THIAGARAJAR COLLEGE OF ENGINEERING
MADURAI – 625 015

SYLLABI

for

P.T.B.E. -ELECTRICAL AND ELECTRONICS ENGINEERING

I to VIII Semester

For the candidates admitted from the
Academic year **2023-2024** onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Government Aided Autonomous Institution affiliated to Anna University)
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Passed in Board of Studies Meeting on 13.07.2023 Approved in 66th Academic Council meeting 16.12.2023

Scheduling Of Courses (B.E. E.E.E Part Time Programme) – 2023-24 Admitted Batch

Sem	Theory				Practical	Credit
I	23PQ110 Calculus for Engineers (4)	23PQ120 Material Science for Electrical Engineering(3)	23PQ130 Electronic Devices and Circuits(3)	23PQ140 Electric Circuit Analysis(3)	23PQ150 Electrical Workshop(1.5)	**14.5**
II	23PQ210 Matrices and Transforms(4)	23PQ220 Thermal Engineering(3)	23PQ230 DC Machines and Transformers(3)	23PQ240 Electromagnetics(3)	23PQ250 Electronic Devices and Circuits Laboratory (1.5)	**14.5**
III	23PQ310 Digital Systems(4)	23PQ320 Mechanics of fluids and Machinery (3)	23PQ330 AC Machines(3)	23PQ340 Linear Integrated Circuits(3)	23PQ350 DC Machines and Transformers Laboratory (1.5)	**14.5**
IV	23PQ410 Numerical Methods(4)	23PQ420 Control Systems(3)	23PQ430 Measurements and Instrumentation(3)	23PQ440 Accounting and Finance(3)	23PQ450 Integrated Circuits Laboratory (1.5)	**14.5**
V	23PQ510 Power Electronics(4)	23PQ520 Transmission and Distribution(3)	23PQ530 Renewable Energy Sources(3)	23PQPXX Elective I(3)	23PQ550 Power Electronics Laboratory (1.5)	**14.5**
VI	23PQ610 Microcontrollers(3)	23PQ620 Power System Analysis(4)	23PQPXX Elective – II(3)	23PQPXX Elective – III(3)	23PQ650 Microcontrollers Laboratory (1.5)	**14.5**
VII	23PQ710 Electric Drives(4)	23PQ720 Switch Gear and Protection (4)	23PQPXX Elective – IV(4)	23PQPXX Elective – V(3)		**15**
VIII	23PQPXX Elective – VI(3)	23PQPXX Elective – VII(3)			23PQ850 Project Work and Viva-voce(12)	**18**
Total						**120**

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23PQZXX	Elective – VII
23PQ850	Project Work and Viva-voce

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI - 625 015.
B.E. Degree in Electrical & Electronics Engineering- Part-Time
(For Candidates admitted from 2023-2024)
Courses of Study

First SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ110	Calculus for Engineers	3	1	0	4
23PQ120	Material Science for Electrical Engineering	3	0	0	3
23PQ130	Electronic Devices and Circuits	3	0	0	3
23PQ140	Electric Circuit Analysis	3	0	0	3
Practical					
23PQ150	Electrical Workshop	0	0	3	1.5

Total: 14.5

Second SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ210	Matrices and Transforms	3	1	0	4
23PQ220	Thermal Engineering	3	0	0	3
23PQ230	DC Machines and Transformers	3	0	0	3
23PQ240	Electromagnetics	3	0	0	3
Practical					
23PQ250	Electronic Devices and Circuits Laboratory	0	0	3	1.5

Total: 14.5

Third SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ310	Digital Systems	3	1	0	4
23PQ320	Mechanics of fluids and Machinery	3	0	0	3
23PQ330	AC Machines	3	0	0	3
23PQ340	Linear Integrated Circuits	3	0	0	3
Practical					
23PQ350	DC Machines and Transformers Laboratory	0	0	3	1.5

Total: 14.5

Fourth SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ410	Numerical Methods	3	1	0	4
23PQ420	Control Systems	3	0	0	3
23PQ430	Measurements and Instrumentation	3	0	0	3
23PQ440	Accounting and Finance	3	0	0	3
Practical					
23PQ450	Integrated Circuits Laboratory	0	0	3	1.5

Total: 14.5

FIFTH SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ510	Power Electronics	3	1	0	4
23PQ520	Transmission and Distribution	3	0	0	3
23PQ530	Renewable Energy Sources	3	0	0	3
23PQPXX	Elective I	3	0	0	3
Practical					
23PQ550	Power Electronics Laboratory	0	0	3	1.5

Total: 14.5

SIXTH SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ610	Microcontrollers	3	0	0	3
23PQ620	Power System Analysis	3	1	0	4
23PQPXX	Elective – II	3	0	0	3
23PQPXX	Elective – III	3	0	0	3
Practical					
23PQ650	Microcontrollers Laboratory	0	0	3	1.5

Total: 14.5

SEVENTH SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					
23PQ710	Electric Drives	3	1	0	4
23PQ720	Switch Gear and Protection	3	1	0	4
23PQPXX	Elective – IV	3	1	0	4
23PQPXX	Elective – V	3	0	0	3

Total: 15

EIGHTH SEMESTER

COURSE CODE	COURSE TITLE	L	T	P	C
Theory					

23PQZXX	Elective – VI	3	0	0	3
23PQZXX	Elective – VII	3	0	0	3
Practical					
23PQ850	Project Work and Viva-voce	0	0	24	12

Total=18

LIST OF ELECTIVES

COURSE CODE	COURSE TITLE	L	T	P	C
23PQPA0	Power System Operation And Control	3	1	0	4
23PQPC0	Operation And Maintenance Of Electrical Equipment	3	0	0	3
23PQPD0	Energy Audit and Management In Electric Utilities	3	1	0	4
23PQPF0	Power System Stability	3	0	0	3
23PQPG0	Computer Organization	3	0	0	3
23PQPH0	Internet Of Things	3	0	0	3
23PQPJ0	Industrial Instrumentation	3	0	0	3
23PQPK0	Flexible AC Transmission Systems	3	0	0	3
23PQPL0	Power Quality	3	0	0	3
23PQPM0	Power Electronics For Renewable Energy Systems	3	0	0	3
23PQPN0	Electric Vehicles	3	0	0	3
23PQPP0	Smart Grid	3	1	0	4
23PQPQ0	Thermal Power Plant Instrumentation And Control	3	0	0	3

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI - 625 015.
B.E. Degree in Electrical & Electronics Engineering – Part Time
(For Candidates admitted during 2004-2005)

SCHEME OF EXAMINATIONS

FIRST SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ110	Calculus for Engineers	3	40	60	100	27	50
2	23PQ120	Material Science for Electrical Engineering	3	40	60	100	27	50
3	23PQ130	Electronic Devices and Circuits	3	40	60	100	27	50
4	23PQ140	Electric Circuit Analysis	3	40	60	100	27	50
	PRACTICAL							

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5	23PQ150	Electrical Workshop	3	60	40	100	18	50

SECOND SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ210	Matrices and Transforms	3	40	60	100	27	50
2	23PQ220	Thermal Engineering	3	40	60	100	27	50
3	23PQ230	DC Machines and Transformers	3	40	60	100	27	50
4	23PQ240	Electromagnetics	3	40	60	100	27	50
	PRACTICAL							
5	23PQ250	Electronic Devices and Circuits Laboratory	3	60	40	100	18	50

THIRD SEMESTER

Sl. No.	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ310	Digital Systems	3	40	60	100	27	50
2	23PQ320	Mechanics of fluids and Machinery	3	40	60	100	27	50
3	23PQ330	AC Machines	3	40	60	100	27	50
4	23PQ340	Linear Integrated Circuits	3	40	60	100	27	50
	PRACTICAL							
5	23PQ350	DC Machines and Transformers Laboratory	3	60	40	100	18	50

FOURTH SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ410	Numerical Methods	3	40	60	100	27	50

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2	23PQ420	Control Systems	3	40	60	100	27	50
3	23PQ430	Measurements and Instrumentation	3	40	60	100	27	50
4	23PQ440	Accounting and Finance	3	40	60	100	27	50
	PRACTICAL							
5	23PQ450	Integrated Circuits Laboratory	3	60	40	100	18	50

FIFTH SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ510	Power Electronics	3	40	60	100	27	50
2	23PQ520	Transmission and Distribution	3	40	60	100	27	50
3	23PQ530	Renewable Energy Sources	3	40	60	100	27	50
4	23PQPXX	Elective I	3	40	60	100	27	50
PRACTICAL								
5	23PQ550	Power Electronics Laboratory	3	60	40	100	18	50

SIXTH SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQ610	Microcontrollers	3	40	60	100	27	50
2	23PQ620	Power System Analysis	3	40	60	100	27	50
3	23PQPXX	Elective – II	3	40	60	100	27	50
4	23PQPXX	Elective – III	3	40	60	100	27	50
PRACTICAL								
5	23PQ650	Microcontrollers Laboratory	3	60	40	100	18	50

SEVENTH SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous	Terminal Exam.		Terminal	Total

				assessment			Exam	
1	23PQ710	Electric Drives	3	40	60	100	27	50
2	23PQ720	Switch Gear and Protection	3	40	60	100	27	50
3	23PQPXX	Elective – IV	3	40	60	100	27	50
4	23PQPXX	Elective – V	3	40	60	100	27	50

EIGHTH SEMESTER

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1	23PQPXX	Elective – VI	3	40	60	100	27	50
2	23PQPXX	Elective – VII	3	40	60	100	27	50
PRACTICAL								
3	23PQ850	Project Work and Viva-voce	3	60	40	100	18	50

ELECTIVES

Sl. No	Sub Code	Name of the Subject	Duration of Exam in Hrs	Marks		Max. Marks	Minimum for Pass	
THEORY				Continuous assessment	Terminal Exam.		Terminal Exam	Total
1.	23PQPA0	Power System Operation And Control	3	40	60	100	27	50
2.	23PQPC0	Operation And Maintenance Of Electrical Equipment	3	40	60	100	27	50
3.	23PQPD0	Energy Audit and Management In Electric Utilities	3	40	60	100	27	50
4.	23PQPF0	Power System Stability	3	40	60	100	27	50
5.	23PQPG0	Computer Organization	3	40	60	100	27	50
6.	23PQPH0	Internet Of Things	3	40	60	100	27	50
7.	23PQPJ0	Industrial Instrumentation	3	40	60	100	27	50
8.	23PQPK0	Flexible AC Transmission Systems	3	40	60	100	27	50
9.	23PQPL0	Power Quality	3	40	60	100	27	50
10.	23PQPM0	Power Electronics For	3	40	60	100	27	50

		Renewable Energy Systems						
11.	23PQPN0	Electric Vehicles	3	40	60	100	27	50
12.	23PQPP0	Smart Grid	3	40	60	100	27	50
13.	23PQPQ0	Thermal Power Plant Instrumentation And Control	3	40	60	100	27	50

23PQ110	CALCULUS FOR ENGINEERS

Category	L	T	P	C	Terminal Exam Type
PC	3	1	-	4	Theory

Preamble

This course aims to provide technical competence of modeling engineering problems using calculus. In this course, the calculus concepts are taught geometrically, numerically, algebraically and verbally. Students will apply the main tools for analyzing and describing the behavior of functions of single and multi-variables: limits, derivatives, integrals of single and multi-variables to model and solve complex engineering problems using analytical methods.

Prerequisite

- NIL

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage (%)
CO1	Cognize the concept of functions, limits and continuity	Understand	10
CO2	Compute derivatives and apply them in solving engineering problems	Apply	20
CO3	Employ partial derivatives to find maxima minima of functions of multi variables	Apply	20
CO4	Use various techniques of integration to evaluate definite integrals.	Apply	20
CO5	Utilize double integrals to evaluate area enclosed between two curves.	Apply	15
CO6	Apply triple integrals to find volume enclosed between surfaces	Apply	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10	100	100	-
Understand	30	30			30
Apply	60	60			70
Analyse					
Evaluate					
Create					

Syllabus

DIFFERENTIAL CALCULUS

Functions - New functions from old functions - Limit of a function - Continuity - Derivative as a function - Maxima and Minima of functions of one variable – Mean value theorem -

FUNCTIONS OF SEVERAL VARIABLES:

Partial derivatives – The Chain rule - Total derivatives – Maxima and minima of functions of two variables - Jacobian –Method of Lagrange's Multipliers

INTEGRAL CALCULUS:

Definite and Indefinite integrals – Substitution rule – Techniques of Integration – Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions – Improper integrals.

MULTIPLE INTEGRALS:

Iterated 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.

Textbook (s)

1) James Stewart, "Calculus Early Transcendentals", 9th Edition, Cengage Learning, New Delhi, 2019.
2) Lecture Notes on Calculus Through Engineering Application Problems and Solutions, Department of Mathematics, Thiagarajar College of Engineering, Madurai.

Reference Books &Web Resources

1) George B. Thomas, "Thomas Calculus: early Transcendentals", 14th edition, Pearson, New Delhi, 2018.
2) Howard Anton, IrlBivens and Stephen Davis, “Calculus: Early Transcendentals”, 12the, John Wiley & Sons, 2021.
3) Kuldeep Singh, "Engineering Mathematics Through Applications", 2nd edition, Blooms berry publishing, 2019.
4) Kuldip S. Rattan, Nathan W. Klingbeil, Introductory Mathematics for Engineering Applications, 2nd e John Wiley & Sons, 2021.

Course Designers

1.	Dr. R. Rammohan	Professor	Department of Mathematics	rr_maths@tce.edu
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3.	Dr. S. Suriyakala	Assistant Professor	Department of Mathematics	ssamat@tce.edu

23PQ120	MATERIALS SCIENCE

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

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 recently developed Solar cell materials, Superconductors and Nanomaterials will be discussed

Prerequisite

- Nil

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage (%)
CO1	Compute the electrical properties of metals based on classical free electron theory.	Apply	20
CO2	Acquire knowledge on different type of	Understand	20

	semiconductors', their properties and applications.		
CO3	Calculate the various dielectric properties at a given frequency.	Apply	15
CO4	Compute the magnetic properties of different magnetic materials.	Apply	15
CO5	Explain the properties and application of Metallic glasses, Nanomaterial & Superconductors.	Understand	20
CO6	LaiExplain the importance of Solar cell materials & Conducting polymers	Understand	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30			30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

Syllabus

Conducting Materials

Conduction in Metals- Ohms law in scalar and vector form-Classical free electron theory of metals- Mobility and Conductivity- Factors affecting resistivity-Thermal Conductivity of metals, polymers and ceramics-Widemaan Franz Law(Statement & Limitations) . Application of low and high resistivity materials.

