	20	20	20
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. "A Resolute instrument is an accurate instrument" Express your opinion on this statement
2. Distinguish between accuracy and precision.

Course Outcome 2 (CO2):

1. Describe about cold junction compensation of Thermocouple.
2. What is the change in resistance in a copper wire when the strain is 5500 micro strains? Assume the initial resistance of the wire is 275 ohms and the gauge factor is 2.7.

Course Outcome 3 (CO3):

1. State the limitations of contact type shaft encoders
2. A digital meter has 10 bit accuracy. What is the resolution on the 16V range?

Course Outcome 2 (CO4):

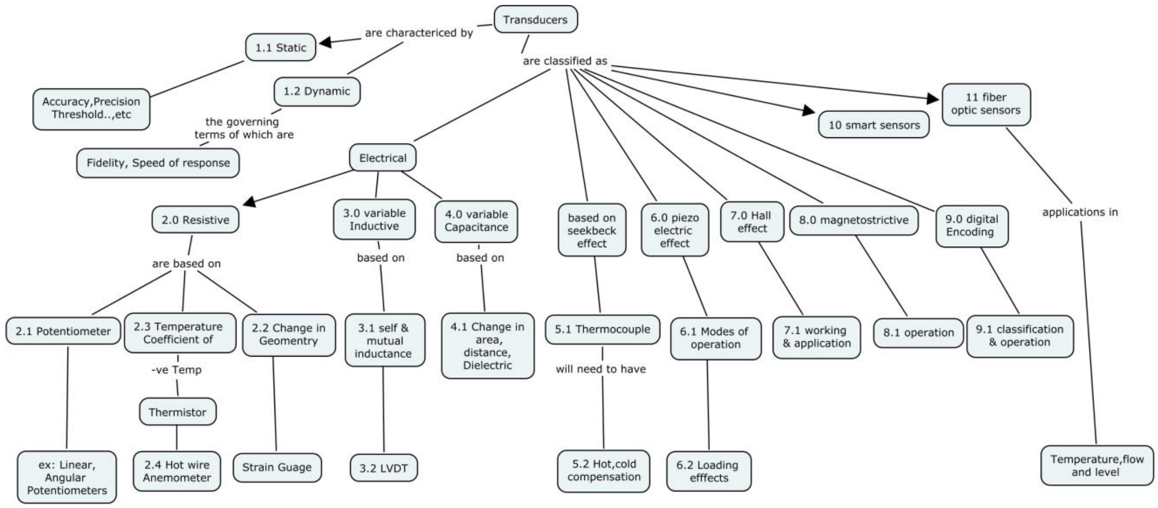
1. Illustrate the role of smart sensors in automated applications.
2. List the advantages of TEDs.

......

Course Outcome n (CO5)

1. Describe the application of strain gauge as load sensor.
2. Mention a transducer that should have a fast response to measure temperature between -50 ºC and 150 ºC.

Concept Map



Syllabus

PERFORMANCE CHARACTERISTICS OF TRANSDUCERS

Static characteristics Meaning of static calibration, Accuracy, Precision, bias, Linearity, Threshold, Resolution, Hysteresis and Dead space, Scale readability and span

Dynamic characteristics – Sinusoidal transfer function, zero order transducer, First order transducer, Step, Ramp, Frequency and Impulse response, Second order transducer, Step, Ramp Frequency and Impulse response.

VARIABLE RESISTANCE TRANSDUCERS

Potentiometers - Loading effect, Power rating of potentiometers, Linearity and Sensitivity, Construction of potentiometers, Non-linear potentiometers,

Strain gauges - Theory of Strain gauges, Types of strain gauges, Characteristics of strain gauges

Resistance thermometers - Characteristics, Linear approximation, Quadratic approximation,

Thermistors - Resistance vs. Temperature characteristics, Voltage vs. current and Current vs. time characteristics,

Hot wire anemometers - Constant current mode and Constant resistance

Variable Inductance transducers – Change of self-inductance, Change of mutual inductance, Production of eddy currents, Linear Variable Differential Transformer Construction, Working principle

Variable capacitance transducers - Change in area of plates, Change in distance between the plates, Differential arrangement, Variation of dielectric constant, Frequency response.

Thermocouples – Construction, Measurement of thermocouple output, Compensating circuits, Reference junction compensation, Lead compensation

Piezoelectric transducers Modes of operation of piezoelectric crystals, Properties, Equivalent circuit of piezoelectric transducers, Loading effects and frequency response, Impulse response,

Hall effect transducers working principle, application,

Magnetostrictive transducers principle of operation

Digital encoding transducers – Classification of encoders, Construction of encoders, Brush type, Optical displacement transducers

Smart sensors – Introduction, primary sensors, Excitation, Amplification, Filters, Convertors, Compensation, Information coding process, Data communication

Fibre optic sensors – Temperature sensors, Liquid level sensing, Fluid flow sensing, Microbend sensors
List of applications of various transducers

Text Book

1. E.O.Doubelin, Measurement Systems, McGraw Hill Book Company, 2008.
2. A.K.Sawheney, A Course in Electrical and Electronic Measurements and Instrumentation, Dhanpatrai & Co. Pvt. Ltd., 2007.
3. D. Patranabis, Sensors and Transducers, Wheeler Publishing, 2006.

