Curriculum and Detailed Syllabi

For

B.E. Mechatronics
2022 Regulations

Thiagarajar College of Engineering

(A Govt. Aided, Autonomous Institution, Affiliated to Anna University)

Madurai – 625 015, Tamil Nadu

CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

First Semester

For the students admitted from the
academic year 2022 - 2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF MECHATRONICS ENGINEERING

Vision:

"Be a globally renowned school of engineering in Mechatronics"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfil the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of B.E.

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze Complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Specific Outcomes (PSO) of B.E. Mechatronics Engineering

After the successful completion of the B.E. Mechatronics Engineering degree programme, the students will be able to:

PSO1: Design, develop and retrofit conventional mechanical system into low-cost automated system using sensors and controllers

PSO2: Design, develop and analyse mechatronics system using hardware and software tools.

SCHEDULING OF COURSES

Sem	Theory / Theory cum Practical / Laboratory Courses								CDIO / Audit Courses	Total Credits
I	22MA110 Calculus for Engineers BSC 4	22PH120 Physics BSC 3	22CH130 Chemistry BSC 3	22EG140 Technical English HSMC 2	22ME160 Engineering Graphics ESC 4	22EG170 English Laboratory HSMC 1	22PH180 Physics Laboratory BSC 1	22CH190 Chemistry Laboratory BSC 1	22ES150 Engineering Exploration ESC 2	21
II	22MT210 Matrices and Ordinary Differential Equations BSC 4	22MT220 Analog Electronics PCC 3	22MT230 Free Body Mechanics PCC 3	22MT240 Problem Solving using C ESC 3	22MT250 Manufacturing Process PCC 3	22MT260 Mechatronic Workshop ESC 1	22MT270 Manufacturing Laboratory PCC 1	22MT280 Introduction to Mechatronic Systems ESC 1	Audit Course 1	19
III	22MT310 Partial Differential Equations BSC 4	22MT320 Digital Electronics PCC 3	22MT330 Kinematics and Dynamics of Machinery ESC 3	22MT340 Thermal Fluid Systems PCC 3	22MT350 Electrical Machines ESC 3	22MT360 Thermal Engineering Laboratory PCC 1	22MT370 Electrical Machines Laboratory ESC 1	22MT380 Electronic Circuits and Digital Laboratory PCC 1	22ES390 Design Thinking ESC 3	22
IV	22MT410 Probability and Statistics BSC 4	22MT420 Microcontroller based system design PCC 3	22MT430 Power Electronics and Drives ESC 3	22MT440 Sensors and Measurements PCC 3	22MT450 Digital Signal Processing PCC 3	22MT460 Project Management HSMC 3	22MT470 Microcontroller Laboratory PCC 1	22MT480 Sensors and Measurements Laboratory PCC 1	Audit Course 2	21
V	22MT510 Control Systems PCC 4	22MT520 Design of Machine Elements PCC 3	22MT530 Industrial Automation PCC 3	22MT540 CNC Technology PCC 3	22MTPx0 Program Elective I PEC 3	22yyGx0 Inter disciplinary Elective IE 3	22MT5500 CAD / CAM Laboratory PCC 1	22MT560 Industrial Automation Laboratory PCC 1	22MT570 Sensors and Instrumentation Project PW 3	24
VI	22MT610 Accounting and Finance HSMC 4	22MT620 Industrial Robotics PCC 3	22MTPx0 Program Elective II PEC 3	22MTPx0 Program Elective III PEC 3	22MT630 Professional Communication HSMC 2	22yyFx0 Basic Science Elective BSE 3	22MT640 Control and Dynamics Laboratory PCC 1	22MT650 Robotics Laboratory PCC 1	22MT660 Mechanical Systems Project PW 3	23
VII	22MT710 Mechatronics System Design PCC 3	22MTPx0 Program Elective IV PEC 3	22MTPx0 Program Elective V PEC 3	22MTPx0 Program Elective VI PEC 3	22MTPx0 Program Elective VII PEC 3	22MT720 System Integration Laboratory PCC 3	---	---	22MT730 Robotics and Automation Project PW 3	21
VIII	22MTPx0 Program Elective VIII PEC 3	22MTPx0 Program Elective IX PEC 3	---	---	---	---	---	---	22MT810 System Integration Project PW 3	9
									Total Credits	**160**

CREDIT DISTRIBUTION

Degree: B.E. **Program: Mechatronics**

Sl. No.	Category		Credits	
			Regular Admission	Lateral Entry Admission
A.	**Foundation Courses (FC)**		**54 - 66**	**24 - 36**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	09 - 12
	b.	Basic Science Courses (BSC)	24 - 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 - 27	12 - 15
B.	**Professional Core Courses (PCC)**		**55**	**45**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 - 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 - 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 - 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 - 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 - 06
	b.	Basic Science Elective (BSE)	03 - 06	03 - 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

I SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits
			L	T	P	
THEORY						
22MA110	Calculus for Engineers	BSC	3	1	0	4
22PH120	Physics	BSC	3	0	0	3
22CH130	Chemistry	BSC	3	0	0	3
22EG140	Technical English	HSMC	2	0	0	2
22ES150	Engineering Exploration	ESC	1	1	0	2
22ME160	Engineering Graphics	ESC	3	0	2	4
PRACTICAL						
22EG170	English Laboratory	HSMC	0	0	2	1
22PH180	Physics Laboratory	BSC	0	0	2	1
22CH190	Chemistry Laboratory	BSC	0	0	2	1
		Total	**15**	**2**	**8**	**21**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

I SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE	Max. Marks	TE	Total
THEORY							
22MA110	Calculus for Engineers	3	40	60	100	27	50
22PH120	Physics	3	40	60	100	27	50
22CH130	Chemistry	3	40	60	100	27	50
22EG140	Technical English	3	40	60	100	27	50
22ES150	Engineering Exploration	3	40	60	100	27	50
22ME160	Engineering Graphics	3	40	60	100	27	50
PRACTICAL							
22EG170	English Laboratory	3	60	40	100	18	50
22PH180	Physics lab	3	60	40	100	18	50
22CH190	Chemistry Laboratory	3	60	40	100	18	50

* CA – Continuous Assessment:

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

TE - Terminal Examination

22MA110	CALCULUS FOR ENGINEERS	Category	L	T	P	Credit(s)
		BSC	3	1	0	4

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 and MATLAB.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Cognize the concept of functions, limits and continuity	TPS2	75	70
CO2	Compute derivatives and apply them in solving engineering problems	TPS3	70	65
CO3	Employ partial derivatives to find maxima minima of functions of multi variables	TPS3	70	65
CO4	Demonstrate the techniques of integration to find the surface area of revolution of a curve.	TPS3	70	65
CO5	Utilize double integrals to evaluate area enclosed between two curves.	TPS3	70	65
CO6	Apply triple integrals to find volume enclosed between surfaces	TPS3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO2	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO3	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO4	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO5	S	S	M	M	-	-	-	-	L	-	L	-	-	-
CO6	S	S	M	M	-	-	-	-	L	-	L	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)			
	CAT 1			Assignment 1			CAT 1			Assignment 1						
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Total
CO1	20			50			-			-			-	10	-	10
CO2	32						-			-			-	-	16	16
CO3	36						-			-			-	-	18	18
CO4	12			-			39			50			-	-	25	25
CO5	-			-			35						-	-	17	17
CO6	-			-			26						-	-	14	14
MATLAB	-			50			-			50			-	-	-	-
TOTAL	100			100			100			100			-	10	90	100

***** Assignment 1: (i) Application Problems in CO1, CO2 and CO3 (50%)
(ii) MATLAB Onramp & Introduction to symbolic Math with MATLAB (50%).
**Assignment 2: (i) Application Problems in CO4, CO5 and CO6 (50%).
(ii) Application problems using MATLAB. (50%).
*******Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

DIFFERENTIAL CALCULUS
Functions - New functions from old functions - Limit of a function - Continuity - Limits at infinity - Derivative as a function - Maxima and Minima of functions of one variable – Mean value theorem - Effect of derivatives on the shape of a graph- Application problems in engineering using MATLAB.

FUNCTIONS OF SEVERAL VARIABLES:
Function of several variables- Level curves and level surfaces - Partial derivatives – Chain rule - Maxima and minima of functions of two variables –Method of Lagrange's Multipliers - Application problems in engineering using MATLAB.

INTEGRAL CALCULUS:
The definite integral – Fundamental theorem of Calculus – Indefinite integrals and the Net Change Theorem – Improper integrals – Area of surface of revolution - Volume of solid of revolution -Application problems in engineering using MATLAB.

MULTIPLE INTEGRALS:
Iterated integrals-Double integrals over general regions-Double integrals in polar coordinates-Applications of double integrals (density, mass, moments & moments of inertia problems only)-triple integrals- triple integrals in cylindrical coordinates- triple integrals in spherical coordinates-change of variables in multiple integrals - Application problems in engineering using MATLAB.

Text Book(s)

1. James Stewart, "Calculus Early Transcendentals", 9th Edition, Cengage Learning, New Delhi, 2019.
    a. DIFFERENTIAL CALCULUS: [Sections: 1.3, 2.2, 2.5, 2,6,2.8, 4.1, 4.2 and 4.3.]
    b. FUNCTIONS OF SEVERAL VARIABLES: [Sections: 14.1,14.3,14.5,14.7 and 14.8.]
    c. INTEGRAL CALCULUS: [Sections: 5.2, 5.3, 5.4, 7.8, 8.2 and 6.2.]
    d. MULTIPLE INTEGRAL: [Sections: 15.1-15.4, 15.6-15.9]

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", 14thedition, Pearson, New Delhi, 2018.
2. Howard Anton, Irl Bivens 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 Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**DIFFERENTIAL CALCULUS**	
1.1	Functions and New functions from old functions	2
1.2	Limit of a function &Continuity of a function	1
	Tutorial	**1**
1.3	Limits at infinity	1
1.4	Derivative as a function	2
	Tutorial	**1**
1.5	Maxima and Minima of functions of single variable	2
1.6	The Mean value theorem and effect of derivatives on the shape of a graph of a function	1
	Tutorial	**1**
1.7	Application problems in engineering using MATLAB	1
2	**FUNCTIONS OF SEVERAL VARIABLES**	
2.1	Level curves and level surfaces	2
2.2	Partial derivatives – Chain rule	1
	Tutorial	**1**
2.3	Maxima and minima of functions of two variables	2
2.4	Method of Lagrange’s Multipliers	1
	Tutorial	**1**
2.5	Application problems in engineering using MATLAB	1
3	**INTEGRAL CALCULUS**	
3.1	The definite integral	1
3.2	Fundamental theorem of Calculus	2
	Tutorial	**1**
3.3	Indefinite integrals and the Net Change Theorem	1
3.4	Improper integrals	2
	Tutorial	**1**
3.5	Area of surface of revolution	1

Module No.	Topic	No. of Periods
3.6	Volume of solid of revolution.	2
3.7	Application problems in engineering using MATLAB	1
4	**MULTIPLE INTEGRALS**	
4.1	Iterated integrals	1
4.2	Double integrals over general regions	2
	Tutorial	**1**
4.3	Double integrals in polar coordinates	1
4.4	Applications of double integrals (density, mass, moments & moments of inertia problems only)	2
	Tutorial	**1**
4.5	Triple integrals	1
4.6	Triple integrals in cylindrical coordinates	1
4.7	Triple integrals in spherical coordinates	1
	Tutorial	**1**
4.8	Change of variables in multiple integrals	1
4.9	Application problems in engineering using MATLAB	1
	Total	**48**

Course Designers:

1. Dr. B. Vellaikannan, bvkmat@tce.edu
2. Dr. C.S. Senthilkumar, kumarstays@tce.edu
3. Dr. S.P. Suriya Prabha, suriyaprabha@tce.edu
4. Dr. S. Saravanakumar, sskmat@tce.edu
5. Dr. M. Sundar, msrmat@tce.edu

22PH120	PHYSICS	Category	L	T	P	Credit(s)
		BSC	3	0	0	3

Preamble

The course work aims in imparting fundamental knowledge of mechanics, oscillations and waves and optics, electromagnetism and quantum mechanics which are essential in understanding and explaining engineering devices.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Apply the vector calculus approach and Newton's law in polar coordinates to solve problems in mechanics	TPS3	85	80
CO2	Solve for the solutions and describe the behaviour of a damped harmonic oscillator and waves.	TPS3	85	80
CO3	Introduce Schrodinger equation to arrive at the energy values of particle in a box and linear harmonic oscillator	TPS3	85	80
CO4	Use the principle of quantum mechanics for quantum mechanical tunnelling, quantum confinement and quantum computation	TPS2	85	80
CO5	Use the laws of electrostatics and magnetostatics to explain electromagnetic wave propagation	TPS3	85	80
CO6	Explain the fundamentals of optical phenomena and its applications	TPS2	85	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	L	L	-	-	-	-
CO2	S	M	L	-	-	-	-	-	L	L	-	-	-	-
CO3	S	M	L	-	-	-	-	-	L	L	-	-	-	-
CO4	M	L	-	-	-	-	-	-	L	L	-	-	-	-
CO5	S	M	L	-	-	-	-	-	L	L	-	-	-	-
CO6	M	L	-	-	-	-	-	-	L	-	L	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)			
	CAT 1			Assignment 1			CAT 2			Assignment 2						
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	Total
CO1	8	15	22	100			-	-	-	-	-	-	6	6	10	22
CO2	8	10	15				-	-	-	-	-	-	4	3	10	17
CO3	4	5	13				-	-	15	100			-	2	15	17
CO4	-	-	-				4	15	-				4	6	-	10
CO5	-	-	-				-	-	35				-	3	15	18
CO6	-	-	-				16	15	-				6	10	-	16
Total	20	30	50	100			20	30	50	100			20	30	50	100

*Assignment I, II –Quiz/ Puzzle/ Case analysis/ Problem-solving/ Presentation/ Writing tasks
*****Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

Mechanics of Particles:
Scalars and vectors under rotation transformation - Coordinate system - Cartesian, Polar, Spherical, Cylindrical - Newton's second law of motion - Forces in nature - Central forces - Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite manoeuvres

Oscillations and Waves:
Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator - Q factor- Impedance matching- Wave groups and group velocity - Non dispersive Transverse and Longitudinal waves - Waves with dispersion - Water waves - Acoustic waves - Earthquake and Tsunami waves

Quantum Mechanics:
Wave nature of particles - wave function - probability current density and expectation values - Schrodinger wave equation - Uncertainty principle - Particle in a box in 1D - Linear harmonic oscillator - Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope - Quantum Cascade lasers - Quantum computation (qubit) - Entanglement - Teleportation

Electromagnetic Fields and Waves:
Electric potential and Electric field of a charged disc - Magnetic Vector potential - Maxwell's equation - Equation of continuity – Poynting Vector - Energy and momentum of EM waves - CT/MRI scan

Optics:
Ray paths in inhomogeneous medium and its solutions – Applications - Fibre optics - Numerical Aperture& Acceptance angle - Fibre optic sensors - Liquid Level & Medical Applications - Interference in non-reflecting films - Fabry-Perot interferometer - Diffraction - Fraunhofer diffraction due to double slit.

Text Book(s)

1. Principles of Physics, Halliday, Resnick and Jearl Walker, 9th Edition, Wiley, 2011
2. Paul A. Tipler and G. Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008

Reference Books & Web Resources

MECHANICS OF PARTICLES
1. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 4, 9 & 10).
2. Manoj K. Harbola, Engineering Mechanics, 2nd Edition, Cengage, 2018.

OSCILLATIONS AND WAVES
3. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 14 & 15).
4. H. J. Pain, The Physics of Vibrations and Waves, 6th Edition, John Wiley, 2005 (Chapters 2, 5 & 6).

ELECTROMAGNETIC FIELDS AND WAVES
5. Principles of Physics, Halliday, Resnick and Jearl Walker, 9th Edition, Wiley, 2011 (Chapters - 23, 24, 32 & 33)
6. Paul M. Fishbane, Stephen G. Gasiorowicz and Stephen T. Thornton, Physics for Scientists and Engineers with Modern Physics, 3rd Edition, Pearson, 2005 (Chapters - 26, 28, 31 & 34).

OPTICS
7. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 31 & 33).
8. Ajoy Ghatak, Optics, 5th Edition, Tata McGraw Hill, 2012 (Chapters – 3, 18, 20)

QUANTUM MECHANICS
9. Paul A. Tipler and Gene Mosca, Physics for Scientists and Engineers, 6th Edition, Freeman, 2008 (Chapters – 34 & 35).
10. Stephen T. Thornton and Andrew Rex, Modern Physics for Scientists and Engineers, 4th Edition, Cengage, 2013. (Chapters - 5 & 6).
11. R. Shankar, Fundamentals of Physics – I, II, Yale University Press, 2014, 2016.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Mechanics of Particles**	**8**
1.1	Scalars and vectors under rotation transformation	2
1.2	Coordinate system - Cartesian, Polar, Spherical, Cylindrical	2
1.3	Newton's second law of motion - Forces in nature - Central forces	2
1.4	Conservative and non-conservative forces - Work - Energy theorem - Conservation of angular momentum - Satellite maneuvers	2
2	**Oscillations and Waves**	**6**
2.1	Simple harmonic oscillators - Energy decay in a Damped harmonic oscillator	2
2.2	Q factor- Impedance matching – Wave groups and group velocity	2
2.3	Non-dispersive transverse and Longitudinal waves	1
2.4	Waves with dispersion- Water waves -Acoustic waves – Earthquake and Tsunami waves	1
3	**Quantum Mechanics**	**10**

3.1	Wave nature of particles - wave function -probability current density and expectation values - Schrodinger wave equation	3
	CAT-I after 18 contact hours	
3.2	Uncertainty principle - Particle in a box in 1D – Linear harmonic oscillator	3
3.3	Quantum tunnelling – Quantum confinement in 0D, 1D, 2D systems - Scanning tunnelling microscope – Quantum Cascade lasers – Quantum computation (qubit) – Entanglement - Teleportation	4
4	**Electromagnetic Fields and Waves**	**6**
4.1	Electric potential and Electric field of a charged disc	1
4.2	Magnetic Vector potential – Maxwell's Equations	2
4.3	Equation of continuity-Poynting Vector-Energy and momentum of EM waves	2
4.4	CT/MRI scan	1
5	**Optics**	**6**
5.1	Ray paths in inhomogeneous medium & its solutions–Applications – Fiber optics	2
5.2	Numerical Aperture& Acceptance angle - Fiber optic sensors - Liquid Level & Medical Applications	2
5.3	Interference in non-reflecting films - Fabry- Perot interferometer - Diffraction - Two slit Fraunhofer diffraction	2
	CAT-II after 18 contact hours	
	Total	**36**

Course Designers:

1. Dr. M. Mahendran, Professor, manickam-mahendran@tce.edu
2. Mr. V. Veeraganesh, Assistant Professor, vvgphy@tce.edu
3. Dr. A LSubramaniyan, Assistant Professor, alsphy@tce.edu
4. Dr. A. Karuppusamy, Assistant Professor, akphy@ce.edu

22CH130	CHEMISTRY	Category	L	T	P	Credit(s)
		BSC	3	0	0	3

Preamble

The objective of this course is to bestow basic concepts of chemistry and its applications in engineering domain. It imparts knowledge on properties and treatment methods of water, spectroscopic techniques and their applications. This course provides exposure on electrochemical techniques for corrosion control, surface coatings and energy storage devices and also emphasis the properties and applications of engineering materials.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the essential water quality parameters of water	TPS2	70	70
CO2	Determine hardness of water and identify suitable water treatment method	TPS3	70	70
CO3	Explain the electrochemical process involved in energy storage devices and corrosion of metals	TPS2	70	70
CO4	Interpret the electrochemical principles in modern energy storage devices and corrosion control methods	TPS3	70	70
CO5	Identify the appropriate spectroscopic technique for various applications	TPS3	70	70
CO6	Select the materials based on the properties for Engineering applications	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	-	-
CO2	S	M	L	-	-	-	L	-	-	-	-	-	-	-
CO3	M	L	-	-	-	-	-	-	-	-	-	-	-	-
CO4	S	M	L	-	-	-	-	-	L	-	-	-	-	-
CO5	S	M	L	-	-	-	L	-	L	-	-	-	-	-
CO6	S	M	L	-	-	-	-	-	-	-	-	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)			
	CAT 1			Assignment 1			CAT 2			Assignment 2						
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**Total**
CO1	4	20	0	-	-	-	-	-	-	-	-	-	2	8	-	10
CO2	4	0	20	-	-	50	-	-	-	-	-	-	2	4	10	16
CO3	4	20	0	-	-	-	-	-	-	-	-	-	2	8	-	10
CO4	8	0	20	-	-	50	-	-	-	-	-	-	2	4	10	16
CO5	-	-	-	-	-	-	12	20	20	-	-	50	6	8	10	24
CO6	-	-	-	-	-	-	8	20	20	-	-	50	6	8	10	24
Total	**20**	**40**	**40**	**100**			**20**	**40**	**40**	**100**			**20**	**40**	**40**	**100**

*Assessment type of Assignments: Quiz / Test /Presentation

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

Syllabus

Water:

Water-sources- physical - characteristics - alkalinity - hardness of water – types -determination of hardness by EDTA method. Boiler trouble-Softening of water: internal and External treatment methods. Waste water treatment process.

Electrochemical technologies for energy storage and surface engineering:

Electrochemistry and Energy storage: Basics of electrochemistry. Batteries **-** Primary and Secondary batteries. Fuel cells. Hydrogen generation and storage. Corrosion and Surface Engineering–Basics –Corrosion - causes- factors- types - corrosion of metal and computer components- Corrosion control. Electroplating - Electroless process.

Spectroscopic technique and applications:

Principle, instrumentation, and applications: X-ray-diffraction - UV–Visible spectroscopy- Atomic Absorption Spectroscopy - Fluorescence spectroscopy - Inductively Coupled Plasma - Optical Emission Spectroscopy- Infra-red spectroscopy - Nuclear magnetic resonance spectroscopy**.**

Engineering materials:

Bonding and their influences on the property of materials - melting point - brittleness, ductility – thermal, electrical, and ionic conductivity - optical – magnetic properties, hydrophobic, hydrophilic. Polymer composites - structure and properties-applications. Ceramics and advanced ceramics - types-properties-applications Nano-materials – Synthesis, structure, and properties –applications.

Text Book(s)

1. P.C. Jain and Monica Jain, A Textbook of Engineering Chemistry, DhanpatRai publications, New Delhi, 16thedition, 2015.

Reference Books & Web Resources

1. S.S. Dara and S.S. Umare, “A Textbook of Engineering Chemistry”, S.Chand& Company, 12thEdition, Reprint, 2013.
2. Shashi Chawla, “ A text book of Engineering Chemistry”, DhanpatRai& Co.(pvt) ltd, 3rd edition, reprint 2011.
3. C. N. Banwell and E.M. McCash, “Fundamentals of Molecular Spectroscopy”, Tata McGraw-Hill (India), 5thEdition, 2013.

4. W.F. Smith, Principles of Materials Science and Engineering: An Introduction; Tata Mc-Graw Hill, 2008.
5. V. Raghavan, Introduction to Materials Science and Engineering; PHI, Delhi, 2005.
6. M. Akay, 2015, An introduction to polymer matrix composites," from: https://www.academia.edu/37778336/An_introduction_to_polymer_matrix_composites

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Water**	
1.1	Importance of water, sources, standards for drinking water, (WHO, BIS & ICMR standards) physical, chemical & biological characteristics, Alkalinity (principle only)	1
1.2	Hardness of water - types, units. Determination of hardness by EDTA method and numerical problems	2
1.3	**boiler trouble:** Scale and sludge formation, boiler corrosion, priming and foaming, caustic embrittlement	1
1.4	**Internal treatment methods:** Carbonate, Phosphate, Colloidal, Calgon conditioning	1
1.5	**softening of water:** External treatment methods: Lime-soda process (concept only), zeolite process, ion exchange process	2
1.6	Desalination- reverse osmosis, electro dialysis, solar and multistage flash distillation, nano-filtration	1
1.7	Waste water treatment – primary, secondary, and tertiary treatment	1
2	**Electrochemical technologies for energy storage and surface engineering**	
2.1	**Electrochemistry and Energy storage**: Introduction**–** Basics of electrochemistry – Redox process, EMF	1
2.2	**Energy storage** – Batteries, Battery quality parameters	1
2.3	Primary battery – Dry cell and Alkaline cell	1
2.4	Secondary battery – Lead-acid battery, Lithium-ion battery	1
2.5	Fuel cells – Fundamentals, types and applications. Hydrogen generation and storage	1
2.6	**Corrosion and Surface Engineering**- Basics –Corrosion - causes- factors- types	1
2.7	chemical, electrochemical corrosion (galvanic, differential aeration), corrosion of metal and computer components-	1
2.8	Corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method	1
2.9	Electroplating –Introduction, Process, Applications (Gold and nickel plating). Electroless plating – Principle, process, Applications (PCB manufacturing)	1
3	**Spectroscopic technique and applications**	
3.1	Introduction to Electromagnetic Radiation, Types of atomic and molecular spectra	1
3.2	**Principle, Instrumentation and Applications:** X-ray-diffraction	1

Module No.	Topic	No. of Periods
3.3	UV–Visible spectroscopy, Atomic Absorption Spectroscopy	2
3.4	Fluorescence spectroscopy, Inductively Coupled Plasma - Optical Emission Spectroscopy	2
3.5	Infra-red spectroscopy	2
3.6	Nuclear magnetic resonance spectroscopy – Magnetic resonance imaging	1
4	**Engineering materials**	
4.1	Bonding and its influence on the property of materials	1
4.2	Properties of materials- melting point - brittleness, ductility - thermal, electrical and ionic conductivity	1
4.3	optical – magnetic properties, hydrophobic, hydrophilic	1
4.4	**Polymer composites** - structure and properties	1
4.5	applications -automotive, aerospace, marine, biomedical, and defense	1
4.6	**Ceramics and advanced ceramics** - types-properties	1
4.7	applications- medicine, electrical, electronics, space	1
4.8	**Nano-materials** – Synthesis, structure and properties	1
4.9	applications - sensors, drug delivery, photo and electro-catalysis, and pollution control	1
	Total	36

Course Designers:

1. Dr. M. Kottaisamy, Professor, Chemistry, hodchem@tce.edu
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7. Dr. B. Shankar, Assistant Professor, Chemistry, bsrchem@tce.edu

22EG140	TECHNICAL ENGLISH	Category	L	T	P	Credit(s)
		HSMC	2	0	0	2

Preamble

The course aims at fostering the students 'ability to communicate effectively in various academic, professional, and social settings through oral and written forms. Besides imparting the basic skills namely Listening, Speaking, Reading and Writing (LSRW), significant emphasis is placed on enriching their analytical, descriptive, and creative skills, enabling them to develop and demonstrate a holistic English language proficiency.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	**Relate** the fundamentals of language in terms of vocabulary, grammar and pronunciation in technical communication.	Understand	70%	80%
CO2	**Infer** ideas from technical and general contexts by identifying main ideas, specific details, predicting and note making	Understand	70%	80%
CO3	**Make use of** language in professional and social contexts with clarity and conciseness.	Apply	60%	70%
CO4	**Identify** specific contexts in technical writing, where appropriate lexical and grammatical functions are applied	Apply	60%	70%
CO5	**Develop** the skills such as understanding, evaluating, analysing and summarising the text and graphical representations.	Apply	60%	70%
CO6	**Organise** ideas with coherence, cohesion and precision in formal written communication	Apply	70%	80%

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-	-	M	S	-	S	-	-
CO2	-	-	-	-	-	-	-	-	M	S	-	S	-	-
CO3	-	-	-	-	-	-	-	L	M	S	-	S	-	-
CO4	-	-	-	-	-	-	-	-	M	S	-	S	-	-
CO5	-	-	-	-	-	-	-	-	M	S	-	S	-	-
CO6	-	-	-	-	-	-	-	L	M	S	-	S	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	24	-	100			-	-	-	-	-	-	-	10	-
CO2	-	34	-				-	-	-	-	-	-	-	20	-
CO3	-	-	14				-	-	24	-	-	-	-	-	20
CO4	-	-	14	-	-	-	-	-	34	100			-	-	10
CO5	-	-	14	-	-	-	-	-	-				-	-	20
CO6	-	-	-	-	-	-	-	-	42				-	-	20
Total	100			100			100			100			100		

***** Assignment 1: Speaking activities in CO1, CO2, and CO3 (100%).
**Assignment 2: Writing activities in CO4, CO5, and CO6 (100%).
*******Terminal examination should cover all Course Outcomes in the appropriate TPS Scale level.