Semiconducting Materials

General properties of semiconductors-Intrinsic and extrinsic semiconductors- Fermi level in Intrinsic and Extrinsic Semiconductors. PN junctions-Compound semiconductors –ZnO &GaAs – Direct and Indirect Band gap Semiconductors-Applications-Laser diode and photo diode.

Dielectric materials

Electric polarisation-Different types of polarisation- -Internal field-Claussius Mosotti Relation-Dielectric Loss-Dielectric Breakdown- Frequency and temperature dependence of Polarization - Ferroelectric materials &Piezoelectric materials-Properties & Applications.

Magnetic materials

Origin of magnetic moment Classification of magnetic material, their properties and applications– Domain theory- Hysteresis- Hard and soft magnetic materials, Ferrites – properties & applications.

Advanced Engineering materials

Metallic Glasses-Types of metallic glasses- Properties and applications - Superconductors-Types of superconductor-Properties and Applications , Nanomaterials- Properties and Applications –Solar cell materials-Conducting Polymers

Textbook (s)

1. M.A.Wahab Solid State Physics - Structure and Properties of Materials, 3rd edition,Reprint, Narosa Publishers, 2020

Reference Books & Web Resources

1. William D Callister Materials Science and Engineering – An introduction,10th edition, Wiley Publications, 2018

2. William F Smith, Javed Hashemi, Ravi Prakash Materials Science and Engineering 4th edition, Tata McGraw Hill, 2006
3. https://nptel.ac.in/courses/115102025.

Course Designers

Dr. A.L.Subramaniyan	Assistant Professor	Physics	alsphy@tce.edu
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23PQ130	ELECTRONIC DEVICES AND CIRCUITS

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

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 from the signal. 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 voltage regulator ICs, etc. These could involve rectification, filtering, regulation, amplification, modulation, demodulation, mixing, frequency synthesizing etc.

Prerequisite

Nil

Course Outcomes

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

CO No.	COURSE OUTCOMES	Cognitive Level	Weightage(%)
CO1	Explain the characteristics and applications of diode, special diodes, BJTs and MOSFETs	Understand	30
CO2	Design rectifier, clipper and clamper circuits for the given specifications	Apply	15
CO3	Design BJT and MOSFET based amplifier for the given specifications	Apply	20
CO4	Explain the operation of Class A,B,C and D power amplifiers	Understand	10
CO5	Design feedback amplifiers and oscillators for the given specifications	Apply	15
CO6	Explain the operation of Opto-electronic devices	Understand	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	40			20
Apply	50	40	100	100	60
Analyse					

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Evaluate					
Create					

Syllabus

Diode: Semiconductor – Types, Drift and Diffusion currents, Diode-Operation, V-I Characteristics, Current equation, Parameters and equivalent circuit, Load line analysis, Transition and Diffusion capacitance, Reverse recovery Characteristics, Application of Diodes – Wave shaping circuits: Rectifiers, Clippers and Clampers.

Special Diodes: Zener diode, Varactor diode, Schottky Diode and their application - Selection of diode using data sheets for the given application.

BJTs and UJT: Operation of NPN and PNP transistor, Characteristics of BJT in CB, CE and CC configurations, DC and AC load line, Fixed, Emitter feedback and Voltage divider bias, Stability factor, Application of BJT as amplifier, BJT as switch, Switching characteristics of BJT, Low frequency and high frequency hybrid model, AC analysis of BJT CE amplifier - Selection of BJT using data sheets for the given application - Working principle, operation and applications of UJT.

MOSFETs: Introduction to JFET, Construction, Operation, Characteristics and Parameters of MOSFET, MOSFET as a voltage controlled resistor, Voltage divider bias in MOSFET CS amplifier, Small signal model of MOSFET- AC analysis of MOSFET CS amplifier, Selection of MOSFET using data sheets for the given application-Introduction to FinFET.

Power Amplifiers: Construction and operation of Class A, B, C and D amplifiers.

Feedback amplifiers & Oscillators: Positive and negative feedback- Feedback amplifiers-Gain and frequency response - Oscillators – Colpitts, Hartley and Crystal oscillator

Opto-electronic Devices: Photo diode, Photo transistor, LED**,** LCD, Laser diode, Opto-couplers, IR Emitter and Detector.

Text Book

1. Robert Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory”, 11th Edition, Pearson Education, 2013.

Reference Books & web resources

1. Floyd T.L,” Electronic Devices”, 10th Edition, Pearson Education, 2017.
2. David A. Bell, “Electronic Devices and Circuits”, 5th Edition, Prentice Hall India, 2010.
3. Albert Malvino and David J.Bates, “Electronic Principles”, 7th Edition, Tata Mc-Graw Hill, 2017.
4. Jacob Millman, Halkias C.C and Satyabrata Jit, “Electronic Devices and Circuits”, 4th Edition, Tata Mc-Graw Hill, 2012.
5. Sedra A.S. and Smith K.C, “Microelectronic Circuits”, 7th Edition, Oxford press, 2014.
6. Donald A.Neamen, “Electronic circuit analysis and design”, Second edition, Tata Mc-Graw Hill, 2003.
7. VK.Mehta and Rohit Mehta, “Principles of Electronics”, S.Chand and Company, 11th Edition, 2008.

Course Designers

1. Dr. M.Saravanan, Professor, EEE mseee@tce.edu
2. Dr. V.Suresh Kumar, Professor, EEE vskeee@tce.edu

23PQ140	ELECTRIC CIRCUIT ANALYSIS

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

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

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage (%)
CO1	Explain the fundamental components and the laws of Electric circuits	Understand	10
CO2	Apply mesh analysis, nodal analysis, and network theorems to interpret the behaviour of the given electrical circuit	Apply	30
CO3	Determine the sinusoidal response of electric circuits	Apply	20
CO4	Find the transient response of RL, RC and RLC circuit	Apply	30
CO5	Calculate three-phase quantities of the given three-phase circuit	Apply	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10			10
Understand	30	30			30
Apply	60	60	100	100	60
Analyse					
Evaluate					
Create					

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 response for RL, RC & RLC circuits. Step response for RL, RC & RLC circuits.
Three Phase Circuits
Balanced, unbalanced star–delta connections.

Reference Books and Web Resources

1. W.H. Hayt & J.K. Kemmerly and Steven M. Durbin, “Engineering circuit analysis”, Tata McGraw Hill, 7th edition, New Delhi, 2007
2. Charles K. Alexander, Matthew N.O. Sadiku, "Fundamentals of Electric Circuits", Tata McGraw Hill, 5th edition, 2013
3. Mahmood Nahvi, Joseph A Edminister, “Electric Circuits”, Tata McGraw - Hill Education, 5th Edition, 2010.
4. Sudhakar A and Shyam Mohan SP, “Electric Circuit Analysis”, Tata McGraw Hill, New Delhi, 2008

Course Designers:

1.	Dr.C.K. Babulal	Professor,EEE	ckbeee@tce.edu
2.	Dr.R. Rajan Prakash	Associate Professor,EEE	r_rajanprakash@tce.edu

23PQ150	ELECTRICAL WORKSHOP

Category	L	T	P	C	Terminal Exam Type
PC	-	-	3	1.5	Lab

Preamble
The course is designed to provide students a widespread knowledge and understanding of the basic Electrical Systems Components and Laws. The indispensable and pervasive knowledge of electrical wiring and the electronic circuits will give the students an insight to their practical approach in our daily life.

Prerequisite
Nil

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

CO#	Course Outcome	Cognitive Level	Weightage(%)
CO1	Analyze the resistance, inductance and capacitance of various dimensions/shapes of materials experimentally	Analyze	20
CO2	Analyze Electric field lines and equi-potential lines of different electrode configurations experimentally.	Analyze	20
CO3	Practice assembling, soldering and testing of the given simple electronic circuit using PCB	Apply	20
CO4	Verify Electrical circuit laws, and theorems for the electric circuit using hardware and simulation software	Apply	20
CO5	Verify series resonance phenomena in a RLC circuit experimentally	Analyze	10
CO6	Analyze the transient behavior of the given RL, RC, RLC circuits experimentally	Analyze	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		

Apply	30	30
Analyse	40	40
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	30
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Experiment	CO
Familiarization of magnetic and electric field lines. Familiarization of basic protective devices (fuse, MCB, ELCB) Familiarization of ammeter, voltmeter, wattmeter, rheostat , power supply	C01 to CO6
Design, Develop and Analyze the resistance of various dimensions with different resistivity, inductance of various core dimensions and winding configurations and capacitance of various shapes and materials experimentally	CO1
Plot and analyze Electric field lines and equipotential lines of different electrode configurations experimentally.	CO2
Assembling, Soldering and Testing of Simple electronic Circuit using PCB	CO3
Verification of Electrical laws and Superposition, Thevenin and Maximum power transfer theorems for the electric circuit using simulation software	CO4
Verification of Electrical laws and Superposition, Thevenin and Maximum power transfer theorems for the electric circuit using hardware	CO4
Verification of series resonance phenomena in a RLC circuit	CO5
Analyze the transient behaviour of the given RL ,RC,RLC circuits	CO6

Reference Book

1. Electrical Workshop Manual prepared by TCE Staff Members

Course Designers:

1. Dr.P.S.Manoharan Professor, EEE psmeee@tce.edu
2. Dr.V.Saravanan, Professor, EEE vseee@tce.edu

23PQ210	MATRICES AND TRANSFORMS

Category	L	T	P	C	Terminal Exam Type
PC	3	1	-	4	Theory

Preamble

An Electrical engineering student needs to know the concept of Eigen value problem for construction of engineering modelling. Also mathematical tools Laplace Transforms, Fourier Transforms are very much essential to solve ordinary differential equations, partial

differential equations, integral equations and related initial and boundary value problems. The course is designed to impart the knowledge and understanding the concepts of Fourier series for approximation of periodic functions and apply them in their area of specialization.

Prerequisite

- NIL

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage (%)
CO1	Estimate the Eigen values and Eigen vectors of a square matrix	Apply	10
CO2	Reduce the Quadratic form to Canonical Form using diagonalization.	Apply	10
CO3	Determine Laplace Transform and Inverse Laplace Transform	Apply	15
CO4	Solve initial value problem using Laplace transform.	Apply	15
CO5	Represent the function into infinite Fourier trigonometric series.	Apply	25
CO6	Determine the value of improper integrals and solve integral equation using Fourier Transform.	Apply	25

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10	100	100	-
Understand	30	30			30
Apply	60	60			70
Analyse					
Evaluate					
Create					

Syllabus

MATRIX EIGEN VALUE PROBLEM: Eigen values and Eigenvectors – Properties of Eigen values –Reduction to Diagonal form - Reduction of Quadratic forms to Canonical Form.

LAPLACE TRANSFROMS: Laplace transform -Properties –Transforms of Periodic Functions - Transforms of derivatives and integrals – Evaluations of integrals by Laplace Transform – Inverse Transform - Convolution – Application to Differential Equations.

FOURIER SERIES: Fourier series in (0, 2π) –Even and Odd functions – Half-range Sine and Cosine series – Complex Form of Fourier Series - Harmonic Analysis.

FOURIER TRANSFORM: Fourier transform – Properties of Fourier Transforms – Fourier Sine and cosine transforms – Convolution theorem – Parseval's identity.

Textbook (s)

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2012.

Reference Books &Web Resources

1) Erwin Kreszig, "Advanced Engineering Mathematics",10th edition, Wiley, 2017.
2) Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.

3) Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
4) John Bird, "Higher Engineering Mathematics", Fifth edition, Published by Elsevier Ltd., 2006.

Course Designers

1. Dr. R. Rammohan — Professor — Department of Mathematics — rr_maths@tce.edu
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23PQ220	THERMAL ENGINEERING

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

Electrical engineers design, develop, test, and maintain the electrical equipment such as electric motors, transformers, radar and navigation systems, communications systems and power generation equipment. Electrical engineers also design the electrical systems of automobiles and aircraft. They must have an understanding of thermodynamics and its applications. Hence, this course focuses on the basics of thermodynamics, air standard cycles, steam power cycle, heat transfer, I.C engines and refrigeration cycles.

Prerequisite

- Nil

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage(%)
CO1	Determine the energy transfer and change of properties of thermodynamic systems.	Apply	20
CO2	Determine the performance of various gas power cycles and air compressor.	Apply	20
CO3	Compute the performance of vapour power cycles using steam tables.	Apply	15
CO4	Determine the heat transfer rate in conduction heat transfer.	Apply	15
CO5	Calculate the performance parameters of I.C.Engines.	Apply	15
CO6	Determine the performance of vapour compression refrigeration systems.	Apply	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10			10
Understand	40	40			40
Apply	50	50	100	100	50

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Analyze					
Evaluate					
Create					

Syllabus

Thermodynamics:

Basic Concepts of Thermodynamics – definitions , systems, properties, processes, cycles, equilibrium – Zeroth Law – Energy interaction- First Law –Cycle, Processes– non-flow, steady flow – Second Law – Carnot Engine, Refrigerator, Heat pump. Entropy – Clausius inequality, principle of entropy increase, T-s Diagram (Qualitative treatment only)

Air standard cycles:

Introduction – Otto, Diesel and Dual cycles – thermal efficiency, mean effective pressure.

Reciprocating air compressor: Single stage – work done – volumetric efficiency – Multistage air compressor with Inter cooler – condition for minimum work (Simple problems).

Steam power cycle:

Steam - formation and properties – Steam table and Mollier diagram- Ideal vapour cycle-thermal efficiency (Simple problems). High pressure water tube boiler- Benson, Lamont Boilers- Boiler mountings and accessories. – Turbines – impulse, reaction and compounding – Surface Condenser (Qualitative treatment only).

Basic heat transfer:

Modes of heat transfer – Principles – Conduction heat transfer through simple and composite system – plane wall and cylinders (simple problems). Cooling of electrical machines-Transformer and Electronic circuit boards (Qualitative treatment only)

Internal combustion engines:

Introduction – Two stroke and four stroke engines – Petrol and Diesel engine –Simple carburetor – Battery ignition system- Fuel injection pump-Fuel injector –– cooling and lubrication of IC engine – Performance calculation – mechanical, thermal efficiencies.

Refrigeration Cycles:

Carnot refrigeration cycle – Bell-Coleman cycle – Simple vapour compression cycle – COP, Refrigerating effect (Simple problems)- Vapour absorption system – Refrigerants properties.

Air Conditioning Systems: Introduction – definition, components, classification – Window air conditioners and Central air conditioning system (Qualitative treatment only).