Reference Books

1. Hermann, K.P. Neubert, Instrument Transducers, Oxford University Press, 1988.
2. S. Renganathan, Transducer Engineering, Allied Publishers, 1999
3. D.V.S. Murthy, Transducers and Instrumentation, Prentice Hall of India Pvt. Ltd., 2008.

Course Contents and Lecture Schedule

Sl. No.	Topic	No. of Lectures
1.0	**Performance characteristics of Transducers**	
1.1	**Static characteristics** Meaning of static calibration, Accuracy, Precision, bias, Linearity, Threshold, Resolution, Hysteresis and Dead space, Scale readability and span	3
1.2	**Dynamic characteristics –** Sinusoidal transfer function, zero order transducer, First order transducer, Step, Ramp, Frequency and Impulse response, Second order transducer, Step, Ramp Frequency and Impulse response	3
2.0	**Variable Resistance transducers**	
2.1	**Potentiometers -** Loading effect, Power rating of potentiometers, Linearity and Sensitivity, Construction of potentiometers, Non-linear potentiometers	2
2.2	**Strain gauges -** Theory of Strain gauges, Types of strain gauges, Characteristics of strain gauges, Resistance thermometers, Characteristics, Linear approximation, Quadratic approximation	2
2.3	**Thermistors** - Resistance vs. Temperature characteristics, Voltage vs. current and Current vs. time characteristics	2
2.4	**Hot wire anemometers**	
3.0	**Variable Inductance transducers**	
3.1	Change of self-inductance, Change of mutual inductance, Production of eddy currents	2
3.2	Linear Variable Differential Transformer Construction, Working principle	2
4.0	**Variable capacitance transducers**	
4.1	Change in area of plates, Change in distance between the plates, Differential arrangement, Variation of dielectric constant, Frequency response	3
5.0	**Thermocouples**	

5.1	Construction, Measurement of thermocouple output	2
5.2	Compensating circuits, Reference junction compensation, Lead compensation	2
6.0	**Piezoelectric transducers**	
6.1	Modes of operation of piezoelectric crystals, Properties, Equivalent circuit of piezoelectric transducers	2
6.2	Loading effects and frequency response, Impulse response	2
7.0.	**Hall effect transducers**	
7.1	working principle, application	2
8.0	**Magnetostrictive transducers**	
8.1	Principle of operation	2
9.0	**Digital encoding transducers**	
9.1	Classification of encoders, Construction of encoders, Brush type, Optical displacement transducers	3
10.	**Smart sensors**	
10.1	Introduction, primary sensors, Excitation, Amplification, Filters, Convertors, Compensation, Information coding process, Data communication	3
11.	Fibre Optic Sensors - Temperature sensors, Liquid level sensing, Fluid flow sensing, Microbend sensors	2
	List of applications of various transducers	1
	Total	40

Course Designers:

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		Category	L	T	P	Credit
14EEGFO	**ENERGY CONSERVATION PRACTICES**	GE	2	2	0	3

Preamble

Energy resource scarcity becomes one of the biggest issues in the world and leading to rise in cost. Effective utilization of Electrical energy is one of the key issues to minimize the rising cost of energy and to minimize the global warming. This course will educate the non-electrical engineers on the aspect of energy conservation in electrical equipment and Electrical Installations. It will helpful to select an energy efficient electrical system for an establishment.

Prerequisite

14EEBS160 - Basic Electrical Engineering

Course Outcomes

On the successful completion of the course, students will be able to

	Course Outcomes	Bloom's Level	Expected Proficiency %	Expected Attainment Level %
CO1.	Describe the principles of Energy Audit, Management and Conservation	Understand	70	60
CO2	Estimate the energy performance of Electrical Motors	Apply	60	50
CO3	Estimate the energy performance of Electrical System & Lighting	Apply	60	50
CO4	Identify the potential Energy Conservation aspects in Mechanical Equipment	Understand	70	60
CO5	Selection and Operation aspects of DG Set for Energy Efficiency	Apply	60	50
CO6	Identify the Energy Efficient gadgets for domestic, commercial and industrial applications	Understand	70	60

Mapping with Programme Outcomes

COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**M**							**S**				
CO2	**S**	**M**	**L**									**L**
CO3	**M**	**M**	**L**	**L**								
CO4	**S**	**M**	**L**									**L**
CO5	**S**	**M**				**L**						**L**
CO6	**S**	**M**				**L**	**L**	**L**				

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	20	20	20	20
Understand	60	60	50	50
Apply	20	20	30	30
Analyse	0	0	0	0
Evaluate	0	0	0	0
Create	0	0	0	0

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Mention the types of Energy audit.
2. List down the objective of energy management
3. Explain the implications of part load operation of energy equipment with examples.

Course Outcome 2 (CO2).