Syllabus

MODULE- I - Basics of Language (CO1)
Vocabulary - Word Building, Prefix, Suffix and Root Words, Basics of Grammar – Parts of Speech, Tenses, Phonetics - Phonemes, Syllables and Stress.

MODULE- II– Reading (CO2)
Reading- Skimming and Scanning of Short Comprehension Passages and Answering Questions or Cloze exercises based on the text prescribed for extensive reading, Note-Making.

MODULE- III–Functional English (CO3)
Framing Questions (WH and Yes/No), Modals, Manual Writing, Recommendations Writing, Agenda and Minutes of Meeting.

MODULE-IV – Technical Notions (CO4)
Technical Notions - Subject-Verb Agreement, Relative Clause, Phrasal Verbs, Impersonal Passive Voice, Noun Compounds, Classifications and Definitions, Cause and Effect, Purpose and Function, Numerical Adjectives.

MODULE-V – Analytical Writing and Business Correspondence (CO5 & CO6)
Summary Writing, Interpretation of Graphics, Jumbled Sentences, Paragraph Writing, Formal Letters (Seeking Permission for Industrial Visit / internship / Bonafide), E-mail Writing (BEC Vantage Writing Task I)

Text Book(s)

1. Murphy, Raymond, English Grammar in Use with Answers; Reference and Practice for Intermediate Students, Cambridge: CUP, 2004
2. Jones, Daniel. An English Pronouncing Dictionary, Cambridge: CUP, 2006
3. Brook-Hart, Guy. Cambridge English- Business Benchmark-Upper Intermediate, CUP,2013.
4. Dhanavel, S.P. English and Communication Skills for Students of Science & Engineering, Orient BlackSwan, Chennai: 2016.
5. Swan, Michael. Practical English Usage.4thEdn. OUP. 2017.
6. Elbow, Peter. Writing with Power: Techniques for Mastering the Writing Process. New York, Oxford University Press, 1998.

Reference Books & Web Resources

1. Anthology of Select Five Short Stories
2. Tagore, Rabindranath. Chitra, a Play in One Act. London, Macmillan and Co., 1914.
3. www.englishclub.com
4. owl.english.purdue.edu
5. www.oxfordonlineenglish.com
6. www.bbclearningenglish.com
7. tcesrenglish.blogspot.com

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1.	Word Building, Prefix, Suffix and Root Words	1
2.	Parts of Speech	1
3.	Tenses	1
4.	Skimming and Scanning of Short Comprehension Passages	1
5.	Manual Writing	1
6.	Recommendations	1
7.	Note-Making	1
8.	Subject-Verb Agreement	1
9.	Phonemes	1
10.	Syllables and Stress	1
11.	Answering Questions or Cloze exercises based on the text prescribed for extensive reading	1
12.	Noun Compounds, Classifications and Definitions	1
13.	Cause and Effect, Purpose and Function	1
14.	Summary Writing	1
15.	Interpretation of Graphics	1
16.	Jumbled Sentences	1
17.	Formal Letters (Seeking Permission for Industrial Visit / internship / Bonafide)	1
18.	Phrasal Verbs and Impersonal Passive Voice	1
19.	Numerical Adjectives	1
20.	Framing Questions (WH and Yes/No) and Modals	1
21.	Agenda and Minutes of Meeting	1
22.	Relative Clause	1
23.	E-mail Writing (BEC Vantage Writing Task I)	1
24.	Paragraph Writing	1
Total		**24**

Course Designers:

1. Dr. A. Tamilselvi, tamilselvi@tce.edu
2. Dr. S. Rajaram, sreng@tce.edu
3. Dr. G. JeyaJeevakani, gjjeng@tce.edu
4. Dr. R. TamilSelvi, rtseng@tce.edu
5. Mrs M Sarpparaje, mseeng@tce.edu

22ES150	ENGINEERING EXPLORATION	Category	L	T	P	Credit(s)
		ESC	1	1	0	2

Preamble

The course Engineering Exploration provides an introduction to the engineering field. It is designed to help the student to learn about engineering and how it affects our everyday lives. On the successful completion of the course, students will be to explain how engineering is different from science and technology and how science, mathematics and technology are an integral part of engineering design.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain technological & engineering development, change and impacts of engineering	TPS2	70	70
CO2	Draw a product in enough detail that others can accurately build it and write specification sheet for a given product	TPS3	70	70
CO3	Complete initial steps (Define a problem, list criteria and constraints, brainstorm potential solutions and document the ideas) in engineering design process	TPS3	70	70
CO4	Draw sketches to a design problem and provide a trade-off matrix	TPS3	70	70
CO5	Communicate possible solutions through drawings and prepare project report	TPS3	70	70
CO6	Apply the concept of engineering fundamentals in Civil and Mechanical, Engineering	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	-	-
CO2	S	M	L	-	-	-	-	-	-	-	-	-	-	-
CO3	S	M	L	-	-	-	-	-	-	-	-	-	-	-
CO4	S	M	L	-	-	-	-	-	-	-	-	-	-	-
CO5	S	M	L	-	-	-	-	-	-	-	-	-	-	-
CO6	S	M	L	-	-	-	-	-	-	-	-	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

TPS Scale	Assesment-1 (Theory)						Assesment-2 (Theory)						Terminal Examination (Theory)		
	Worksheet-1			CAT-1			Case study-1			CAT-2					
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	30	-	-	30	-	-	-	-	-	-	-	-	20	-
CO2	-	-	30	-	-	30	-	-	-	-	-	-	-	-	15
CO3	-	-	40	-	-	40	-	-	-	-	-	-	-	-	15
CO4	-	-	-	-	-	-	-	30	-	-	30	-	-	-	20
CO5	-	-	-	-	-	-	-	-	30	-	-	30	-	-	15
CO6	-	-	-	-	-	-	-	-	40	-	-	40	-	-	15

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

Syllabus

What is Engineering: Engineering Requirement, Knowledge within Engineering disciplines, Engineering advancements

Engineering Design: Problem definition, idea generation through brainstorming and researching, solution creation through evaluating and communicating, text/analysis, final solution and design improvement.

Defining problems and Brainstorming: Researching design, sketching problem solving

Communicating solution: Dimensioning orthographic drawing, perspective drawing

Modelling and testing final output: Product evaluation, reverse engineering, final project report.

Civil Engineering: Structural forces structural analysis, bridge design components, structural design

Mechanical Engineering: Types of motion, mechanical power system, mechanical power formula, mechanical design.

Reference Books

1. Ryan A.Brown, Joshua W.Brown and Michael Berkihiser: “Engineering Fundamentals: Design, Principles, and Careers”, Goodheart-Willcox Publisher, Second Edition, 2014.
2. Saeed Moaveni ,“Engineering Fundamentals: An Introduction to Engineering”, Cengage learning, Fourth Edition, 2011.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**What is Engineering**	
1.1	Engineering Requirement	1
1.2	Knowledge within Engineering disciplines,	1
1.3	Engineering advancements	1
2	**Engineering Design**	
2.1	Problem definition,	1
2.2	idea generation through brainstorming and researching	1
2.3	solution creation through evaluating and communicating,	1
2.4	text/analysis	1
2.5	final solution and design improvement	1
3	**Defining problems and Brainstorming:**	
3.1	Researching design	1
3.2	sketching problem solving	2

No.	Topic	No. of Periods
4	**Communicating solution**	
4.1	Dimensioning orthographic drawing	1
4.2	perspective drawing	1
5	**Modelling and testing final output**	
5.1	Product evaluation	1
5.2	reverse engineering	1
5.3	final project report	1
6	**Civil Engineering**	
6.1	Structural forces structural analysis	1
6.2	bridge design components	2
6.3	structural design	1
7	**Mechanical Engineering**	
7.1	Types of motion	1
7.2	mechanical power system	1
7.3	mechanical power formula	1
7.4	mechanical design	1
	Total	24

Course Designers:

1. Dr.S.J. Thiruvengadam, sjtece@tce.edu
2. Dr. V.R.Venkatasubramani, venthiru@tce.edu

22ME160	ENGINEERING GRAPHICS	Category	L	T	P	Credit(s)
		HSMC	3	0	2	4

Preamble

Engineering Graphics is referred as language of engineers. An engineer needs to understand the geometry of any object through its orthographic or pictorial projections. The knowledge on engineering graphics is essential in proposing new product designs through drawings and in reading or understanding the existing drawings. This course covers orthographic and pictorial projections, sectional views, development of surfaces and use of computer aided drafting tools.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Draw the orthographic views of objects from the given isometric views and draw the orthographic projections of points.	TPS 3	70	70
CO2	Draw the orthographic projections (Elevation and Plan) of straight lines inclined to both reference planes.	TPS 3	70	70
CO3	Draw the orthographic projections (Elevation and Plan) of plane surfaces inclined to both reference planes.	TPS 3	70	70
CO4	Draw the orthographic projections (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and Cone) with axis inclined to any one-reference plane.	TPS 3	70	70
CO5	Draw the orthographic projections (Elevation and Plan) of sectioned solids (Prisms, Pyramids, Cylinder and Cone) and true shape of the sections.	TPS 3	70	70
CO6	Draw the development of surfaces (base and lateral) of sectioned regular solids (Prisms, Pyramids, Cylinder and Cone).	TPS 3	70	70
CO7	Draw the isometric projections of regular solids and combined solids (Prisms, Pyramids, Cylinder, Cone and Sphere) and convert the orthographic projections into isometric views.	TPS 3	70	70
CO8	Create computer-aided 3D models for the given drawing (2D/3D) and draw orthographic views for the 3D model with appropriate dimensioning using CAD package (Continuous Assessment only).	TPS 3	Continuous Assessment Only	

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO2	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO3	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO4	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO5	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO6	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO7	S	M	S	M	M	-	-	-	M	M	-	-	-	-
CO8	S	M	S	M	S	-	-	-	M	M	-	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

Bloom's Category / TPS Scale	Continuous Assessment Test	Terminal Examination
Remember / 1	---	---
Understand / 2	---	---
Apply / 3	100	100
Analyze / 4	---	---
Evaluate / 5	---	---
Create / 6	---	---

Marks Allocation for Continuous Assessment:

Sl. No.	Description	Marks
1	Plates (Drawing sheets) submission	20
2	Computer Aided Drafting (CAD) Exercises	15
3	Continuous Assessment Test (CAT)	15
	Total	**50**

Question Pattern for Terminal Examination:

Q. No.	Description	Type	Marks
1	Orthographic views from isometric view / Projection of Points	Either or type	10
2	Projection of lines	Either or type	15
3	Projection of planes	Either or type	15
4	Projection of solids	Either or type	15
5	Section of solids	Either or type	15
6	Development of surfaces	Either or type	15
7	Isometric projections of combined solids / Conversion of orthographic views into isometric view	Either or type	15
Total			**100**

Note:

1. One test or two tests will be conducted locally by respective Faculty In - charges during regular class hours to account for continuous assessment test (CAT) marks.
2. Terminal examination (3 hrs.) will be conducted centrally by the office of controller of examinations.

Syllabus

Introduction - Significance of engineering graphics, Use of drawing instruments, Standards, Lettering and dimensioning, Scales.

Orthographic Projection - Principles of orthographic projections, First angle projection, Orthographic projection of objects from pictorial views. Projection (Elevation and Plan) of points located in all quadrants.

Projection (Elevation and Plan) of straight lines in first quadrant, inclined to both reference planes by rotating line method.

Projection (Elevation and Plan) of plane surfaces in first quadrant, inclined to both reference planes by rotating object method.

Projection (Elevation and Plan) of regular solids (Prisms, Pyramids, Cylinder and cone) in first quadrant, by rotating object method when the axis is inclined to one of the reference planes.

Projection (Elevation and Plan) of sectioned solids (Prisms, Pyramids, Cylinder and cone) and true shape of the sections, when the axis of the solid is perpendicular to horizontal plane.

Development of base and lateral surfaces of sectioned regular solids (Prisms, Pyramids, Cylinder and Cone) with cutting plane inclined to HP only.

Isometric projection – Principle, isometric scale, Isometric views and Isometric projections of single simple solids. Combination of solids (Prisms, Pyramids, Cylinder, Cone and sphere - in simple vertical positions only). Conversion of orthographic projections (Elevation, Plan and Side view) of solid parts / engineering components into isometric views.

Computer Aided Drafting (For Continuous Assessment only):

Overview of Computer Graphics, list of computer technologies, impact on graphical communication. Demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Cross hairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), Command Line, Status Bar, Different methods of zoom as used in CAD, Select and erase objects. Setting up of units and drawing limits. Dimensioning – Guidelines – ISO and ANSI standards for coordinate dimensioning - Defining local coordinate systems. Orthographic and isometric views.

Practice on drawing of 2 dimensional geometric patterns consisting of entities such as lines, arcs and circles. Practice on creation of 3 dimensional wire-frame and shaded models. Dimensioning in isometric and orthographic views.

Text Book

1. Bhatt N.D., Panchal V.M. and Ingle P.R., (2014) “Engineering Drawing”, Charotar Publishing House.

Reference Books

1. Natarajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2012.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2019.

3. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2011.
4. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 2017.
5. Shah M.B, and Rana B.C (2009) “Engineering Drawing and Computer Graphics”, Pearson Education.
6. CAD Software Theory and User Manuals.

Course Contents and Lecture Schedule

Sl. No.	Topic	Lecture Hours	Practice Hours
1	**Introduction**- Significance of engineering graphics, Use of drawing instruments –Standards, Lettering and dimensioning, Scales	2	1
2	**Orthographic Projection-** Principles of orthographic projections, First angle projection, **Orthographic projection of objects from pictorial views.**	2	2
3	**Projection (Elevation and Plan) of points** located in all quadrants.	2	1
4	**Projection (Elevation and Plan) of straight lines** in first quadrant, inclined to both reference planes by rotating line method.	4	2
5	**Projection (Elevation and Plan) of plane surfaces** in first quadrant, inclined to both reference planes by rotating object method.	5	3
6	**Projection (Elevation and Plan) of regular solids** (Prisms, Pyramids, Cylinder and cone) in first quadrant, by rotating object method when the axis is inclined to one of the reference planes.	5	3
7	**Projection (Elevation and Plan) of sectioned solids** (Prisms, Pyramids, Cylinder and cone) and true shape of the sections, when the axis of the solid is perpendicular to horizontal plane.	4	2
8	**Development of surfaces** (base and lateral) **of sectioned regular solids** (Prisms, Pyramids, Cylinder and Cone) with cutting plane inclined to HP only.	4	2
9	**Isometric projection** – Principle, isometric scale, Isometric views and Isometric projections of single simple solids. Combined solids (Prisms, Pyramids, Cylinder, Cone and sphere - in simple vertical positions only). **Conversion of orthographic projections** (Elevation, Plan and Side view) of solid parts / engineering components into isometric views.	4	2

Sl. No.	Topic	Lecture Hours	Practice Hours
10	**Computer Aided Drafting** (For Continuous Assessment only)**:** **10.1** Overview of Computer Graphics, list of computer technologies, impact on graphical communication. Demonstrating knowledge of the theory of CAD software such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Cross hairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line, The Status Bar, Different methods of zoom as used in CAD, Select and erase objects. Setting up of units and drawing limits. Dimensioning – Guidelines – ISO and ANSI standards for coordinate dimensioning - Defining local coordinate systems. Orthographic and isometric views.	1	1
	10.2 – Practice on drawing of 2 dimensional geometric patterns consisting of entities such as lines, arcs and circles. Practice on creation of 3 dimensional wire-frame and shaded models. Dimensioning in isometric and orthographic views.	3	5
	TOTAL	**36**	**24**

Course Designers:

1. Dr. B. Karthikeyan, Assistant Professor, Mechanical Engineering bkmech@tce.edu
2. Dr. M. Kannan, Assistant Professor, Mechanical Engineering mknmech@tce.edu

22EG170	ENGLISH LABORATORY	Category	L	T	P	Credit(s)
		HSMC	0	0	2	1

Preamble

This practical course enables the students to develop and evaluate their basic English language skills through individualized learning process at the Language Lab, using English Software and online resources. In addition, it facilitates students with the need-based student-centric presentation sessions in a multi-media driven classroom environment.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale
CO1	Interpret words correctly through listening and watching general and technical online contents	Understand
CO2	Develop appropriate pronunciation skills through listening and speaking practices	Apply
CO3	Build and apply a wide range of lexicons in general and technical presentations	Apply
CO4	Identify and apply the key ideas and spoken English features learnt through auditory and visual listening tools	Apply
CO5	Experiment with inventiveness by creating a blog, vlog, or YouTube channel.	Apply
CO6	Prepare and deliver oral and written presentations using digital tools.	Apply

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	-	-	-	-	-	-		M	S	-	S	-	-
CO2	-	-	-	-	-	-	-		M	S	-	M	-	-
CO3	-	-	-	-	-	-	-	L	M	S	-	S	-	-
CO4	-	-	-	-	-	-	-	L	M	S	-	M	-	-
CO5	-	-	-	-	-	-	-	L	M	S	-	S	-	-
CO6	-	-	-	-	-	-	-	L	S	S	-	S	-	-

S – Strong M – Medium L – Low

Assessment Pattern

Students' performance will be assessed in the language lab/ classroom as given below:

- Spoken Task - General / Technical Presentation / Picture Description : 20 Marks
- Listening Task – (MCQs, Gap Filling Exercises) : 10 Marks
- Written Test - Phonetics, Grammar, Vocabulary, Reading : 20 Marks

External:

- Online Exam- Phonetics, Grammar, Vocabulary, Reading (45 Minutes) : 50 Marks
- Listening Test : 20 Marks
- Submission of Students' Record on Practical Tasks in the Class and Lab : 10 Marks
- BEC Vantage Speaking Tasks I and II : 20 Marks

List of Experiments

Sl. No.	Topic	Hours
	LAB ACTIVITIES (12 Hours)	
1	Listening to TED Talks/ Podcasts/ Product Advertisements/ News Bulletins.	2
2	Phonetics – Tutorials through Online Repositories, English Movie Clips and Software in the Lab(S-net)	2
3	Vocabulary Development through Movies / Short Films/ Documentaries	2
4	Language Development through English software S-net and Online Content (Tenses, Voices, SV Agreement, Prepositions, Coherence Markers, Relative Clauses, Modals, Punctuation)	2
5	Reading Comprehension – I (General / Technical, BEC Vantage Reading Task III)	2
6	Creating a Blog/Vlog/YouTube Channel –Uploading MP3/MP4 – Practice (Movie/Book/ Gadget Review, General/Tech Talks, Interview with Celebrities)	1
7	Revision – Model Online Aptitude Test	1
	CLASSROOM ACTIVITIES (12 Hours)	
8	Introduction of Spoken English Features	1
9	Self-introduction and Introducing others	1
10	Video Comprehension – Brainstorming and Note-Taking	2
11	Role-Play, Picture/Movie Description	1
12	Reporting the events from Media / Newspapers – Discussion	1
13	Interactive Games for Language Development	1
14	Reading / Note Making (Extensive Reading – News Paper Reports)	1
15	Presentation – I (Book /Movie Review, Story Telling, General Presentations)	2
16	Presentation – II (Technical Presentations)	2
	Total	24

Software Used:

1. English Software S Net
2. Business English Certificate-Vantage- Practice Software

Teaching Resources and Websites:

1. Open Online Repositories from Oxford / Cambridge / British Council/ Voice of America
2. Free Video Downloads from YouTube
3. www.ted.com
4. tcesrenglish.blogspot.com

Course Designers:

1. Dr. A.Tamilselvi, tamilselvi@tce.edu
2. Dr. S. Rajaram, sreng@tce.edu
3. Dr. RS. Swarnalakshmi, rssleng@tce.edu
4. Mrs. M. Sarpparaje, mseeng@tce.edu

22PH180	PHYSICS LABORATORY	Category	L	T	P	Credit(s)
		BSC	0	0	2	1

Preamble

This course ensures that students are able to apply the basic physics concepts and carry out the experiments to determine the various physical parameters related to the material

- Learn the necessary theory to understand the concept involved in the experiment.
- Acquire the skills to carry out the experiment.
- Tabulate the observed data and use the formula to evaluate the required quantities.
- Plot the data in a graph and use it for calculation.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Analyse the mechanical & electrical oscillations and determine their resonance frequency	TPS3	85	90
CO2	Analyse the interference and diffraction patterns for micron sized objects	TPS3	85	90
CO3	Investigate the V-I characteristics of photodiode, phototransistor under dark and bright illumination conditions	TPS3	85	90
CO4	Determine the Planck's constant using LEDs	TPS3	85	90
CO5	Plot the VI characteristics of solar cell and find the fill factor	TPS3	85	90
CO6	Determine the reversibility of classical and quantum logic gates	TPS3	85	90
CO7	Identify the variation of magnetic field with distance for circular coils	TPS3	85	90

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO2	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO3	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO4	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO5	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO6	S	M	L	-	-	-	-	-	S	-	-	L	-	-
CO7	S	M	L	-	-	-	-	-	S	-	-	L	-	-

S – Strong M – Medium L – Low

List of Experiments

1. Quantum Logic Gate-Toffoli gate
2. Study of Optoelectronic Devices- Photodiode, Phototransistor.
3. Solar cell VI characteristics, fill factor & Optical fibre-Determination of numerical aperture.
4. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of regular objects.
5. Laser Diffraction - Determination of wave length of the laser using grating and determination of micro particle size. (Observing diffraction pattern due to single and double slit)
6. Air wedge – Determination of thickness of a thin sheet/wire.
7. Determination of Planck's constant through V-I characteristics of LED.
8. Determination of magnetic field-Stewart and Gees.
9. LCR Circuit – Determination of resonant frequency

Course Designers:

1. Dr. N. Sankarasubramanian, Professor, nssphy@tce.edu
2. Dr. A. L. Subramaniyan, Assistant Professor, alsphy@tce.edu
3. Dr. P.K. Kannan, Assistant Professor, akphy@ce.edu

22CH190	CHEMISTRY LABORATORY	Category	L	T	P	Credit(s)
		BSC	0	0	2	1

Preamble

This course aims to provide the students, a basic practical knowledge in chemistry. The objective of this course is to develop intellectual and psychomotor skills of the students by providing hands on experience in quantitative, electrochemical and photo-chemical analysis.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale
CO1	Estimate the chemical water quality parameters of sample water / effluent	Apply
CO2	Demonstrate presence of calcium ions in milk sample	Apply
CO3	Determine the surface tension of solvent mixtures	Apply
CO4	Estimate pH and acid content of samples using pH metric and conductometric titrations	Apply
CO5	Illustrate the strength of oxidisable materials present in given sample by potentiometric method	Apply
CO6	Determine Fe2+ ion in effluent using colorimetric method	Apply
CO7	Calculate the efficiency of electroplating	Apply
CO8	Determine the rate of corrosion of metal & alloy using potentio-dynamic polarisation method	Apply

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO2	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO3	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO4	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO5	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO6	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO7	S	M	L	-	M	-	-	-	L	-	-	-	-	-
CO8	S	M	L	-	M	-	-	-	L	-	-	-	-	-

S – Strong M – Medium L – Low

List of Experiments

Experimental List	CO
Quantitative Analysis	
Estimation of total hardness of water sample	CO1
Estimation of COD of industrial effluent	CO1
Determination of calcium ion in milk sample	CO2
Determination of surface tension of solvent mixture	CO3
Electrochemical and Photochemical Analysis	
Determination of the Phosphoric acid content in soft drinks using conductometric titration	CO4
Determination of pH of soil by pH metric titration	CO4
Potentiometric redox titration ($K_2Cr_2O_7$vs FAS, $KMnO_4$vs FAS)	CO5
Estimation of iron content in water sample using colorimeter	CO6
Estimation of current density of electroplating process using Hull cell	CO7
Determination of rate of corrosion of metal and alloy using potentio-dynamic polarisation technique (TAFEL)	CO8

Learning Resources:

1. Vogel's Textbook of Quantitative Chemical Analysis (8THedition, 2014)
2. Laboratory Manual – Department of Chemistry, Thiagarajar College of Engineering (2022)

Course Designers:

1. Dr. M. Kottaisamy, hodchem@tce.edu
2. Dr. V. Velkannan, velkannan@tce.edu
3. Dr. S. Sivailango, drssilango@tce.edu
4. Dr. M Velayudham, mvchem@tce.edu
5. Dr. R Kodi Pandyan, rkp@tce.edu
6. Dr. A Ramalinga Chandrasekar, arcchem@tce.edu
7. Dr. B. Shankar, bsrchem@tce.edu

CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

Second and Third Semester

For the students admitted from the
academic year 2022 - 2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF MECHATRONICS ENGINEERING

Vision:

"Be a globally renowned school of engineering in Mechatronics"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfil the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of B.E.