Textbook (s)

1. Nag P.K. Engineering Thermodynamics, McGraw Hill Education; 6th edition, 2017.
2. Joel Rayner, Basic Engineering Thermodynamics, Pearson Education, 2008.
3. R.S Khurmi & J.K Gupta, Steam Tables, S Chand; 8th edition, 2008.

Reference Books & Web Resources

1. Yunus A. Cengel, Michael A. Boles and Mehmet Kanoglu, Thermodynamics - An Engineering Approach, McGraw Hill, 9th Edition, 2019.
2. Mahesh M Rathore , Thermal Engineering , McGraw Hill Education; 2010
3. Rajput R.K., Thermal Engineering, Laxmi Publications; 11th edition, 2020.

Course Designers

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2. Dr.M.S.Govardhanan Asst. Professor Mechanical Engg govardhanans@tce.edu

23PQ230	DC MACHINES AND TRANSFORMERS

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

The course aims in imparting fundamental knowledge of construction, types, Operation of Transformers and Direct current (DC) machines. 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 motor speeds or precise control of motor output. A transformer is a device used to transfer electrical energy from one circuit to another. It changes electricity from one level to other level of voltage using the properties of electricity.

Prerequisite

Nil

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage(%)
CO1	Explain the construction, principle of operation and various types of DC machines.	Understand	20%
CO2	Determine the characteristics and performance of DC machines at loaded conditions.	Apply	20
CO3	Choose the starting methods, speed control, and testing methods DC Motors.	Apply	10
CO4	Explain the basic principles and construction of single phase, three phase transformer and application specific transformers	Understand	20
CO5	Illustrate the operation of transformer at no load and loaded conditions	Apply	20
CO6	Determine the performance of the given single transformer using equivalent circuit diagram and testing methods	Apply	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

Syllabus

DC Generators

Construction-Principle of operation, Emf equation-types, Armature reaction-commutation, Characteristics of generators, Losses & efficiency, Regulation, parallel operation, Applications

DC Motors

Principle of operation, Torque equation, Types-characteristics, Losses-Efficiency, Speed control and starters, Swinburne's Test , Heat run Test ,Hopkinson's Test

Transformers

Transformer construction and principle, Ideal Transformer, EMF equation, Transformer on no load & load Losses, efficiency and regulation, All day efficiency, Auto transformer, three phase transformer connections, Parallel operation of Transformers, Welding transformers, Tap changers on load & off load , OC&SC Test on transformers, Sumpners Test

DC Generators

Construction-Principle of operation, Emf equation-types, Armature reaction-commutation, Characteristics of generators, Losses & efficiency, Regulation, parallel operation, Applications

DC Motors

Principle of operation, Torque equation, Types-characteristics, Losses-Efficiency, Speed control and starters, Swinburne's Test , Heat run Test ,Hopkinson's Test

Transformers

Transformer construction and principle, Ideal Transformer, EMF equation, Transformer on no load & load Losses, efficiency and regulation, All day efficiency, Auto transformer, three phase transformer connections, Parallel operation of Transformers, Welding transformers, Tap changers on load & off load , OC&SC Test on transformers, Sumpners Test

Textbook (s)

1. D.P.Kothari & I.J.Nagrath, " Electrical Machines", Tata-McGrawhill, Newdelhi, 5th Edition, 2010.

Reference Books & Web Resources

1. R.K.Rajput, " Electrical Technology", Laxmi Publications, 3rd edition, 2005.
2. Vincent Deldoro ," Electromechanical Energy Conversion " PHI III edition,
3. M.G.Say, Theory and performance of electrical machines, Tata-Mcgraw hill

Course Designers

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23PQ240	ELECTROMAGNETICS

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

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 behavior 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

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage (%)
CO1	Explain the coordinate systems and vector calculus applicable to electric and magnetic fields.	Understand	10
CO2	Compare the behavior of Electric and Magnetic field in free space and in material space using basic laws.	Understand	10
CO3	Relate Voltage, Current and basic circuit laws using Electric fields	Apply	20
CO4	Demonstrate Resistance, Inductance and capacitance with materials of different resistivity/Permeability /Permittivity and of different dimensions with the help of electric fields.	Apply	20
CO5	Explain the force on a current carrying conductor and torque on a current loop subjected to magnetic fields	Understand	20
CO6	Relate dynamic electric and magnetic fields with help of Faraday's Law and Maxwell's Equation, and, their applications to electrical machines	Apply	20

*** Weightage depends on Bloom's Level, number of contact hours,

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	60	50			50
Apply	20	30			30
Analyse					
Evaluate					
Create					

Syllabus

Mathematical Foundation

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 Fields

Coulomb's Law, Charge density, Electric field intensity, Electric flux density, Gauss law, Potential, Potential Difference, Basic circuit laws - verifications.

Material Characteristics - Current, Current Density, Conductivity/ Resistance of materials. Continuity equation and time constant. Permittivity / Dielectric Strength of materials and application to capacitance & electrical insulation. Multiple Dielectrics and field behavior at the interfaces. Calculation of capacitance for various applications and energy storage. Capacitance of Transmission lines and cables.

Magneto static Fields

Biot – Savart's Law and Ampere's Law, Magnetic flux density and Magnetic field Intensity, Field behaviour at interface of magnetic materials, Inductance, application to Energy Storage and Magnetic Circuits. Inductance of Transmission lines and cables. Simulation of Magnetic Fields using FEM packages.

Force and Torque

Force on a current carrying conductor subjected to a magnetic field, Torque on a current loop subjected to a magnetic field and working principle of motor.

Dynamic Fields

Faraday's Law of Electromagnetic Induction, Principle of operation of generator and transformer, Displacement current , Maxwell's equations, Poynting Theorem.

Reference 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.
4. K.A. Gangadhar and P.M. Ramanathan, "Electromagnetic Field Theory (Including Antennas and Wave Propagation)" Khanna Publishers– 2012

Course Designers:

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23PQ250	ELECTRONIC DEVICES AND CIRCUITS LABORATORY

Category	L	T	P	Credit	TE Type
Core	-	-	3	1.5	Theory

Preamble

This laboratory gives a practical exposure to the students to learn the characteristics of various electronic devices such as diodes, BJT, and MOSFET 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. To validate the experimental results, the use of simulation tools for the performance analysis of the circuits is also introduced to the students

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome	Cognitive Level	Weightage(%)
CO1	Determine the equivalent circuit parameters of the given Diode, BJT, and MOSFET	Apply	30
CO2	Design voltage regulator using Zener diode for the given specifications	Apply	10
CO3	Analyze the performance of the diode rectifier circuit designed for the given specifications	Analyze	10
CO4	Analyze the performance of the wave shaping circuits (Clippers and Clampers) designed for the given specifications	Analyze	20
CO5	Analyze the performance of the amplifier and	Analyze	20

	oscillator designed for the given specifications		
CO6	Analyze the performance of the analog device characteristics and analog circuits using simulation tools	Analyze	10

*** Weightage depends on Bloom's Level, number of contact hours

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	40	40
Analyse	30	30
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	30
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

No.	Name of the experiment	CO	No. of Sessions
1.	Characteristics of PN junction diode, Zener diode	CO1	1
2.	Characteristics of BJT and MOSFET	CO1	2
3.	Design of voltage regulator using zener diode	CO2	1
4.	Design of Full wave rectifier with and without filter	CO3	1
5.	Design of wave shaping circuits (clippers and clampers)	CO4	1
6.	Design of BJT-CE amplifier and LC Oscillator	CO5	2
7.	Characteristics of Opto-couplers	CO6	1
8.	Analyze the characteristics of analog devices and analog circuits using PSPICE/PSIM/Simulink/NI-MY DAQ	CO6	2

Reference Books & web resources

1. Robert Boylestad and Lowis Nashelsky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson Education, 2013.
2. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Prentice Hall India, 2010.
3. https://powersimtech.com/.
4. PSpice Technologies for Academic | PSpice.
5. Simulink - Simulation and Model-Based Design - MATLAB & Simulink.
6. https://www.ni.com/.

Course Designers

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23PQ310	DIGITAL SYSTEMS

Category	L	T	P	Credit	TE Type
Core	3	1	-	4	Theory

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. Digital systems are designed to store, process, and communicate information in digital form. They are found in a wide range of applications, including process control, communication systems, digital instruments, and consumer products

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome	Cognitive Level	Weightage(%)
CO1	Explain different number systems, codes, code converters and digital logic families	Understand	10
CO2	Design combinational circuit for the given applications using logic gates and standard combinational circuits (multiplexers and de multiplexers ,adders, subtractors, Encoders and Decoders)	Apply	40
CO3	Design synchronous sequential circuits for the given requirement including counters	Apply	20
CO4	Explain the characteristics and working of asynchronous sequential logic circuits	Understand	10
CO5	Implement the given digital application using Programmable Logic Devices	Apply	10
CO6	Illustrate the function of memories.	Understand	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Review of Number systems & Boolean Algebra: Decimal, binary, signed binary, octal, hexadecimal number - Binary arithmetic, one's and two's complements arithmetic - Base

conversions - C**odes:** BCD, Excess-3, Gray, ASCII codes, Code conversions, Boolean Algebra and laws- Simplification of Boolean expressions.

Logic gates & Logic Families: Logic gates and their truth table**-** Characteristics of digital ICs- Digital Logic Families - Comparison of TTL, ECL and MOS families - Operation of CMOS logic gates.

Combinational logic circuits: Introduction to sum of products (SOP) & product of sums (POS) forms- Logic Minimization using K-map and their realization using logic gates - Multiplexer, De-Multiplexer, Decoders- Realization of Boolean functions using multiplexers- Adders, Subtractors, Basic ALU design - Magnitude comparator, parity checker/generator, code converters, priority encoder.

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, Ring).

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

Memory & Programmable logic devices: RAM (static and dynamic), ROM (EEPROM, FLASH), Programmable Logic Array (PLA), Programmable Array Logic (PAL), Introduction to CPLD and FPGA

Reference Books and Web Resources

1. M.Morris Mano and Michael D.Ciletti, Digital Design, Sixth Edition, Pearson Prentice Hall, 2019
2. RP Jain, Modern Digital Electronics,fourth edition, Tata Mcgraw Hill Publishers,2010
3. Floyd and Jain, Digital Fundamentals, 8th Edition, Pearson Education, 2009
4. Charles H.Roth and Lizy K.John, Digital system design using VHDL, 3rd edition, Cengage learning, 2017
5. Donald Leach, Albert Malvino and Goutam Saha, Digital Principles and Applications, 8th edition ,McGraw Hill Publishers,2015
6. J. F. Wakerly Digital Design Principles and Practices, 5th edition, Prentice Hall of India, 2021.
7. NPTEL course: https://onlinecourses.nptel.ac.in/noc18_ee33

Course Designers:

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23PQ320	MECHANICS OF FLUIDS AND MACHINERY

Category	L	T	P	C	Terminal Exam Type
PC	2	1	-	3	Theory

Preamble

Mechanics of Fluid is a subject of engineering science deals with the behaviour of fluids at rest as well as in motion. It is an important subject with unlimited practical applications ranging from biological systems to automobiles, airplanes and spacecraft propulsion. Thus this subject is given considerable importance in Civil, Mechanical and Electrical Engineering at core as well as at professional levels

Prerequisite

Basic Concepts of Physics and Mathematics

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage(%)

CO1	Apply the knowledge of fluid properties in real fluid flow problems.	Apply	13
CO2	Use the knowledge of Pascal's law and Hydrostatic law to find the pressure of the static and flowing fluid.	Apply	17
CO3	Find the velocity and acceleration of fluids in pipes.	Apply	13
CO4	Apply Bernoulli's theorem to solve a variety of fluid flow problems.	Apply	19
CO5	Design and study the performance of various types of hydraulic turbines.	Apply	19
CO6	Design and study the performance of various types of pumps	Apply	19

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	20	20	-	-	20
Apply	60	60	100	100	60
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

Syllabus

Fluid Properties: Density, Specific weight, Specific volume, Specific gravity, Viscosity, Kinematic viscosity, Surface tension, Compressibility, Capillarity, types of fluids.

Pressure Measurements: Pascal's law, Hydrostatic law, Manometers, hydrostatic forces on vertical and horizontal plane surfaces,

Fluid Kinematics: Types of fluid flows, continuity equation, velocity and acceleration, potential function and stream function.

Fluid Dynamics: Euler's equation, Bernoulli's equation and its applications.Flow measurements in pipes using Pitot tube, Venturimeter and Orificemeter.

Water turbines: Classification, Pelton wheel, Francis turbine, Kaplan turbine, specific speed and Cavitation.

Pumps: Types of pumps, Selection of pumps, Centrifugal pump, Troubles and remedies, Characteristics curves, Specific speed. Single and double acting reciprocating pump, Indicator diagram, Slip and Air vessels.

Textbook (s)

1. Bansal R.K, "A Text Book of Fluid Mechanics and Hydraulic Machines" Lakshmi Publications, New Delhi, 10th Edition 2019

Reference Books &Web Resources

1. Modi P.N and Seth S.M, "Hydraulics and Fluid Mechanics Including Hydraulic Machines" Standard Book House" New Delhi, 22nd Edition 2019
2. Yunus A. Cengel and John M. Cimbala, "Fluid Mechanics" Fundamentals and Applications, Tata McGraw Hill Publishing Company Ltd, New Delhi, 4th Edition 2019
3. Kumar.K.L, "Engineering Fluid Mechanics" S.Chand Ltd., New Delhi, 2016.

Course Designers

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23PQ330	AC MACHINES

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

Preamble

Rotating electrical machines are widely used for the purpose of converting energy from one form to another. Alternating Current (AC) machines are becoming more and more attractive in many applications such as those requiring variable speed and flexible control. Also, AC machines are the most preferred for generation of electric power. AC motors are the commonly used in industry for motive power for applications. 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 economic advantages, AC motors are widely used in applications requiring a wide range of speeds or precise control of output.

Prerequisite

Nil

Course Outcomes

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

CO NOs	Course Outcome	Cognitive Level	Weightage (%)
CO1	Explain the construction and working principles of Synchronous machine	Understand	10
CO2	Explain the construction and working principles of Asynchronous machine	Understand	10
CO3	Obtain the performance of AC Generators	Apply	25
CO4	Obtain the performance of AC Motors using equivalent circuit	Apply	25
CO5	Explain the Operation and Control of AC Machines	Understand	10
CO6	Apply the testing procedures for AC Machines as per the standard practice	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30			30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

Syllabus

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.

ASYNCHRONOUS MACHINE

Three Phase Induction Motor: Types, Construction, Working Principle, Characteristics, Applications, Performance Analysis, Types of losses and efficiency calculations, Equivalent Circuit, Circle Diagram, Starting Methods and Speed Control.