1. Name three types of motors in industrial practice.
2. An 89% efficient 30HP Size standard efficiency induction motor was replaced with a 93% efficient 30HP size Premium efficiency induction motor to improve energy efficiency. Calculate the Annual energy saving potential and payback period for the above proposal, using the following data given for the above applications.
   Load factor - 90%
   Operating Hours per year - 8000 Hours
   Cost per kWh of Energy - Rs.5
   Cost of Premium efficiency induction motor - Rs.60000/-
   Scrap value of old standard efficiency induction motor - Rs.20000/-
   Assume the operating efficiency is as that of designed efficiency at 90% load factor condition.

Course Outcome 3 (CO3):

11. Define contracted demand and billing demand.
12. A textile mill operates with a load of 1800kVA demand at 0.85 power factor lagging. If the power factor is improved from 0.85 to 0.95 lagging by adding additional capacitors, calculate the reduction in demand. The demand charge is Rs.300 per kVA demand per month. Calculate the demand cost saving per year due to the power factor improvement.
13. In a sub-station 2Nos. of identical 5000kVA 33kV / 11kV Transformers are operated parallel to meet a domestic load. The iron and full load copper loss of the above Transformer is 9.2 kW and 32.5kW respectively. Initially the two transformers are operated in parallel to meet the load. The load pattern of the domestic load is as follows:

Load in kW	6000	3500	3000	8000	1500
Power factor	0.8 Lagging	0.78 Lagging	0.75 Lagging	0.9 Lagging	0.7 Lagging
Time in	6.00 A.M to	9.00 A.M to	12 Noon to	6.00 P.M to	10.00 P.M to

24 Hours	9.00 A.M	12 Noon	6.00 P.M	10.00 P.M	6.00 A.M

Suggest the best operating practice for the sub-station to minimize the transformer loss and also quantify the transformer loss minimized due to the best transformer operating practice.

14. In a factory shop floor lighting 60Nos. of 400Watts High Pressure Mercury Vapour(HPMV) lamps are replaced with 250Watts Metal Halide Lamps to reduce energy consumption. The luminous efficacy of HPMV Lamp and Metal Halide lamp are 60 & 100 Lumens per watt. Calculate the Annual energy saving potential and payback period for the above energy saving proposal, if the lamps are used for 12 Hours daily for 330Days in a year. The cost per fitting of Metal halide lamp is Rs.6000/- and cost per kWh energy is Rs.5/-.
15. In a Textile Mill to minimize the lighting power consumption Conventional 9Watts loss Tube light Ballast was replaced with 2Watts loss Electronic Ballast and 40Watts Tube lights are replaced with 36Watts tube lights in 750Nos. of Single Lamp Tube Light Fittings. The cost of Electronic Ballast and 36Watts Tube lights are Rs. 225 and Rs.45/- per unit. Calculate the Power and Energy Saving Potential, if the mill operates for 8000 Hours in a year. Also calculate the investment required and payback period for the above ENCON Proposal, when the Energy cost is Rs. 4.50 per kWh.

Course Outcome 4 (CO4)

1. What are the effects of moisture on compressed air?
2. Discuss the various energy conservation opportunities in a refrigeration plant.
3. Explain what do you understand by static head and friction head
4. List the factors affecting energy efficiency in air compressors.

Course Outcome 5 (CO5)

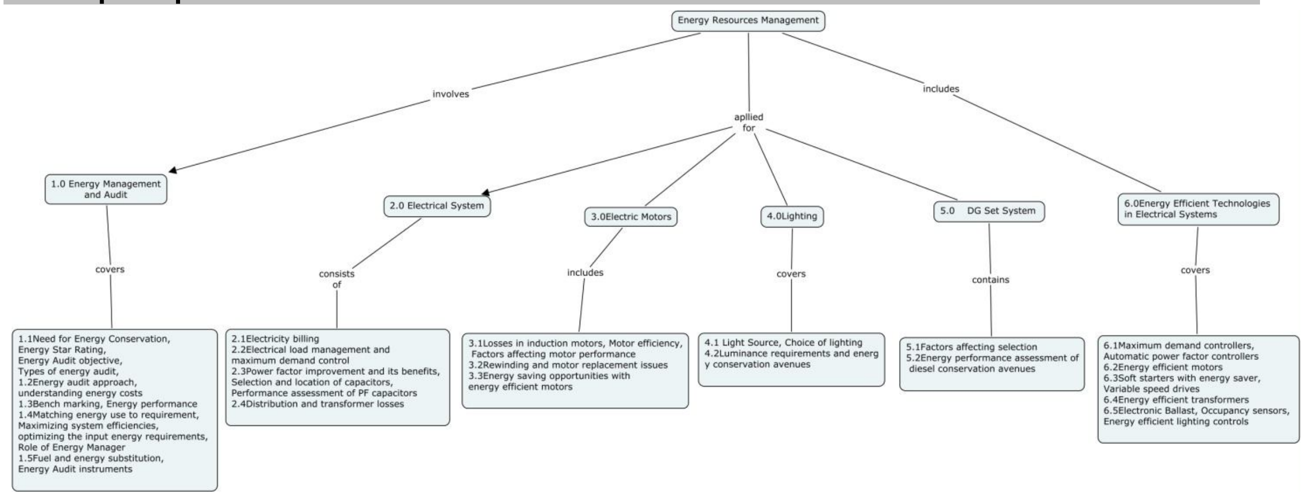
1. Specify the role of Turbo chargers.
2. List the energy savings opportunities in an industrial DG Set plant.
3. The Specific Fuel Consumption of a 500KVA Diesel Generating Set is 3.2kWh per litre of Diesel at 40% Load Factor. If the Load Factor is improved from 40% to 70%, the Specific Fuel Consumption is 3.8kWh per litre of Diesel. Calculate the fuel saving per day because of the load factor improvement.