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze Complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Specific Outcomes (PSO) of B.E. Mechatronics Engineering

After the successful completion of the B.E. Mechatronics Engineering degree programme, the students will be able to:

PSO1: Design, develop and retrofit conventional mechanical system into low-cost automated system using sensors and controllers

PSO2: Design, develop and analyse mechatronics system using hardware and software tools.

SCHEDULING OF COURSES

Sem	Theory / Theory cum Practical / Laboratory Courses								CDIO / Audit Courses	Total Credits
I	22MA110 Calculus for Engineers BSC 4	22PH120 Physics BSC 3	22CH130 Chemistry BSC 3	22EG140 Technical English HSMC 2	22ME160 Engineering Graphics ESC 4	22EG170 English Laboratory HSMC 1	22PH180 Physics Laboratory BSC 1	22CH190 Chemistry Laboratory BSC 1	22ES150 Engineering Exploration ESC 2	21
II	22MT210 Matrices and Ordinary Differential Equations BSC 4	22MT220 Analog Electronics PCC 3	22MT230 Free Body Mechanics PCC 3	22MT240 Problem Solving using C ESC 3	22MT250 Manufacturing Process PCC 3	22MT260 Mechatronic Workshop ESC 1	22MT270 Manufacturing Laboratory PCC 1	22MT280 Mechatronic System Laboratory ESC 1	Audit Course 1	19
III	22MT310 Partial Differential Equations BSC 4	22MT320 Digital Electronics PCC 3	22MT330 Kinematics and Dynamics of Machinery ESC 3	22MT340 Thermal Fluid Systems PCC 3	22MT350 Electrical Machines ESC 3	22MT360 Thermal Engineering Laboratory PCC 1	22MT370 Electrical Machines Laboratory ESC 1	22MT380 Electronic Circuits and Digital Laboratory PCC 1	22ES390 Design Thinking ESC 3	22
IV	22MT410 Probability and Statistics BSC 4	22MT420 Microcontroller based system design PCC 3	22MT430 Power Electronics and Drives ESC 3	22MT440 Sensors and Measurements PCC 3	22MT450 Digital Signal Processing PCC 3	22MT460 Project Management HSMC 3	22MT470 Microcontroller Laboratory PCC 1	22MT480 Sensors and Measurements Laboratory PCC 1	Audit Course 2	21
V	22MT510 Control Systems PCC 4	22MT520 Design of Machine Elements PCC 3	22MT530 Industrial Automation PCC 3	22MT540 CNC Technology PCC 3	22MTPx0 Program Elective I PEC 3	22yyGx0 Inter disciplinary Elective IE 3	22MT5500 CAD / CAM Laboratory PCC 1	22MT560 Industrial Automation Laboratory PCC 1	22MT570 Sensors and Instrumentation Project PW 3	24
VI	22MT610 Accounting and Finance HSMC 4	22MT620 Industrial Robotics PCC 3	22MTPx0 Program Elective II PEC 3	22MTPx0 Program Elective III PEC 3	22MT630 Professional Communication HSMC 2	22yyFx0 Basic Science Elective BSE 3	22MT640 Control and Dynamics Laboratory PCC 1	22MT650 Robotics Laboratory PCC 1	22MT660 Mechanical Systems Project PW 3	23
VII	22MT710 Mechatronics System Design PCC 3	22MTPx0 Program Elective IV PEC 3	22MTPx0 Program Elective V PEC 3	22MTPx0 Program Elective VI PEC 3	22MTPx0 Program Elective VII PEC 3	22MT720 System Integration Laboratory PCC 3	---	---	22MT730 Robotics and Automation Project PW 3	21
VIII	22MTPx0 Program Elective VIII PEC 3	22MTPx0 Program Elective IX PEC 3	---	---	---	---	---	---	22MT810 System Integration Project PW 3	9
									Total Credits	**160**

CREDIT DISTRIBUTION

Degree: B.E. **Program: Mechatronics**

Sl. No.	Category		Credits	
			Regular Admission	Lateral Entry Admission
A.	**Foundation Courses (FC)**		**54 - 66**	**24 - 36**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	09 - 12
	b.	Basic Science Courses (BSC)	24 - 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 - 27	12 - 15
B.	**Professional Core Courses (PCC)**		**55**	**45**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 - 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 - 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 - 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 - 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 - 06
	b.	Basic Science Elective (BSE)	03 - 06	03 - 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

II SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT210	Matrices and Ordinary Differential Equations	BSC	3	1	0	4
22MT220	Analog Electronics	PCC	3	0	0	3
22MT230	Free Body Mechanics	PCC	3	0	0	3
22MT250	Manufacturing Process	PCC	3	0	0	3
THEORY CUM PRACTICAL						
22MT240	Problem Solving using C	ESC	1	0	4	3
PRACTICAL						
22MT260	Mechatronic Workshop	ESC	0	0	2	1
22MT270	Manufacturing Laboratory	PCC	0	0	2	1
22MT280	Mechatronic System Laboratory	ESC	0	0	2	1
		Total	**13**	**1**	**10**	**19**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

II SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT210	Matrices and Ordinary Differential Equations	3	40	60	100	27	50
22MT220	Analog Electronics	3	40	60	100	27	50
22MT230	Free Body Mechanics	3	40	60	100	27	50
22MT250	Manufacturing Process	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22MT240	Problem Solving using C	3	50	50	100	25	50
PRACTICAL							
22MT260	Mechatronic Workshop	3	60	40	100	18	50
22MT270	Manufacturing Laboratory	3	60	40	100	18	50
22MT280	Mechatronic System Laboratory	3	60	40	100	18	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

III SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT310	Partial Differential Equations	BSC	3	1	0	4
22MT320	Digital Electronics	PCC	3	0	0	3
22MT330	Kinematics and Dynamics of Machinery	ESC	3	0	0	3
22MT340	Thermal Fluid Systems	PCC	3	0	0	3
22MT350	Electrical Machines	ESC	3	0	0	3
PRACTICAL						
22MT360	Thermal Engineering Laboratory	PCC	0	0	2	1
22MT370	Electrical Machines Laboratory	ESC	0	0	2	1
22MT380	Electronic Circuits and Digital Laboratory	PCC	0	0	2	1
22ES390	Design Thinking	ESC	2	0	2	3
		Total	**15**	**1**	**6**	**22**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

III SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT310	Partial Differential Equations	3	40	60	100	27	50
22MT320	Digital Electronics	3	40	60	100	27	50
22MT330	Kinematics and Dynamics of Machinery	3	40	60	100	27	50
22MT340	Thermal Fluid Systems	3	50	50	100	25	50
22MT350	Electrical Machines	3	40	60	100	27	50
PRACTICAL							
22MT360	Thermal Engineering Laboratory	3	60	40	100	18	50
22MT370	Electrical Machines Laboratory	3	60	40	100	18	50
22MT380	Electronic Circuits and Digital Laboratory	3	60	40	100	18	50
22ES390	Design Thinking	3	60	40	100	18	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

22MT210	MATRICES AND ORDINARY DIFFERENTIAL EQUATIONS	Category	L	T	P	C	TE
		BSC	3	1	0	4	Theory

Preamble

Several mathematical problems encountered in scientific or industrial applications involve solving a linear system at some stage and that are arise in applications to such areas as electronics, engineering and physics. In engineering, particularly Solid Mechanics, Fluid Flow, Heat Flow and Robotics have application that requires an understanding of Vector Calculus and Differential Equations. Moreover, Laplace Transform is essential to solve ordinary differential equations that occur in the above areas. This course designed to impart the knowledge and understanding of the above concepts to all 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 Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Compute the unknowns of the system of linear equations.	TPS2	80	75
CO2	Apply various operations on matrices to solve traffic flow, electric networks and construct an orthonormal basis of an inner product space.	TPS3	75	70
CO3	Compute divergence and curl of vector functions.	TPS2	80	75
CO4	Apply the concepts of vector differentiation and vector integration to evaluate work done by the force and fluid flow problems.	TPS3	75	70
CO5	Apply Laplace transform to solve the initial value problems arise in engineering.	TPS3	75	70
CO6	Solve the homogeneous and non-homogeneous differential equations using appropriate methods.	TPS3	75	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO2	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO3	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO4	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO5	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO6	S	M	-	-	-	L	-	-	-	-	L	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

	Theory						Theory						Theory		
	Assessment-1						Assessment-2						Terminal Examination		
	Assignment-1			CAT-1			Assignment-2			CAT-2					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	100%			17%			-	-	-	-	-	-	8%		-
CO2				33%						-	-	-	17%		
CO3				8%			-			-	-	-	4%		-
CO4				42%			-			-	-	-	21%		
CO5	-		-	-			100%			50%			25%		
CO6	-		-	-						50%			25%		

Syllabus

MATRICES AND SYSTEM OF EQUATIONS: Systems of Linear Equations- Equivalent Systems- Row Echelon Form- Overdetermined Systems- Underdetermined Systems- Reduced Row Echelon Form- Applications: Traffic Flow, Electric Networks - Kirchhoff's Laws – Vector Spaces – Basis and dimension – Eigen values and eigen vectors of a matrix. - Hermitian and Unitary matrices - Inner Product space – Orthonormal vectors - Gram Schmidt orthogonalization process.

VECTOR CALCULUS: Divergence of a Vector Field- Curl of a Vector Field- Line Integrals- Path independence of line integrals- Green's Theorem in the plane- Surface Integrals- Triple Integrals, Divergence Theorem of Gauss- Applications of the Divergence Theorem- Stoke's Theorem.

LAPLACE TRANSFORMS: Laplace transform, Linearity, First Shifting theorem – Transforms of derivatives and integrals, ODEs – Unit step function, Second shifting theorem – Short Impulses, Dirac's delta function, partial fractions – Convolution, Integral Equations – Differentiation and integration of transforms.

ORDINARY DIFFERENTIAL EQUATIONS: Homogeneous Linear ODEs of second order – Homogeneous Linear ODEs with constant coefficients – Euler Cauchy Equation – Existence and uniqueness of solutions, Wronskian – Non homogeneous ODE- Solution by Variation of Parameters.

Text and Reference Book(s)

1. Steven Leon, "Linear Algebra with Applications", 9th Edition, Pearson Education, 2015.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", 10thedition, Wiley, New Delhi, 2017.
3. David C. Lay, "Linear Algebra and its Applications", 4th Edition, Pearson Education, 2014.
4. B.S. Grewal, "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, New Delhi, 2014.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**MATRICES AND SYSTEM OF EQUATIONS**	
1.1	Systems of Linear Equations- Equivalent Systems	1
1.2	Row Echelon Form- Overdetermined Systems	1
1.3	Underdetermined Systems- Reduced Row Echelon Form-	1
	Tutorial	1
1.4	Applications: Traffic Flow, Electric Networks - Kirchhoff's Laws	2
1.5	Vector Spaces – Basis and dimension	1
1.6	Eigen values and eigen vectors of a matrix	1
	Tutorial	1
1.7	Inner Product space – Orthonormal vectors	1
1.8	Gram Schmidt orthogonalization process	1
	Tutorial	1
2.	**VECTOR CALCULUS**	
2.1	Gradient, divergence and curl of a scalar and vector field	2
2.2	Line Integrals	2
	Tutorial	1
2.3	Green's Theorem in the Plane, Surface Integrals	2
	Tutorial	1
2.4	Triple Integrals. Divergence Theorem of Gauss	1
2.5	Applications of the Divergence Theorem	1
2.6	Stoke's Theorem	1
	Tutorial	1
3.	**LAPLACE TRANSFORMS**	
3.1	Laplace Transform, Linearity, First Shifting Theorem (*s*-Shifting)	2
3.2	Transforms of Derivatives and Integrals: ODEs	2
	Tutorial	1
3.3	Unit Step Function, Second Shifting Theorem	1
3.4	Short Impulses, Dirac's Delta Function and Partial Fractions	1
	Tutorial	1
3.5	Convolution. Integral Equations	2
3.6	Differentiation and integration of transforms	1
	Tutorial	1
4	**ORDINARY DIFFERENTIAL EQUATIONS**	
4.1	Homogeneous Linear ODEs of Second Order	2
4.2	Homogeneous Linear ODEs with Constant Coefficients	1
	Tutorial	1
4.3	Euler–Cauchy Equations	1
4.4	Existence and Uniqueness of Solutions. Wronskian	1
	Tutorial	1
4.5	Nonhomogeneous ODEs	2
4.6	Solution by Variation of Parameters	2
	Tutorial	1
	Total	**48**

Course Designers:

1. Dr. S. Saravanakumar, sskmat@tce.edu
2. Dr. M. Sundar, msrmat@tce.edu

22MT220	ANALOG ELECTRONICS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

This course provides engineering students with basic understanding of analog electronic components and designs of circuits using them. The syllabus includes Construction of Transistor, MOSFET its construction and different circuit configurations. Then we have some of the Op-amp basics, its configurations and different configurations for different applications. Then we learn about the feedback mechanisms used in the circuits for the generation of sinusoidal oscillations in generating waveforms using different Devices and IC.
Then we discuss about the voltage convertors and Regulators for powering the analog electronics.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the different types of transistors for specific applications	TPS2	80	80
CO2	Construct a FET based transistor circuits for switching applications	TPS3	70	70
CO3	Interpret the working of an operational Amplifier	TPS2	80	70
CO4	Select operational amplifier circuits for applications like clipper, amplifier, switches etc	TPS3	70	70
CO5	Construct Tuned oscillator circuits for filter and frequency selection applications	TPS3	70	70
CO6	Identify the appropriate Voltage Regulators and Convertors for analog circuits	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	M	-	-	-	-	-		M	M	L
CO2	S	M	L	-	M	-	L	-	M	-	M	M	M	L
CO3	S	M	-	-	M	-	-	-	-	-		S	S	S
CO4	S	M	L	-	M	-	L	-	M	-	M	S	S	L
CO5	S	M	L	-	M	-	L	-	-	-	M	S	S	M
CO6	S	M	L	-	M	-	-	-	M	-	M	S	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	25	-	-	25	-	-	-	-	-	-	-	-	10	-
CO2	-	-	50	-	-	50	-	-	-	-	-	-	-	-	20
CO3	-	25	-	-	25	-	-	-	-	-	-	-	-	10	-
CO4	-	-	-	-	-	-	-	-	50	-	-	50	-	-	20
CO5	-	-	-	-	-	-	-	-	25	-	-	25	-	-	20
CO6	-	-	-	-	-	-	-	-	25	-	-	25	-	-	20

Syllabus

Introduction: Introduction to Electronic Devices – Circuit theorems, Review of BJT Working and its applications

Field Effect Transistors: Junction Field Effect Transistors (JFET) –Construction of N channel and P Channel Devices – Transfer Characteristics - Metal oxide semiconductor FET (MOSFET) – Types - P channel and N channel MOSFET – FET Biasing

Operational Amplifiers: Basic information about op-amps – Ideal Operational Amplifier – General operational amplifier stages. DC and AC performance characteristics, slew rate, Open and closed loop, Error analysis

Applications: Sign Changer, Scale Changer, Voltage Follower, V-to-I and I-to-V converters, adder, subtractor, Instrumentation amplifier, Integrator, Differentiator, Comparators, Schmitt trigger, Precision rectifier, peak detector, Low-pass, high-pass and band-pass Butterworth filters. Special ICs-555 timer and applications

Feedback and Oscillator circuits: Feedback Concepts - Feedback Connection Types - Feedback Circuits - Feedback Amplifier - Phase and Frequency Considerations - Oscillator Operation - Phase-Shift Oscillator - Wien Bridge Oscillator - Tuned Oscillator Circuit - Crystal Oscillator.

Voltage Regulators: Introduction, General Filter Considerations, Capacitor Filter, RC Filter, Discrete Transistor Voltage Regulation, IC Voltage Regulators and Convertors

Text Book(s)

1. Electronic Devices and Circuits theory - Robert L. Boylestead, Louis Nashelsky, New International Edition, 2013, Pearson ISBN-13 978-1292025636
2. Introductory Circuit Analysis, Global Edition, (13th Edition) September 2015 by Robert Boylestad, ISBN-13 978-1292098951
3. Open Circuits: The Inner Beauty of Electronic Components, by Windell Oskay and Eric Schleper, September 2022, 304 pp. ISBN-13: 97817185023

Reference Books & Web Resources

1. Integrated Electronics, Jacob Milman,Christos C Halkias, Mcgraw Hill Education
2. Thomas L.Floyd, “Electronic devices” Conventional current version, Pearson prentice hall, 10th Edition, 2017
3. David A. Bell,” Electronic devices and circuits”, Oxford University higher education,5th edition 2008
4. Electronic Devices and Circuits, S Salivahanan, N Suresh Kumar, A Vallvaraj, 5th Edition, MCGRAW HILL EDUCTION
5. Electronics Circuits and Application, Md H Rashid, Cengage 2014

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	Course Outcome
1	**Introduction:**	-	-
1.1	Induction to Electronic Devices - Review of BJT Working and its applications	1	CO1
1.2	Circuit theorems	2	CO1
2	**Field Effect Transistors:**	-	-
2.1	Junction Field Effect Transistors (JFET) – Construction of N channel and P Channel Devices –	2	CO1
2.2	Transfer Characteristics - Metal oxide semiconductor FET (MOSFET) – Types - P channel and N channel MOSFET –	2	CO2
2.3	FET Biasing	2	CO2
3	**Operational Amplifiers**	-	-
3.1	Ideal Operational Amplifier	1	CO3
3.2	General operational amplifier stages. DC and AC performance characteristics, slew rate	2	CO3
3.3	Open and closed loop, Error Analysis	1	CO3
3.4	Sign Changer, Scale Changer, Voltage Follower	1	CO4
3.5	V-to-I and I-to-V converters, adder, subtractor	2	CO4
3.6	Instrumentation amplifier, Integrator, Differentiator	2	CO4
3.7	Comparators, Schmitt trigger, Precision rectifier, peak detector	2	CO4
3.8	Low-pass, high-pass, and band-pass Butterworth filters. Special ICs-555 timer and applications	3	CO4
4	**Feedback and Oscillator circuits**	-	-
4.1	Feedback Concepts- Feedback Connection Types - Feedback Circuits	2	CO5
4.2	Feedback Amplifier—Phase and Frequency Considerations	1	CO5
4.3	Oscillator Operation	1	CO5
4.4	Operation Phase-Shift Oscillator Wien Bridge Oscillator	2	CO5
4.5	Tuned Oscillator Circuit Crystal Oscillator	1	CO5
5	**Voltage Regulators**	-	-
5.1	General Filter Considerations, Capacitor Filter	2	CO6
5.2	RC Filter	2	CO6
5.3	Discrete Transistor Voltage Regulation, IC Voltage Regulators	2	CO6
	Total	**36**	

Course Designers:

1. Mr. S Parthasarathi, parthasarathi_s@tce.edu
2. Mr. S.A.R. Sheik Masthan, sarsmech@tce.edu

22MT230	FREE BODY MECHANICS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Mechanics is the branch of physics concerned with the behavior of physical bodies when subjected to forces or displacements, and the subsequent effect of the bodies on their environment. The course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving. For an engineer the knowledge of engineering mechanics is very essential. It helps an engineer in planning, designing, and construction of various types of structures and machines. If an engineer study engineering mechanics in systematic and scientific manner than he can take up his job more skillfully. The course covers a basic introduction to both statics and dynamics. Emphasis is placed upon the gaining of real understanding of the laws and principles of mechanics.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Understand the laws and principles of mechanics	TPS2	70	80
CO2	Analyse and solve simple problems using the concept of static equilibrium	TPS3	70	80
CO3	Find the centroid and moment of inertia of a 2D and 3D components	TPS3	70	80
CO4	Solve problems involving frictional phenomena in machines	TPS3	70	80
CO5	Solve problems involving kinematics and kinetics of rigid bodies in plane motion	TPS3	70	80
CO6	Solve problems using D'Alembertz principles	TPS3	70	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	-	-	-	-	-	-	-	M	-	L	L
CO2	S	M	M	-	-	-	-	-	-	-	M	-	L	L
CO3	S	M	M	-	-	-	-	-	-	-	M	-	L	L
CO4	S	M	M	-	-	-	-	-	-	-	M	-	L	M
CO5	S	M	M	-	-	-	-	-	-	-	M	-	L	M
CO6	S	M	M	-	-	-	-	-	-	-	M	-	L	M

S – Strong M – Medium L – Low

Assessment Pattern

	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	-	-	-	30	-	-	-	-	-	-	-	4	-
CO2	-	10	35	-	-	35	-	-	-	-	-	-	4	4	12
CO3	-	10	35	-	-	35	-	-	-	-	-	-	4	4	12
CO4	-	-	-	-	-	-	-	10	-	-	-	30	4	4	12
CO5	-	-	-	-	-	-	-	10	35	-	-	35	4	4	12
CO6	-	-	-	-	-	-	-	10	35	-	-	35	4	-	12

Syllabus

Static Equilibrium of Mechanical Systems: Equilibrium Conditions-Two force body-Three force body.

System of forces: Representation of Force, Moment and Couples-Reduction of system of forces to one force and couple.

Distributed forces: Centroid of lines and areas-Centre of gravity of mass-Moment of inertia of areas-Mass moment of inertia.

Objects with friction: Ladder friction-Wedge Friction-Screw Friction-Applications

Dynamic equilibrium: Particles in motion-Kinematics of particles-rectilinear motion-Curvilinear Motion-Kinetics of particles-Newton's Law of motion-Work-energy principle-Impulse-Momentum principle, D'Alembert's principle.

Rigid body motion: Kinematic Motion -Rotary motion of rigid bodies-Plane Motion-Kinetic motion.

Text Book(s)

1. Beer F.P. and Johnston Jr. E.R., Vector Mechanics for Engineers: Statics and Dynamics, Twelfth student Edition, Tata McGraw Hill College, 2018
2. Hibbeler R.C., Engineering Mechanics – Statics & Dynamics, Fourteenth Edition, Pearson Publisher, 2015

Reference Books & Web Resources

1. R.C Hibbeler, Irving H Shames, D.P Sharma., Engineering Mechanics, Pearson Education 2011
2. Tayal A.K., Engineering Mechanics, Fourteenth Edition, Umesh Publications, 2010
3. https://nptel.ac.in/courses/112103108/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours
1.	Introduction Static Equilibrium of mechanical systems	2
1.1	Fundamental laws, Free body diagram	1
1.2	Two force body, three force body	1
2.	**System of forces**	
2.1	Representation of Force,	1
2.2	Moment and Couples	1
2.3	Reduction of system of forces to one force and couple	1
3	**Distributed forces**	
3.1	Centroid of lines and areas	1
3.2	Centre of gravity of mass	2
3.3	Moment of inertia of areas	1
3.4	Tutorial Problems in Moment of Inertia	2
4.	**Objects with friction**	
4.1	Ladder friction	2
4.2	Wedge friction	1
4.3	Screw friction	2
5.	**Dynamic equilibrium**	
5.1	Particles in motion	1
5.2	Kinematics of particles	1
5.3	Rectilinear motion	1
5.4	Curvilinear motion	1
5.5	Kinetics of particles	1
5.6	Newton's Law of motion	2
5.7	Work-energy principle	2
5.8	Impulse-Momentum principle,	2
5.9	Tutorial Problems	1
6.	**Rigid body motion**	
6.1	General plane motion	1
6.2	Kinematic Motion –Rotary motion of Rigid bodies	1
6.3	Plane motion -D Alembert's principle	1
6.4	Kinetic motion	1
6.5	Tutorial Problems	2
	Total	**36**

Course Designer(s):

1. Dr. G Kanagaraj, gkmech@tce.edu

22MT240	PROBLEM SOLVING USING C (TCP)	Category	L	T	P	C	TE
		ESC	1	0	4	3	Practical

Preamble

This course is intended for the candidate who desires to learn problem-solving techniques and the design of computer solutions in a precise manner. This course emphasizes problem-solving methodologies, algorithm designs and development of computer programming skills using C Language. The intention is to provide sufficient depth in these topics to enable candidates to achieve better understanding of problem-solving using C Language.
The modules in the course reflect solving general problems via programming solution. Thus, modules collectively focus on programming concepts, strategies and techniques; and the application of these toward the development of programming solutions.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Develop algorithms for solving simple mathematical and engineering problems	TPS3	70	70
CO2	Explain the various programming concepts in C Language	TPS2	70	70
CO3	Translate algorithms to programs in C Language	TPS3	70	70
CO4	Examine the suitability of appropriate branching, selection, iteration, structures, data types for given problem and develop solution for the same	TPS3	70	70
CO5	Organize files, perform text operations like editing, pattern searching and string manipulation related problems	TPS3	70	70
CO6	Analyse and debug the programs written in C Language for syntax, run time and logical errors	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO2	M	L	-	-	-	-	-	-	M	M	-	M	-	M
CO3	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO4	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO5	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO6	S	M	L	-	M	-	-	-	M	M	-	M	-	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Continuous Assessment Test (CAT)*		Terminal (Practical)
	CAT 1 (Theory)	CAT 2 (Lab Model Exam)	
CO1	30	100	100
CO2	20		
CO3	10		
CO4	-		
CO5	40		
CO6	-		

Syllabus

Algorithms: Introduction to Computer, Program Design, Flowcharts, Developing an Algorithm, Fundamental Algorithms, Algorithms Using Selection and Repetition, exchanging values of variables, Counting

C Components: Program structure - Compilers – Assemblers – Linkers – Loaders - Integrated Development Environment - Project Creation

C Programming Concepts: Data Types – Operators - Control Structures – Format Specifiers – Arrays – 1D, 2D – Character and String handling - Functions – passing values – recursive functions - Scope and extent - Storage Classes - Pointers – pointer arithmetic – pointers and arrays – pointers as arguments - Structures – array of structures – union – dynamic memory allocation - File operations – I/O operations – error handling

Debugging Techniques: Error Types, identification – Debugging steps and tools – watch window – breakpoint – step in, out

Text Book(s) and Reference Materials

1. Herbert Schildt, C: The Complete Reference, 4th edition, McGraw Hill Education, 2017
2. Yashavant Kanetkar, Let Us C: Authentic guide to C programming language, 18th edition, BPB Publications, 2021