Single Phase Induction Motor: Types, Construction, Working principle, Applications, AC Series Motor.

SPECIAL MACHINES

Special Machines: Linear Induction Motor, Hysteresis Motor, Eddy Current Motor, Brushless DC motor, Stepper motor, Induction Generator.

Text Book

1. H.Wayne Beaty & James. L.Kirtley. Jr "Electric Motor Handbook", McGraw-Hill, USA, 1st Edition, 1998.

Reference Books

1. A.K.Sawhney and A.Chakrabarti, "A course in Electrical Machine Design",6th Edition, Dhanpat Rai & Co (P) Ltd., 2006.
2. P. S. Bimbhra, "Electrical machinery", Seventh Edition, Khanna Publications, 2014.
3. Gupta.J.B,"Theory of Performances of Electrical Machines' Katson, 7th Edition, 1987
4. Stephen J.Chapman, "Electric Machinery Fundamentals', "McGraw Hill Intl. Edition, New Delhi, 6 th Edition, 2012.
5. Vincent Deldoro ," Electromechanical Energy Conversion " PHI III edition,
6. M.G.Say, The Performance and Design of Alternating Current machines, Tata-McGraw Hill.

Course Designer(s):

Dr. S. Latha, Professor, EEE - sleee@tce.edu
Dr. D. Nelson Jayakumar, Assistant Professor, EEE – dnjayakumar@tce.edu

23QP340	LINEAR INTEGRATED CIRCUITS

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

A linear integrated circuit is a solid-state analog device characterized by a theoretically infinite number of possible operating states. It operates over a continuous range of input levels. Linear ICs are employed in audio amplifiers, Analog to Digital converters, averaging amplifiers, differentiators, DC amplifiers, integrators, multivibrators, oscillators, audio filters, and sweep generators. Some devices contain several amplifiers within a single housing.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Explain the Linear Integrated Circuits	Understand	20

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	fabrication techniques		
CO2	Explain the working of operation amplifier and its characteristics.	Understand	10
CO3	Design linear circuits using operational amplifiers for the given specifications	Apply	30
CO4	Design Multivibrator circuits using 555 timer IC	Apply	10
CO5	Design voltage regulators, Analog to digital converters and Digital to Analog converters for the given specifications	Apply	20
CO6	Explain the operation of Phase Locked Loop	Understand	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

Syllabus

Introduction: Integrated circuits – Classification, Thin and thick film techniques, SMT(Surface Mount Technology) Monolithic technique - wafer preparation, Epitaxial growth, Oxidation, Photolithography, Diffusion, Ion Implantation, Isolation, Metallization and Packaging, Fabrication of Integrated resistors, capacitors and inductors - Bipolar and MOSFET devices fabrication techniques.

Operational amplifier: Basic concepts - differential amplifiers - block diagram-ideal op-amp parameters - Basic op-amp applications Scale changer, Inverting and non-inverting amplifiers, summer and subtractor, differentiator and Integrator, Instrumentation amplifier

Op-amp circuits: V to I and I to V converters- Precision rectifier- Clipper and clamper- Active filters: first order LPF and HPF- Comparators - Regenerative comparator (Schmitt Trigger)- Square wave and Triangular wave generators

Other Linear ICs: IC voltage regulators – Fixed and Variable voltage regulators-78XX and 79XX series regulators -Switching Regulator- 555 timer IC: Astable and Monostable modes - Phase locked loop and its applications- D/A converters: weighted resistor and R-2R ladder- A/D converters: Successive approximation, Counter type and Flash type

Text Book

1. Roy choudhury and shall B.Jain, Linear Integrated circuits, Wiley Eastern Ltd, 5th edition, 2018.

Reference Books & Web Resources

1. Ramakant A. Gayakwad, Op-amps and Linear Integrated Circuits, Pearson Education; Fourth edition, 2015
2. K.R.Botkar, Integrated Circuits, Hanna Publishers, 2008
3. Jacob Millman & Christos C.Halkias- Integrated electronics, McGraw Hill Education; 2 edition ,2017.
4. Fred F. Driscoll and Robert F. Coughlin , Operational Amplifiers and Linear Integrated Circuits, Pearson; 4 edition 1997.
5. NPTEL courses web:http://nptel.ac.in/courses/108106068/

6. MOOCs course link: https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
7.

Course Designers:

1. Dr.M.Saravanan Professor, EEE -mseee@tce.edu
2. Dr.S.Arockia Edwin Xavier, Associate Professor, EEE - saexeee@tce.edu

23PQ350	DC MACHINES AND TRANSFORMERS LABORATORY

Category	L	T	P	C	Terminal Exam Type
PC	-	-	3	1.5	Lab

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

Course Outcomes

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

CO#	Course Outcome	Cognitive Level	Weightage(%)
CO1	Obtain the characteristics of DC Generator (Shunt, Series & Compound) independently	Apply	20
CO2	Obtain the characteristics of DC Motor (Shunt & Series) independently	Apply	20
CO3	Determine the Efficiency of DC Machine and calculate the maximum efficiency	Apply	10
CO4	Obtain the Voltage Regulation and Efficiency characteristics of Transformer independently	Apply	20
CO5	Sketch the Circuit Model of Transformer	Analyze	20
CO6	Obtain the Thermal & Vibration characteristics of DC Machines and Transformers	Apply	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand	10	
Apply	40	30
Analyse	20	40
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	Mini project /Practical Component/Observation

Perception	
Set	
Guided Response	10
Mechanism	20
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

Exp.No	Name	CO
DC Machine		
1	Load characteristics of DC Generators	CO1
2	Methods of Excitation and Voltage Control of DC Generators	CO1
3	Measuring the resistance of Armature and Field Windings	CO1
4	Methods of Starting and Speed Control of DC Motors	CO2
5	Load Characteristics of DC Motors	CO2
6	Swinburne's & Hopkinson's tests	CO3
7	Thermal and Vibration Study of DC Machines	CO6
Transformer		
8	Performance estimation using various load	CO4
9	Performance calculation using equivalent circuit	CO4
10	Measurement of Winding Resistance and Inductance	CO5
11	Sumpner's test / Polarity Test	CO5
12	Thermal and Vibration Study of Transformer	CO6

Reference Book

1. DC Machines and Transformers Laboratory Manual prepared by TCE Staff Members

Course Designers:

1. Dr. V.Saravanan ,Professor,EEE vseee@tce.edu
2. Dr.S.Latha ,Professor,EEE sleee@tce.edu

23PQ410	NUMERICAL METHODS

Category	L	T	P	C	Terminal Exam Type
PC	3	1	-	4	Theory

Preamble

An 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. The course is designed to impart the knowledge and understanding of the above concepts to Electrical Engineers and apply them in their areas of specialization.

Prerequisite

- NIL

Course Outcomes

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

CO#	Course Outcome	Cognitive	Weightage(%)

		Level	
CO1	Solve single non-linear algebraic, transcendental equation numerically.	Apply	15
CO2	Solve system of linear equations numerically	Apply	15
CO3	Solve the initial value problems in ODE numerically using single step and multi-step methods.	Apply	20
CO4	Solve the boundary value problems in PDE using finite difference methods.	Apply	15
CO5	Compute the derivative of the polynomial fitting the given data set.	Apply	20
CO6	Compute the integral of the given function using quadrature methods.	Apply	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10	100	100	-
Understand	30	30			30
Apply	60	60			70
Analyse					
Evaluate					
Create					

Syllabus

Solution to a Single Non-linear Equation and a System of Linear Equations: Introduction to Numerical Solution – The Bisection Method - Fixed point iteration method – Newton Raphson method – Solution of Linear Simultaneous Equations: Gauss Elimination method – Gauss Jordan Method – Iterative Methods: Gauss Jacobi Method – Gauss Seidel methods.

Numerical Solution of ODEs: Euler's method – Modified Euler's method – Runge-Kutta methods of order 4 – Predictor corrector methods – Adam's predictor corrector formula – Milne's Predictor corrector formula. **Numerical Solution of PDEs:** Classification of Second order equation - Solution to Elliptic, Parabolic and Hyperbolic PDEs

Interpolation and Numerical Differentiation: Newton's forward and backward interpolation formula – Lagrange's interpolation formula - Divided differences – Newton's Divided Difference formula – Numerical Differentiation – Formulae for derivatives – Derivatives using forward and backward difference formula.

Numerical Integration: Trapezoidal Rule - Simpson's 1/3 rule – Simpson's 3/8 rule – Romberg's method – Two and three point Gaussian Quadrature formula.

Textbook (s)

1. Steven C. Chapra, Raymond P. Canale, "Numerical Methods for Engineers", 7th Edition, McGraw Hill Higher Education,2016.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2012

Reference Books &Web Resources

1. Richard L Burden and Douglas J Faires, "Numerical Analysis", Thomas Learning, New York, 2017.
2. Ward Cheney and David Kincaid, "Numerical Mathematics and Computing", Cengage Learning, USA, 2018.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley, 10th Edition, 2017

4. Mathews J. H. and Howell R. W, "Complex Analysis for Mathematics and Engineering", Narosa Publishing House, New Delhi, 2012

Course Designers

1.	Dr. R. Rammohan	Professor	Department of Mathematics	rr_maths@tce.edu
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23PQ420	CONTROL SYSTEMS

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

This course is to impart students the knowledge of fundamental principles in control engineering. The course includes: Mathematical Modeling of Linear Continuous Time Invariant Single Input - Single Output Dynamical Systems, Transfer Functions and State Space Models, Performance Specifications, and Analysis of Closed Loop Control Systems using time domain and frequency domain approaches.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome 1 (CO1)	Cognitive Level	Weightage(%)
CO1	Determine the transfer function and state space model of the given electrical, mechanical and electro-mechanical system	Apply	25
CO2	Calculate the time response specifications of a given transfer function model	Apply	25
CO3	Calculate the frequency response specifications of a given transfer function model	Apply	20
CO4	Determine the closed loop characteristics of a given transfer function model using root locus	Apply	15
CO5	Explain the effects of compensators in improving the performance of the system	Understand	05
CO6	Determine the stability, controllability and observability of the given dynamical system	Apply	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	10	10			10
Understand	30	30			30
Apply	60	60	100	100	60
Analyze					

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Evaluate					
Create					

*Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

Modeling:

Industrial control examples, Feedback control: Open loop and Closed loop systems, Benefits of feedback, Transfer function models of linear time invariant systems. Concept of state variable, state space model. Mathematical models of electrical, mechanical and electromechanical systems, Block diagram reduction, signal flow graphs and Mason gain formula.

Time domain analysis and stability:

Test Signals, Steady state errors, Time response of First order and second order systems- Dominant pole approximation of higher order systems, Concept of Stability and Characteristic equation, Routh-Hurwitz criteria- Root-locus construction and interpretation, closed loop analysis using root locus,

Frequency-domain analysis:

Frequency responses and Frequency domain specifications, Bode plot, polar plot, construction and interpretation, Nyquist stability criterion- Gain and phase margin.

Compensation:

Types of compensators, characteristics and effects of lead, lag, lag-lead compensators

State Variable Analysis:

Relation between state space and transfer functions, canonical forms, solution of state equation, Eigen values and stability analysis, Controllability and Observability.

Text Book

1.Norman S. Nise, Control Systems Engineering, 6th edition, John Wiley, 2010. (Indian edition)

Reference Books& web resources

1. I.J. Nagrath and M Gopal, Control Systems engineering, 5th Edition, New Age International, 2007
2. Robert H Bishop and Richard C Dorf, Modern Control Systems, 12th Edition, Pearson Education, 2010
3. John JD Azzo, Constantine H Houpis, and Stuart N Sheldon, Linear Control Systems: Analysis and Design with MATLAB, 5th Edition, Taylor and Francis, 2003
4. B.C. Kuo, and F.Golnaraghi, Automatic Control Systems, 9th Edition. Wiley India Pvt limited 2014. (Student edition)
5. Katsuhiko Ogata, Modern Control Engineering, 5th edition, PHI, 2010
6. M Gopal, Control Systems-Principles and Design, 4th Edition, McGraw Hill India, 2012
7. NPTEL Online Course: Control Systems, URL: https://nptel.ac.in/courses/107106081/72

Course Designer(s):

1. Dr. S. Baskar, , Professor, EEE Department,sbeee@tce.edu
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23PQ430	MEASUREMENTS AND INSTRUMENTATION

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

The rapid development of new and exciting means of measurement using new technologies, the adoption of new standards give us a path way to the state of “Classic Electrical Measurements”. However, knowledge of these subjects is important to understand the principles of modern measuring instruments. Instrumentation systems help 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 is designed to impart fundamental knowledge of analog and digital measuring instruments.

Prerequisite

- Nil

Course Outcomes

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

CO#	**Course Outcome Statement**	**Cognitive Level**	**Weightage(%)**
CO1	Explain the fundamental art of measurement in Engineering	Understand	10
CO2	Apply suitable analog instrument to measure the various electrical parameters (current, voltage, power and energy)	Apply	20
CO3	Apply suitable DC bridge circuit to measure Resistance	Apply	10
CO4	Apply suitable AC bridge circuit to measure Inductance, Capacitance and frequency.	Apply	20
CO5	Apply suitable transducers for the measurement of various non-electrical parameters	Apply	20
CO6	Explain the working principle of various Digital instruments.	Understand	20

Assessment Pattern

Cognitive Levels	**Continuous Assessment Tests**		**Assignments**		**Terminal Examination**
	1	**2**	**1**	**2**	
Remember	20	20			20
Understand	50	50	50	50	50
Apply	30	30	50	50	30
Analyse					
Evaluate					
Create					

Syllabus

CONCEPTS OF MEASUREMENTS

Classification of Instruments – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement - Statistical evaluation of measurement data - Standards and Calibration

ANALOG INSTRUMENTS FOR MEASUREMENT OF ELECTRICAL PARAMETERS

Introduction and Classification of analog measuring instruments –-Construction, operating principle and applications of : Moving coil and Moving iron meters –Dynamometer type watt meters - Single phase Induction type Energy meter - Instrument Transformers (CT & PT) - Measurement of power in a single phase circuit using CT & PT.

DC & AC BRIDGES

Wheatstone bridge - cable fault location, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges and their applications - Sources of errors in bridges.

TRANSDUCERS FOR MEASUREMENT OF NON - ELECTRICAL PARAMETERS

Classification of transducers – **Temperature transducers-** RTD, thermistor, Thermocouple – **Displacement transducer -** Inductive, capacitive, LVDT, **Pressure transducer –** Bourdon

tube-**Speed transducer -** Digital Encoders –Strain gauges – Piezo electric and Hall Effect transducers- Concept of MEMS based smart sensors.