Course Outcome 6 (CO6)

1. Specify the advantages of energy efficient motors.
2. Explain why centrifugal machines offer the greatest savings, when operating with Variable speed drives.
3. Mention the role of demand controller in industrial plants.
4. What is the function of Automatic Power factor controller?
5. A 500KVA 11KV/415V Transformer was proposed to buy for an Industrial application. The conventional Core Transformer Cost Rs. 2,50,000/-, whereas the Energy Efficient Amorphous core Transformer cost Rs.2,90,000/-. The Iron losses of Conventional and Amorphous core Transformers are 2200 Watts and 800Watts respectively. The copper losses for the both the transformers are same. Calculate the payback period for the excess investment paid for the Energy efficient Amorphous core transformer, when compared to conventional core Transformer. The cost of Electrical Energy is Rs.5 per kWh and the Transformer proposed to operate for 8760 Hours in a year.
6. A Chemical industry planned to install a Maximum Demand Controller and an Automatic Power Factor Controller to minimize the Demand Cost. The existing Contracted Demand is 4500KVA and actual demand is 4375KVA. The electricity board billing is based on

90% of contracted demand or Actual demand reached, whichever is higher. The demand charge is Rs.400 per KVA per month. The existing power factor is 0.92 lagging. After installing the Maximum Demand Controller and Automatic Power factor controller, the Actual Maximum Demand reached is 3900KVA. The investment incurred in the Demand Saving measure is Rs. 9,00,000/-. Calculate the Demand Cost saving per year and Payback period for the above Encon proposal.

Concept Map



Syllabus

Energy Management and Audit –Need of Energy Conservation, Energy Star Rating/Green Labelling, Energy Audit objective, Types of energy audit, Energy audit approach, understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, optimizing the input energy requirements, Fuel and energy substitution, Simple Payback calculation, Energy Audit instruments, Role of Energy Manager

Electric Motors – Types, Losses in induction motors, Motor efficiency, Factors affecting motor performance, Rewinding and motor replacement issues, Energy saving opportunities with energy efficient motors. (Case Studies)

Electrical System – Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefits, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses. (Case Studies)

Lighting – Light Source, Choice of lighting, Luminance requirements and energy conservation avenues. (Case Studies)

Mechanical Equipments

Compressed Air System - Efficient compressor operation, Leakage test, factors affecting performance and Efficiency. HVAC & Refrigeration System – Factors affecting system performance and energy savings opportunities. Fans & Blowers – Flow control strategies and energy conservation opportunities. Pumps – Flow control strategies and energy conservation opportunities. Cooling Towers– Flow control strategies and energy saving opportunities.

DG Set System – Factors affecting selection, Energy performance assessment of diesel conservation avenues. (Case Studies)

Energy Efficient Technologies in Electrical Systems – Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic Ballast, Occupancy sensors, Energy efficient lighting controls. Checklist & Tips for Energy Efficiency in Electrical System.

Text Books

1. Book I - General aspect of energy management and energy audit, Second Edition 2005, By Bureau of Energy Efficiency, Ministry of Power, India.
2. Book III - Energy efficiency in electrical utilities, Second Edition 2005, By Bureau of Energy Efficiency, Ministry of Power, India.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lecture Hours
1.0	**Energy Management and Audit**	
1.1	Need for Energy Conservation, Energy Star Rating, Energy Audit objective, Types of energy audit,	2
1.2	Energy audit approach, understanding energy costs	2
1.3	Bench marking, Energy performance	2
1.4	Matching energy use to requirement, Maximizing system efficiencies, optimizing the input energy requirements, Role of Energy Manager	2
1.5	Fuel and energy substitution, Simple Payback calculation Energy Audit instruments	2
2.0	**Electric Motors**	
2.1	Losses in induction motors, efficiency, Factors affecting motor performance	2
2.2	Rewinding and motor replacement issues	2
2.3	Energy saving opportunities with energy efficient motors	2
3.0	**Electrical System**	
3.1	Electricity billing	2
3.2	Electrical load management and maximum demand control	2
3.3	Power factor improvement and its benefits, Selection and location of capacitors, Performance assessment of PF capacitors	2
3.4	Distribution and transformer losses	2
4.0	**Lighting**	
4.1	Light Source, Choice of lighting	2
4.2	Luminance requirements and energy conservation avenues	2
4.0	**Mechanical Equipments**	
4.1	Compressed Air System – Efficient compressor operation, Leakage test, factors affecting performance and Efficiency	2