Reference Materials and Web Resources

1. E. Balagurusamy, “Programming in ANSI C”, 8th edition, McGraw Hill Education, 2019
2. NPTEL Course: https://onlinecourses.nptel.ac.in/noc17_cs43/preview
3. NPTEL Course: https://onlinecourses.nptel.ac.in/noc20_cs06/preview
4. https://www.tutorialspoint.com/cprogramming/index.htm
5. https://www.geeksforgeeks.org/c-programming-language/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	
		Theory	Practical
1	**Algorithms**	-	-
1.1	Introduction to Computer, Program Design, Flowcharts, Developing an Algorithm, Fundamental Algorithms,	2	-
1.2	Algorithms Using Selection and Repetition, exchanging values of variables, Counting	2	-
	Exercise involving algorithm development	-	2
2	**C Components**	-	-
2.1	Program structure - Compilers – Assemblers – Linkers – Loaders - Integrated Development Environment - Project Creation	2	-
3	**C Programming Concepts**	-	-
3.1	Data Types – Operators - Control Structures – Format Specifiers	2	-
	Algorithm to C Program Conversion	-	2
	Fundamentals Problem solving using Control Structures	-	6
3.2	Arrays – 1D, 2D – dynamic arrays	2	-
	Programs using Arrays	-	4
3.3	Character and String handling	2	-
	Programs involving character and string handling	-	2
3.4	Functions – passing values – recursive functions - Scope and extent - Storage Classes	4	-
3.5	Pointers – pointer arithmetic – pointers and arrays – pointers as arguments – Structures – array of structures – union – dynamic memory allocation	4	-
	Programs involving Functions and pointers	-	4
3.6	File operations – I/O operations – error handling	2	
	Programs involving files	-	2
4	**Debugging Techniques**	-	-
4.1	Error Types, identification – Debugging steps and tools – watch window – breakpoint – step in, out	2	-
	Programs predicting the output and debugging	-	2
	TOTAL	**24**	**24**

Course Designers:

1. S.A.R. Sheik Masthan, sarsmech@tce.edu

22MT250	MANUFACTURING PROCESS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Primarily, the manufacturing processes are being carried out through casting, forming, machining, and joining processes. This course aims to provide knowledge on the working principles, basic operations and applications on the above stated processes

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the principle, process capabilities of metal casting, forming, joining and machining processes.	TPS2	75	80
CO2	Select the suitable metal casting and forming processes for the given product.	TPS3	75	80
CO3	Suggest the suitable joining methods for assembly of product.	TPS2	75	80
CO4	Select a suitable process for machining of a given part.	TPS3	75	80
CO5	Select a suitable process for the given manufacturing applications.	TPS3	75	80
CO6	Calculate the machining time for lathe and drilling operations	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	L
CO2	S	M	L	-	-	-	-	-	-	-	-	-	M	L
CO3	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO4	S	M	L	-	-	-	L	-	-	-	-	-	M	M
CO5	S	M	L	-	L	-	-	-	-	-	-	-	L	M
CO6	S	M	L	-	-	-	-	-	-	-	-	-	L	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 1			Assignment 1					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	4	20	-	-	-	-	-	-	-	-	-	-	4	10	-
CO2	4	20	-	-	-	-	-	-	-	-	-	-	4	10	-
CO3	2	20	30	-	-	100	-	-	-	-	-	-	4	5	10
CO4	-	-	-	-	-	-	4	10	20	-	-	35	4	5	10
CO5	-	-	-	-	-	-	4	10	20	-	-	35	2	5	10
CO6	-	-	-	-	-	-	2	10	20	-	-	30	2	5	10

Syllabus

Manufacturing Processes- Classification of Manufacturing Processes- Metal Casting-Metal Forming- Machining Processes- Metal Joining Processes- Metal Finishing Processes.
Metal Casting Processes: Expendable mould Casting Processes -Sand Casting – Shell moulding – Plaster Mould casting – Ceramic mould casting – Investment casting – Permanent Mold casting Processes – Pressure casting - Die casting - Centrifugal casting, Role of materials and chemistry in casting.
Plastic forming Processes: Plastics, general properties and applications of thermo plastics and thermosets, Extrusion, Injection Molding, Blow Molding, Rotational Molding, Thermoforming, Compression Molding, Transfer molding**.**
Metal Forming Processes: Flat Rolling – Flat Rolling Practice –Rolling Mills – Shape Rolling operations – Production of seamless tubing and pipe – Forging –Open die forging – Impression Die and Closed die forging – Extrusion - Hot extrusion – Cold extrusion – Impact extrusion – Hydrostatic extrusion.
Sheet metal forming Processes: Shearing – Sheet Metal characteristics – Bending sheet and plate.
Metal Joining Processes: Fusion Welding Processes- Oxy Acetylene welding - Arc welding processes: Consumable Electrode and Non-consumable Electrode – Electron Beam Welding – Laser Beam Welding. Solid State Welding Processes: **-** Ultrasonic welding – Friction welding – Resistance welding.
Brazing, Soldering: Introduction to Brazing and Soldering
Machining processes for producing round shapes: Centre Lathe, Horizontal Boring Machine – Radial Drilling Machine.
Machining processes for producing various shape: Vertical Milling machine – Horizontal Broaching machine, Surface treatment.
Abrasive machining and finishing processes: Abrasives – Bonded Abrasives (Grinding Wheels) – Cylindrical Grinding Machine – Surface Grinding Machine - Lapping – Honing - Super finishing.
Introduction to Additive Manufacturing and Unconventional Machining Process – Laser cutting, Chemical and Electro chemical Machining, Composite Manufacturing.

Text Book(s)

1. Serope Kalpakjian and Steven R.Schmid, “Manufacturing Engineering and Technology”, Eighth Edition, Pearson, 2020.
2. Mikell P.Groover, “Fundamental of Modern Manufacturing”, Wiley India Edition, Third Edition, Reprint, 2012.

Reference Books & Web Resources

1. E. Paul DeGarmo, J. T. Black and Ronald A. Kohser, “Degarmo's Materials and Processes in Manufacturing”, John Wiley & Sons, 11th Edition 2011.
2. Philip F. Oswald, and Jairo Munoz, “Manufacturing Process and systems”, John Wiley India Edition, 9th Edition, Reprint 2008.
3. S. K. Hajra Choudhury, Nirjhar Roy, A. K. Hajra Choudhury, “Elements of Work shop Technology”, Vol – II Manufacturing Processes, Media Promoters and Publishers Pvt. Ltd, 2009.
4. P.N.Rao, “Manufacturing Technology”, Volume-2, Tata McGraw Hill, New Delhi, Third Edition, 2011.
5. P.C. Sharma, “A Text Book of Production Technology (Manufacturing Processes)”, S. Chand & Company Ltd., New Delhi, Seventh Reprint, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1.	**Manufacturing Processes**	
1.1	Classification of Manufacturing Processes- Metal Casting- Metal forming- Machining Processes- Metal Joining Processes- Metal Finishing Processes.	2
1.2	**Metal casting Processes** Expendable mould Casting Processes -Sand Casting Shell molding – Plaster Mould casting	2
1.3	Ceramic mould casting – Investment casting Permanent Mould casting Processes – Slush casting	2
1.4	Pressure casting – Die casting – Centrifugal casting	1
1.5	**Plastic forming Processes:** Plastics, general properties and applications of thermo plastics and thermosets, Extrusion	2
1.6	Injection Molding, Blow Molding, Rotational Molding, Thermoforming, Compression Molding, Transfer molding**.**	2
2	**Metal Forming Processes**	
2.1	Production of seamless tubing and pipe	1
2.2	Forging –Open die forging, Impression Die and Closed die forging and related forging operations	2
2.3	Extrusion- Hot extrusion – Cold extrusion, Impact extrusion – Hydrostatic extrusion	2
2.4	**Sheet metal forming Processes:** Shearing, Sheet Metal characteristics – Bending sheet and plate	2
3	**Metal Joining Processes**	
3.1	Fusion Welding Processes-Oxy Acetylene welding	1
3.2	Arc welding processes: Consumable Electrode and Non consumable Electrode	2
3.3	Electron Beam Welding – Laser Beam Welding.	1
3.4	Solid State Welding Processes: **-** Ultrasonic welding, Friction welding – Resistance welding	2
3.5	Introduction to Brazing and Soldering	1
4	**Machining processes for producing round shapes**	
4.1	Centre Lathe - Horizontal Boring Machine, Radial Drilling Machine	3
4.2	**Machining processes for producing various shape** Vertical Milling machine	1
4.3	Horizontal Broaching machine - surface treatment	1
4.3	**Abrasive machining and Finishing processes** Abrasives – Bonded Abrasives (Grinding Wheels)	1
4.4	Cylindrical Grinding Machine - Surface Grinding Machine	1
4.5	Lapping – Honing - Super finishing	1
4.6	Introduction to Additive Manufacturing	1
4.7	Unconventional Machining Process - LASER cutting, Chemical and Electro chemical Machining, Composite Manufacturing	2
	Total	**36**

Course Designers:

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22MT260	MECHATRONIC WORKSHOP	Category	L	T	P	C	TE
		ESC	0	0	2	1	Practical

Preamble

Workshop is a hands-on training practice to engineering students. The aim of this course is to impart fundamental hands-on skill in carrying out experiments at higher semester practical courses.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Make different types of wooden joints and sheet metal components	TPS3	80	90
CO2	Construct protection circuits using Fuse, MCB, MCCB, ELCB	TPS3	80	90
CO3	Prepare and test an Ethernet cable for Local Area Network connection	TPS3	80	90
CO4	Construct Switching circuits using Transistor, MOSFET and Thyristors	TPS4	75	80
CO5	Design and fabricate a Printed Circuit Board	TPS3	80	90
CO6	Assemble components in PCB using Soldering Techniques	TPS4	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	L	-	-	M	M	-	L	L	M
CO2	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO3	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO4	S	S	M	L	-	-	-	-	M	M	-	S	S	S
CO5	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO6	S	S	M	L	-	-	-	-	M	M	-	S	S	S

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Name of the Experiment	No. of Periods
1	Preparation of wooden parts like Door frame / Office tray	4
2	Preparation of Sheet metals like Litre Cone/Dustpan (Straight, Taper)/Tray (Straight, Taper).	4
3	Electrical Wiring practices (One way switch and Two-way switch)	2
4	Electrical Wiring practices and testing with circuit breakers using Fuse, MCB, MCCB, ELCB	
5	Local Area Network Structure cabling	2
6	Verification of Transistor switching circuits using breadboard	2
7	Verification of MOSFET and Thyristor switching circuits using breadboard	2
8	Construction of timer circuits using 555 Timer IC	2
9	Identification of electronic components	2
10	Design a PCB layout for a given circuit	2
11	Fabricate a PCB using wet Etching	2
12	Assemble and dissemble of electronic components using soldering	2
	Total	**24**

Course Designers:

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22MT270	MANUFACTURING LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

Manufacturing processes are the steps through which raw materials are transformed into a final product. Manufacturing processes can be classified as: 1. Casting Processes, 2. Forming Processes, 3. Machining Processes, 4. Joining Processes, 5. Finishing Processes.
Casting is a manufacturing process by which a liquid material is usually poured into a mould, which contains a hollow cavity of the desired shape, and then allowed to solidify.
This course is aimed to provide practical experience on the working principles, process capabilities, process parameters, equipment advantages, limitations and applications of various casting, metal joining and Machining processes.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Prepare a mould using suitable casting process.	TPS3	80	90
CO2	Select a suitable material and process for a given product to perform welding.	TPS3	80	90
CO3	Perform tapering, turning and threading in lathe for the given component.	TPS3	80	90
CO4	Machine a given component using suitable milling process	TPS3	80	90

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	L	M	-	-	L	L	L
CO2	S	M	L	-	-	-	-	L	M	-	-	L	M	M
CO3	S	M	L	-	-	-	-	L	M	-	-	L	L	L
CO4	S	M	L	-	-	-	-	L	M	-	-	L	-	L

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Name of the Experiment	No. of Periods
1	Preparation of Mould for sand casting using single piece pattern	2
2	Preparation of Mould for sand casting using split pattern	2
3	Make a butt/lap/ corner/ Tee joint using the given metal strips in ARC welding	2
4	Make a butt/lap/ corner/ Tee joint using the given metal strips in MIG welding	2
5	Make a butt/lap/ corner/ Tee joint using the given metal strips in SPOT welding	2
6	Plain, Taper and Step turning in lathe	2
7	Grooving (UCD) and Thread (Left), and Thread (Right) in lathe	2
8	Spur / Helical Gear Cutting in Horizontal Milling Machine	2
9	Key Way Milling and Flat Milling in Vertical Milling Machine	2
10	Plain Grinding, Morse Taper Grinding in Grinding Machine	2
11	Drilling, Counter Boring and Tapping	2
12	Demonstration of 3D printing in RP Machine	2
	Total	**24**

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22MT280	MECHATRONIC SYSTEM LABORATORY	Category	L	T	P	C	TE
		ESC	0	0	2	1	Practical

Preamble

Mechatronics allows the engineer to integrate mechanical, electronics, control engineering and computer science into a product design process. Competing in a globalized market requires the adaptation of modern technology to yield flexible, multifunctional products that are better, cheaper, and more intelligent than those currently on the shelf. The importance of mechatronics is evidenced by the myriad of smart products that we take for granted in our daily lives, from the cruise control feature in our cars to advanced flight control systems and from washing machines to multifunctional precision machines.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Identify the components present in a Mechatronics system.	TPS3	80	80
CO2	Assemble and Disassemble a Mechatronics System	TPS3	70	70
CO3	Summarize the components present in a Mechatronics system.	TPS3	80	70
CO4	Develop a Toy Using the Electrical, Mechanical and Electronics components	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	M	-	-	-	-	-		M	M	L
CO2	S	M	L	-	M	-	L	-	M	-	M	M	M	L
CO3	S	M	-	-	M	-	-	-	-	-		S	S	S
CO4	S	M	L	-	M	-	L	-	M	-	M	S	S	L

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Name of the Experiment	No. of Periods
1	Identifying the Electrical, mechanical, and electronic Circuits available in an Automobile.	4
2	Assemble and disassemble a 3D Printer and Explain the working of its components.	2
3	Assemble and Disassemble a Washing Machine and Explain the working of its Components	2
4	Assemble and Disassemble a Microwave Oven and Explain the working of its Components	2
5	Assemble and Disassemble a Mobile Robot and Explain the working of its Components	2
6	Identify the Electrical, mechanical and Electronics Components for an Industrial Robot	2
7	Implementing the Electronic Circuits identified in the Electronics circuits.	4
8	Built a Creative Toy Using the Electrical, Mechanical and Electronics components Identified in the above experiments	6
	Total	**24**

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22MT310	PARTIAL DIFFERENTIAL EQUATIONS	Category	L	T	P	C	TE
		BSC	3	1	0	4	Theory

Preamble

Fourier series are infinite series that represent periodic functions in terms of cosines and sines that are of greatest importance to the engineer and applied mathematician. Integral theorems play a vital role to obtain Fourier transform from Fourier series. Fourier transform have wide applications in engineering especially in designing electrical circuits, solving differential equations, signal processing, signal analysis, image processing and filtering. The course also develops students' skills in the formulation, solution, understanding and interpretation of partial differential equation models, which helps to solve wave propagation and heat phenomena.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Demonstrate Fourier series to study the behaviour of periodic functions and their applications in engineering applications.	TPS3	75	70
CO2	Understand Fourier integral theorems to transform of elementary functions.	TPS2	80	75
CO3	Apply Fourier transform to illustrate discrete/continuous functions arising in signals and systems.	TPS3	75	70
CO4	Solve the partial differential equations using various methods.	TPS3	75	70
CO5	Distinguish the partial differential equations of second order.	TPS2	80	75
CO6	Solve the boundary value problems involving wave phenomena and heat propagation using suitable methods.	TPS3	75	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO2	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO3	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO4	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO5	S	M	-	-	-	L	-	-	-	-	L	-	-	-
CO6	S	M	-	-	-	L	-	-	-	-	L	-	-	-

S – Strong M – Medium L – Low

Assessment Pattern

	Theory						Theory						Theory		
	Assessment-1						Assessment-2						Terminal Examination		
	Assignment-1			CAT-1			Assignment-2			CAT-2					
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	100%			42%			-			-	-	-	21%		
CO2				13%		-	-			-	-	-	6%		-
CO3				45%			-			-	-	-	23%		
CO4	-			-	-	-	100%			50%			25%		
CO5	-			-	-	-				13%			6%		-
CO6	-			-	-	-				37%			19%		

Syllabus

Fourier series: Conditions for Fourier expansion - Functions having points of discontinuity - Change of interval - Odd and even function- Periodic functions – Half range series – Fourier series of typical waveforms - Parseval's formula – Complex form of Fourier series – Harmonic analysis.

Fourier Transforms:
Fourier Integral theorem – Fourier sine and cosine integrals – Complex form of Fourier integrals – Fourier Transform – Fourier sine and cosine transforms – Finite Fourier sine and cosine transforms–Properties of Fourier transforms- Convolution theorem for Fourier transforms – Parseval's identity for Fourier transforms.

Partial differential equations:
Formation of partial differential equations – Solutions of partial differential equations – Equations solvable by direct integration – Linear equations of the first order – Nonlinear equations of the first order – Homogeneous linear equations with constant coefficients – Rules for finding the complementary functions – Rules for finding the particular integral –Working procedure to solve homogeneous and non-homogeneous linear equations.

Applications of Partial Differential Equations:
Method of separation of variables – Classification of second order partial differential equations Vibrations of a stretched string: Wave equations – One dimensional heat flow – Two-dimensional heat flow: Solution of Laplace equation in Cartesian coordinates –Laplace equations in polar coordinates.

Text Book(s)

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012

Reference Books & Web Resources

1. Peter V.O. Neil, "Advanced Engineering Mathematics",7th edition, Cengage Learning, 2017.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi,2016.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods	CO
1	**Fourier Series**		
1.1	Conditions for Fourier expansion, Euler's formula, Functions having points of discontinuity	1	
1.2	Change of interval, Odd and even functions, Expansions of odd or even and periodic functions	2	
	Tutorial	1	
1.3	Half range series	2	**CO1 (10)**
1.4	Fourier series of typical wave forms, Harmonic analysis	3	
	Tutorial	1	
2	**Fourier Transforms**		
2.1	Fourier Integral theorem – Fourier sine and cosine integrals	1	
2.2	Complex form of Fourier integrals	1	**CO2 (3)**
	Tutorial	1	
2.3	Fourier Transform, Fourier sine and cosine transforms	2	
	Tutorial	1	
2.4	Finite Fourier sine and cosine transforms	2	
2.5	Properties of Fourier transforms	1	
	Tutorial	1	**CO3 (11)**
2.6	Convolution theorem for Fourier transforms, Parseval's	3	
	Tutorial	1	
3.	**Partial Differential Equations**		
3.1	Formation and Solutions of PDE	1	
3.2	Equations solvable by direct integration, Linear Equations of the first order	2	
	Tutorial	1	
3.3	Nonlinear equations of the first order	2	
3.4	Homogeneous linear equations with constant coefficients, Rules for finding the complementary functions	1	
	Tutorial	1	**CO4 (12)**
3.5	Rules for finding the particular integral	1	
3.6	Working procedure to solve homogeneous and non-homogeneous linear equations	2	
	Tutorial	1	
4.	**Applications of Partial Differential Equations**		
4.1	Method of Separation of variables	1	
4.2	Classification of second order partial differential equations	1	**CO5 (3)**
	Tutorial	1	
4.2	Vibrations of a stretched string – Wave equations	2	
	Tutorial	1	
4.3	One dimensional heat flow	2	
4.5	Solution of Laplace equation in Cartesian coordinates	2	**CO6 (9)**
4.6	Laplace equations in polar coordinates	1	
	Tutorial	1	
	Total	**48**	

Course Designers:

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22MT320	DIGITAL ELECTRONICS	Category	L	T	P	C	TE
		PCC	3	0	0	3	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. Because of this discretization, relatively small changes to the analog signal levels due to manufacturing tolerance, signal attenuation or parasitic noise do not leave the discrete envelope, and as a result are ignored by signal state sensing circuitry. In most cases the number of these states is two, and they are represented by two voltage bands: one near a reference value typically termed as "ground", and the other a value near the supply voltage. These correspond to the "false" ("0"), and "true" ("1"), values of the Boolean domain, respectively, yielding binary code. Digital electronic circuits are usually made from large assemblies of logic gates. Computer controlled digital systems can be controlled by software, allowing new functions to be added without changing hardware.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Interpret the different number systems and coding schemes and arithmetic operations on binary numbers	TPS2	80	80
CO2	Utilize K- Map for gate level minimization of the given Boolean function	TPS3	70	70
CO3	Construct combinational logic circuits for the given requirement	TPS3	80	70
CO4	Classify Different Latches and Flipflops used in memory-based circuit Design	TPS2	70	70
CO5	Construct synchronous and asynchronous counters for the Given requirement	TPS3	70	70
CO6	Experiment with programmable logic circuits for Desired application	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	M	-	-	-	-	-		M	M	L
CO2	S	M	L	-	M	-	L	-	M	-	M	M	M	L
CO3	S	M	-	-	M	-	-	-	-	-		S	S	S
CO4	S	M	L	-	M	-	L	-	M	-	M	S	S	L
CO5	S	M	L	-	M	-	L	-	-	-	M	S	S	M
CO6	S	M	L	-	M	-	-	-	M	-	M	S	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 1			Assignment 1					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	20	-	-	20	-	-	-	-	-	-	-	-	10	-
CO2	-	-	40	-	-	40	-	-	-	-	-	-	-	-	20
CO3	-	20	-	-	20	-	-	-	-	-	-	-	-	10	-
CO4	-	-	-	-	-	-	-	-	30	-	-	30	-	-	10
CO5	-	-	-	-	-	-	-	-	30	-	-	30	-	-	20
CO6	-	-	-	-	-	-	-	-	40	-	-	40	-	-	20
CO7	-	20	-	-	20	-	-	-	-	-	-	-	-	10	-

Syllabus

Logic Gates and Minimization Techniques: Introduction to Analog and Digital Electronics, Need for digital, why digital, Number systems, Basic digital circuits: Characteristics of Digital IC's and Fan in -Fan out Logic circuits - universal building block construction using logic gates - Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions minterm (SOP) maxterm (POS) - K Map representation of logic functions - simplification of logic functions using K Map – Don't care conditions

Combinational Circuits: Half and Full Adders-Half and Full Subtractors - Code converters - Encoder-Decoder - Multiplexer- Demultiplexer - Binary/ BCD adders, subtractors - Carry look ahead adder- parity checker-parity generators- Magnitude comparator

Sequential Circuits: General model of sequential circuits - flip-flops - latches - level triggering, edge triggering - master slave configuration - Mealy/Moore models - state diagram - state table - State minimization State assignment Excitation table and maps

Synchronous and Asynchronous Sequential Circuits: Design of synchronous sequential circuits – Counter - parity checker - sequence detector - Asynchronous sequential logic: Race conditions and Cycles - Hazards in combinational circuits.

Sequential Memories: Shift registers, Recirculation shift registers Programmable Logic Devices (PLD) - Programmable Logic Array (PLA) - Programmable Array Logic (PAL) Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using RAM, ROM, PLA, PAL, Applications in Automobile industries.

Text Book(s)

1. M. Morris Mano, Michel D. Ciletti, Digital Design with an Introduction to the Verilog HDL, VHDL, and System Verilog, Sixth Edition Global Edition Pearson Education, New Delhi, 2019. ISBN 10: 1-292-23116-5 ISBN 13: 978-1-292-23116-7
2. Ronald J. Tocci Neal S. Widmer and Gregory L. Moss, Digital Systems: Principles and Applications, Prentice Hall of India, New Delhi, 2010.

Reference Books & Web Resources

1. Anand Kumar, Fundamentals of Digital Circuits, PHI Learning Pvt. Ltd. 2014.
2. Thomas L. Floyd, Digital Fundamentals, Pearson Education Inc, New Delhi, 2003.
3. Donald P.Leach and Albert Paul Malvino, Digital Principles and Applications, Tata McGraw- Hill Charles H.Roth. Fundamentals of Logic Design, Thomson Learning, 2003
4. Charles H.Roth. Fundamentals of Logic Design, Thomson
5. https://onlinecourses.nptel.ac.in/noc19_ee09/preview
6. https://nptel.ac.in/courses/117106086/.