DIGITAL INSTRUMENTS

Working Principles and applications: Digital Voltmeter- Digital Multimeter - Digital Frequency Meter - Digital measurement of phase and time interval - Digital Storage Oscilloscope - Harmonic analyzer -Concept of Smart meters.

Textbook (s)

1. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, Edition 2011.

Reference Books & Web Resources

1. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009
2. J.J. Carr, 'Elements of Electronic Instrumentation and Measurement', Pearson Education India, New Delhi, 2011
3. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3 rd Edition 2014.
4. E. O. Doebelin and D. N. Manik, "Measurement Systems – Application and Design", Tata McGraw-Hill, New Delhi, 6th Edition 2017.
5. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016.

Course Designers

1.	Dr.K.Selvi,	Professor	EEE	kseee@tce.edu
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3.	Dr.B.Ashok Kumar	Assistant Professor	EEE	ashokudt@tce.edu

23PQ440	ACCOUNTING AND FINANCE

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

Preamble

The engineering profession involves lots of decision-making. The decisions may range from operation to non-operation. An engineer needs other data about the organization's routine and non-routine operations to make decisions of these kinds. Accounting is a science that provides all the data by recording, classifying, summarizing, and interpreting the various transactions taking place in an organization and thereby helps an engineer in effectively taking vital decisions. Finance is an allied but separate field relying on accounting and enables engineers to 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

CO#	Course Outcome	Cognitive Level	Weightage(%)
CO1	Prepare accounting financial statements and analyze them.	Analyze	20
CO2	Perform cost sheet, depreciation, and its applications	Apply	15

	in Electrical appliances.		
CO3	Compute various types of budgets in an organization	Apply	15
CO4	Compute activity-based costing systems for business applications.	Apply	15
CO5	Evaluate working capital requirements and long-term investment decisions	Apply	20
CO6	Apply the appropriate sources of finance and mobilize the right quantum of finance and use them in the most profitable investment avenues	Apply	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	35	35			20
Apply	30	30	50	50	36
Analyse	15	15	50	50	24
Evaluate					
Create					

Syllabus

Accounting – Introduction, definition, accounting principles-functions of accounting -– Preparation of Financial statements and their analysis.

Cost Accounting - Meaning and importance -Elements of cost- classification of cost- Cost center, Preparation of cost sheet for electrical components and their applications. Depreciation – meaning and causes of depreciation, Methods to find out the depreciation

Budget and Budgetary Control- Introduction- Meaning -objectives of budgetary control – Budget- Types of budgets and their preparation.

Marginal costing- Introduction, Activity-based Costing.

Capital budgeting- Meaning and features, capital budgeting decisions, Methods of evaluating capital budgeting decisions by traditional and modern methods. Working capital management - concept, classification, Estimation of working capital requirements.

Finance: Functions, Objectives of financial management and Source of finance and financial institutions, Venture capital.

Text Books :

1. M.C.Shukla,T.S.Grewal,“Advanced Accounts-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. P.S.BoopathiManickam “Financial and Management Accounting” PSG publications 2009.
2. Don R. Hansen and Maryanne M. Mowen “Cost Management: Accounting and Control, Fifth Edition” Thomson, 2006.
3. Michael C . Ehrhardt and Eugene F . Brigham, “Financial Management: Theory and Practice -thirteenth edition” South-Western Cengage learning, 2011
4. Pandey, “Financial Management”, Vikas Publishing House Pvt. Ltd., 2007
5. Paramasivan.C, Subramanian.T, “Financial management” New Age international Publishers, 2014.
6. https://nptel.ac.in/courses/110101003/

7. https://swayam.gov.in/nd1_noc19_mg38/preview
8. Finance for everyone – Coursera

Course Designers:

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23PQ450	INTEGRATED CIRCUITS LABORATOTY

Category	L	T	P	Credit	TE Type
Core	-	-	3	1.5	Lab

Preamble

This laboratory gives a practical exposure to the students to learn the characteristics of analog and digital ICs that are used in most of the electronic circuits. Student can also conceive ideas on different electronics circuits have analog and digital ICs and can be able to design and implement it for particular applications.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Analyze the performance of the designed circuits like amplifier, filters using operational amplifier for the given applications.	Analyze	30
CO2	Design the Multivibrator circuits using 555 timers for the given specifications.	Analyze	5
CO3	Design the voltage regulators using linear Regulator ICs for the given specifications.	Analyze	5
CO4	Design the Combinational digital circuits for the given requirements using suitable digital ICs.	Analyze	20
CO5	Design the Digital sequential circuits for the given requirements using suitable digital ICs.	Analyze	20
CO6	Develop IC based electronic system for a real-world applications	Analyze	20

*** Weightage depends on Bloom's Level, number of contact hours

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	50	50
Analyze	20	20
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	~~Miniproject~~ /Practical Component/~~Observation~~

Perception	
Set	
Guided Response	
Mechanism	20
Complex Overt Responses	10
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

E.No	Name of the experiment	CO	No. of sessions
1.	Design of Comparator, Amplifier, Integrator, differentiator and Precision rectifiers using OP-AMP	CO1	1
2.	Design of Instrumentation Amplifier, Second order active filters using OP AMP	CO1	1
3.	Design of Multivibrator circuits using 555 Timer ICs	CO2	1
4.	Design of Voltage Regulator for given specification	CO3	1
5.	Realization of Boolean expression using universal gates.	CO4	1
6.	Realization of Full adder, Subtractor, Multiplexer, Demultiplexer, code converters, Decoder and encoder using suitable Digital ICs.(Hardware/ verilog simulation)	CO4	1
7.	Realization of shift Registers and counters using suitable Digital ICs. (Hardware/ verilog simulation)	CO5	1
8.	Development of IC based electronic system for a real-world applications (selected by group of students)	CO6	2

Reference Books

1. Roy Choudhury and shall B.Jain, Linear Integrated circuits, Wiley Eastern Ltd, 5th edition, 2018
2. Jacob Millman & Christos C.Halkias- Integrated electronics, McGraw Hill Education; 2 edition ,2017
3. M.Morris Mano and Michael D.Ciletti, Digital Design, Sixth Edition, Pearson Prentice Hall, 2018

Course Designers:

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23PQ510	POWER ELECTRONICS

Category	L	T	P	C	Terminal Exam Type
PC	3	-	-	3	Theory

Preamble

Power Electronics can be defined as the application of solid state electronics for the control, conversion and transmission of electric power. Power electronic circuits convert electrical energy from one form to another form required by the load in an efficient and effective way. They find applications in industrial motor control, power supplies, vehicle propulsion systems, high voltage direct current (HVDC) systems, flexible AC transmissions (FACTs), heat controls and light controls.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Explain steady state characteristics and applications of Power diode, Power transistor, Power MOSFET, IGBT, SCR, TRIAC, Silicon carbide devices and GaN devices.	Understand	10
CO2	Design SCR triggering circuits, protection circuits and commutation circuits for the given requirements.	Apply	15
CO3	Design controlled single phase and three phase rectifiers for the given specifications	Apply	15
CO4	Design single phase and three phase voltage source inverters for the given specifications	Apply	15
CO5	Design buck, boost and buck-boost DC-DC converters for the given specifications	Apply	15
CO6	Explain the SMPS topologies, single phase and three phase AC voltage controllers.	Understand	10
CO7	Analyze the performance of the given power converter and gate drive circuits using PLECS /PSPICE / MATLAB /PSIM software.	Analyze	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100		40
Analyse				100	
Evaluate					
Create					

Syllabus

Power Semiconductor Devices

Principle of operation & static V-I Characteristics of power diode, power transistor, MOSFET, IGBT, SCR and TRIAC, merits of silicon carbide devices and GaN devices, **SCR:** Triggering circuits, protection circuits and commutation circuits.

AC to DC Converters

Review of uncontrolled rectifiers, Controlled Rectifiers: Half wave, half controlled, fully controlled single phase and three phase controlled rectifiers, performance parameters.

DC to AC Converters

Single phase and three phase voltage source inverter, frequency and voltage control, PWM schemes, harmonic distortion.

DC-DC & AC-AC Converters

Principle of working: Step-down, step-up, voltage commutated, current commutated chopper, switching regulators: buck, boost & buck-boost, SMPS topologies, single phase and three phase ac voltage controller.

Applications

Electric Drives, uninterruptible power supply, HVDC transmission, FACTS, distributed generation, custom power devices.

Simulation of Power Converters

Performance analysis of the power converters and gate drive circuits using PLECS /PSPICE / MATLAB /PSIM software.

Text Book

1. Muhammad H.Rashid, Power Electronics Devices, Circuits & Applications, Fourth Edition, Pearson Education India Publication, New Delhi, 7th Impression, 2019.

Reference Books& web resources

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. Bimbhra, Power Electronics- Khanna Publishers, Sixth Edition, 2018.
4. John G.Kassakian, Martin F.Schlecht, George C.Verghese, Principles of Power Electronics, Pearson Education, 12th Impression, 2014.
5. Daniel W.Hart, Introduction to Power Electronics, First Edition, Prentice Hall International Inc.,1996.
6. L. Umanand, Power Electronics: Essentials and Applications- Wiley India, 2009.
7. Marty Brown, Power Sources and Supplies, ELSEVIER, 2008.
8. https://ocw.mit.edu/courses/electrical-engineering.

Course Designers:

1. Dr. S. Arockia Edwin Xavier Associate Professor,EEE - saexeee@tce.edu
2. Dr. G. Sivasankar Assistant Professor,EEE - gsivasankar@tce.edu

23PQ520	TRANSMISSION AND DISTRIBUTION

Category	L	T	P	Credit	TE Type
Core	3	0	0	3	Theory

Preamble

This course introduces the determination of network parameters, modeling and performance analysis of transmission lines are included. The performance of insulators and underground cables, voltage and current calculation in distribution lines are also included.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Calculate the line parameters of overhead transmission lines.	Apply	20
CO2	Calculate the performance indices of transmission lines using nominal-T, π, rigorous methods and Power circle diagram.	Apply	20
CO3	Explain the construction and performance of various types of insulators and underground	Understand	20

	cables.		
CO4	Calculate the string efficiency of suspension insulators.	Apply	10
CO5	Calculate the voltage gradient of Underground cables.	Apply	10
CO6	Calculate the voltages and currents for the given distribution System	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	10			20
Understand	40	40			40
Apply	40	50	100	100	40
Analyse					
Evaluate					
Create					

Syllabus

Modeling of Transmission lines - AC and DC transmission systems - Inductance and Capacitance Calculations - Single phase transmission lines - two wire system and composite conductors - Three phase transmission lines with unsymmetrical spacing, transposition of conductors, double circuit line – Bundled conductors - Skin effect, Proximity effect - Effect of earth on transmission line capacitance.

Performance of transmission lines – Performance of Short, Medium and Long transmission lines with Nominal-T, π and rigorous methods - ABCD constants - Power Circle diagram, Ferranti effect, Effect of Corona, Compensators - Series and Shunt.

Insulators and Cables - Overhead line insulators -Types of Insulators – Potential distribution over insulator string – Methods of Improving String Efficiency.

Underground cables - Construction and types - Single core and multi core cables - Capacitance, Insulation resistance, Electric stresses and Dielectric loss – Grading of Cables- Capacitance Grading and Inter-sheath Grading.

Distribution systems - AC and DC Distribution Systems – Feeders, distributors and service mains- Radial and ring main systems- Calculation of voltage and current in distributors fed at both ends with concentrated and distributed loads.

Text Books

1. C.L. Wadhwa - "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& web resources

1. S.N. Singh, Electric Power Generation, Transmission and Distribution, Prentice Hall of India, ISBN – (978-81-203-36508), Second edition 2008.
2. Chetan Singh Solanki, Renewable Energy Technologies, PHI Learning Private Limited, New Delhi, 5th Printing, 2013.
3. B.R.Gupta, "Power System Analysis and Design", S.Chand& Co. pvt.ltd.,2015 Edition.
4. H. Cotton and H. Barber - Transmission and distribution of electrical energy

– BI, New Delhi -1992.
5. S.L. Uppal - Electrical power, Khanna Publishers, 1996.
6. Soni ML and Gupta PV - A Textbook on Power Systems Engineering – Dhanpath Rai 1st Edition-1998.
7. IS 12360:1988 - Voltage Bands For Electrical Installations Including Preferred Voltages And Frequency
8. T.S.M. Rao - Principles and practice of electric power transfer systems, 1994.
9. 141-1993 - IEEE Recommended Practice for Electric Power Distribution for Industrial Plants.

Course Designers:

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23PQ530	RENEWABLE ENERGY SOURCES	Category	L	T	P	Credit	TE Type
		Core	3	0	0	3	Theory

Preamble

Wind energy is the fast renewable source for the electricity generation. The course presents broad overview of wind energy technology. Due to the growing demand for renewable energy resource especially harnessing power from sun it is felt essential to offer a course on solar photovoltaic technology and systems.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	TCE Proficiency Scale	Weightage(%)
CO1	Demonstrate the power produced in wind turbine, types of wind turbine and its effect on tower height, maximum rotor efficiency.	Apply	20
CO2	Explain the different types of wind Electric generators such as Asynchronous (induction) generator and synchronous generator.	Understand	10
CO3	Derive the average power, energy produced in the wind turbine, wind farms and wind turbine economics.	Apply	20
CO4	Determinethe fill factor and efficiency of photovoltaic cell and construct the simple and accurate equivalent circuit.	Apply	20
CO5	Determine the effect of irradiation in Photovoltaic cells, module, and arrays and also study the impact of temperature and shading effect on a PV module.	Apply	20

CO6	Explain simplified grid connected PV system, Current voltage curves for loads, DC motor IV curves, Battery IV curves, maximum powerpoint trackers, hourly IV curves, and Grid connected systems.	Understand	10

Assessment Pattern: Cognitive Domain

Syllabus

Wind Power Systems

Historical Development of Wind Power, Types of wind turbines, Power in the wind, Impact of tower height, Maximum rotor efficiency.

Wind Turbine Generators

Asynchronous (Induction) generator- Squirrel cage Induction generator, Wound rotor Induction generator- Optislip Induction generator- Doubly-fed Induction generator.
Synchronous generator- Wound rotor generator- Permanent magnet generator, Indian standards.

Wind Turbine performance evaluations

Average power in a wind, Simple estimates of wind turbine energy, Wind farms, Specific wind turbine performance calculations, Wind turbine economics – Capital cost and Annual cost.