Module No.	Topic	No. of Lecture Hours
4.2	HVAC & Refrigeration System – Factors affecting system performance and energy savings opportunities	2
4.3	Fans & Blowers – Flow control strategies and energy conservation opportunities	2
4.4	Pumps – Flow control strategies and energy conservation opportunities	1
4.5	Cooling Towers– Flow control strategies and energy saving opportunities	2
5.0	**DG Set System**	
5.1	Factors affecting selection	1
5.2	Energy performance assessment of diesel conservation avenues	1
6.0	**Energy Efficient Technologies in Electrical Systems**	
6.1	Maximum demand controllers, Automatic power factor controllers	1
6.2	Energy efficient motors	1
6.3	Soft starters with energy saver, Variable speed drives	1
6.4	Energy efficient transformers	1
6.5	Electronic Ballast, Occupancy sensors, Energy efficient lighting controls	1
6.6	Checklist & Tips for Energy Efficiency in Electrical System.	1
	Total	**45**

Course Designers:

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14EEGG0	SYSTEMS APPROACH FOR ENGINEERS	Category	L	T	P	Credit
		GE	3	0	0	3

Preamble

In the Global economy, it is required that every engineer simultaneously performs as a scientist/engineer/manager, with a constant eye on the most value added output relevant for the company. Such interdisciplinary thinking also promotes the ability to acquire and use all available resources (Knowledge Integration) from within the company and outside. Such System Thinking and its effectiveness in problem resolution is very much the need in the industry today.

Prerequisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain about the context, principles and working of systems	Understand
CO2	Select the various types of Inputs and transformations required to achieve the desired outputs of a System.	Apply
CO3	Select suitable diagnostics tools to identify the vital signs in transformations occurring in System.	Apply
CO4	Implement System approach frame work to real world problems	Apply
CO5	Use System thinking for engineering the solutions as an Engineer and also as a Manager	Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	S	S	M	M	L	S	M	-	L	M	M	S
CO2.	S	S	M	M	M	S	M	-	L	S	M	S
CO3.	S	S	M	S	S	M	M	-	M	L	S	S
CO4.	S	S	S	M	S	S	M	-	S	S	S	S
CO5	S	S	S	M	S	L	M	-	S	S	M	S

S- Strong; M-Medium; L-Low

Assessment Pattern

Bloom's Category	Continuous Assessment Tests			Terminal Examination
	1	2	3	
Remember	40	30	30	30
Understand	40	40	30	30
Apply	20	30	40	40
Analyse	-	-	-	-
Evaluate	-	-	-	-
Create	-	-	-	-

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Define system based on your perspective.
2. Show the different context of systems with suitable examples.
3. State the principles of system.

Course Outcome 2 (CO2):

3. List the various input categories used in system approach.
4. Differentiate Technical outputs and System outputs.
5. Discuss about the importance of transformation in system.

Course Outcome 3 (CO3):

4. Define Vital signs.
6. List few commonly used diagnostic devices to measure transformation.
7. Discuss about Signature analysis with suitable examples.

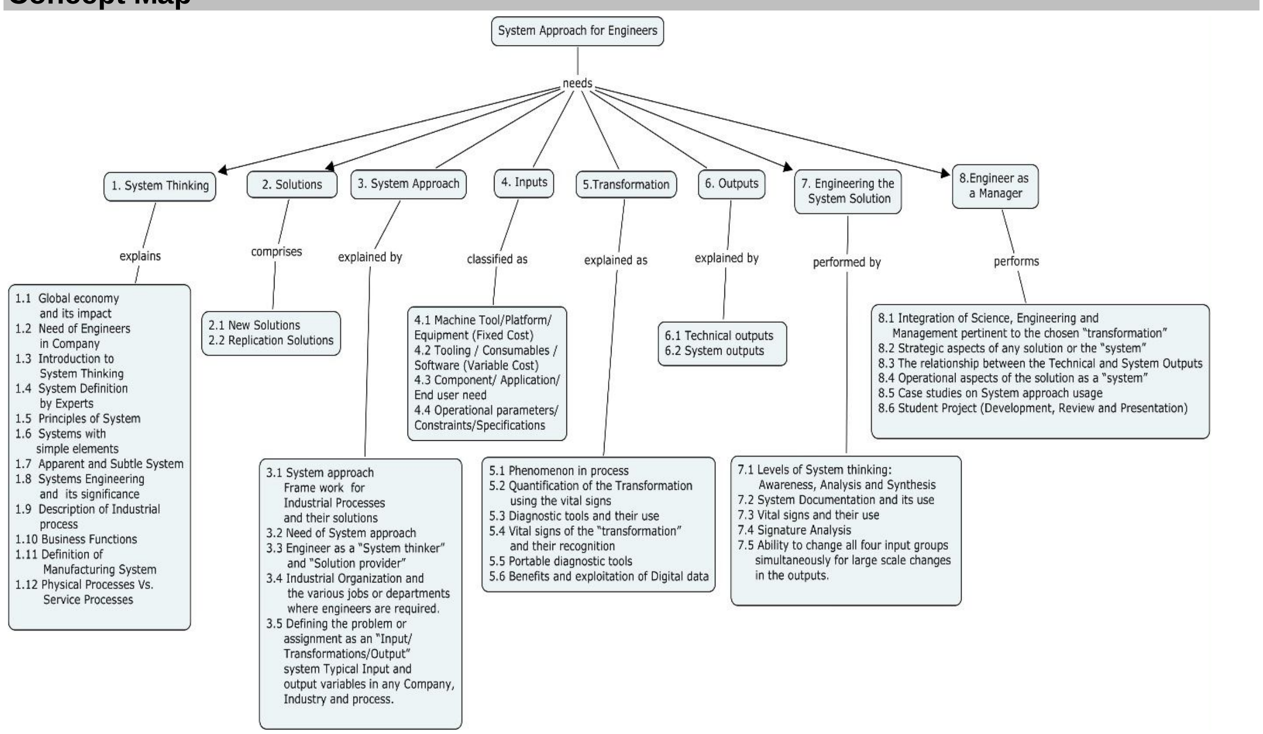
Course Outcome 4 (CO4):