Course Contents and Lecture Schedule

Module No	Topic	No. of. Lectures	Course Outcome
1	**LOGIC GATES AND MINIMIZATION TECHNIQUES**		
1.1	Introduction to Analog and Digital Electronics, Need for digital, why digital, Number systems	2	CO1
1.2	Characteristics of Digital IC's - Logic circuits - Universal building block construction using logic gates	2	CO1
1.3	Boolean Algebra- Simplification of Boolean functions - special forms of Boolean functions minterm (SOP) maxterm (POS)	2	CO2
1.4	K Map representation of logic functions - simplification of logic functions using K Map	2	CO2
1.5	Don't care conditions	1	CO2
2	**COMBINATIONAL CIRCUITS**		
2.1	Half and Full Adders-Half and Full Subtractors	1	CO3
2.2	Code converters -Encoder-Decoder	1	CO3
2.3	Multiplexer and Demultiplexer	1	CO3
2.4	Binary/ BCD adders, subtractors	1	CO3
2.5	Carry look ahead adder	1	CO3
2.6	Parity checker-parity generators	1	CO3
2.7	Magnitude comparator	1	CO3
3	**SEQUENTIAL CIRCUITS**		
3.1	General model of sequential circuits - flip-flops	1	CO4
3.2	Latches - level triggering, edge triggering	1	CO4
3.3	Master slave configuration - Mealy/Moore models	2	CO4
3.4	State diagram - state table - State minimization State assignment Excitation table and maps	2	CO4
4	**SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS**		
4.1	Design of synchronous sequential circuits - parity checker - sequence detector	2	CO5
4.2	Asynchronous sequential logic:	2	CO5
4.3	Race conditions and Cycles	2	CO5
4.4	Hazards in combinational circuits	2	CO5
5	**SEQUENTIAL MEMORIES**		
5.1	Shift registers, Recirculation shift registers	2	CO6
5.2	Programmable Logic Devices (PLD) - Programmable Logic Array (PLA) - Programmable Array Logic (PAL)	1	CO6
5.3	Field Programmable Gate Arrays (FPGA)	1	CO6
5.4	Implementation of combinational logic circuits using PAL, PLA	1	CO6
5.5	Applications in Automobile industries.	1	CO6
	Total	**36**	

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22MT330	KINEMATICS AND DYNAMICS OF MACHINERY	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Kinematics is a subject which deals with relative motion between the various parts of the moving elements in a machinery. Machines are used to transform the available form of energy into other form, which transmits both force and motion to produce the specific operation. Kinematics of machines deals with the theoretical aspect such as the relative motion of the various parts of the machine. Dynamics of machinery deals with the analysis of forces and couples on the members of the machine due to external forces due to accelerations of machine elements.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Develop skills for design and analyse the linkages, mechanism and its inversions	TPS1	70	80
CO2	Determine the velocity and acceleration for simple mechanism	TPS3	70	80
CO3	Construct the turning moment diagram for flywheel	TPS3	70	80
CO4	Develop the cam profile for three types of follower	TPS2	70	80
CO5	Design gear and gear trains for a given input/output motion or force relationship	TPS3	70	80
CO6	Determine the natural frequency of longitudinal, transverse and torsional vibrations	TPS3	70	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	-	-	M	-	-	-	-	-		M	M	L
CO2	S	M	L	-	M	-	L	-	M	-	M	M	M	L
CO3	S	M	-	-	M	-	-	-	-	-		S	S	S
CO4	S	M	L	-	M	-	L	-	M	-	M	S	S	L
CO5	S	M	L	-	M	-	L	-	-	-	M	S	S	M
CO6	S	M	L	-	M	-	-	-	M	-	M	S	S	S

S – Strong M – Medium L – Low

Assessment Pattern

	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	10	-	-	-	30	-	-	-	-	-	-	-	4	-
CO2	-	10	35	-	-	35	-	-	-	-	-	-	4	4	12
CO3	-	10	35	-	-	35	-	-	-	-	-	-	4	4	12
CO4	-	-	-	-	-	-	-	10	-	-	-	30	4	4	12
CO5	-	-	-	-	-	-	-	10	35	-	-	35	4	4	12
CO6	-	-	-	-	-	-	-	10	35	-	-	35	4	-	12

Syllabus

Elements of machines and mechanism: Introduction, Links-types, Kinematics pairs-classification, Constraints-types, Degree of Freedom, Grubler's equation, linkage mechanisms, inversions of four bar linkage, slider crank chain and double slider crank chain.
Velocity in Mechanisms: Velocity diagram - Slider Crank and Four Bar mechanism, relative velocity method
Acceleration in Mechanisms: Acceleration diagram, Slider Crank and Four Bar mechanism Klein's construction for Slider Crank mechanism
Force Analysis: Static force analysis of linkages, Equivalent offset inertia force, Dynamic analysis of slider crank mechanism.
Turning moment diagrams: Fluctuation of energy and speed, coefficient of fluctuation of energy and speed, Energy stored in a Flywheel, Dimensions of the flywheel rim.
Cams and followers: classification of cam & follower, pressure angle evaluation, cam profile for constant velocity, SHM and constant acceleration and retardation motion with knife edge and roller followers.
Gears & Gear trains: Classification, law of gearing, forms of tooth, interference, under cutting, minimum number of teeth on gear and pinion to avoid interference, contact ratio, simple, compound Epicyclic gear trains and Differential gears.
Vibrations: Introduction - Types of Vibration – Free and forced vibration, longitudinal, transverse and torsional vibrations

Text Book(s)

1. Gordon R. Pennock & Joseph E. Shigley John J. Uicker "Theory of Machines and Mechanisms", Fourth Edition, Oxford University Press, 2014.
2. Cho W.S. To, "Introduction to Kinematics and Dynamics of Machinery (Synthesis Lectures on Mechanical Engineering)" Morgan & Claypool Publishers (30 December 2017)

Reference Books & Web Resources

1. Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co., New Delhi, Fourth edition, 2017
2. Thomas Bevan, "Theory of Machines", CBS – Third Edition, 2010.
3. Singh, V.P., "Theory of Machines", Dhanpat Rai & Co., (P) Ltd., New Delhi, 2011.
4. Sadhu Singh, "Theory of Machines". Pearson Education, New Delhi, 2009.
5. Ashok G.Ambekar," Mechanism and Machine theory",Prentice Hall of India , New Delhi,2011.
6. Ballaney, P.L., "Theory of Machines", Khanna Publishers, New Delhi, 2002.
7. Web resources :http://nptel.ac.in/courses/112104121/

Course Contents and Lecture Schedule

Module No.	Topics	No. of Lectures	Course Outcome
1	**Elements of machines and mechanism**		
1.1	Kinematic link, Kinematic pairs	1	CO1
1.2	Kinematic chains – Mechanism	1	CO1
1.3	Mobility of mechanism, Inversions of Four bar chain	2	CO1
1.4	Inversions of Single slider crank chain mechanisms	2	CO1
1.5	Inversions of double slider crank chain mechanisms	2	CO1
2	**Velocity & Acceleration in Mechanisms:**		
2.1	Relative velocity method	1	CO2
2.1.1	Velocity and acceleration of four bar mechanisms and Single slider crank chain Mechanisms	2	CO2
2.2	**Klein's construction**		CO2
2.2.1	Velocity and acceleration of Single slider crank chain Mechanisms	1	CO2
3.1	**Force Analysis** Static force analysis of linkages, Equivalent offset inertia force	2	CO2
3.2	Dynamic analysis of slider crank chain mechanism. Piston and Crank effort, Inertia, Torque,	2	CO2
4.1	**Turning moment diagrams**	2	CO3
4.2	Fluctuation of energy and speed, coefficient of fluctuation of energy and speed	1	CO3
4.3	Energy stored in a Flywheel, Dimensions of the flywheel rim	1	CO3
5.1	**Cams** Types of cams and followers - Cam Nomenclature-Displacement, velocity and acceleration curves for various types of motions of follower- pressure angle evaluation in CAM profile	2	CO4
5.2	Construction of cam profiles- Knife edge followers - Roller follower - -Uniform Velocity Motion- Uniform Acceleration and Retardation Motion	2	CO4
6	**Gear and Gear trains**		CO5
6.1	General profiles of gears-Terminology of gears and types	1	CO5
6.2	law of gearing, forms of tooth, Interference, under cutting	2	CO5
6.3	Minimum number of teeth on gear and pinion to avoid interference, contact ratio	2	CO5
6.4	Simple, Compound Gear trains	1	CO5
6.5	Epicyclic gear trains- Differential gears	1	CO5
7.1	**Vibrations** Types of Vibration	1	CO6
7.2	Free Vibration, Forced Vibration	3	CO6
7.3	Longitudinal, transverse and torsional vibrations	1	CO6
	Total	**36 Hours**	

Course Designers:

1. Dr. G Kanagaraj, gkmech@tce.edu

22MT340	THERMAL FLUID SYSTEMS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

This course aims at providing fundamental knowledge and applications in the field of thermal engineering and Fluid mechanics. The basic concepts, the laws and the methods to analyse the thermal and fluid systems will be discussed.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Perform energy analyses of closed and open systems	TPS3	75	80
CO2	Determine efficiency of heat engines and COP of refrigerator & Heat pump	TPS3	75	80
CO3	Calculate entropy generation in heating with finite temperature difference	TPS3	75	80
CO4	Calculate fluid properties, static pressure variation in fluids and force required in Pascal devices	TPS3	75	80
CO5	Determine velocity and flow rate of fluid using Bernoulli equation	TPS3	75	80
CO6	Perform hydraulic circuit analysis taking into account energy loss due to friction	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	L	-	L	-	-	-	-	-	L	L	L
CO2	S	S	M	L	-	-	-	-	-	L	-	-	M	M
CO3	S	S	M	L	-	-	-	-	L	-	-	-	-	-
CO4	S	S	M	L	-	-	-	-	L	-	-	-	-	-
CO5	S	S	M	L	-	-	-	-	-	L	-	-	M	M
CO6	S	S	M	L	-	L	-	-	-	-	-	L	L	L

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 1			Assignment 1					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	4	10	20	-	-	35	-	-	-	-	-	-	2	5	8
CO2	4	10	20	-	-	35	-	-	-	-	-	-	2	5	10
CO3	2	10	20	-	-	40	-	-	-	-	-	-	2	5	10
CO4	-	-	-	-	-	-	4	10	20	-	-	35	2	5	10
CO5	-	-	-	-	-	-	4	10	20	-	-	35	2	5	10
CO6	-	-	-	-	-	-	2	10	20	-	-	30	2	5	10
CO7	4	10	20	-	-	35	-	-	-	-	-	-	2	5	8

Syllabus

Thermal Fluid Systems Applications: Introduction to air conditioning, Steam power plant, Domestic refrigerator and air conditioner, Power brake system in automobile, role of Mechatronics in thermal-fluid systems.

Basic Concepts: Thermodynamic system, properties, process, cycle – Zeroth law and temperature measurement-Energy interactions: Types of work transfer and heat transfer

First Law of thermodynamics: Closed system undergoing a process and cycle- Internal energy and specific heats. Open system - steady flow energy equation for nozzle, turbine, and compressor.

Second Law of thermodynamics: Kelvin Planck and Clausius Statement – Heat engine, refrigerator, Heat pump – Carnot and Reversed Carnot Engine – Efficiency and COP calculations, Thermal Treatment in devices.

Entropy: Concept of entropy, the increase of entropy principle, calculation of entropy generation in heating with finite temperature difference

Basic Concepts of Fluid Mechanics: Concept of fluid- Properties of Fluids: Pressure, Density, Specific Gravity, Viscosity, Surface Tension, Capillarity, Compressibility and Bulk Modulus.

Fluid Statics: Pressure at a Point: Pascal's Law – hydrostatic law –U- tube manometer

Fluid Kinematics: Types of flow – Velocity and Acceleration of a fluid particle - Continuity Equation in Cartesian Co-ordinates.

Fluid Dynamics: Bernoulli's Equation - Euler's Equation for Motion - Applications of Bernoulli's Equation, Venturimeter and Orifice meter.

Friction loss in hydraulic systems: laminar and turbulent flow, Reynolds number, friction factor for laminar and turbulent flow, head loss in a pipeline undergoing laminar or turbulent flow, frictional losses in valves and fittings, K factor, equivalent length, energy analysis of a complete hydraulic circuit.

Text Book(s)

1. Yunus A Cengel, John M Cimbala, Robert H Turner, Fundamentals of Thermal fluid Sciences, McGraw Hill Education, 2017
2. P. K. Nag, S. Pati, T. Jana, Engineering Thermodynamics and Fluid Mechanics,2nd edition, McGraw Hill Education, 2011

Reference Books & Web Resources

1. Anthony Esposito, Fluid Power With Applications, 7th Edition, Pearson New International Edition, 2014.
2. Merle Potter, Elaine P Scott, Thermal Sciences: An introduction to Thermodynamics, Fluid Mechanics and Heat Transfer, 1st Edition, Cengage Learning, 2007

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Thermal Fluid Systems Applications**	
1.1	Introduction to air conditioning, Steam power plant, Domestic refrigerator and air conditioner	1
1.2	Power brake system in automobile, role of Mechatronics in thermal-fluid systems.	2
1.3	**Basic Concepts:** Thermodynamic system, properties, process, cycle – Zeroth law and temperature measurement	2
1.4	Energy interactions: Types of work transfer and heat transfer	1
1.5	**First Law of thermodynamics:** Closed system undergoing a process and cycle- Internal energy and specific heats.	2
1.6	Open system - steady flow energy equation for nozzle, turbine, and compressor.	2
2	**Second Law of thermodynamics**	
2.1	Kelvin Planck and Clausius Statement	2
2.2	Heat engine, refrigerator	1
2.3	Heat pump – Carnot and Reversed Carnot Engine	1
2.4	Efficiency and COP calculations, Thermal Treatment in devices.	1
3	**Entropy**	
3.1	Concept of entropy, the increase of entropy principle	2
3.2	Calculation of entropy generation in heating with finite temperature difference	2
4	**Basic Concepts of Fluid Mechanics**	
4.1	Concept of fluid- Properties of Fluids: Pressure, Density, Specific Gravity	1
4.2	Viscosity, Surface Tension, Capillarity, Compressibility and Bulk Modulus.	2
4.3	**Fluid Statics**: Pressure at a Point: Pascal's Law – hydrostatic law –U- tube manometer	2
4.4	**Fluid Kinematics:** Types of flow, Velocity and Acceleration of a fluid particle, Continuity Equation in Cartesian Coordinates.	2
5	**Fluid Dynamics**	
5.1	Bernoulli's Equation	1
5.2	Euler's Equation for Motion	1
5.3	Applications of Bernoulli's Equation, Venturimeter and Orifice meter	2
6	**Friction loss in hydraulic systems**	
6.1	laminar and turbulent flow, Reynolds number, friction factor for laminar and turbulent flow	2
6.2	Head loss in a pipeline undergoing laminar or turbulent flow	1
6.3	frictional losses in valves and fittings, K factor	1
6.4	Equivalent length, energy analysis of a complete hydraulic circuit.	2
	Total	**36**

Course Designers:

1. Dr. G. Kumaraguruparan, gkgmech@tce.edu
2. Mr. M. M. Devarajan, mmdmech@tce.edu

22MT350	ELECTRICAL MACHINES	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

In future, the machines play a vital role in transforming the manufacturing system into automatic system. An electrical machine is the apparatus that converts energy in three categories: generators which convert mechanical energy to electrical energy, motors which convert electrical energy to mechanical energy, and transformers which changes the voltage level of an alternating current. The academic study of electric machines has become considerable importance in recent years for development of mechatronics in industries. This course aims to provide knowledge on construction and working principle, advantages, limitations and applications of various industrial machines

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Discuss about machines and its principles in real world application.	TPS2	80	70
CO2	Illustrate the various types of Machines, principle and operation.	TPS3	70	75
CO3	Explain the Construction principle and control of different types of Machines.	TPS2	80	70
CO4	Determine the characteristics, application of various types of Electrical Machines.	TPS3	70	75
CO5	Determine performance parameters of different machines to solve the problems related to its application.	TPS3	70	75
CO6	Select the suitable machine & working principle for a given situation and application.	TPS3	70	75

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO2	S	M	L	-	-	-	-	-	-	-	-	-	S	M
CO3	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO4	S	M	L	-	-	-	-	-	-	-	-	-	S	M
CO5	S	M	L	-	-	-	-	-	-	-	-	-	S	S
CO6	S	M	L	-	L	-	-	L	-	L	-	-	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)		Assessment 2 (%)		Terminal (%)
	CAT 1	Assignment 1	CAT 2	Assignment 1	
CO1	20	-	-	-	10
CO2	10	-	20	-	15
CO3	30	-	20	-	20
CO4	20	-	10	-	20
CO5	20	100	20	-	15
CO6	-	-	30	100	20

Syllabus

Introduction: Overview and Introduction about Electrical systems and Electrical machines.
Solenoids: Types - Construction – Working principle – circuit diagram- characteristics - Applications
DC Machines: Types - Constructional details – Principle & operation - Emf equation -Methods of excitation of D.C. generators - Characteristics of series, shunt generator - Principal operation of D.C. motor - Back emf and torque equation - Characteristics of series and shunt motors - Starting of D.C. motors - Speed control of D.C. motors – Applications.
Transformer: Types - Construction - Working principle - Emf equation – Losses - Voltage regulation - CT & PT - Applications.
AC Machines: Production of rotating magnetic field - Torque equation - Torque – Slip characteristics - Power stages and efficiency - Principle and operation of single phase and three phase Induction motors - methods of speed control – applications.
Special Machines: Stepper Motor: Constructional features – Step angle - Principle of operation -Variable reluctance motor – Single and multi-stack configurations.
Servo Motor: types - Construction and Working principle of Servomotor-Types-Position, speed control.
Switch Reluctance Motor: Construction and Working principle of SRM, Speed control characteristics.
Permanent magnet DC motor, BLDC motor - Construction and working Principle. Application: Application and case study of Special Machines in Mechatronics System.

Text Book(s)

1. Stephen J Chapman, “Electrical machines fundamentals” 4th edition. Tata McGraw hill, 2005.
2. A.E.Filtgerald & Charles Kingsley jr, “Electric Machinery “6th edition, McGrow science,2002.

Reference Books & Web Resources

1. J B Gupta, “Theory and Performances of Electrical Machines” 14th edition SK Kataria & Sons 2010.
2. D P Kothari and I J Nagrath,” Electric Machines” 4th Edition, McGraw Hill Education,2010.
3. Takashi Kenjo, “Stepper motor & their microprocessor control” 2nd edition, Oxford science publication 1995.
4. Vedam Subramanian, “Electric Drives", 2nd edition, Tata McGraw Hill, 2011
5. https://nptel.ac.in/courses/108106071/
6. https://nptel.ac.in/courses/108106072/
7. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-685-electric-machines-fall-2013/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Introduction:**		
1.1	Overview and Introduction about Electrical systems and Electrical machines	1	CO1
2.	**Solenoids:**		
2.1	Types - Construction – Working principle	1	CO1, CO2
2.2	Circuit diagram- characteristics - Applications	2	CO2, CO6
3.	**DC Machines:**		
3.1	Types - Constructional details – Principle & operation	2	CO1, CO2
3.2	Emf equation -Methods of excitation of D.C. generators	2	CO3, CO5
3.3	Characteristics of series, shunt generator, and series and shunt motors	2	CO4
3.4	Principle operation of D.C. motor - Back emf and torque equation	2	CO3, CO5
3.5	Starting of D.C. motors - Speed control of D.C. motors – Applications.	2	CO4, CO6
4.	**Transformer:**		
4.1	Types - Construction - Working principle	2	CO1, CO2
4.2	Emf equation - Voltage regulation- Losses	2	CO4, CO5
4.3	CT & PT - Applications.	1	CO5, CO6
5.	**AC Machines:**		
5.1	Types- Production of rotating magnetic field- Principle and operation of single phase and three phase Induction motors	2	CO1, CO2
5.2	Torque equation - Torque – slip characteristics - Power stages and efficiency	2	CO3, CO5
5.3	Methods of speed control – applications.	1	CO5, CO6
6.	**Special Machines:**		
6.1	Constructional features – Step angle -Principle of operation -Variable reluctance motor	2	CO1, CO2
6.2	Single and multi-stack configurations	1	CO2, CO4
6.3	Types - Construction and Working principle of Servomotor-Types-Position, speed control.	2	CO3, CO4
6.4	Switch Reluctance Motor: Construction and Working principle of SRM, Speed control characteristics	2	CO3, CO4
6.5	Permanent magnet DC motor, Switched reluctance motor, BLDC motor - Construction and working Principle.	2	CO2, CO3
6.6	Application and case study of Special Machines in Mechatronics System	3	CO6

Course Designers:

1. Dr. S. Julius Fusic, sjf@tce.edu
2. Mr. H. Ramesh, rameshh@tce.edu

22MT360	THERMAL ENGINEERING LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

The laboratory exercises are aimed at providing practical knowledge in thermal systems such as IC engines, compressors, and refrigerators. Some experiments are focussed on modelling and experimental verification of Hydraulic and Thermal Systems.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Determine the parameters like volumetric efficiency, friction power of internal combustion engine	TPS2	80	80
CO2	Determine fluid properties namely viscosity of incompressible fluids	TPS2	80	80
CO3	Calculate the Coefficient of performance of refrigerant	TPS2	85	85
CO4	Model, simulate and verify experimentally the flow rate of fluid in Hydraulic Suspension Systems	TPS2	90	85

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	S	-	-	-	-	-	-	M	M	M
CO2	S	M	L	-	S	-	-	-	-	-	-	M	M	M
CO3	S	M	L	-	S	-	-	-	-	-	-	M	M	M
CO4	S	M	L	-	S	-	-	-	-	-	-	S	S	S
CO5	S	M	L	-	S	-	-	-	-	-	-	M	M	M
CO6	S	M	L	-	S	-	-	-	-	-	-	M	M	M

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Experiments / Exercise	No. of Hours	Course Outcome
1.	Determination of friction power of diesel engine using retardation test	2	CO1
2.	Performance test on single-cylinder 4-stroke diesel engine at a constant speed	2	CO1
3.	Determination of mass flow rate of air through an orifice meter	2	CO2
4.	Determination of COP of vapour compression refrigerant system	2	CO3
5.	Determination of volumetric efficiency of a diesel engine	2	CO1
6.	Energy balance test on Diesel engine using exhaust	2	CO1

Expt. No.	Experiments / Exercise	No. of Hours	Course Outcome
	gas calorimeter measurement method		
7.	Determination of viscosity of an incompressible fluid	2	CO2
8.	Determine the volumetric efficiency of compressor	2	CO2
9.	Physical Network Modelling and Experimental verification of heat transfer in Insulated pipe	2	CO4
10.	Modelling and experimental verification of thermal effects in a battery	2	CO4
11.	Physical network modelling and verification of hydraulic system	2	CO4
12.	Experiment on air conditioning test rig	2	CO4

Reference Books & Web Resources

1. Yunus A Cengel , John M Cimbala, Robert H Turner “Fundamentals of thermal fluid sciences”4 th Edition, McGraw Hill Education (India) Private Ltd., 2017
2. Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, Rothmayer, “Fluid Mechanics”, Seventh Edition, Wiley India Pvt. Ltd, 2015
3. Yunus A. Cengel and Michael A. Boles, “Thermodynamics: An Engineering Approach”, 7th Edition, McGraw Hill Education (India) Private Ltd., 2011.

Course Designers:

1. Dr. G. Kumaraguruparan, gkmech@tce.edu
2. Mr. M.A. Ganesh, ganeshma2015@tce.edu

22MT370	ELECTRICAL MACHINES LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

Electric motors impact almost every aspect of modern living. Refrigerators, vacuum cleaners, air conditioners, fans, computer hard drives, automatic car windows, and multitudes of other appliances and devices all use electric motors to convert electrical energy into useful mechanical energy. In addition to running the common place appliances that we use every day; electric motors are also responsible for a very large portion of industrial processes. Electric motors are used at some point in the manufacturing process of nearly every conceivable product that is produced in modern factories.

The systems that controlled electric motors in the past suffered from very poor performance and were very inefficient and expensive. In recent decades, the demand for greater performance and precision in electric motors, combined with the development of better solid-state electronics and cheap microprocessors has led to the creation of modern Adjustable speed drives. The course is designed to provide the students a hands-on experience to understand the Characteristics of Electrical machines and its control which enables them to select the suitable motor for the given application.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Characteristics analysis of no load and load condition of various DC motors.	TPS4	80	80
CO2	Characteristics analysis of no load and load condition of various AC motors.	TPS4	80	80
CO3	no load and load characteristics analysis of transformers and study applications of CT and PT.	TPS4	80	80
CO4	Formulate performance parameters of Electrical machines in different conditions.	TPS3	80	80
CO5	Study and practice the function of different motor starters.	TPS2	80	80
CO6	Select the suitable special machines for given real time application.	TPS3	80	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	L	-	-	-	-	-	-	-	-	M	M
CO2	S	S	M	L	-	-	-	-	-	-	-	-	S	M
CO3	S	S	M	L	-	-	-	-	-	-	-	-	M	M
CO4	S	M	L	-	-	-	-	-	-	-	-	-	S	M
CO5	M	L	-	-	-	-	-	-	-	-	-	-	S	S
CO6	S	M	L	-	L	-	-	L	-	L	-	-	S	S

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Exercises / Experiments	No of Hours.	COs
1	Load test on DC Series Motors	2	CO1
2	Speed control of DC Shunt motor	2	CO1
3	Study of DOL and Star-Delta starting of Induction motor.	2	CO5
4	Load test on Single phase Transformer	2	CO3, CO5
5	OC/SC test on single phase Transformer	2	CO3, CO4
6	Characteristic study of CT and PT	2	CO3, CO4
7	Load test on Single phase Induction motor	2	CO2, CO5
8	Load test on Three phase Induction motor.	2	CO2, CO5
9	Speed control of Induction motor using VFD.	2	CO2
10	Position and Speed control of Stepper Motor.	2	CO6
11	Characteristics study of AC Servo motor	2	CO6
12	Speed control of BLDC motor.	2	CO5, CO6
13	Speed control of SRM motor.	2	CO6
14	Speed control of PMAC motor	2	CO6

Note:

1. **Any 12 experiments should be given as Laboratory experiment.**

Reference Books

1. Stephen J Chapman, “Electrical machines fundamentals” 4th edition. Tata McGraw hill,2005
2. Department Laboratory Manual

Course Designers:

1. Dr. S. Julius Fusic, sjf@tce.edu
2. Mr. H. Ramesh, rameshh@tce.edu

22MT380	ELECTRONIC CIRCUITS AND DIGITAL LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

This laboratory course provides a hands-on experience on signal conditioning circuit on analog domain and combinational and sequential circuit design on digital domain

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Construct circuits for performing analog arithmetic operations.	TPS3	80	80
CO2	Use Analog to Digital convertors and digital to Analog Convertors for Interfacing applications	TPS3	80	80
CO3	Develop combinational circuits for Desired applications	TPS3	80	80
CO4	Develop synchronous and asynchronous sequential logic circuits for the given requirement	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	L	-	-	M	M	-	L	L	M
CO2	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO3	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO4	S	M	L	L	-	-	-	-	M	M	-	S	S	S

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Exercises / Experiments	No. of Periods
	Analog Experiments	
1.	Design of Signal Conditioning Circuits – 1 Adder and subtractor for AC and DC circuits	2
2.	Design of Signal Conditioning Circuits – 2 Comparator and instrumentation amplifier	2
3.	Design and Implementation of Analog to Digital Convertor using Operational Amplifier	2
4.	Design and Implementation of Digital to Analog using Operational Amplifier	2
5.	Design of active filters using operational amplifiers	2
	Digital experiments	
6.	Design and Implementation of Arithmetic operations using combinational circuit Design.	2
7.	Design and Implementation of Code Convertors using combinational circuit Design.	2
8.	Design and Implementation of Magnitude comparator and Selector Circuits	2
9.	Construction and Verification of 4 bit Ripple counter	2
10.	Implementation of SISO, SIPO, PISO and PIPO shift registers using Flip- flops	2
11.	An automobile alarm circuit is used to detect certain undesirable conditions. Three switches are used to indicate the status of the door by the driver's seat, the ignition, and the headlights respectively. Design the logic circuit with these three switches as inputs so that the alarm will be activated whenever either of the following conditions exists: The headlights are on while the ignition is off •The door is open while ignition is on.	2
12.	A simple security system for two doors consists of a card reader and a keypad. A person may open a particular door if he or she has a card containing the corresponding code and enters an authorized code for that card. The output from the card reader are as follows.	2
	Total	**24**

Course Designers:

1. Mr. S. Parthasarathi, parthasarathi_s@tce.edu
2. Mr. M.M. Devarajan, mmdmech@tce.edu

CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

Fourth Semester (Lateral Entry)

For the students admitted from the
academic year 2023 - 2024 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

22MTL10	PROBABILITY, STATISTICS AND FOURIER SERIES	Category	L	T	P	C	TE
		BSC	3	1	0	4	Theory

Preamble

This course introduces the various measures in statistics, which frequently applied in our daily life and basic level problems across all branches of engineering. It also helps to discuss the correlation between various kind of attributes and discuss the distributions will arise in engineering problems. Also, this course includes the idea about to obtain the Fourier series of a given periodic function. At the end of the course, former ideas are combined to solve boundary value problems for wave propagation and heat phenomena problems using Fourier series.