A Generic Photovoltaic Cell

Simplest equivalent circuit for a photovoltaic cell – A More equivalent circuit for a PV cell, Solar cells to modules, Solar cells to arrays, PV – IV curve under standard test conditions, Impacts of temperature and insulation on IV curves, Shading impacts on IV curves.

Performance of Solar cells

Parameters of solar cells, solar cell technologies – Factors affecting electricity

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	40	40	-	-	40
Apply	40	40	100	100	40
Analyse	-	-	-	-	-
Evaluate	-	-	-	-	-
Create	-	-	-	-	-

generated by a solar cell, Solar PV module, Standard PV module parameters, IV and PV characteristics of SPV module, Solar PV modules arrays – connection of modules in series and parallel.

Photovoltaic Systems

Introduction to Simplified grid connected PV systems, Current voltage curves for loads - DC motor IV curves - Battery IV curves – maximum powerpoint trackers – hourly IV curves, grid connected systems.

Text Books

1. Non-Conventional Energy resources – G.S Sawhney – PHI 2012.
2. Solar Photovoltaic Technology and Systems – Chetan Singh Solanki – PHI 2018.

3. Solar Photovoltaics Third edition - Chetan Singh Solanki – PHI 2017.

Reference Books

1. Renewable and Efficient electric power systems – Gilbert M Masters – John Wiley & Sons Inc. 2004.
2. Course material on 20th National Training course on wind energy technology organized by NIWE, Chennai.
3. On line courses organized by Udemy, courseera, edx, MOOC, NPTEL and SWAYAM in the area of renewable energy.
4. https://www.hindawi.com/journals/ijp/2014/763106/

Course Designers:

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23PQ550	POWER ELECTRONICS LABORATORY

Category	L	T	P	Credit	TE Type
Core	-	-	3	1.5	Lab

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

Nil

Course Outcomes

CO No.	Course outcomes	Cognitive Level	Weightage
CO1	Analyze the performance of driver circuits for SCR/MOSFET/IGBT experimentally	Analyze	15
CO2	Analyze the performance of the SCR commutation circuits designed for the given specifications experimentally	Analyze	10
CO3	Analyze the performance of the designed controlled rectifiers with 'R' and 'RL' loads experimentally	Analyze	10
CO4	Analyze the performance of the DC chopper and static circuit breakers designed for the given specifications experimentally	Analyze	10
CO5	Analyze the performance characteristics of the given DC and AC drive by conducting suitable experiments	Analyze	20
CO6	Develop a power electronic circuit for the given design specifications	Analyze	20
CO7	Analyze the performance of the given Power electronic circuit using PSIM/ MATLAB-Simulink/ PSPICE/ PLECS/ VSIM/ PSCAD simulation tool	Analyze	10
CO8	Demonstrate the working of Battery simulator, Mixed domain oscilloscope, Programmable AC /DC Power supplies and Picoscope.	Apply	5

Assessment Pattern: cognitive domain:

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	30	30
Analyze	50	50
Evaluate		
Create		-

Assessment Pattern: Psychomotor

Psychomotor Skill	Miniproject /Practical Component/Observation
Perception	
Set	
Guided Response	
Mechanism	
Complex Overt Responses	20
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

1. 'R' and RC triggering circuits for half wave controlled rectifiers (CO1)
2. UJT triggering circuit for half wave controlled rectifier (CO1)
3. Voltage, current and complementary commutation techniques(CO2)
4. Half controlled and fully controlled rectifier with 'R' and 'RL' loads(CO3)
5. Static DC and AC circuit breakers(CO4)
6. Single quadrant DC chopper(CO4)
7. Half controlled rectifier fed DC motor(CO5)
8. Voltage commutated chopper fed DC motor(CO5)
9. AC voltage controller fed single phase induction motor(CO5)
10. PLC/DSP based 3 phase induction motor drive(CO5)
11. BLDC motor drive(CO5)
12. Simulation of power electronic converter circuits using PSIM/ MATLAB-Simulink/ PSPICE/PLECS/VSIM/PSCAD (CO7)
13. Study of Battery simulator, Mixed domain oscilloscope, Programmable AC /DC Power supplies and Picoscope.(CO8)
14. Design, implementation and operation of the power electronic circuits for the given design specifications.(CO6)

Reference Books & Web Resources

1. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications - Pearson Education India Publication, New Delhi, 7th Impression, 2009.
2. M.D.Singh & K.B.Khanchandani, Power Electronics – Tata Mc Graw Hill publishing company Ltd, New Delhi, 2008.
3. Ned Mohan, Tore Undeland & William Robbins, Power Electronics : converters Applications and Design-John Willey and sons, 3rd Edition, 2003.
4. P.S. Bimbra, Power Electronics- Khanna Publishers, 3rd Edition, 2004.
5. Daniel W.Hart, Introduction to power Electronics – Prentice Hall International Inc., 1997.
6. L. Umanand, Power Electronics: Essentials and Applications- Wiley India, 2009.
7. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-334-power-electronics-spring-2007/

Course designers

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23PQ610	MICROCONTROLLERS

Category	L	T	P	Credit	TE Type
Core	3	-	-	3	Theory

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, assembly language & embedded 'C' language programming of Intel 8051 Microcontroller and interfacing various peripherals with 8051 and ATmega328 Microcontroller architecture.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Explain the evolution and architecture of microprocessors and microcontrollers.	Understand	10
CO2	Explain the architecture and the function of on-chip hardware units in 8051 Microcontroller.	Understand	10
CO3	Develop 8051 Assembly Language programs for data manipulations.	Apply	30
CO4	Explain the architecture and hardware features of ATmega328p Microcontroller	Understand	10
CO5	Explain the basics of Embedded-C programs	Understand	10
CO6	Develop 8051 based embedded C programs for interfacing LED, Matrix Keyboard, LCD, DAC, ADC, 7 segment LED Display and Stepper/DC Motors.	Apply	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	30	20			20
Understand	50	40			40

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Apply	20	40	100	100	40
Analyse					
Evaluate					
Create					

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, GPUs, and Mobile Processors – Introduction to ARM Microcontroller family, Applications of Microprocessors and Microcontrollers - Selection of Microcontroller for an application.

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 –Look up tables – subroutines

Embedded 'C' Programming: Introduction to Schematic based Simulators and IDE – Embedded C Data Types-Program structure

8051 Interfacing with Peripherals using Embedded 'C': LED - Matrix Keyboard – LCD – DAC – ADC – 7-segment LED Display – DC motor / Stepper motor.

ATmega328p Microcontroller: Architecture- I/O Ports - Watchdog timer-Fast PWM generation using Output Compare unit and Input Capture unit in 16 bit Timer1-On chip ADC.

Text Book

1. Muhammad Ali Mazidi, Janice GillispieMazidi, and Rolin D. McKinlay,The 8051 Microcontroller and Embedded Systems, (second edition), 2006 Pearson Education, Inc.
2. Thomas Grace, Programming and Interfacing ATMEL® AVR® Microcontrollers, Cengage Learning PTR, 2016.

Reference Books& web resources

1. Ajay V.Deshmukh, Microcontrollers- Theory and applications, Tata McGraw-Hill, publisher,2005.
2. N.Senthilkumar, M.Saravanan, S.Jeevanandhan, Microprocessors and Microcontrollers, Oxford university press, 2010.
3. P.S.Manoharan, P.S.Kannan, Microcontroller based system design, ScitechPublications Pvt. Ltd., Chennai, 2007.
4. Kenneth .J. Ayala, The 8051 Microcontroller, Architecture, Programming & Applications (third edition), Penram International, India (2004).
5. René Beuchat, Florian Depraz, Andrea Guerrieri, SahandKashani, Fundamentals of System-on-Chip Design on Arm® Cortex®-M Microcontrollers, Arm Education Media , 2021.
6. http://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf
7. B. Kanta Rao,Embedded Systems, PHI Learning Pvt. Ltd., Second Printing, 2013.
8. https://nptel.ac.in/courses/108105102/ (Microprocessors and Microcontrollers)
9. https://www.arm.com/resources/education/books
10. https://www.instructables.com/circuits/

Course Designer(s):

1. Dr.L.Jessi Sahaya Shanthi, Associate Professor,EEE ljseee@tce.edu
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23PQ620	POWER SYSTEM ANALYSIS

Category	L	T	P	Credit	TE Type
Core	3	1	-	4	Theory

Preamble

The objective of the course is to instil confidence and understanding of the fundamental concepts of power system analysis. This course provides an exposure of representation of power system, formulation of network matrices, methods of solving power flow equations, symmetrical fault analysis, and symmetrical component method of unsymmetrical fault analysis and stability studies.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Develop a mathematical model of a power system under steady state operating condition by single line diagram and per unit notations.	Apply	20
CO2	Apply direct inspection and singular transformation methods to determine Y-bus matrix of the given system.	Apply	20
CO3	Describe the concept of load flow problem formulation and various numerical methods of solution.	Understand	10
CO4	Calculate the fault current for various types of symmetrical faults on the given power system.	Apply	20
CO5	Calculate the fault current for various types of unsymmetrical faults on the given power system.	Apply	20
CO6	Explain the role of stability, swing equation and equal area criterion.	Understand	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	30	30			30
Apply	50	50	100	100	50
Analyse					
Evaluate					
Create					

Syllabus

An Overview and Modelling of the Power System: Introduction - Structure of Electric Power System - Modelling of Power System Components - Single line diagram - Impedance Diagram - Reactance Diagram - Per unit System - Network Modelling - 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.

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.

Reference Books & Web Resources

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.
4. Hadi Saadat., 'Power System Analysis' Tata McGraw Hill Publishing Company, New Delhi, 2002.
5. E.W.Kimbark, Power system stability, Vol I & III, John Wiley & Sons, 2006
6. Stagg*, G.W. and* El-Abiad*,* A.H., Computer Methods in Power System Analysis", McGraw-Hill Book Co. 1968
7. K.A. Gangadhar., 'Electric Power Systems (Analysis, Stability and Protection)', Khanna Publishers Second Edition, 1992.
8. J. Duncan Glover, Thomas Overbye, Mulukutla S. Sarma,'Power System Analysis and Design' Cengage learning, 5th edition, 2016.
9. www.schneider-electric.com
10. NPTEL courses web: nptel.ac.in/courses/108105067/
11. MOOCs course link:https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/

Course Designers:

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23PQ650	MICROCONTROLLERS LABORATORY

Category	L	T	P	Credit	TE Type
Core	-	-	3	1.5	Lab

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 8051 microcontroller for interfacing various peripherals and for performing them through simulation using software tools.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Analyze 8051 microcontroller-based assembly language programs to implement basic operations.	Analyze	20
CO2	Analyze 8051 embedded 'C' programs to implement basic operations by software tools.	Analyze	15
CO3	Analyze 8051 ALP/embedded 'C' programs for accessing on-chip hardware units such as timer/counter, interrupts and serial communication.	Analyze	15
CO4	Analyze 8051 ALP/embedded 'C' programs for Keyboard and display interface.	Analyze	10
CO5	Analyze 8051 based ALP/embedded 'C' programs for ADC and DAC interfacing and Motor control,	Analyze	20
CO6	Analyze 8051 microcontroller based embedded 'C' programs to implement the given application through simulation by software tools.	Analyze	20

*** Weightage depends on Bloom's Level, number of contact hours,

Assessment Pattern: Cognitive Domain

Cognitive Levels	Model Examination	Terminal Examination
Remember		
Understand		
Apply	45	45
Analyse	30	30
Evaluate		
Create		

Assessment Pattern: Psychomotor

Psychomotor Skill	~~Miniproject~~/Practical Component/~~Observation~~
Perception	
Set	
Guided Response	
Mechanism	25
Complex Overt Responses	
Adaptation	
Origination	

List of Experiments/Activities with CO Mapping

List of Experiments:

Module – 1 (CO1)

- Use of ALP
- Evaluation of arithmetic expressions

Module -2 (CO2)

- Use of software simulation tools
- Evaluation of embedded-c programs

Module -3 (CO3 & CO4)

- Timer/Counter applications with and without interrupts: (i) square wave generation (ii) Frequency measurement
- Serial communication (I^2C, UART) and Parallel communication.

Module - 4 (CO5 &CO6)

- Control of illumination of LED string / Traffic light
- Keyboard and Seven segment LED interfacing
- ADC and DAC interfacing
- Speed control of DC motor / Stepper motor

Reference Books & Web Resources

1. Ajay V.Deshmukh, "Microcontrollers- Theory and applications", Tata McGraw-Hill, publisher,2005.
2. The 8051 Microcontroller and Embedded Systems, (second edition). By Muhammad Ali Mazidi, Janice GillispieMazidi, and Rolin D. McKinlay © 2005 Pearson Education, Inc
3. N.Senthilkumar, M.Saravanan, S.Jeevanandhan, "Microprocessors and Microcontrollers", Oxford university press, 2010.
4. P.S.Manoharan, P.S.Kannan, "Microcontroller based system design", ScitechPublicationsPvt. Ltd., Chennai, 2007.
5. https://nptel.ac.in/courses/108105102/ (Microprocessors and Microcontrollers)
6. UNIVERSAL EMBEDDED TRAINER (VUET-REV0) – Manual

Course Designers:

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23PQ710	ELECTRIC DRIVES

Category	L	T	P	Credit	TE Type
PCC	3	1	-	4	Theory

Preamble

Electric Drives are designed to control the motion of electrical machines. It is considered an important component of various industrial processes equipment as it helps in easy optimization of motion controlling. Electric Drives, both ac and dc types, come in many shapes and sizes. Some drives 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 the rating. 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

Nil

Course Outcomes

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

CO No.	COURSE OUTCOMES	Cognitive Level	Weightage(%)
CO1	Make a drive for particular applications	Apply	10
CO2	Design controlled rectifier based dc drive	Apply	20

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CO3	Design various dc to dc converter topology based dc drive	Apply	20
CO4	Explain speed control of inverter fed induction motor and synchronous motor drives	Understand	20
CO5	Explain speed control of traction drives, solar and battery powered drives	Understand	15
CO6	Analyze different electric drives using MATLAB/Simulink, PLECS and PSIM	Analyze	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			30
Apply	40	40	100		50
Analyse				100	
Evaluate					
Create					

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

Synchronous Motor Drives - Speed control - Inverter fed synchronous motors – Vector control of Synchronous motor

Traction and Solar powered Drives - Speed control of Traction drives - Solar and battery powered drives

Simulation of Electrical Drive Systems: DC motor drives- Induction motor drives.

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. Muhammad H.Rashid, Power Electronics Circuits, Devices & Applications - Pearson Education India Publication, New Delhi, 11th Edition, 2007.
3. Ned Mohan, Tore Undeland & William Robbins, Power Electronics: converters Applications and Design-John Willey and sons 2003.
4. R.Krishnan - Electric motor drives – Modeling, analysis and control, Pearson Education, New Delhi, 2003.