5. Discuss about the System approach framework.
8. Write about the need for system documentation.
9. Summarise about the importance digital data.

Course Outcome 5 (CO5):

6. Discuss an case study of System approach implementation.
10. Illustrate the system implementation methodology.
11. Justify the role of an Engineer as a Manager in finding Engineering Solutions.

Concept Map



Syllabus

System Thinking - Global economy and its impact on the workers – across the globe; & inside of India - Need of Engineers in Company - – Introduction – System Definition by Experts – Principles of System – Systems with simple elements – Apparent and Subtle System - Systems Engineering - its Significance- Description of Industrial processes – Business Functions - Definition of Manufacturing System - Physical Processes Vs. Service Processes - **Solutions** - New Solutions Vs. Replication Solutions - System approach Frame work for Industrial Processes and their solutions – Need of System approach. Engineer as a “System thinker” and “Solution provider” - Industrial Organization and the various jobs or departments where engineers are required. Defining the problem or assignment as an “Input/Transformations/Output” system. Typical Input and output variables in any Company, Industry and process. **Inputs** - Machine Tool/Platform/Equipment (Fixed Cost) - Tooling / Consumables /Software (Variable Cost) - Component/ Application / End user need - Operational parameters / Constraints/Specifications. **Transformation:** Phenomenon in process - Quantification of the Transformation using the vital signs -Diagnostic tools and their use - Vital signs of the “transformation” and their recognition - Portable diagnostic tools - Benefits and exploitation of Digital data. **Outputs:** Technical outputs - System outputs
Engineering the solution system - Levels of System thinking: Awareness, Analysis and Synthesis - System Documentation and its use - Vital signs and their use - Signature Analysis - Ability to change all four input groups simultaneously for large scale changes in the outputs.
Engineer as a Manager: Integration of Science, Engineering and Management pertinent to the chosen “transformation” - Strategic aspects of any solution or the “system” - The relationship between the Technical and System Outputs - Operational aspects of the solution as a “system” – Case studies on System approach usage - Student Project (Development, Review and Presentation)

Text Book

1. Dr.K.Subbu Subramanian, “The System Approach” Hanser Gardner Publications, 1st Edition 2000

Reference Books

1. Lecture Materials and Hand Outs prepared by Course Designers

Course Contents and Lecture Schedule

S.No	Topics	No. of Lectures
1.	**System Thinking**	
1.1	Global economy and its impact on the workers – across the globe; & inside of India	1
1.2	Need of Engineers in any Company or Organization	
1.3	Introduction to System Thinking	1
1.4	System Definition by Experts	
1.5	Principles of System	1
1.6	Systems with simple elements	1
1.7	Apparent and Subtle System	
1.8	Systems Engineering and its significance	1
1.9	Description of Industrial processes	1
1.10	Business Functions	
1.11	Definition of Manufacturing System	1
1.12	Physical Processes Vs. Service Processes	

2.	**Solutions**	
2.1	New Solutions	1
2.2	Replication Solutions	
3.	**System approach**	
3.1	System approach Frame work for Industrial Processes and their solutions	1
3.2	Need of System approach	1
3.3	Engineer as a “System thinker” and “Solution provider”	
3.4	Industrial Organization and the various jobs or departments where engineers are required.	1
3.5	Defining the problem or assignment as an “Input/Transformations/Output” system	1
3.6	Typical Input and output variables in any Company, Industry and process	1
4	**Inputs**	
4.1	Machine Tool/Platform/Equipment (Fixed Cost)	1
4.2	Tooling / Consumables /Software (Variable Cost)	
4.3	Component/ Application / End user need	1
4.4	Operational parameters / Constraints/Specifications	
5	**Transformation**	
51	Phenomenon in process	1
5.2	Quantification of the Transformation using the vital signs	1
5.3	Diagnostic tools and their use	1
5.4	Vital signs of the “transformation” and their recognition	1
5.5	Portable diagnostic tools	1
5.6	Benefits and exploitation of Digital data	1
6	**Outputs**	
6.1	Technical outputs	1
6.2	System outputs	1
7	**Engineering the solution system**	
7.1	Levels of System thinking: Awareness, Analysis and Synthesis	1
7.2	System Documentation and its use	1
7.3	Vital signs and their use	1
7.4	Signature Analysis	2
7.5	Ability to change all four input groups simultaneously for large scale changes in the outputs.	1
8	**Engineer as a Manager**	
8.1	Integration of Science, Engineering and Management pertinent to the chosen “transformation”	1
8.2	Strategic aspects of any solution or the “system”	1
8.3	The relationship between the Technical and System Outputs	1
8.4	Operational aspects of the solution as a “system”	1
8.5	Case studies on System approach usage	1
8.6	Student Project (Development, Review and Presentation)	2
	Total	**36**