Prerequisite

- 22MA310 – Essentials of Matrices and Calculus

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Compute the measures of central tendency and interpret their significance in the relevant area of study	TPS2	80	75
CO2	Compute and interpret the correlation and regression coefficients that arise in engineering problems	TPS3	75	70
CO3	Apply the concept of probability through distributions and employ them in suitable situations	TPS3	75	70
CO4	Compute the Fourier series of functions occurs in various engineering applications.	TPS3	75	70
CO5	Employ the techniques of Fourier series to boundary value problems such as vibration of string and one-dimensional heat flow problems	TPS3	75	70
CO6	Adopt Fourier series techniques to solve two-dimensional heat flow problems in cartesian coordinates	TPS3	75	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO2	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO3	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO4	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO5	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO6	S	S	M	-	L	L	-	-	-	-	-	L	-	-

S – Strong M – Medium L – Low

Assessment Pattern

Assessment	CAT 1			Assignment 1			CAT 2			Assignment 2			Terminal Exam		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	20		-	-	-	-	-	-	-	-	-	-	12	-
CO2	-	-	25	-	-	40	-	-		-	-	-	-	-	12
CO3	5	10	35	-	-	60	-			-	-	-	-	6	20
CO4	-	-	-	-	-	-	5	20	25	-	-	50	-	6	18
CO5	-	-	-	-	-	-	5	10	20	-	-	30	-	6	12
CO6	-	-	-	-	-	-	-	-	15	-	-	20	-	-	8

Syllabus

Descriptive Statistics and Correlation: Mean, median, mode, Geometric mean, Harmonic mean- Measures of Dispersion: Range and standard deviation - Coefficient of variation - Correlation - Coefficient of correlation- Lines of Regression –Rank correlation- properties of regression coefficients.

Probability Distributions: Random experiment - Conditional probability - Baye's Theorem- Random variables – Discrete Probability distributions – Continuous Probability distributions – Expected values - Binomial and normal distributions.

Fourier Series: Introduction – Euler's formulae – Conditions for Fourier expansion –Odd and even function- Expansion of odd or even periodic functions–Half range series–Harmonic analysis.

Applications of Partial Differential Equations: Method of separation of variables - Vibrations of a stretched string – Wave equations – One dimensional heat flow problem – Two-dimensional heat flow–Solution of Laplace equation in Cartesian coordinates.

Text and Reference Book(s)

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012
2. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences" (English) Eighth Edition, Cengage Learning India Pvt Ltd, New Delhi, 2012.
3. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi,2016.
4. P. Kandasamy, K. Thilagavathy and K. Gunavathi, "Engineering Mathematics", Volume-III, S.Chand & Company Ltd, Fourth Edition,2008.
5. T. Veerarajan, "Engineering Mathematics",3rdEdition,Tata McGraw Hill ,New Delhi,2004.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**Descriptive statistics and Correlation**	
1.1	Mean, median, mode	3
1.2	Geometric mean, Harmonic mean	1
1.3	Range and standard deviation and coefficient of variation	1
	Tutorial	1
1.4	Correlation - coefficient of correlation	1
	Tutorial	1
1.5	Lines of Regression	2
1.6	Rank correlation	1
	Tutorial	1
2.	**Probability Distributions**	
2.1	Random experiment-Conditional probability -	1
2.2	Baye's Theorem	2
	Tutorial	1
2.3	Random Variables, Discrete and Continuous Probability distributions	2
2.4	Expectation and variance	1
	Tutorial	1
2.5	Binomial and Normal Distributions	3
	Tutorial	1
3.	**Fourier Series**	
3.1	Introduction, Euler's formulae,	1
3.2	Conditions for Fourier expansion, Functions having points of discontinuity	1
3.3	Fourier Expansion in (0,2π)	2
	Tutorial	1
3.4	Odd and even functions, Expansions of odd or even periodic functions	1
3.5	Half range series	2
	Tutorial	1
3.6	Harmonic analysis	2
	Tutorial	1
4.	**Boundary value problems**	
4.1	Method of separation of variables	2
4.2	Vibrations of a stretched string - Wave equation	2
	Tutorial	1
4.3	One-dimensional heat flow	2
	Tutorial	1
4.4	Two-dimensional heat flow: Solution of Laplace's equation in Cartesian coordinates	3
	Tutorial	1
	Total	**48**

Course Designers:

1. Dr. S. Saravanakumar, sskmat@tce.edu
2. Dr. M. Sundar, msrmat@tce.edu

CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

Fourth and Fifth Semester

For the students admitted from the
academic year 2022 - 2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF MECHATRONICS ENGINEERING

Vision:

"Be a globally renowned school of engineering in Mechatronics"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfil the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of B.E.

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze Complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Specific Outcomes (PSO) of B.E. Mechatronics Engineering

After the successful completion of the B.E. Mechatronics Engineering degree programme, the students will be able to:

PSO1: Design, develop and retrofit conventional mechanical system into low-cost automated system using sensors and controllers

PSO2: Design, develop and analyse mechatronics system using hardware and software tools.

SCHEDULING OF COURSES

Sem	Theory / Theory cum Practical / Laboratory Courses								CDIO / Audit Courses	Total Credits
I	22MA110 Calculus for Engineers BSC 4	22PH120 Physics BSC 3	22CH130 Chemistry BSC 3	22EG140 Technical English HSMC 2	22ME160 Engineering Graphics ESC 4	22EG170 English Laboratory HSMC 1	22PH180 Physics Laboratory BSC 1	22CH190 Chemistry Laboratory BSC 1	22ES150 Engineering Exploration ESC 2	21
II	22MT210 Matrices and Ordinary Differential Equations BSC 4	22MT220 Analog Electronics PCC 3	22MT230 Free Body Mechanics PCC 3	22MT240 Problem Solving using C ESC 3	22MT250 Manufacturing Process PCC 3	22MT260 Mechatronic Workshop ESC 1	22MT270 Manufacturing Laboratory PCC 1	22MT280 Mechatronic System Laboratory ESC 1	Audit Course 1	19
III	22MT310 Partial Differential Equations BSC 4	22MT320 Digital Electronics PCC 3	22MT330 Kinematics and Dynamics of Machinery ESC 3	22MT340 Thermal Fluid Systems PCC 3	22MT350 Electrical Machines ESC 3	22MT360 Thermal Engineering Laboratory PCC 1	22MT370 Electrical Machines Laboratory ESC 1	22MT380 Electronic Circuits and Digital Laboratory PCC 1	22ES390 Design Thinking ESC 3	22
IV	22MT410 Probability and Statistics BSC 4	22MT420 Microcontroller based system design PCC 3	22MT430 Power Electronics and Drives ESC 3	22MT440 Sensors and Measurements PCC 3	22MT450 Digital Signal Processing PCC 3	22MT460 Project Management HSMC 3	22MT470 Microcontroller Laboratory PCC 1	22MT480 Sensors and Measurements Laboratory PCC 1	Audit Course 2	21
V	22MT510 Control Systems PCC 4	22MT520 Design of Machine Elements PCC 3	22MT530 Industrial Automation PCC 3	22MT540 CNC Technology PCC 3	22MTPx0 Program Elective I PEC 3	22yyGx0 Inter disciplinary Elective IE 3	22MT5500 CAD / CAM Laboratory PCC 1	22MT560 Industrial Automation Laboratory PCC 1	22MT570 Project I PW 3	24
VI	22MT610 Accounting and Finance HSMC 4	22MT620 Industrial Robotics PCC 3	22MTPx0 Program Elective II PEC 3	22MTPx0 Program Elective III PEC 3	22MT630 Professional Communication HSMC 2	22yyFx0 Basic Science Elective BSE 3	22MT640 Control and Dynamics Laboratory PCC 1	22MT650 Robotics Laboratory PCC 1	22MT660 Project II PW 3	23
VII	22MT710 Mechatronics System Design PCC 3	22MTPx0 Program Elective IV PEC 3	22MTPx0 Program Elective V PEC 3	22MTPx0 Program Elective VI PEC 3	22MTPx0 Program Elective VII PEC 3	22MT720 System Integration Laboratory PCC 3	---	---	22MT730 Project III PW 3	21
VIII	22MTPx0 Program Elective VIII PEC 3	22MTPx0 Program Elective IX PEC 3	---	---	---	---	---	---	22MT810 Project IV PW 3	9
									Total Credits	**160**

CREDIT DISTRIBUTION

Degree: B.E. **Program: Mechatronics**

Sl. No.	Category		Credits	
			Regular Admission	Lateral Entry Admission
A.	**Foundation Courses (FC)**		**54 - 66**	**22 - 35**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	08 - 11
	b.	Basic Science Courses (BSC)	24 - 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 - 27	08 - 15
B.	**Professional Core Courses (PCC)**		**55**	**45**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 - 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 - 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 - 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 - 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 - 06
	b.	Basic Science Elective (BSE)	03 - 06	03 - 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

IV SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT410	Probability and Statistics	BSC	3	1	0	4
22MT420	Microcontroller based system design	PCC	3	0	0	3
22MT430	Power Electronics and Drives	ESC	3	0	0	3
22MT440	Sensors and Measurements	PCC	3	0	0	3
22MT460	Project Management	HSMC	3	0	0	3
THEORY CUM PRACTICAL						
22MT450	Digital Signal Processing	PCC	1	0	4	3
PRACTICAL						
22MT470	Microcontroller Laboratory	ESC	0	0	2	1
22MT480	Sensors and Measurements Laboratory	PCC	0	0	2	1
		Total	**16**	**1**	**8**	**21**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

IV SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT410	Probability and Statistics	3	40	60	100	27	50
22MT420	Microcontroller based system design	3	40	60	100	27	50
22MT430	Power Electronics and Drives	3	40	60	100	27	50
22MT440	Sensors and Measurements	3	40	60	100	27	50
22MT460	Project Management	3	40	60	100	27	50
THEORY CUM PRACTICAL							
22MT450	Digital Signal Processing	3	50	50	100	25	50
PRACTICAL							
22MT470	Microcontroller Laboratory	3	60	40	100	18	50
22MT480	Sensors and Measurements Laboratory	3	60	40	100	18	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

V SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT510	Control Systems	PCC	3	1	0	4
22MT520	Design of Machine Elements	PCC	3	0	0	3
22MT530	Industrial Automation	PCC	3	0	0	3
22MT540	CNC Technology	PCC	3	0	0	3
22MTPx0	Program Elective I	PEC	3	0	0	3
22yyGx0	Inter disciplinary Elective	IE	3	0	0	3
PRACTICAL						
22MT550	CAD / CAM Laboratory	PCC	0	0	2	1
22MT560	Industrial Automation Laboratory	PCC	0	0	2	1
PROJECT						
22MT570	Project I	PW	0	0	6	3
		Total	**18**	**1**	**10**	**24**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

V SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT510	Control Systems	3	40	60	100	27	50
22MT520	Design of Machine Elements	3	40	60	100	27	50
22MT530	Industrial Automation	3	40	60	100	27	50
22MT540	CNC Technology	3	40	60	100	27	50
22MTPx0	Program Elective I	3	40	60	100	27	50
22yyGx0	Inter disciplinary Elective						
PRACTICAL							
22MT550	CAD / CAM Laboratory	3	60	40	100	18	50
22MT560	Industrial Automation Laboratory	3	60	40	100	18	50
PROJECT							
22MT570	Project I	-	40	60	100	27	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

22MT410	PROBABILITY AND STATISTICS	Category	L	T	P	C	TE
		BSC	3	1	0	4	Theory

Preamble

This course introduces the various measures of statistics, which are applied frequently in our daily life and basic level problems across all branches of engineering. It also helps to discuss the correlation between various kind of attributes and discuss the distributions involved in various engineering problems. Statistical methods are important tools that provide the engineers with both descriptive and analytical methods for dealing with the variability in observed data. Moreover, this course enables the students to cognitive learning in statistics and develops skills to analyse data's using various parametric and non-parametric tests.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Discover the measures of central tendency and interpret their significance in the relevant area of study.	TPS2	80	75
CO2	Compute and interpret the correlation and regression coefficients that arise in engineering problems.	TPS3	75	70
CO3	Illustrate the concepts of probability through distributions and employ them in suitable situations.	TPS3	75	70
CO4	Predict the hypotheses and test the inferences on a single sample.	TPS3	75	70
CO5	Predict the hypotheses and test the inferences based on two samples.	TPS3	75	70
CO6	Apply the appropriate non-parametric hypothesis testing procedure for various types and samples.	TPS3	75	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO2	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO3	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO4	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO5	S	S	M	-	L	L	-	-	-	-	-	L	-	-
CO6	S	S	M	-	L	L	-	-	-	-	-	L	-	-

S – Strong M – Medium L – Low

Assessment Pattern

Assessment	CAT 1			Assignment 1			CAT 2			Assignment 2			Terminal Exam		
TPS / COs	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	5	20	-	-	-	-	-	-	-	-	-	-	-	12	-
CO2	-	-	25	-	-	33	-	-	-	-	-	-	-	-	12
CO3	5	10	35	-	-	67	-	-	-	-	-	-	-	6	19
CO4	-	-	-	-	-	-	4	-	17	-	-	21	-	-	10
CO5	-	-	-	-	-	-	4	10	15	-	-	29	-	6	10
CO6	-	-	-	-	-	-	-	20	30	-	-	50	-	6	19

Syllabus

Descriptive Statistics and Correlation: Mean, median, mode, Geometric mean, Harmonic mean- Measures of Dispersion: Range and standard deviation - Coefficient of variation - Correlation - Coefficient of correlation - Lines of Regression – Rank correlation- properties of regression coefficients.

Probability Distributions: Random experiment - Conditional probability - Baye's Theorem- Random variables – Discrete Probability distributions – Continuous Probability distributions – Expected values - Binomial and normal distributions.

Test of Hypothesis: Hypotheses and test procedures – Tests about a population mean – Tests concerning a population proportion – z tests and confidence intervals for a difference between two population means–The two-sample t Test and confidence interval – Inferences concerning a difference between population proportions.

Non-Parametric Statistics: Introduction- sign test - Signed rank test - Wilcoxon rank sum test - Kruskal's Wallis test- Runs test.

Text and Reference Book(s)

1. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 42nd Edition, 2012
2. Jay L. Devore, "Probability and Statistics for Engineering and the Sciences" (English) Eighth Edition, Cengage Learning India Pvt Ltd, New Delhi, 2012.
3. Ronald E. Walpole, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, New Delhi, 2012.
4. Mendenhall William, "Introduction to Probability and Statistics", 14th Edition, Duxbury Press, New Delhi 2012.

Course Contents and Lecture Schedule

No.	Topic	No. of Periods
1.	**Descriptive statistics and Correlation**	
1.1	Mean, median, mode	3
1.2	Geometric mean, Harmonic mean	1
1.3	Range and standard deviation and coefficient of variation	1
	Tutorial	1
1.4	Correlation - coefficient of correlation	1
	Tutorial	1
1.5	Lines of Regression	2
1.6	Rank correlation	1
	Tutorial	1
2.	**Probability Distributions**	
2.1	Random experiment-Conditional probability	1
2.2	Baye's Theorem	2
	Tutorial	1
2.3	Random Variables, Discrete and Continuous Probability distributions	2
2.4	Expected values	1
	Tutorial	1
2.5	Binomial and Poisson Distributions	2
2.6	Normal Distribution	1
	Tutorial	1
3	**Testing of Hypothesis**	
3.1	Hypothesis and Test Procedures	1
3.2.	Tests about a population mean	2
3.3	Tests concerning a population proportion	1
	Tutorial	1
3.4	z tests and confidence intervals for a difference between two population means	2
	Tutorial	1
3.5	The two sample t Test and confidence interval	2
3.6	Inferences concerning a difference between population proportions.	1
	Tutorial	1
4	**Non-Parametric Statistics**	
4.1	Introduction- Sign test	2
4.2	Signed rank test	2
	Tutorial	1
4.3	Wilcoxon rank sum test	2
	Tutorial	1
4.4	Kruskal's Wallis test - Runs test	3
	Tutorial	1
	Total	**48**

Course Designers:

1. Dr. S. Saravanakumar, sskmat@tce.edu
2. Dr. M. Sundar, msrmat@tce.edu

22MT420	MICROCONTROLLER BASED SYSTEM DESIGN	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Microcontrollers based embedded systems are involved in almost every facet of modern life. Consumer gadgets, entertainments gadgets, medical devices and automobiles all contain embedded Microcontroller. The tremendous number of applications for embedded computing has given rise to high demand for engineers with experience in designing and implementing embedded systems with microcontroller. This course is designed to provide an introduction to microcontroller architecture, internal and external peripherals, assembly language programming and embedded c programming. Students will be taught the basic use of a programming environment and how to develop the basic C programming for embedded application. This course highlights the general interfacing techniques and concepts through peripheral's data representation from input/output, and memory usage in the microcontroller in embedded C.

Prerequisite

- 22MT320 - Digital Electronics

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Describe the architecture and pin diagram of 8051 microcontroller, and evaluate its suitability for various applications.	TPS2	80	70
CO2	Develop programs using assembly language and C for the 8051 microcontrollers, and integrate them with peripherals, such as timers, interrupts, and UART.	TPS3	70	70
CO3	Design and implement systems using the 8051 microcontroller and its advanced features, such as analog-to-digital conversion and interfacing with LCD and keypad.	TPS3	70	70
CO4	Describe the architecture and pin diagram of the Cortex M0+ microcontroller, and evaluate the features of the Raspberry Pi Pico for IoT applications.	TPS2	80	70
CO5	Develop applications using the Raspberry Pi Pico and its I/O devices, such as GPIO, PWM, and ADC.	TPS3	70	70
CO6	Design and implement IoT systems using the Raspberry Pi Pico, and interface it with I2C and SPI sensors to acquire and process data.	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	L	-	-	-	-	-	-	-	-	S	S
CO2	S	M	L	M	-	-	-	-	-	-	-	-	S	S
CO3	S	M	L	M	L	-	-	-	-	L	L	L	S	S
CO4	S	M	L	L	-	-	-	-	-	-	-	-	S	S
CO5	S	M	L	M	L	-	-	-	-	-	-	L	S	S
CO6	S	M	L	M	L	L	-	-	-	L	L	L	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	10	-
CO2	-	10	30	-	-	-	-	-	-	-	-	-	-	5	15
CO3	-	20	20	-	-	100	-	-	-	-	-	-	-	10	10
CO4	-	-	-	-	-	-	-	20	-	-	-	-	-	10	-
CO5	-	-	-	-	-	-	-	10	30	-	-	-	-	5	15
CO6	-	-	-	-	-	-	-	20	20	-	-	100	-	10	10

Syllabus

Introduction to 8051 Microcontroller and Architecture: Overview of microcontrollers and their applications, Architecture and pin diagram of 8051 microcontroller, Memory organization and addressing modes, Instruction set and programming in assembly language, Interfacing of I/O devices with 8051

Advanced 8051 Programming Techniques: Interrupts and their handling in 8051, Timers and counters in 8051, Serial communication, Analog-to-digital conversion using 8051, Interfacing of LCD and keypad with 8051

Programming 8051 using C Language: Introduction to C language and its programming principles, Configuring and programming the 8051-microcontroller using C, Interfacing of I/O devices with 8051 using C language, Debugging and testing microcontroller programs in C

Introduction to Raspberry Pi Pico and Cortex M0+ Architecture: Overview of Raspberry Pi Pico and its features, Architecture and pin diagram of Cortex M0+ microcontroller, Memory organization and addressing modes, Instruction set and programming in assembly language, Interfacing of I/O devices with Raspberry Pi Pico

Advanced Raspberry Pi Pico Programming Techniques: Interrupts and their handling in Raspberry Pi Pico, Timers and counters in Raspberry Pi Pico, Serial communication in Raspberry Pi Pico, Analog-to-digital conversion using Raspberry Pi Pico, Interfacing of LCD and keypad with Raspberry Pi Pico

GNU ARM Toolchain and Programming using VS Code: Introduction to GNU ARM toolchain and its features, Configuring and programming the Raspberry Pi Pico using VS Code, Interfacing of I/O devices with Raspberry Pi Pico using VS Code, Debugging and testing microcontroller programs using VS Code

Text Book(s)

1. "Programming and Customizing the 8051 Microcontroller" by Myke Predko (McGraw-Hill Education, 1999)
2. "The 8051 Microcontroller and Embedded Systems: Using Assembly and C" by Muhammad Ali Mazidi, Rolin D. McKinlay, and Janice Gillispie Mazidi (Pearson Education, 2016)
3. Ayala Kenneth J, "The 8051 Microcontroller, Third Edition: Architecture, Programming, and Applications", Cengage Learning, 2019

4. "Programming with Raspberry Pi Pico: Coding Tiny Embedded Systems in C and C++" by Simon Monk, 1st edition, McGraw-Hill Education TAB, 2021.
5. "Raspberry Pi Pico User Guide: Programming your Pico from Beginner to Expert" by Gareth Halfacree and Ben Everard, 1st edition, Raspberry Pi Press, 2021.
6. Harry fairhead, “Programming The Raspberry Pi Pico/W In C”, Second Edition, I/O press,2022
7. "Cortex-M0 and Cortex-M0+ Processors: The Definitive Guide" by Joseph Yiu, 2nd edition, Newnes, 2016.

Reference Books & Web Resources

1. Raspberry Pi Pico C/C++ SDK: https://datasheets.raspberrypi.com/pico/raspberry-pi-pico-c-sdk.pdf
2. Getting started with Raspberry Pi Pico: https://datasheets.raspberrypi.com/pico/getting-started-with-pico.pdf

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction to 8051 Microcontroller and Architecture:**	
1.1	Overview of microcontrollers and their applications	1
1.2	Architecture and pin diagram of 8051 microcontroller	1
1.3	Memory organization and addressing modes	1
1.4	Instruction set and programming in assembly language	2
1.5	Interfacing of I/O devices with 8051	2
2	**Advanced 8051 Programming Techniques**	
2.1	Interrupts and their handling in 8051	1
2.2	Timers and counters in 8051	1
2.3	Serial communication	1
2.4	Analog-to-digital conversion using 8051	1
2.5	Interfacing of LCD and keypad with 8051	1
3	**Programming 8051 using C Language**	
3.1	Introduction to C language and its programming principles	2
3.2	Configuring and programming the 8051-microcontroller using C	2
3.3	Interfacing of I/O devices with 8051 using C language	2
3.4	Debugging and testing microcontroller programs in C	1
4	**Introduction to Raspberry Pi Pico and Cortex M0+ Architecture**	
4.1	Overview of Raspberry Pi Pico and its features	2
4.2	Architecture and pin diagram of Cortex M0+ microcontroller	1
4.3	Memory organization and addressing modes	1
4.4	Instruction set and programming in assembly language	1
4.5	Interfacing of I/O devices with Raspberry Pi Pico	2
5	**Advanced Raspberry Pi Pico Programming Techniques**	
5.1	Interrupts and their handling in Raspberry Pi Pico,	2
5.2	Timers and counters in Raspberry Pi Pico,	1
5.3	Serial communication in Raspberry Pi Pico,	1
5.4	Analog-to-digital conversion using Raspberry Pi Pico,	1
5.5	Interfacing of LCD and keypad with Raspberry Pi Pico	1
6	**GNU ARM Toolchain and Programming using VS Code**	
6.1	Introduction to GNU ARM toolchain and its features,	2

Module No.	Topic	No. of Periods
6.2	Configuring and programming the Raspberry Pi Pico using VS Code	1
6.3	Interfacing of I/O devices with Raspberry Pi Pico using VS Code	1
6.4	Debugging and testing microcontroller programs using VS Code	1
	Total	**37**

Course Designers:

1. Mr. S Parthasarathi, parthasarathi_s@tce.edu
2. Mr. M M Devarajan, mmdmech@tce.edu

22MT430	POWER ELECTRONICS AND DRIVES	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Power Electronics is a technology that deals with the conversion and control of electrical power with high efficiency switching mode electronic devices. Around 40 percent of the world's power needs are currently met by electrical energy and that proportion is expected to rise as countries cut carbon emissions and shift to renewable energy sources. As the trend towards electrification and renewable energies increases, enabling technologies such as power electronics are becoming ever more important. Electrification is opening up more applications for power electronics such as drive trains for electric vehicles (EVs) and hybrids, as well as DC fast-charging stations, which can charge EV batteries in a matter of 15-30 minutes, compared with the many hours it takes using standard residential charging ports. Power-electronics technologies are able to vary the speed of motor drives, making processes more efficient and reducing the amount of energy consumed. Electrical drives are required in large numbers in many industrial and domestic applications like transportation systems, rolling mills, paper machines, machine tools, fans, pumps, robots etc. This course covers in detail the basic and advanced control of power electronic converters that are used in electric drives.

Prerequisite

- 22MT220 - Analog Electronics
- 22MT350 - Electrical Machines

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the operations of controlled converters for different types of Loads.	TPS2	80	70
CO2	Differentiate the characteristics and performance parameters of different power electronic converters.	TPS3	70	70
CO3	Explain different power semiconductor switching circuits used in Electrical drives.	TPS2	80	70
CO4	Illustrate the frequency and phasor control of AC drives using AC converter circuits.	TPS3	70	70
CO5	Choose appropriate converter technique to control different drives in industrial applications.	TPS3	70	70
CO6	Select and integrate suitable electrical drives for motion control applications such as Machine tools and Industrial robotics.	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO2	S	M	L	-	L	-	-	-	-	-	-	-	S	M
CO3	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO4	S	M	L	-	-	-	-	L	-	L	-	-	S	M
CO5	S	M	L	-	L	-	-	-	-	-	-	-	S	M
CO6	S	M	L	-	L	-	-	-	-	-	-	-	S	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)		Assessment 2 (%)		`Terminal (%)
	CAT 1	Assignment 1	CAT 2	Assignment 2	
CO1	20	-	-	-	10
CO2	20	-	20	-	15
CO3	20	-	20	-	15
CO4	-	-	20	-	15
CO5	40	100	20	-	30
CO6	-	-	20	100	15

Syllabus

Introduction: Power devices- SCR, Power MOSFET, IGBT- Electrical drive system-Types of Electric drives- selection of electrical drives- Modes of operation of electrical drives - types of power electronic converters- classification of controlled converters-Modes of operation of electrical drives- closed loop control of Drives.