5. Peter Vas - Sensorless, Vector and Direct Torque Control, Oxford University Press, 1998.

Course designers

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23PQ720	SWITCHGEAR AND PROTECTION

Category	L	T	P	C	Terminal Exam Type
PC	3	1	-	4	Theory

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

- Nil

Course Outcomes

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

CO#	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Explain the layout of a typical substation and discuss its components	Understand	10
CO2	Select Circuit breakers and Fuses for a given requirement	Apply	20
CO3	Explain the principles of different types of protective relays	Understand	20
CO4	Select a suitable protective scheme for specific faults in generator and transformers	Apply	15
CO5	Explain the principles of various protective schemes of bus bars and feeders.	Understand	15
CO6	Select a suitable protection method for lines and apparatus against over voltages in Power Systems	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50	50	50	50
Apply	30	30	50	50	30

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Analyse					
Evaluate					
Create					

Syllabus

Introduction

Switchgear - essential features - Substations — Types — Equipment - Layout of a typical substation- Current and voltage transformers for protection.

Circuit Breakers and Fuses

Circuit Breakers **-** Arc phenomenon - Restriking and Recovery voltage – resistance switching- auto re-closure. Types — air, oil, SF6 and vacuum circuit breakers — ELCB - Selection of circuit breakers for a specific requirement-Testing of circuit breakers according to IS/IEC codes. Fuses - Types - HRC Fuses – Characteristics and applications.

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. Selection of protective devices for a specific requirement.

Protection against over-voltages

Causes of over voltages — Protection of Transmission lines, Stations and Sub-Stations against direct lightning stroke - Protection against travelling waves - -Surge Protective Devices (MOV, Thyrite Arrester, MCB type surge protector)-Peterson coil - Insulation coordination.

Textbook (s)

1. Badri Ram and D.N. Vishwakarma, “Power System Protection and Switch Gear”, Tata McGraw Hill 2nd edition — 2011
2. Oza, Nair, Mehta and Makwana, — “Power System Protection and Switchgear”, Tata McGraw- Hill. Revised edition,2010.

B. Ravindranath and N.Chander, “Power System Protection and Switch Gear”, New Age International Ltd., New Delhi, Reprint 2005**.**

Reference Books & Web Resources

1. Lewis Blackburn, J., Thomas J. Domin, Protective Relaying — Principles and Applications", 3rd edition, CRC Press, , New York, 2006.
2. Y.G Paithankar and S.R Bhide, “Fundamentals of power system protection”, Prentice-Hall of india, 2003.
3. ABB Electrical installation handbook volume 2 — Electrical devices 3rd edition, June 2005 published by ABB SACE via Baioni, 35-24123, Bergamo (Italy).
4. .Sunil S. Rao, “Protection and Switch Gear”, Khanna Publishers- Revised edition, New Delhi, 2011.

Course Designers

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Passed in Board of Studies Meeting on 13.07.2023 Approved in 66th Academic Council meeting 16.12.2023

ELECTIVES

23PQPA0	POWER SYSTEM OPERATION AND CONTROL	Category	L	T	P	Credit	TE Type
		Elective	3	-	-	3	Theory

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

Nil

Course Outcomes

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

CO	Course outcomes	Cognitive Level	Weightage(%)
CO1	Find the load factor and diversity factor for the consumer load.	Apply	20
CO2	Find the change in real power and frequency for the variation in load.	Apply	15
CO3	Find the change in reactive power for the variation in load.	Apply	20
CO4	Describe the various voltage control methods.	Understand	10
CO5	Find the optimum unit commitment for a power system.	Apply	15
CO6	Estimate the economic load dispatch for a system comprising of ‘n’ thermal plants	Apply	15
CO7	Explain the various operating states of a power system and control actions required to obtain secured operation	Understand	5

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

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.

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).

Energy Management System: 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. 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.
4. Haadi Sadat, "Power System Analysis", TATA McGraw hill, 2002 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 Designers:

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23PQPC0	OPERATION AND MAINTENANCE OF ELECTRICAL EQUIPMENT

Category	L	T	P	Credit	TE Type
Elective	3	-	-	3	Theory

Preamble

This course will provide the technical and practical information required for ensuring correct operation, maintenance and troubleshooting of electrical equipment and systems such as transformer, motor, generator, substation, switchgear and transmission and distribution system.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcome	Cognitive Level	Weightage(%)
CO1	Explain the types, procedures and records of maintenance.	Understand	10
CO2	Explain the causes of electrical accidents, safety measures, regulations and annual inspection methods of electrical installation.	Understand	20
CO3	Calculate the earth resistance for a given electric system with suitable method of earthling.	Apply	20
CO4	Explain the general procedure to maintain electrical equipment's in any point.	Understand	10
CO5	Identify the possible cause for the faulty behavior of the given Electrical equipment.	Apply	20
CO6	Explain the method of rectification of fault in the given Electrical equipment.	Understand	20

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Maintenance: Importance of Plant maintenance, Types of maintenance - Preventive, Breakdown and Production maintenance, Need, classification, advantages, activities and frequency of maintenance, Maintenance Records, Role of Maintenance Engineer.

Electrical Accidents and Safety: Causes of electrical accidents, Electrical shock - Factors of severity, Actions to be taken, Safety regulations and safety measures, Indian electricity supply act 1948-1956, Factory Act -1948, Safe working of Electrical Equipments, Electrical inspectorate's rules for operation and maintenance, Annual Inspection, Internal Electrical Installation in Buildings, Fire extinguishers.

Earthing: Necessity, Types and Methods of earthing, Earth electrodes, plate, pipe and coil earthing, Earth resistance - factors affecting, Maximum permissible resistance of earthing system, Equipment earthing and system grounding.

Generator, Substation and Switchgears: Operation procedure, Routine and breakdown Maintenance, Causes of Failure and Precautions measure of Generator. Sub-station shut down procedure - certificate of requisition for shut down; certificate of Permit to work and certificate of Line clear, Maintenance of Lightning Arrestor and circuit breakers.

Transformer, Motors and Starters:, On-load tap changer, Dissolved gas analysis, Overhauling and Drying out of transformer, Oil Purification and Impulse voltage testing on transformer. Maintenance schedule, Routine and Breakdown Maintenance, Causes of failure, Precautions and Trouble-shooting methods of transformer, Motors and starters.

Transmission and Distribution system: Rules for Low, Medium and High voltages, Factor of safety, Special precautions, Minimum Clearance of Conductors, Laying of underground cable and Fault location.

Text Book

1. B.V.S.Rao, "Operation and Maintenance of Electrical Equipment", Volume I & II, 2008 Edition, Media Promoters & Publishers Pvt. Ltd., Mumbai.
2. S. Rao, "Testing Commissioning Operation and Maintenance of Electrical Equipments", Sixth Edition, Khanna Publishers, New Delhi, 2010.

Reference Books& web resources

1. Tarlok Singh, "Installation Commissioning and Maintenance of Electrical Equipments", First Edition, S. K. Kataria & Sons, 2013.
2. Paul Gill, "Electrical Power Equipment Maintenance and Testing", Second Edition, CRC Press, 2013.
3. https://www.weschler.com/wp-content/uploads/2020/01/gettingdown toearth.pdf

Course Designer:

1. Dr. N. Shanmuga Vadivoo, Professor, EEE – nsveee@tce.edu

23PQPD0	ENERGY AUDIT AND MANAGEMENT IN ELECTRIC UTILITIES

Category	L	T	P	C	Terminal Exam Type
PC	3	1	-	4	Theory

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. The objective of the course is to provide an introduction to principles of Energy Conservation in Electrical System. 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

- Nil

Course Outcomes

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

CO	Course Outcome	Cognitive Level	Weightage(%)
CO1	Describe the principles of Energy Audit, Management and Conservation	Understand	20

CO2	Estimate the energy performance of Electrical System	Apply	20
CO3	Estimate the energy performance of Electrical Motors	Apply	20
CO4	Estimate the energy performance of Lighting System	Apply	20
CO5	Selection and Operation aspects of DG Set for Energy Efficiency	Understand	10
CO6	Identify the Energy Efficient gadgets for domestic, commercial and industrial applications	Apply	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

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.

Textbook (s)

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 Designers

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23PQPF0	POWER SYSTEM STABILITY	Category	L	T	P	Credit	TE Type
		Elective	3	-	-	3	Theory

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 at understanding the basic modelling requirement of various power system components and operations, different types of stability problems and analytical methods for assessment.

Prerequisite

Nil

Course Outcomes

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

Course Outcome No.	Course Outcomes	Cognitive Level	Weightage(%)
CO1	Explain the modelling of power system components in stability studies	Understand	10
CO2	Assess the stability of the power system using Point by point, Modified Euler's and Runke-Kutta methods	Apply	30
CO3	Find the critical clearing angle and time from equal area criterion	Apply	30
CO4	Explain the modelling of the excitation system	Understand	10
CO5	Describe the small signal stability of SMIB and multi-machine systems.	Understand	10
CO6	Explain voltage collapse and voltage stability assessment methods	Understand	10

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Introduction to Power system Stability

Modelling of power system components in stability studies (Synchronous machine, Inductionmachine, Transformer and Load) – definition and illustrations of various terms

in power system stability – bad effects of instability – the 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 ofmulti machine system.

Voltage Stability

Introduction – comparison of angle and voltage stability – reactive power flow and voltagecollapse – voltage stability analysis – prevention of voltage collapse

Text Books

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, TataMcGraw Hill, 2011.

Reference Books

1. P.M.Anderson and A.A.Fouad, Power System Control and Stability, 2nd Edition, WileyIndia Pvt.Ltd., 2008.
2. P.W.Sauer and M.A.Pai, Power System Dynamics and Stability, Pearson Education,2007.

Course Designers:

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23PQPG0	**COMPUTER ORGANIZATION**

Category	L	T	P	Credit	TE Type
Elective	3	-	-	3	Theory

Preamble

Computers find lot of applications in most of the fields in the present day world. Due to the continuous technological developments taking place in the field of semiconductor, the modern day computers are equipped with high performance processors (CPUs) which have multi cores, on-chip cache memories, on-chip floating point units and can perform superscalar pipeline execution of instructions. Developments in the field of semiconductor memory technology lead to availability of high speed and high density memories with lower cost nowadays which are used in present day computers.

Prerequisite

Nil

Course Outcomes

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

CO No.	COURSE OUTCOMES	Cognitive Level	Weightage(%)
CO1	Explain the basic structure of computers	Understand	10
CO2	Develop assembly language programs for solving the given problems in computers	Apply	20
CO3	Explain the Input/Output organization in computers	Understand	20
CO4	Determine the performance parameters of different memories used in computers	Apply	10
CO5	Explain the operation of basic processing unit (CPU) in computers	Understand	20
CO6	Determine the performance parameters of the processor due to the pipeline execution of instructions	Apply	20

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Basic Structure of Computers: Computer types-Functional units-Basic operational concepts- Bus structures- Software-Performance- Multiprocessors and Multicomputers.

Machine Instructions and Programs: Numbers, arithmetic operations and characters-Memory locations and addresses-Memory operations-Instructions and instruction sequencing-Addressing modes- Assembly language- Basic input/output operations- Stacks and Queues- Subroutines- Encoding of machine instructions- Assembly language Programs.

Input/Output Organization: Accessing I/O devices-Interrupts- Direct memory access (DMA)- Buses- Interface circuits – Standard I/O interfaces: PCI bus, USB.

The Memory System: Semiconductor RAM memories- Read only memories- Speed, size and cost -Cache memories- Performance considerations- Virtual memories- Memory management requirements- Secondary storage: Solid State Drive (SSD).

Basic Processing Unit (CPU): Fundamental concepts- Execution of a complete instruction-Multiple bus organization- Hardwired control- Introduction to Microprogrammed control.

Pipelining: Basic concepts- Pipeline organization- Pipelining issues-Data dependencies-Memory delays-Branch delays- Resource limitations- Performance evaluation.

Text Book

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization and Embedded systems, 6th Edition, McGraw Hill, 2012.

Reference Books & web resources

1. Shuangbao Paul Wang, Computer Architecture and Organization, Springer publishing, 2021.
2. Jim Ledin, Modern Computer architecture and Organization, Packt Publishing, 2022.
3. David A. Patterson and John L.Hennessy, Computer organization and design-Elsevier Publishing,5th edition,2016.

Course Designer

1. Prof. M.Saravanan, Professor, EEE, mseee@tce.edu

23PQPH0	**INTERNET OF THINGS**

Category	L	T	P	Credit
PC	3	-	-	3

Preamble

Internet of Things (IoT) refers to things that can be connected to internet and can send or receive data through internet for sensing/monitoring and/or control purposes. IoT consists of combination of Hardware and Software. IoT systems are used in realization of smart appliances, smart home, smart city, smart grid, smart irrigation and smart transportation etc. Microcontrollers, sensors and/or actuators and communication modules are the major components of IoT system. In this course, Python programming is introduced and building IoT applications using Arduino and Raspberry Pi is covered.

Prerequisite

- 22PQ520 – Microcontrollers

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Weightage %
CO1	Explain the basics of IoT and the major components of IoT System	Understand	10
CO2	Explain the working principle of various sensors, Communication modules and communication technologies used in IoT System	Understand	30
CO3	Develop the logical design of IoT using Python Programming	Apply	20
CO4	Develop Arduino and Raspberry Pi based IoT Applications	Apply	20
CO5	Explain the Cloud computing and Cloud Computing Services	Understand	20

Assessment P Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignment		Terminal Examination
	1	2	1	2	
Remember	20	20	-	-	20
Understand	50	30	-	-	30
Apply	30	50	100	100	50
Analyse					
Evaluate					

Passed in Board of Studies Meeting on 13.07.2023 Approved in 66th Academic Council meeting 16.12.2023

Create					

Syllabus

Introduction: Definition and Characteristics of Internet of Things- Physical design of IoT: Things in IoT- IoT Protocols used in link layer, network layer, transport layer and application layer.

Major Components of IoT System: Hardware: Microcontrollers – The Basics of Arduino and Raspberry pi - Sensors and Actuators - Examples with their working principles - Communication Technologies-RFID-Bluetooth – Zigbee - Wi-Fi - RF Links-Cellular Networks-Wired communication

Logical Design of IoT- IoT functional blocks- IoT Communication models - IoT Communication APIs - Python Programming: Data Types & Data Structures, Control Flow, Functions, Modules, Packages, File Handling - Building IoT applications using Arduino and Raspberry pi.