Course Designers:

1. M.Balamurali balacim82@tce.edu

14EEGH0	MANUFACTURING OF AUTOMOTIVE ELECTRICAL AND ELECTRONICS PARTS	Category	L	T	P	Credit
		GE	3	0	0	3

Preamble:

This course 'Manufacturing of automotive electrical and electronics engineering, a departmental Elective course, is preceded by courses "Utilization of Electrical energy", Basic Electrical and Electronics Engineering and 'Basics of Mechanical Engineering' The course mainly discusses the manufacturing process of different automotive electrical, Electronics and lighting parts and its implantation in the vehicle.

Prerequisite

14EE250 : Analog Devices and Circuits

14EE270 : Electric Circuit Analysis

Course Outcomes

Sl. No	Course Outcomes	Blooms level K/S	**Expected Proficiency (%)**	**Expected Attainment Level (%)**
CO1	Explain the Vehicle Integration, Mounting methods, Routing methods, Fastening and Clearance/Interference fit	Understand	**60**	**70**
CO2	Explain the Process flow, process specifications and Inspection methodologies for Starter Motor, relay, horn, switches and wiring harness	Understand	**60**	**70**
CO3	Explain the PCB fabrication process	Understand	**60**	**70**
CO4	Discuss the automotive lighting systems in the vehicle	Understand	**60**	**70**

Assessment pattern:

	Bloom's Category	Test 1	Test 2	Test 3/End-semester examination
1	Remember	40	40	40
2	Understand	60	60	60
3	Apply	0	0	0
4	Analyze	0	0	0
5	Evaluate	0	0	0
6	Create	0	0	0

Mapping with Programme Outcomes

COs	PO 1K3	PO 2 K4	PO3 K5	PO4 K5	PO5 K3/K5/K6	PO 6	PO 7	PO8	PO9	PO10	PO11	PO12
CO1	M	L	L									M
CO2	M	L	L									M
CO3	M	L	L									M
CO4	M	L	L									M

Course Level Learning Objectives

CO1

1. List the parts used for routing wiring harness along a vehicle frame
2. How is a battery mounted on a vehicle frame?

CO2

1. How is a Starter Motor mounted on an engine?
2. Why is a rubber boot generally used for mounting an electronic unit on a vehicle frame?
3. Why is a corrugated tube used in a wiring harness?