Controlled Rectifiers (Converters) DC Drives: Single Phase and three phase Half wave / full wave half controlled /fully controlled converters with R, RL and RLE loads, Continuous and discontinuous current operations- Evaluation of performance parameters –single and three Phase controlled DC drives.

Chopper Controlled DC Drives: Four Quadrant chopper- types- principle of operation of buck, boost, buck-boost Converter fed DC Drives.

Control of AC drives: Dynamic Modelling of Induction machines- Single phase bridge inverters with R, RL and RLE loads -Phase controlled Induction motor drive-Frequency controlled Induction motor drives-Variable frequency Drives Three phase 120 and 180 degree mode Inverter fed AC machine –Vector controlled Induction motor drives – Direct and Indirect vector control.

Switching circuits for special machines and power supply applications: Synchronous Machines with PMs-Vector control of PMSM -Sensor less control BLDC motor- UPS configurations- online & offline UPS, SMPS

Text Book(s)

1. P. S. Bimbhra, “Power Electronics“ KHANNA PUBLISHSERS-DELHI, 2012
2. Mohammed H Rashid, “Power electronics” Pearson Education India, 2009.

Reference Books & Web Resources

1. R.Krishnan, “Electrical motor drives modelling, analysis and control” Pearson India, 2015.
2. Gopal K.Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing house, 2017.
3. Bimal Bose, “Power electronics and driver circuits”, Elseveir, 2006.
4. Bogdan M. Wilamowski, J. David Irwin, ”Power Electronics and Motor Drives”, CRC Press, 2011
5. Bimal K Bose, “Modern Power electronics and AC drives”, Prentice Hall, 2002.
6. https://onlinecourses.nptel.ac.in/noc19_ee03
7. https://nptel.ac.in/downloads/108105066/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Introduction**		
1.1	Power devices- SCR, Power MOSFET, IGBT	2	CO3
1.2	Electrical drive system, types of Electric drives, Selection of electrical drives, Modes of operation of electrical drives.	1	CO2
1.3	Types of power electronic converters, classification of controlled converters- Modes of operation of electrical drives- -closed loop control of Drives.	1	CO2
2.0	**Controlled Rectifier (Converters) DC Drives**		
2.1	Single Phase and 3-phase Half wave and Full wave converter	1	CO1
2.2	Single phase Half controlled and fully controlled converters with R, RL and RLE loads, Continuous and discontinuous operations	2	CO1
2.3	Fully controlled converters with R, RL and RLE loads	2	CO2
2.4	Evaluation of performance parameters	2	CO2
2.5	Single & three phase controlled DC Drives	2	CO5
3.0	**Chopper controlled DC drives**		
3.1	Four quadrant chopper, Principle of operation of buck converter	2	CO2
3.2	Boost Converter	1	CO3
3.3	Buck-boost Converters	1	CO3
3.4	DC chopper Drives.	2	CO5
4.0	**Control of AC Drives**		
4.1	Dynamic Modelling of Induction machines- Single phase bridge inverters with R, RL and RLE loads	2	CO4
4.2	Frequency controlled Induction motor drives	1	CO4
4.3	Phase controlled Induction motor drive	1	CO4
4.4	Three phase 120 and 180 degree mode Inverter fed AC machine	3	CO4
4.5	Single phase and Three phase ac voltage controllers	2	CO4
4.6	Vector controlled Induction motor drives −Direct and Indirect vector control.	3	CO6
5.0	**Switching circuits for special machines and Power supply applications**		
5.1	Synchronous Machines with PMs.	1	CO5
5.2	Vector control of PMSM.	1	CO6
5.3	Sensor less control BLDC motor	1	CO6
5.4	UPS configurations- online & offline UPS, SMPS	2	CO5
	TOTAL	**36**	

Course Designer(s):

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22MT440	SENSORS AND MEASUREMENTS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

In today's world, there is a growing need for professionals who can integrate different fields of knowledge to solve complex problems. Mechatronics is a prime example of this trend, as it combines mechanical, electrical, and computer engineering principles to design and develop advanced systems. The use of sensors and PLC-based systems is essential in mechatronics, as these technologies allow for real-time monitoring and control of mechanical and electrical processes.

Moreover, the importance of measurement in scientific research and manufacturing cannot be overstated. Accurate measurement is critical to ensuring the reliability and validity of experimental results, and to ensuring consistency in product quality. With the globalization of research and manufacturing, there is a need for international standards of measurement to ensure that measurements made in one laboratory or facility can be compared to those made in another. This requires a thorough understanding of metrology, the science of measurement, and its principles and applications.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the basic principles and characteristics of sensors, including their operating principles, selection criteria, calibration, and signal conditioning techniques.	TPS2	80	70
CO2	Classify and explain the measurement principles of displacement, pressure, temperature, velocity, acceleration, and optical sensors, and their applications in mechatronics systems.	TPS3	70	70
CO3	Discuss the importance of signal conditioning circuits in achieving accurate and reliable sensor performance.	TPS2	70	70
CO4	Explain the various components of data acquisition systems and their functions, including sensors, signal conditioning circuits, analog-to-digital converters	TPS2	80	70
CO5	Discuss the advantages and limitations of different types of data acquisition systems, including PC-based systems and standalone systems	TPS3	70	70
CO6	Analyse real-world case studies of sensors and data acquisition systems in mechatronics applications, and assess their performance and limitations.	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	L
CO2	S	M	L	-	-	-	M	-	-	-	-	-	M	L
CO3	S	M	L	-	-	-	M	-	-	-	-	-	M	L
CO4	M	L		-	-	-	M	-	-	-	-	-	M	L
CO5	S	M	L	-	S	M	S	-	-	-	-	S	S	S
CO6	S	M	M	L	-	-	S	-	-	-	-	S	M	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	25	-	-	25	-	-	-	-	-	-	-	-	10	-
CO2	-	-	40	-	-	40	-	-	-	-	-	-	-	-	20
CO3	-	-	35	-	-	35	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	25	-	-	25	-	-	10	-
CO5	-	-	-	-	-	-	-		40	-	-	40	-	-	20
CO6	-	-	-	-	-	-	-		35	-	-	35	-	-	20

Syllabus

Science of Measurement: Significance of Measurements and Methods, Characteristics of Measurement systems, Errors in Measurements, Calibration, Primary and secondary standards

Displacement, Pressure, Temperature sensors: Strain gauge, Gauge factor, sensing elements, configuration, and unbounded strain gage, Inductive and Magnetic Sensors, LVDT and RVDT, Hall Effect Sensors, Ultrasonic Sensors, Radar Sensors, Bellows, Membranes, and Thin Plates, Piezoresistive Sensors, Pirani Gauge, Thermosensitive Sensors, Resistance Temperature Detectors, Thermistors, Thermoelectric Contact Sensors

Velocity, Acceleration and optical sensor: Capacitive Accelerometers, Piezoresistive Accelerometers, Piezoelectric Accelerometers, Gyroscopes, Optical displacement sensors and optical encoders, Optoelectronic Motion Detectors, Sensor Structures, Visible and Near Infrared Light Motion Detectors, Far-Infrared Motion Detectors

Signal conditioning circuits: Functions of signal conditioning circuits, Preamplifiers, Concepts of passive filters, Impedance matching circuits, AC and DC Bridges, wheat stone bridge, Kelvin, Maxwell, Hay, Schering

Data acquisition systems: Components of an analog and digital data acquisition system, Use of data acquisition system, Use of recorders in digital systems, Input conditioning equipment.

Text Book(s)

1. A.K.Sawhney, — Electrical & Electronics Measurement and Instrumentation‖,10th edition, Dhanpat Rai & Co, New Delhi, 19th Revised edition 2011, Reprint 2014.
2. John G. Webster, — Medical Instrumentation Application and Design‖, 4th edition, Wiley India Pvt Ltd, New Delhi, 2015.

Reference Materials and Web Resources

1. Ernest O Doebelin and Dhanesh N Manik, Measurement systems, Application and design, 6th edition, McGraw-Hill, 2012.
2. Khandpur R.S, ―Handbook of Biomedical Instrumentation, III edition, Tata Mc Graw Hill, New Delhi, 2014.
3. Leslie Cromwell, ―Biomedical Instrumentation and measurement‖, 2nd edition, Prentice Hall of India, New Delhi, 2015.
4. Albert D. Helfrick and William D. Cooper. Modern Electronic Instrumentation and Measurement Techniques‖, Prentice Hall of India, I edition, 2016

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1	**Science of Measurement**		
1.1	Significance of Measurements and Methods	1	CO1
1.2	Characteristics of Measurement systems	1	CO1
1.3	Errors in Measurements	1	CO1
1.4	Calibration	1	CO1
1.5	Primary and secondary standards	1	CO1
2	**Displacement, Pressure, Temperature sensors**		
2.1	Strain gauge		CO2
2.1.2	Gauge factor, sensing elements, configuration, and unbounded strain gage	1	CO2
2.2	Inductive and Magnetic Sensors		CO2
2.2.1	LVDT and RVDT	2	CO2
2.2.2	Hall Effect Sensors	1	CO2
2.3	Ultrasonic Sensors	1	CO2
2.4	Radar Sensors	1	CO2
2.5	Bellows, Membranes, and Thin Plates	1	CO2
2.6	Piezoresistive Sensors	1	CO2
2.7	Pirani Gauge	1	CO2
2.8	Thermosensitive Sensors		CO2
2.8.1	Resistance Temperature Detectors	1	CO2
2.8.2	Thermistors	1	CO2
2.9	Thermoelectric Contact Sensors	1	CO2
3	**Velocity, Acceleration and optical sensor**		
3.1	Capacitive Accelerometers	1	CO3
3.2	Piezoresistive Accelerometers	1	CO3
3.3	Piezoelectric Accelerometers	1	CO3
3.4	Gyroscopes	1	CO3
3.5	Optical displacement sensors and optical encoders	1	CO3
3.6	Optoelectronic Motion Detectors		CO3
3.6.1	Sensor Structures	1	CO3
3.6.2	Visible and Near-Infrared Light Motion Detectors	1	CO3
3.6.3	Far-Infrared Motion Detectors	1	CO3

Module No.	Topic	No. of Hours	Course Outcome
4	**Signal conditioning circuits**		
4.1	Functions of signal conditioning circuits	1	CO4
4.2	Preamplifiers	1	CO4
4.3	Concepts of passive filters	1	CO4
4.4	Impedance matching circuits	1	CO4
4.5	AC and DC Bridges	1	CO5
4.5.1	wheat stone bridge	1	CO5
4.5.2	Kelvin, Maxwell	1	CO5
5	**Data acquisition systems**		
5.1	Components of an analog & digital data acquisition system	1	CO5
5.2	Use of data acquisition system	1	CO6
5.3	Use of recorders in digital systems	1	CO6
5.4	Input conditioning equipment.	1	CO6
	Total	**36**	

Course Designers:

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2. Mr. S Parthasarathi, parthasarathi_s@tce.edu

22MT450	DIGITAL SIGNAL PROCESSING (TCP)	Category	L	T	P	C	TE
		PCC	1	0	4	3	Practical

Preamble

This course on Digital Signal Processing (DSP) aims at providing the fundamentals of digital signal processing and its applications in various fields. DSP has become an essential tool in many areas of engineering, including telecommunications, audio processing, control systems, and many others. This course will cover topics such as digital signal analysis, LTI systems, Fourier analysis, filter design, and spectral analysis.

Students will gain an understanding of the principles and techniques used in DSP, and will learn how to apply them to solve practical problems. By the end of this course, students will have the skills and knowledge necessary to design and implement DSP systems for a wide range of applications.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Understand and explain the basic concepts of signals and systems, including the difference between analog and digital signals, sampling and quantization	TPS2	80	80
CO2	Implement the basic signal processing techniques such convolution, correlation using software tools	TPS3	70	70
CO3	Analyse the signals in both the time and frequency domains and extract information about the signal	TPS3	70	70
CO4	Design and implement digital filters for various applications, including low-pass, high-pass, band-pass, and notch filters, using techniques like windowing, FIR filter design, and IIR filter design	TPS3	70	70
CO5	Perform signal processing techniques such Gray Scale Transformations, Image Segmentation, Contour Tracing, Template matching and Edge Detection on 2D signal	TPS3	70	70
CO6	Apply DSP concepts and techniques to solve practical problems, including designing and implementing signal processing algorithms using software tools	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	M	M	-	M	-	M
CO2	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO3	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO4	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO5	S	M	L	-	M	-	-	-	M	M	-	M	-	M
CO6	S	M	L	-	M	-	-	-	M	M	-	M	-	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Continuous Assessment Test (CAT)			Terminal (Practical)
	CAT 1 (Theory)	CAT 2 (Theory)	Lab Model Exam	
CO1	40	-	100	100
CO2	40	-		
CO3	30	-		
CO4	-	30		
CO5	-	50		
CO6	-	20		

Syllabus

Signals and Systems: Analog and Digital signals – Conversion process – Sampling – Aliasing - Nyquist criteria – Quantization. Linear Time Invariant Systems

Signal Operations and Measurements: Signal generation - Convolution - Correlation – Windowing – Overlap Add and Save Methods - Padding – Delays - Peak Finding – Zero Crossing - Time Scope

Transforms: Fourier Transform – Fast Fourier Transform - Spectrum Analysis – Frequency Domain Analysis

Digital Filters: Low Pass – High Pass – Band Pass - Notch Filters – FIR and IIR Filter Design

2D Signal Processing: Image as a 2D signal. Gray Scale Transformations - Image Arithmetic. Image Segmentation - Regions of Interests (ROIs) - Binary Segmentation - Contour Tracing - Template matching - Edge Detection

Applications and Case Study:
1D Signals: Echo Cancellation – Noise removal from ECG Signal – Separation of Audio Signal from Music – Vibration Analysis
2D Signal: Bar Code Identification - Character Recognition - Print Quality Inspection - Gauging - Presence Verification

Text Book(s)

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, 5th edition, Pearson, 2021
2. Christian Demant, Bernd Streicher-Abel, Carsten Garnica, “Industrial Image Processing”, Second Edition, Springer, 2013

Reference Books & Web Resources

1. Keonwook Kim, “Conceptual Digital Signal Processing with MATLAB”, Springer International Publishing, 2021
2. Samir I. Abood, “Digital Signal Processing: A Primer With MATLAB”, CRC Press, Inc., 2020
3. https://in.mathworks.com/solutions/signal-processing.html
4. R.C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Fourth Edition, Prentice Hall India, 2018
5. https://swayam.gov.in/nd1_noc19_ee55/preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	
		Theory	Practical
1	**Signals and Systems:**	-	-
1.1	Analog and Digital signals – Conversion process – Sampling	1	-
1.2	Aliasing - Nyquist criteria – Quantization. Linear Time Invariant Systems	2	-
2	**Signal Operations and Measurements:**	-	-
2.1	Signal generation - Convolution -	1	-
2.2	Correlation – Windowing – Overlap Add and Save Methods -	2	
2.3	Padding – Delays - Peak Finding – Zero Crossing - Time Scope	2	
	Experiments in signal generation, sampling and aliasing	-	4
3	**Transforms:**	-	-
3.1	Fourier Transform – Fast Fourier Transform - Spectrum Analysis – Frequency Domain Analysis	2	-
	Experiments involving FFT, finding the frequency in the given multi tone signal, frequency analysis	-	4
4	**Digital Filters:**	-	-
4.1	Low Pass – High Pass – Band Pass - Notch Filters – FIR and IIR Filter Design	2	-
	Experiments involving filter design	-	4
5	**2D Signal Processing:**	2	-
5.1	Image as a 2D signal. Gray Scale Transformations - Image Arithmetic.	2	-
5.2	Image Segmentation - Regions of Interests (ROIs) - Binary Segmentation -	2	-
3.5	Contour Tracing - Template matching - Edge Detection	2	-
	Experiments involving image pre-processing and post processing	-	4
6	**Applications and Case Study**	-	-
6.1	**1D Signals:** Echo Cancellation – Noise removal from ECG Signal – Separation of Audio Signal from Music – Vibration Analysis	2	
	Implementation of any two applications of 1D signal processing	-	4
6.2	**2D Signal:** Bar Code Identification - Character Recognition - Print Quality Inspection - Gauging - Presence Verification	2	-
	Implementation of any two applications of 2D signal processing	-	4
	TOTAL	**24**	**24**

Course Designers:

1. Mr. S A R Sheik Masthan, sarsmech@tce.edu

22MT460	PROJECT MANAGEMENT	Category	L	T	P	C	TE
		HSMC	3	0	0	3	Theory

Preamble

Management in business and human organization activity is simply the act of getting people together to accomplish desired goals. Qualified project managers are in high demand in this competitive world. This course focuses on project management methodology that will increase your ability to initiate and manage projects more efficiently and effectively. The Project Management course discusses activities of planning, organizing, motivating, controlling resources and leadership in theory and practice and the roles and responsibilities of the project manager. It deals with approaches to achieve the project goals and to optimize the allocation of necessary inputs and to integrate them.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the importance of project management and project initiation.	TPS2	80	80
CO2	Determine the project duration and time estimates by Gantt Chart, Bar chart and network diagram.	TPS3	70	70
CO3	Determine the project duration and time estimation using Network techniques - PERT and CPM	TPS3	70	70
CO4	Optimize resources of projects using resource smoothing or resource levelling techniques.	TPS3	70	70
CO5	Crash the project to its bare minimum value and obtain the optimum time – minimum cost relationships.	TPS3	70	70
CO6	Describe about risk assessment process, project closure and agile techniques.	TPS2	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	M	M	M	M	M	M	-	-
CO2	S	M	L	-	-	-	M	M	M	M	M	M	-	-
CO3	S	M	L	-	M	-	M	M	M	M	M	M	-	-
CO4	S	M	L	-	M	-	M	M	M	M	S	M	-	-
CO5	S	M	L	-	M	-	M	M	M	M	S	M	M	-
CO6	S	M	L	-	-	-	M	M	M	M	M	M	M	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)		Assessment 2 (%)		Terminal (%)
	CAT 1	Assignment 1	CAT 2	Assignment 2	
CO1	20	-	-	-	10
CO2	40	50	-	-	20
CO3	40	50	-	-	20
CO4	-	-	40	50	20
CO5	-	-	40	50	20
CO6	-	-	20	-	10

Syllabus

Overview of Project Management: Definition - Project Life Cycle - Objectives of Project management - Project knowledge areas - organization structure-roles of project management group-project management office and its role - Project Management Principles - ISO 21500:2012: Guidance on project management.

Project Initiation: Generation and Screening of PM ideas- Triple Constraint – Time, Cost and Scope – TOR / Project Charter / SOW (Statement of Work) - Project Presentation & Approval-Technology transfer: PPP – case study

Time Management: Work break down structure - Gantt Charts, Milestone chart - Project Network - Fulkerson's rules – Activity-On-Arrow and Activity-On-Node networks – Network Techniques: Critical path method (CPM) - Project updating and monitoring - Program Evaluation & Review Technique (PERT) - case study

Resource Management: Types of resources - Balancing of resource - Resource Smoothing technique - Resource levelling technique - case study

Cost Management: Types of cost – Cost Slope - Variation of Cost with time - Crash time and crash cost - Optimize project cost for time and resource - case study

Risk Management and Agile: Risk Identification - Risk management process – Failure modes – NPD - FMEA - Project Closure - Project Report - Agile Project management - Enterprise project Management – Earned Value Management - software for PM - case study

Text Book(s) and Reference Materials

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide), Seventh Edition, Project Management Institute. 2021
2. Punmia B. C. and Khandelwal K.K., "Project Planning and Control with PERT/CPM", Laxmi publications, New Delhi,
3. Erik W. Larson, Clifford F. Gray, "Project Management: The Managerial Process", McGraw-Hill/Irwin, eighth Edition, 2017.
4. Construction Project Scheduling and Control, 4th Edition by Saleh A. Mubarak fourth edition 2019.

Reference Materials and Web Resources

1. NPTEL – Online course on Project Management
2. https://www.pmi.org
3. https://www.iso.org/standard

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.	**Overview of Project Management**		
1.1	Definition - Project Life Cycle- Objectives of Project management	1	CO1
1.2	Project knowledge areas-	1	CO1
1.3	organization structure-roles of project management group-project management office and its role	1	CO1
1.4	Project Management Principles ISO 21500:2012: Guidance on project management	1	CO1
2.	**Project Initiation**		
2.1	Generation and Screening of PM ideas- Triple Constraint – Time, Cost and Scope -	1	CO1
2.2	TOR/ Project Charter/ SOW (Statement of Work)	1	CO1
2.3	Project Presentation & Approval –transfer: PPP, Case Study	1	CO1
3.	**Time Management**		
3.1	Work break down structure	2	CO2
3.2	Gantt Charts, Milestone chart	2	CO2
3.3	Project Network- Fulkerson's rules	1	CO2
3.4	Activity-On-Arrow and Activity- On -Node networks	2	CO2
3.5	Critical path method (CPM)	3	CO3
3.6	Project updating and monitoring	1	CO3
3.7	Program Evaluation & Review Technique (PERT)	2	CO3
4.	**Resource Management**		
4.1	Types of resource- Balancing of resource-	2	CO4
4.2	Resource Smoothing technique	2	CO4
4.3	Resource levelling technique	2	CO4
5.	**Cost Optimization**		
5.1	Types of cost – Cost slope	1	CO5
5.2	Variation of Cost with time - Crash time and crash cost	1	CO5
5.3	Optimize project cost for time and resource	4	CO5
6.	**Risk Management, Agile**		
6.1	Risk Identification, Risk management process	1	CO6
6.2	Failure modes, NPD, FMEA	1	CO6
6.3	Project Closure, Project Report	1	CO6
6.4	Agile Project management, Enterprise project Management – Earned Value Management - software for Project Management - Case study	1	CO6
	Total	36	

Course Designers:

1. Mr. M M Devarajan, mmdmech@tce.edu
2. Mr. S Rajkumar, srmech@tce.edu

22MT470	MICROCONTROLLER LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

This course covers the basics of 8051 microcontroller architecture, assembly language programming, and interfacing of I/O devices. It also includes advanced topics such as interrupt handling, timers, serial communication, and analog-to-digital conversion. Additionally, it introduces the Raspberry Pi Pico and its Cortex M0+ architecture, and covers programming techniques using C/C++ and the GNU ARM toolchain. The syllabus also includes a list of experiments to reinforce the concepts covered in the course. Overall, the course aims to provide students with a comprehensive understanding of microcontroller programming and interfacing, along with practical experience in designing and implementing microcontroller-based projects.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Analyze the architecture and pin diagram of 8051 microcontroller and apply different addressing modes and memory organization to solve programming problems.	TPS3	80	90
CO2	Evaluate the instruction set of 8051 microcontroller and apply assembly language programming techniques to interface I/O devices and handle interrupts.	TPS3	80	90
CO3	Synthesize C programming principles to configure and program 8051 microcontroller and design programs to interface I/O devices using C language.	TPS3	80	90
CO4	Evaluate the architecture and pin diagram of Cortex M0+ microcontroller and apply different addressing modes and memory organization to design programs using assembly language.	TPS4	75	80
CO5	Analyze the features of Raspberry Pi Pico and apply advanced programming techniques such as interrupt handling, serial communication, and interfacing with LCD and keypad.	TPS3	80	90
CO6	Create programs using C/C++ SDK for Raspberry Pi Pico to interface I/O devices, generate PWM signals, and communicate with peripheral devices using I2C and SPI protocols.	TPS4	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	L	-	-	M	M	-	L	L	M
CO2	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO3	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO4	S	S	M	L	-	-	-	-	M	M	-	S	S	S
CO5	S	M	L	-	-	-	-	-	M	M	-	L	L	M
CO6	S	S	M	L	-	-	-	-	M	M	-	S	S	S

S – Strong M – Medium L – Low

List of Experiments

Sl. No.	Exercises / Experiments	No of Periods.
1.	Write an assembly language program for single and double precision operations	4
2.	Write an assembly language program to read data from an input port and display it on an output port.	4
3.	Write a C program to generate a square wave on an output port using timers. Use timer 0 to generate a 1kHz square wave on Port 1 Pin 0.	2
4.	Write a C program to implement interrupt-based serial communication between two 8051 microcontrollers. Use timer 1 to generate the Baud rate, and interrupt when a byte is received.	
5.	Write a C program to implement timer interrupt to control the brightness of an LED connected to an output port. Use timer 0 interrupt to vary the duty cycle of a PWM signal.	2
6.	Write a C program to interface an LCD display with 8051 microcontrollers using the UART communication protocol. Use timer 1 to generate the Baud rate, and send data to the LCD display using UART.	2
7.	Configure GPIO pins of Raspberry Pi Pico and turn on/off an LED.	2
8.	Implement PWM signal generation using Raspberry Pi Pico and control the brightness of an LED.	2
9.	Interface a push button with Raspberry Pi Pico and detect its state change.	
10.	Interface a digital temperature sensor with Raspberry Pi Pico and read temperature values.	2
11.	Implement I2C communication protocol between Raspberry Pi Pico and a peripheral device.	2
12.	Implement SPI communication protocol between Raspberry Pi Pico and a peripheral device.	2
	Total	**24**

Project Activity
Interfacing of any sensor with Raspberry Pi Pico and display text on LCD.
Interfacing of actuator and control with Raspberry Pi Pico.
Implementing a simple music synthesizer using Raspberry Pi Pico and a speaker. Use the DAC output to generate different frequencies of sine waves to produce musical notes, and play different melodies using C/C++ SDK.