Introduction to Cloud computing and Cloud Services: Basic services and Architectures: Cloud computing Components, Models and Architectures, Benefits of Cloud computing – Cloud computing and IoT- Introduction to open cloud computing services for sensor management- Thingspeak.

Text Book

1.ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015.

2.Charalampos Doukas, “Building Internet of Things with the Arduino”,Barcode Books International,2012.

Reference Books& web resources

1.Raj Kamal, “Internet of Things-Architecture and Design Principles”, MC Graw Hill Education,2017.

2. Donald Norris, “The Internet of Things-Do -It-Yourself at Home Projects for Arduino, Raspberry Pi, and BeagleBone Black”, MC Graw Hill Education,2015.

3. . Dragan Ibrahim, The complete ESP32 Projects Guide, Elektor Publishers, 2019.

4. Peter Waher “Learning Internet of Things”, PacktPublishing,UK, 2015.

5. Miguel de Sousa”,Internet of Things with Intel Galileo” ”, PacktPublishing,UK, 2015

6. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014

7. Adrian McEwen, Hakim Cassimally “Designing the Internet of Things”,WileyPublishing, 2015

8. https://nptel.ac.in/courses/106105166- Introduction to Internet of Things

9.https://www.coursera.org/specializations/iot

Course Designer(s):

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23PQPJ0	INDUSTRIAL INSTRUMENTATION

Category	L	T	P	Credit	TE Type
Elective	3	-	-	3	Theory

Preamble

Instrumentation is the science of automated measurement and control. The process of measuring and controlling various quantities in industries by utilizing various industrial instruments is called as industrial instrumentation. It is a collective term for measuring instruments used for indicating, measuring and recording physical quantities. For controlling any quantity, primarily that particular quantity has to be measured 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

Nil

Course Outcomes

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

CO No	Course Outcome	Cognitive Level	Weightage(%)
CO1	Explain the principle and operating characteristics of Force and torque measuring techniques	Understand	10
CO2	Apply suitable technique for measurement Acceleration and Vibration for a given application	Apply	20
CO3	Apply suitable technique for measurement of Flow and Level for a given application	Apply	20
CO4	Explain the principle and operating characteristics of Viscosity measuring techniques	Understand	10
CO5	Apply suitable technique for measurement of high temperature for a given application	Apply	20
CO6	Apply suitable technique for measurement of Pressure for a given application	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

MEASUREMENT OF FORCE, TORQUE

Different types of load cells - Hydraulic, Pneumatic, strain gauge-Magnetoelastic 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 -Electromagnetic flow meter — Ultrasonic flow meters

LEVEL MEASUREMENT

Float gauges - Electrical types: Conductivity sensors, Differential pressure level measurement

MEASUREMENT OF VISCOSITY

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

Text Book

1. Patranabis, D. Principles of Industrial Instrumentation, 3rd Edition, Tata McGraw Hill, New Delhi, 2017.
2. Doebelin, E.O.and Manik,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, 2013.
2. Singh,S.K., Industrial Instrumentation and Control, Tata McGrawHill Education Pvt. Ltd., New Delhi, 2009.
3. Jain, R.K., Mechanical and Industrial Measurements, Khanna Publishers, Delhi, 2017

Course Designers:

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23PQPK0	FLEXIBLE AC TRANSMISSION SYSTEMS

Category	L	T	P	Credit	TE Type
Elective	3	-	-	3	Theory

Preamble

FACTS devices 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.

Prerequisite

Nil

Course Outcomes

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

CO	Course Outcomes	Cognitive Level	Weightage(%)
CO1	Explain the need for reactive power control, types of reactive power compensations and need for FACTS controllers.	Understand	10
CO2	Analyse the performance of various shunt type FACTS controllers	Apply	20
CO3	Analyse the performance of various series type FACTS controllers	Apply	20
CO4	Describe the performance and applications of UPFC.	Understand	10
CO5	Model a FACTS controller for the given network configuration with respect stability.	Apply	20

CO6	Model a FACTS controller for the given network configuration based on load flows.	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Introduction

Reactive power control in electrical power transmission lines -Uncompensated transmission line – Fixed series and shunt compensation – Basic types of FACTS controllers – Brief description and definitions 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

Unified Power Flow Control

Introduction, Implementation of power flow control using conventional thyristors, Unified power flow concept, Implementation of unified power flow controller.

Modelling of FACTS Controllers

Modelling of Shunt and Series Controllers for Power Flow and Transient stability, Modelling of UPFC.

Text Book

1. N.G. Hingorani & L. Gyugyi, Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems, Wiley; IEEE Press, 2000.
2. R. Mohan Mathur, Rajiv K. Varma. Thyristor-Based FACTS Controllers for Electrical Transmission Systems, Wiley & IEEE Press, 2002.

Reference Books

1. T.J.E Miller, Reactive Power Control in Electric Systems, New Age International, New Delhi, 1994.
2. K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution, New Age International Publishers, 2nd Edition, 2016.

Course Designer(s):

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3. Mr. C. Balasundar Assistant Professor, EEE cbreee@tce.edu

23EEPL0	POWER QUALITY	Category	L	T	P	Credit	TE Type
		Elective	3	-	-	3	Theory

Preamble

This course imparts knowledge about various electrical power quality issues and their origin and addresses 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

Nil

Course Outcomes

Course Outcome No.	Course Outcomes	Cognitive Level	Weightage(%)
CO1	Explain various power quality problems	Understand	10
CO2	Discuss the root cause of power quality problems	Understand	20
CO3	Determine the PQ indices in the given electrical system	Apply	20
CO4	Assess the severity of PQ problems in distribution system	Apply	20
CO5	Analyze various power quality issues and their solutions in residential / commercial / industrial facilities	Analyze	20
CO6	Develop an ability to analyse the measured data	Apply	10

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			30
Apply	40	40	100	100	50
Analyse					
Evaluate					
Create					

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

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)

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

Effect of Grounding
Shock and fire hazards, essential of a grounded system, earth resistance tests, methods of grounding, effect of poor grounding on power quality.

Solving PQ problems using CPD and PQ Measurement
Introduction to custom power devices (CPD) – STATCOM, DVR, UPQC - Power quality measuring equipment-Smart power quality analysers.

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.

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23EEPM0	POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

Category	L	T	P	Credit	TE Type
Elective	3	-	-	3	Theory

Preamble
This course will cover the applications of power electronics for the control and conversion of electrical power with emphasis on renewable energy systems.

Passed in Board of Studies Meeting on 13.07.2023 Approved in 66th Academic Council meeting 16.12.2023

Prerequisite

Nil

Course Outcomes

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

Course Outcome NO.	Course Outcomes	Cognitive Level	Weightage(%)
CO1	Explain contribution and impact of renewable energy sources	Understand	10
CO2	Describe the features of power electronics and their role in renewable energy system	Understand	20
CO3	Design appropriate converter for renewable energy systems	Apply	20
CO4	Categorize various issues experienced during grid connection of wind generators	Apply	15
CO5	Categorize various issues experienced during grid connection of PV systems	Apply	15
CO6	Demonstrate the control aspects of converters used in wind generators and PV systems	Apply	20

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			30
Apply	40	40	100	100	50
Analyse					
Evaluate					
Create					

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

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

3. 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.

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23EEPN0	ELECTRIC VEHICLES	Category	L	T	P	Credit	TE Type
		Elective	3	-	-	3	Theory

Preamble

In the future transportation sector, electric vehicles (EV) and hybrid electric vehicles (HEV) will play a significant role. Because it has more advantages than internal combustion engine (ICE) based vehicles. This course introduces the fundamental concepts, analysis and design of hybrid electric and electric vehicles. The students learn about the various aspects of hybrid and electric vehicles such as their configuration, powertrain sizing, types of electric machines and their control, and energy storage devices, etc.

Prerequisite

Nil

Course outcomes

COs	Course outcomes	Cognitive Level	Weightage(%)
CO1	Explain the basic concepts of Electric vehicle (EV) and hybrid electric vehicles(HEV)	Understand	10
CO2	Calculate the tractive force, tractive power and energy required for the given road, acceleration and velocity profile condition in a vehicle	Apply	20
CO3	Calculate the power rating of motor, ICE and battery energy requirements for the given EV and HEV specifications	Apply	20
CO4	Discuss the G2V and V2G operations of the EV	Understand	15
CO5	Explain the different energy storage systems, their characteristics and charging methods	Understand	15
CO6	Calculate the different parameters in the DC drives and AC drives used for motor control in EV and HEV	Apply	20

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		**Terminal Examination**
	1	2	1	2	
Remember	20	20			20
Understand	40	40	50	50	40
Apply	40	40	50	50	40
Analyse					
Evaluate					
Create					

Syllabus

Introduction History of Electric vehicles (EV) and Hybrid electric vehicles (HEV)-EV and HEV components-Vehicle mass and performance-Electric motor and engine ratings- Well to wheel analysis- EV and Conventional Vehicle comparison

Vehicle Mechanics

Roadway fundamentals-Laws of motion-Vehicle kinetics-Dynamics of vehicle motion-Propulsion power-Velocity and acceleration

EV and HEV architectures and power train component sizing

Architecture of EV, HEV and PHEV- Powertrain component sizing for EV, HEV- Mass analysis - V2G and G2V operations– Fuel cell vehicles.

Energy storage systems

Battery energy storage- Batteries in EV and HEV-Battery basics-Battery parameters-Battery modeling- Traction batteries-Battery pack management-SOC and Fast Charging-Ultra capacitors

Electric motor drives

Electric drive components- DC drives- AC drives-Control of AC machines-Induction machine vector control- PM machine vector control – SRM drives

References Books:

1. Iqbal Husain, Electric and hybrid vehicles-Design fundamentals, Second edition, CRC Press,2011
2. Chris Mi, M. Abul Masrur, David Wenzhong Gao, 'Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives', Wiley, 2011.
3. Mehr Ehsani, Yimin Gao, Sebestien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
5 T. Denton, "Electric and Hybrid Vehicles", Routledge Pub., 2016.
6. Ion Boldea and S.A Nasar, 'Electric drives', CRC Press, 2005.
7. James Larminie & amp; John Lowry "Electric Vehicle Technology Explained ", John Wiley & sons, 2012

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23PQPP0	**SMART GRID**

Category	L	T	P	Credit	TE Type
Elective	3	1	-	4	Theory

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

Nil

Course Outcomes

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

CO	Course Outcome	Cognitive level	Weightage %
CO1	Explain the fundamentals of smart power grids and its international & Indian scenarios.	Understand	10
CO2	Calculate voltage and power loss for the given distribution system.	Apply	20
CO3	Apply demand side management concept in advanced metering infrastructure system.	Apply	20
CO4	Apply synchrophasor measurement technology in the operation of transmission system.	Apply	20
CO5	Explain the data communication and technology used in smart grid.	Understand	15
CO6	Explain the communication standard protocols used in smart grid.	Understand	15

Assessment Pattern

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	40	40			40
Apply	40	40	100	100	40
Analyse					
Evaluate					
Create					

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& web resources

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

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23EEPQ0	THERMAL POWER PLANT INSTRUMENTATION AND CONTROL	Category	L	T	P	Credit	TE Type
		Elective	3	-	-	3	Theory

Preamble

This course aims to give the fundamental concepts and practical aspects of thermal power plant instrumentation and control. A power station is a complex entity. It involves a wide range of engineering disciplines. The basic principles of steam and water cycles, fuel, air and flue gas circuits are discussed. Also the steam generator, boiler drum and circulation, water treatment and various types of controls in a steam power plant has been discussed. It includes the compression and draught control, feed water control, steam temperature control and control equipment have been discussed. The updated information on combined cycle generation is also provided.

Prerequisite

Nil

Course Outcomes

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

CO Number	Course Outcome Statement	Cognitive Level	Weightage(%)
CO1	Explain the basic principles of power system instrumentation and control.	Understand	10
CO2	Describe the operation of water circuit and its control in a thermal power plant.	Understand	10
CO3	Determine the performance of power plant instrumentation and control systems.	Apply	20
CO4	Describe the control equipment Practices in boiler and turbine power plant.	Apply	20
CO5	Selection of demand for the steam Generator.	Understand	20
CO6	Suggest suitable instrumentation system for power plant management.	Apply	20

Assessment Pattern: Cognitive Domain

Cognitive Levels	Continuous Assessment Tests		Assignments		Terminal Examination
	1	2	1	2	
Remember	20	20			20
Understand	50	50			50
Apply	30	30	100	100	30
Analyse					
Evaluate					
Create					

Syllabus

Introduction: Importance of instrumentation and control in Power plants-Piping and Instrumentation Diagram (P and I diagram).Process of power generation in coal-fired and oil fired in thermal power plants-Nature of steam-Thermal efficiency-Gas turbine and combined cycle plants.

Instrumentation and Control schemes in Water Circuit: Water circuit-Measurements in water circuits-controls in water circuits-impurities in water and steam.

Instrumentation and Control schemes in Air- Fuel Circuit: Air-Fuel Circuit-measurements in Air-Fuel circuit – Controls in Air- Fuel Circuit-Analytical Measurements-Oxygen measurement in flue gas- Carbon-di-oxide measurement in flue gas-Infra red flue gas analysis-Smoke detector-dust monitor-chromatography-pollution monitoring instruments

Control aspects in Boiler and Turbine: The principles of compression control-Draught control-The principles of feed water control-One, two and three elements feed water control. Turbine steam Inlet System- Turbine Measurements-Turbine Control system- Turbo-alternator Cooling system.

Control aspects in setting the demand for the steam generator: Nature of the demand-Setting the demand in power stations applications-Master demand in power station applications-Load demand in combined heat and power plants-Waste to energy plants

Power Plant Management: Introduction-Master control-combustion process-boiler efficiency-maintenance of measuring instruments-intrinsic and electrical safety-interlocks for boiler operation.

Text Books

4. David Lindsley, “Thermal Power Plant Control & Instrumentation” second edition, IET Publications, London, UK (2018).
5. P.K.Nag, ”Power Plant Engineering” Tata McGraw-Hill, New Delhi, 2005
6. Sam G.Dukelow, “The control of Boilers”, Instrument Society of America, 1991.

Reference Books

1. Elonka, S.M. and Kohal A.L, “Standard Boiler Operations”, McGraw Hill, New Delhi, 1994.
2. R.K.Jain, “Mechanical and Industrial Measurements”, Khanna Publishers, New Delhi, 1995.
3. A.K.Mahalanbias-“Power System Instrumentation”-Tata McGraw Hill.
4. K.KrishnaswamyansM.PonniBala-“Power Plant Instrumentation-” – PHI Learning Pvt. Ltd., New delhi, 2015.

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