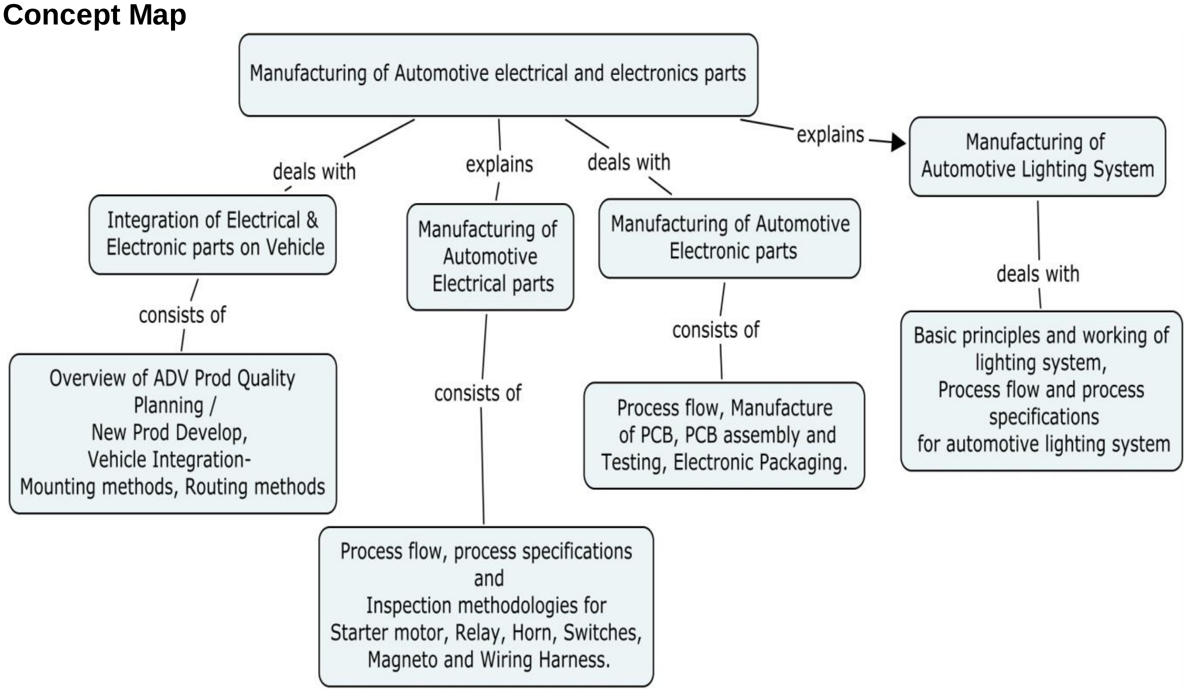
CO3

1. Explain the reflow soldering process? How is it different from wave soldering?
2. How are PCBs tested for correct assembly and soldering at end of line?

CO4

1. Explain the process of manufacturing a vehicle headlamp?
2. What are the critical process parameters that affect light intensity in a vehicle headlamp? How do they affect the light intensity?

Concept Map



Syllabus

Integration of Electrical & Electronic parts on Vehicle: Overview of ADV Prod Quality Planning /New Prod Develop, Vehicle Integration- Mounting methods, Routing methods, Fastening, Clearance/Interference fit. **Manufacturing of Automotive Electrical parts:** Process flow, process specifications and Inspection methodologies for Starter motor, Relay, Horn, Switches, Magneto and Wiring Harness. **Manufacturing of Automotive Electronic parts:** Process flow, Manufacture of PCB, PCB assembly and Testing, Electronic Packaging. **Manufacturing of Automotive Lighting System:** Basic principles and working of lighting system, Process flow and process specifications for automotive lighting system

References:

1. APQP Manual

Course Contents and lecture schedule

S.No	Topic	No of Lectures
1.	**Integration of Electrical & Electronic parts on Vehicle**	
1.1	Overview of APQP/NPD	4
1.2	Vehicle Integration- Mounting methods, Routing methods, Fastening, Clearance/Interference fit	4
2.	**Manufacturing of Automotive Electrical parts**	
2.1	Process flow, process specifications and Inspection methodologies for Starter Motor	3
2.2	Process flow, process specifications and Inspection methodologies for Relay	2
2.3	Process flow, process specifications and Inspection methodologies for Horn	2
2.4	Process flow, process specifications and Inspection methodologies for Switches	2
2.5	Process flow, process specifications and Inspection methodologies for Magneto	3
2.6	Process flow, process specifications and Inspection methodologies for Wiring Harness	2
3.	**Manufacturing of Automotive Electronic parts**	
3.1	Process flow for manufacture of PCB	4
3.2	Methods of manufacturing of PCB	4
3.3	PCB assembly and Testing	3
3.4	Electronic Packaging	3
4.	**Manufacturing of Automotive Lighting System**	
4.1	Process flow for manufacturing automotive lighting system	2

4.2	Process specifications and Inspection methodologies for automotive lighting system	2

Course designers:

1. Dr. S. Arockia Edwin Xavier - saexeee@tce.edu

General Electives offered to B.EEEE Programme by other Programmes						
14ITGA0	Object Oriented Programming With C++	3	0	0	3	2
14ITGB0	Object Oriented Programming With Java	3	0	0	3	2
14ITGC0	Software Engineering	3	0	0	3	2
14ITGD0	Database Management Systems	3	0	0	3	2
14ITGE0	Data Science	3	0	0	3	2
14ITGF0	Mobile App Development Using Android	3	0	0	3	2
14ITGG0	Cloud Technologies	3	0	0	3	2
14CEGA0	Sustainable Development	3	0	0	3	3
14CEGB0	Building Services	3	0	0	3	3
14CEGC0	Disaster Assessment and Mitigation measures	3	0	0	3	3
14CEGD0	Project Management	3	0	0	3	3
14CEGE0	Road Safety	3	0	0	3	3
14CEGF0	Climate Change and Policy	3	0	0	3	3
14CSGE0	Object Oriented Concepts and Design	3	0	0	3	3
14CSGC0	Animation: Theory and Practice	3	0	0	3	3
14CSGD0	Essentials of Information Technology	3	0	0	3	3
14CSGF0	Enterprise Application Development	3	0	0	3	3
14CSGB0	Essentials of Mobile Application Development	3	0	0	3	3
14CSGA0	Web Technologies	3	0	0	3	3
14ECGC0	Telecom Systems	3	0	0	3	3
14ECGA0	Consumer Electronics	3	0	0	3	3
14ECGB0	Multimedia Systems	3	0	0	3	3
14ECGD0	Image Processing And Applications	3	0	0	3	3
14MEGA0	Systems Approach for Engineers	3	0	0	3	3
14MEGC0	Industrial Robotics	3	0	0	3	3
14MTGA0	Industrial Automation	3	0	0	3	3
14MTGB0	Mechatronics	3	0	0	3	3
14ECGC0	Telecom Systems	3	0	0	3	3