Course Designers:

1. Mr. S Parthasarathi, parthasarathi_s@tce.edu
2. Mr. M M Devarajan, mmdmech@tce.edu

22MT480	SENSORS AND MEASUREMENTS LABORATORY	Category	L	T	P	C	TE
		ESC	0	0	2	1	Practical

Preamble

Sensors are indeed becoming increasingly important in many fields and industries, as they allow us to measure and monitor a wide range of parameters with high accuracy and precision. Some of the key benefits of sensors include their ability to provide real-time data, automate processes, and improve safety and efficiency. As you mentioned, sensors can measure various physical and chemical properties, including temperature, pressure, flow, and viscosity, among others. They can also be used to detect motion, proximity, light, sound, and many other environmental factors. Overall, sensors are a critical component in many modern technologies, and their importance is only expected to increase in the coming years.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Select Appropriate Resolution ADC for Sensor Measurements	TPS3	80	90
CO2	Prepare Signal conditioning Circuits for the Active and Passive Sensors	TPS3	80	90
CO3	Measure change of capacitance using Touch and Proximity based Capacitance Sensors	TPS3	80	90
CO4	Measure luminescence, Temperature, Force and calibrate for Error	TPS3	75	80
CO5	Construct a Pressure and strain measurement system	TPS3	80	90
CO6	Collect Vibration measurement and AC Power Measurement for Real Time Monitoring	TPS3	75	80
CO7	Measure Linear, angular, thread elements, 2D & 3D profiles, surface roughness, flatness and straightness	TPS3	75	80
CO8	Check and calibrate different dimensions for given components	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	M	M	-	L	M	-
CO2	S	M	L	-	L	-	-	-	M	M	-	M	M	-
CO3	S	M	L	-	L	-	-	-	M	M	-	M	M	S
CO4	S	M	L	-	L	-	-	L	M	M	-	L	M	S
CO5	S	M	L	-	L	-	-	-	M	M	-	M	M	S
CO6	S	M	L		L				M	M		M	M	S
CO7	S	M	L		L				M	M		M	M	S
CO8	S	M	L		L				M	M		M	M	S

S – Strong M – Medium L – Low

List of Experiments

Sl. No.	Exercises / Experiments	No of Hrs	COs
1	Design of Signal Conditioning circuits -1 Adder and Subtractor for AC and DC Signals.	2	CO2
2	Design of Signal Conditioning circuits -2 Comparator and Instrumentation amplifier	2	CO2
3	Experimenting with Analog to Digital Conversion and Digital to Analog conversion	2	CO2
4	Measurement of Power and Energy of AC and DC source	2	CO1
	case studies / mini project submission Design of Energy meters, Power factor meters, Metal Detector		
5	Experimenting with capacitive and Inductive Proximity Sensors	2	CO3
6	Characterisation and Calibration of Thermistor and Thermocouple		CO4
7	Characterisation and Calibration of Light Dependent Resistor, Photodiode		CO4
8	Characterisation and Calibration of Strain Gauge - Load cell	2	CO5
9	Measurement of Acceleration and Characterisation using Acceleration Sensors	2	CO6
10	Characterisation and Calibration Flow Sensor.	2	CO4
	case studies: soil moisture measurement, fuel level, pH sensor, Oxygen sensors		
11	Characterisation and Calibration of Force Sensor using ANOVA	2	CO6
12	Profile measurement of linear, angular and thread elements using Profile Projector.	2	CO6
13	Straightness / Flatness Testing using Autocollimator	2	CO7
14	2D & 3D measurements using Coordinate Measuring Machine		CO7
15	Profile measurement of linear, angular and thread elements using Tool Makers Microscope	2	CO8
	Case studies: Displacement Measurement sensor, Pressure Sensor, Torque Measurement		
	Total	**24**	

Course Designers:

1. Dr. M Palaninatharaja, pnatharaja@tce.edu
2. Mr. S. Parthasarathi, parthasarathi_s@gmail.com

22MT510	CONTROL SYSTEMS	Category	L	T	P	C	TE
		PCC	3	1	0	4	Theory

Preamble

Control system consists of interconnected components to achieve desired objective. The basis for analysis of a system is the foundation provided by linear system theory, which assumes a cause-effect relationship for the components of a system. The input-output relationship represents the cause-and-effect relationship of the process, which in turn represents a processing of the input signal to provide an output signal variable, often with a power amplification. A closed-loop control system utilizes an additional measure of the actual output to compare the actual output with the desired output response. The mathematical modelling, time and frequency response analysis, and controller design using transfer function and state space approaches of this course enable the students to design and analyse suitable control systems for mechatronics applications.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Develop a Mathematical model for physical Systems	TPS3	70	70
CO2	Investigate the Performance Specification of Control system using Time domain techniques	TPS3	70	70
CO3	Investigate the Performance Specification of Control system using Frequency domain techniques	TPS3	70	70
CO4	Select the suitable compensator to improve the performance of control systems	TPS3	70	70
CO5	Design a PID controller and predict optimal PID parameters using suitable technique.	TPS3	70	70
CO6	Determine the system Observability and controllability using state space approach	TPS2	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	-	-	-	-	-	-	-	-	-	M	M
CO2	S	S	M	-	-	-	-	-	-	-	-	-	S	M
CO3	S	S	M	-	-	-	-	-	-	-	-	-	M	M
CO4	S	S	M	M	M	-	-	-	M	-	-	-	S	M
CO5	S	S	M	M	M	-	-	-	M	-	-	-	S	S
CO6	S	M	-	-	-	-	-	-	-	-	-	-	M	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)		Assessment 2 (%)		Terminal (%)
	CAT 1	Assignment 1	CAT 2	Assignment 2	
CO1	30	40	-	-	20
CO2	40	40	-	-	15
CO3	30	20	-	-	15
CO4	-	-	40	30	20
CO5	-	-	30	40	15
CO6	-	-	30	30	15

Syllabus

Mathematical Modelling: Basic elements in control systems - open loop and closed loop systems – Introduction to mathematical modelling - Introduction to Nonlinear system – linear approximation through Taylor's series- Transfer functions of mechanical, electrical and analogous systems-Modelling of Actuator Process Transducer system structure- Tutorials: Modelling Liquid level control process, manufacturing process component.

Time response analysis: Time response - Time domain specifications -Types of test inputs, First and Second order system response - Steady state error, error constants, generalized error coefficient - Stability concept and definition - Characteristic equation - Location of poles - Routh Hurwitz criterion - Root locus techniques: construction. Tutorials: Time response analysis of mechatronics systems.

Frequency domain analysis: Frequency response methods -Bode plots - Polar plot - Nyquist stability criterion. Tutorials: Frequency response analysis of mechatronics systems. Tutorials: Time response analysis of mechatronics systems.

Compensator and controller design: Design of lag, lead, lag lead series compensator (using Bode plot), PID Controller design-PID tuning Methods-Practical aspects of PID controller design. Tutorials: PID controller design for HVAC and Motor control.

State space analysis: State variable representation of systems, State space to transfer function conversion, transfer function to state space conversion, controllability and observability of control systems-poles, Eigen values and system stability-Introduction to model predictive and sliding mode control. Tutorials: MPC and sliding mode process control design.

Text Book(s)

1. Norman S. Nise, "Control System Engineering", 6th Edition, John Wiley & Sons, 2018.
2. Jacqueline wilkie, Micheal Johnson and Reza Katebi, "Control Engineering", Palgrave, macmillan, 2002.

Reference Books & Web Resources

1. Richard C. Dorf, Robert H. Bishop, "Modern control systems" 13th edition, Pearson Education, 2017.
2. M.Gopal, "Digital control and State variable methods", Tata McGraw Hill, 2017.
3. J.Nagrath and M.Gopal, "Control System Engineering", New age International Publisher, New Delhi,2018.
4. K.Ogata,"Modern Control Engineering",Pearson,2015.
5. https://nptel.ac.in/courses/108107115/
6. https://nptel.ac.in/courses/108102043/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Mathematical Modelling**	
1.1	Basic elements and open loop and closed loop systems - introduction to nonlinear system	1
1.2	linear approximation through Taylor's series	1
1.3	Introduction to mathematical modelling - Transfer functions of mechanical and electrical systems	2
1.4	Transfer functions of analogous systems	1
1.5	Modelling of Actuator Process Transducer system structure	2
1.6	**Tutorials:** Mathematical Modelling Liquid level control process, manufacturing process component.	2
2	**Time response analysis**	
2.1	Time domain specifications	1
2.2	Types of Test input, First order system response	1
2.3	Second order system response	1
2.4	Steady state error, error constants, generalized error coefficient	1
2.5	Stability, Characteristic equation	1
2.6	Routh Hurwitz criterion	2
2.7	Root locus techniques	2
2.8	**Tutorials:** Time response analysis of mechatronics systems.	2
3	**Frequency domain analysis**:	
3.1	Bode plots	2
3.2	Polar plot	2
3.3	Nyquist stability criterion.	2
3.4	**Tutorials:** Frequency response analysis of mechatronics systems.	2
4	**Compensator and Controller design**	
4.1	Lag Compensator design	2
4.2	Lead Compensator design	2
4.3	Lag Lead Compensator Design	1
4.4	PID Controller Design and tuning methods	3
4.5	Practical aspects of PID controller design.	1
4.6	**Tutorials**: PID controller design for process and Motor control.	2
5	**State space analysis**	
5.1	State variable representation of systems	2
5.2	State space to transfer function conversion, transfer function to state space conversion,	1
5.3	Controllability and Observability of control systems	1
5.4	Poles, Eigen values and system stability	1
5.5	Introduction to model predictive and sliding mode control.	2
5.6	**Tutorials:** MPC and sliding mode process control design.	2
	Total	**48**

Course Designers:

1. Mr. H Ramesh, rameshh@tce.edu
2. Mr. M A Ganesh, ganeshma2015@tce.edu

22MT520	DESIGN OF MACHINE ELEMENTS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Design of machine elements is the process of deriving a system, component, or process to meet desired needs. It is a decision-making process, in which the basic sciences, mathematics and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment or objectives and criterion, synthesis, analysis, construction, testing and evaluation. Machine Elements Design deals with the creation of machine element that goes into the making of a machine as a product.

Prerequisite

- 22MT230 – Free Body Mechanics

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Compute the static and fatigue strength of mechanical components.	TPS2	70	80
CO2	Design the shafts for different loading conditions	TPS3	70	80
CO3	Design the flexible coupling for given power transmission.	TPS3	70	80
CO4	Select and Design suitable belt drive for given loading condition	TPS3	70	80
CO5	Select a suitable gear drive for given orientation of shaft and loading condition	TPS3	70	80
CO6	Select a rolling contact bearing and sliding contact bearing for given power transmission application	TPS3	70	80
CO7	Design Bolts and power screw.	TPS3	70	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	L	-	-	-	-	-	S	-	-	-	M	M
CO2	S	S	S	-	-	-	-	-	S	-	-	-	S	S
CO3	S	S	M	-	-	-	-	-	S	-	-	-	S	S
CO4	S	S	M	-	-	-	-	-	S	-	-	-	S	S
CO5	S	S	M	-	-	-	-	-	S	-	-	-	S	S
CO6	S	S	M	-	-	-	-	-	S	-	-	-	S	S
CO7	S	S	M	-	-	-	-	-	S	-	-	-	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	10	10	-	-	-	30	-	-	-	-	-	-	4	4	-
CO2	-	10	30	-	-	35	-	-	-	-	-	-	-	4	12
CO3	-	10	30	-	-	35	-	-	-	-	-	-	4	4	12
CO4	-	-	-	-	-	-	5	10	-	-	-	30	4	4	12
CO5	-	-	-	-	-	-	5	10	30	-	-	35	4	4	12
CO6	-	-	-	-	-	-	-	10	30	-	-	35	4	-	12

Syllabus

Machine Design Concepts: Machine Elements, Procedure for design of machine elements, Basic requirements of machine elements, Preferred Numbers, Engineering materials-its properties and selection, limits, fits, tolerance, Stress, Strain, Torsion, Bending, Factor of safety, Theories of failure, Variable stress.

Design of Rotating elements and Brakes: Shafts, Shafts subjected to twisting moment, combined Bending and twisting moment with axial loads. Design of Keys for shafts. Design of flexible coupling.

Design of power transmission drives: Drives classification, selection of Flat belt drive, selection of V belt Drive, Design of chain drive, design of timing belt drive, Design of Spur gear and bevel gear

Design of Bearings: Introduction, Classification, select of sliding contact bearing and rolling contact bearing.

Design of Linear motion elements: Introduction, Design of bolts and power screws, Design of guide ways.

Text Book(s)

1. V.B. Bhandari, “Design of machine elements”, Fourth edition, Tata McGraw Hill, 2017.
2. Joseph Edward Shigley and Charles R. Misucke, “Mechanical Engineering Design”, Tenth Edition, Tata McGraw Hill, 2015.
3. Robert L. Norton, “Machine Design: An integrated Approach”, Third edition, Prentice Hall, 2005.

Reference Books & Web Resources

1. Sundarajamoorthy T.V. and Shanmugam. N, “Machine Design”, Anuradha Publications, 2003.
2. K. Ganesh Babu, K.Srithar, “Design of machine Elements”, MCGraw Hill Education, 2009.
3. Hall, Holowenko and Laughin, “Theory and Problems of Machine Design”, Tata McGraw Hill Company, 2002.
4. Sharma P. C, and Agarwal D.K, “Machine design”, S.K. Kataria and Sons, New Delhi, 2000.
5. M. F. Spotts, T. E. Shoup, “Design of Machine Elements”, Eighth Edition, Pearson Education Asia, 2006.

6. Amit U Pawar, Apurav A Wagh and D U Patil," Design of Linear Motion Guideways", International journal of Engineering Research and Science & Technology, Vol.2, No. 4, 2015.
7. PSG, "Design Data Book", 2015
8. https://archive.nptel.ac.in/courses/112/105/112105124/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Machine design Concepts**	
1.1	Machine elements	1
1.2	Procedure for design of machine elements	1
1.3	Basic requirements of machine elements, Preferred numbers	1
1.4	Engineering materials- Its properties and selection	1
1.5	Stress, Strain, Torsion	1
1.6	Bending, variable stress, Factor of safety	1
1.7	Theories of failure	2
2	**Rotating Elements and Brakes**	
2.1	Shafts, Shafts subjected to Twisting moment and Combined Bending and Twisting moment	1
2.2	Shafts subjected to Combined Bending and Twisting moment with axial loads	2
2.3	Design of Keys for shafts	2
2.4	Design of Brake	2
3	**Design of power transmission drives**	
3.1	Drives introduction and its classification	1
3.2	Selection of Flat belt drive	2
3.3	Selection of V belt drive	2
3.4	Design of chain drive	2
3.5	Design of spur gear	2
3.6	Design of bevel gear	2
4	**Design of Bearings**	
4.1	Introduction and classification	2
4.2	select of sliding contact bearing and rolling contact bearing.	2
5	**Design of Linear motion elements**	
5.1	Introduction	1
5.2	Design of bolts	2
5.3	Design of power screws	2
5.4	Design of Guide ways	2
	Total	**36**

Course Designers:

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2. Dr. G Kanagaraj, gkmech@tce.edu
3. Dr. K J Nagarajan, kjnmech@tce.edu

22MT530	INDUSTRIAL AUTOMATION	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Today's highly increasing competitiveness over the industry demands high quality and most consistent products with a competitive price. To address this challenge number of industries considering various new product designs and integrated manufacturing techniques in parallel with the use of automated devices. One of the remarkable and influential moves for getting the solutions of above-mentioned challenge is the industrial automation. Industrial automation facilitates to increase the product quality, reliability and production rate while reducing production and design cost by adopting new, innovative and integrated technologies and services. Industrial Automation is the replacement with computers and machines to that of human thinking. Industrial automation deals with the set of technologies and automatic control devices that results the automatic operation and control of industrial processes and machines without significant human intervention and achieving superior performance than manual control. These automation devices include PLCs, HMI, SCADA etc. and technologies include various industrial communication systems.

Prerequisite

- 22MT340 - Thermal Fluid Systems
- 22MT350 - Electrical Machines

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the selection and programming methods of different automation components like PLC, SCADA, DCS and communication buses.	TPS 2	80	70
CO2	Explain the construction, working and control strategies of different industrial drives and valves.	TPS 2	80	75
CO3	Design pneumatic and hydraulic circuits for industrial applications.	TPS 3	70	70
CO4	Construct a program using PLC to solve problems pertaining to Manufacturing industries.	TPS 3	70	70
CO5	Design an automation system by interconnecting work cell devices through an industrial network.	TPS 3	70	70
CO6	Select suitable automation system for given Industrial application.	TPS 3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	L
CO2	M	L	-	-	-	-	-	-	-	-	-	-	L	L
CO3	S	M	L	-	L	-	-	-	-	-	-	-	M	S
CO4	S	M	L	-	-	-	-	-	-	-	-	-	M	M
CO5	S	M	L	-	L	-	-	-	-	-	-	-	M	S
CO6	S	M	L	-	L	-	-	-	-	-	-	-	M	S

S – Strong M – Medium L – Low

Assessment Pattern

	Assessment 1 (%)		Assessment 2 (%)		Terminal (%)
	CAT 1	Assignment 1	CAT 2	Assignment 2	
CO1	20	-	10	-	15
CO2	20	-	-	-	10
CO3	-	-	30	-	20
CO4	-	-	30	-	20
CO5	20	-	20	100	15
CO6	40	100	10	-	20

Syllabus

PLC Basics: Basics of Electrical control-Parts of a PLC -Principles of Operation –Advantages and Disadvantages of PLC - PLC Size and Application- The I/O Section -Discrete I/O Modules-Analog I/O Modules-Special I/O Modules – I/O Specifications-Scanning cycle of PLC-The CPU-Memory Design-Memory Types- Processor Memory Organization-I/O Interfacing.

Programming PLC: PLC Programming Languages- PLC Modes of Operation - Relay-Type Instructions- Instruction Addressing-Branch Instructions Internal Relay Instructions Programming EXAMINE IF CLOSED and EXAMINE IF OPEN Instructions - Designing a Ladder Diagram for large process –Programming Timers-Programming Counters - High Speed Counter-Subroutine and Interrupt -programming Analog module - Developing a PLC program for Machine, Process and Motion control.

HMI and SCADA: HMI programming-Interfacing PLC with HMI. Basics of SCADA system-SCADA key features - Remote terminal units (RTUs)-Typical requirements for an RTU system - PLCs used as RTUs-Consideration and benefits of SCADA system-SCADA software package- Selection of Profibus, Profinet, Sercos, Ethernet and OPC/UA.

Fluidic Power Automation: Fundamentals of hydraulic and pneumatic drives-basic definitions and principles-benefits of fluidic drives-components of fluidic drive systems-Actuators-Control valves Classification- Directional, Pressure, Flow, Proportional and servo valves- Electro pneumatic circuit -Fluidic sequential circuit design using classical, cascade and step counter methods.

Industrial Applications: Role of PLC in Industry 4.0 application, Application of Wireless Networks for Industrial automation, Application of Pneumatic, Hydraulic circuits in Industrial automation.

Text Book(s)

1. Frank D Petruzella, **Programmable logic controllers,** Fourth edition, McGraw Hill higher education ,2016
2. Fluid power with applications by Antony Esposito ,Pearson publications,2017
3. Rajesh Mehra, Vikrant Vij, **PLCs & SCADA: Theory and Practice,** Laxmi Publications-2016

Reference Books & Web Resources

1. Steve Mackay ,Edwin Wright MIPENZ, Deon Reynders, John Park "**Practical Industrial Data Networks -Design, Installation, trouble shooting"** ,IDC Technologies, Australia.
2. Frank D petruzella, **Electrical Motor and control systems,** McGraw Hill higher education ,2010
3. Krishna Kant -**Computer Based Industrial Control**, EEE-PHI, 2nd edition, 2010.
4. Garry Dunning-**Introduction to Programmable Logic Controllers**, 2nd edition, Thomson, ISBN: 981-240-625-5.
5. W.Bolton- **Programmable Logic Controllers**, Sixth Edition (Paperback) ISBN-13: 978-0128029299, 2012.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1.1	Basics of Electrical control-Parts of PLC, Principles of Operation, Advantages and Disadvantages of PLC.	1
1.2	PLC Size and Application- The I/O Section -Discrete I/O Modules	1
1.3	Analog I/O Modules-Special I/O Modules – I/O Specifications	1
1.4	Scanning cycle of PLC-The CPU-Memory Design-Memory Types- Processor Memory Organization, I/O interfacing.	1
2.0	**Programming PLC**	
2.1	Processor Memory Organization- PLC Programming Languages-PLC Modes of Operation	1
2.2	Relay-Type Instructions- Instruction Addressing-Branch Instructions Internal Relay Instructions	1
2.3	Programming EXAMINE IF CLOSED and EXAMINE IF OPEN Instructions	1
2.4	Designing a ladder diagram for Large Process	1
2.5	Programming Timers	1
2.6	Subroutine and Interrupt Concepts	1
2.6	Programming Counters-High speed counter.	1
2.7	Programming Analog module	1
2.9	Developing a PLC program for Machine, Process and Motion control.	2
3.0	**HMI and SCADA**	
3.1	HMI programming	1
3.2	Interfacing PLC with HMI	1
3.3	Basics of SCADA system-SCADA key features	1
3.4	Remote terminal units (RTUs)-Typical requirements for an RTU	1
3.5	PLCs used as RTUs-Consideration and benefits of SCADA system	1
3.6	SCADA software package	1
3.7	SCADA software package. Selection of Profibus, Profinet, Sercos, Ethernet and OPC/UA.	1
4.0	**Fluidic Power Automation**	
4.1	Fundamentals of hydraulic and pneumatic drives	1
4.2	Basic definitions and principles-benefits of fluidic drives	1

Module No.	Topic	No. of Periods
4.3	Components of fluidic drive systems	1
4.4	Control valves Classification-Pressure, Flow, Directional, Proportional and servo valves.	2
4.5	Fluidic actuators-Motors and Cylinders	1
4.6	Basic Fluidic Circuits	1
4.7	Electro pneumatic circuit	2
4.8	Fluidic speed control circuits –meter in and Meter out	1
4.9	Sequential circuit-manual, electro and proportional, Cascading circuit-manual and electrical control	2
5.0	**Industrial Applications**	
5.1	Role of PLC in Industry 4.0 application	1
5.2	Application of Wireless Networks for Industrial automation	1
5.3	Application of Pneumatic, Hydraulic circuits in Industrial automation.	1
	Total	**36**

Course Designers:

1. Mr. H. Ramesh, rameshh@tce.edu
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22MT540	CNC TECHNOLOGY	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

This course provides fundamental knowledge about the CNC system that are predominantly found in most manufacturing industries. CNC machining is a manufacturing process in which pre-programmed computer software dictates the movement of factory tools and machinery. A CNC system is typically a traditional mechanical machine tool whose motion is controlled by electrical motors which depends on a computer program. CNC machines can produce components with good accuracy and precision along with very high production rate. The dependency on the skill of the worker can be eliminated when CNC machines are employed. In modern CNC systems, the design of a mechanical part and its manufacturing program is highly automated. The part's mechanical dimensions are defined using CAD software, and then translated into manufacturing directives by computer-aided manufacturing (CAM) software. The resulting directives are transformed into the specific commands necessary for a particular machine to produce the component, and then are loaded into the CNC machine

Prerequisite

- 22MT430 - Power Electronics and Drives

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Classify the CNC machine based on their specifications.	TPS2	70	70
CO2	Illustrate the construction features of mechanical components used in a CNC system.	TPS2	70	70
CO3	Design a 3 axis CNC System by selecting suitable controller, feed and spindle drives.	TPS3	70	70
CO4	Develop CNC part program for turning as per product geometry.	TPS3	70	70
CO5	Develop CNC part program for Milling Operations	TPS3	70	70
CO6	Develop a CNC system by selecting suitable components and Suggest methodologies for CNC system maintenance and troubleshooting.	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO2	M	L	-	-	-	-	-	-	-	-	-	-	M	M
CO3	S	S	M	-	-	-	-	-	M	-	-	-	M	M
CO4	S	S	M	-	S	-	-	-	M	-	-	-	M	M
CO5	S	S	M	-	S	-	-	-	M	-	-	-	M	M
CO6	S	S	M	-	-	-	M	-	M	-	-	-	S	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	15	10	-	-	30	-	-	-	-	-	-	-	6	6	-
CO2	15	15	-	-	30	-	-	-	-	-	-	-	6	18	-
CO3	5	15	25	-	-	40	-	-	-	-	-	-	4	6	10
CO4	-	-	-	-	-	-	-	10	20	-	-	30	2	-	15
CO5	-	-	-	-	-	-	10	10	20	-	-	40	2	-	15
CO6	-	-	-	-	-	-	-	10	20	-	-	30	2	-	10

Syllabus

Introduction to CNC Systems: Fundamentals of NC, CNC and DNC technologies, Evolution of CNC Turning centre, Evolution of CNC Milling centre, Principles, specification, features, advantages and applications of CNC machines, Factors influencing the selection of CNC machines, Practical aspects of introducing CNC machines in manufacturing industry, Safety aspects of CNC machines.

Structure and Elements of CNC System: Machine physical architecture – Structural details, Types of loads on CNC machine, Types of guide ways – Friction guide ways, Antifriction guide ways, Elements for rotary motion to linear motion – Screw & nut, recirculating ball screw, , rack & pinion, Torque transmission elements – gears, timing belt, flexible coupling, bearing, Hydraulic and pneumatic systems in a CNC system – Industry 4.0 for Machine tools.

CNC Tooling: Cutting tool materials, types of cutting tool, tool selection, tool holder, tool probing and pre-setting, tool compensation, automatic turret changer, tool monitoring system

CNC Drives and Control: Spindle drive – Three phase induction motor – Construction, Characteristics, Speed control methods, VFD, Axis Drive – AC Servo motor, Construction Characteristics, Closed loop position control. Feedback devices – Rotary encoder, linear scale encoder, proximity sensor, synchronous resolver. Introduction to functioning and programming of CNC Controller, PLC, Man machine interface

CNC Programming: Machine axes identification NC Programming, Part programming terminology – G and M codes, Types of interpolation, Types of Programming – manual part programming: fixed cycle and canned cycle for turning and milling operations, Computer Assisted Part Programming (CAPP), CNC part programming using CAD/CAM tools. Introduction to Cloud computing for CNC programming.

Design, Verification and Maintenance of CNC Machines: Selection and Integration of CNC components-Case study 3 axis CNC turning and milling Machine, Verification of technical and functional aspects, Verification of CNC machine during idle running, Verification of CNC machine tool and work piece accuracy, Analysis of dynamic behaviour of CNC machines, Maintenance of CNC machines- Role of IOT in CNC maintenance sector, IOT based condition monitoring-Case study.

Text Book(s)

1. HMT, “Mechatronics”, Tata McGraw-Hill Publishing Company Limited, New Delhi – 2018.
2. CNC Programming by Dr. S.K. Sinha, Galgotia publications Pvt. Ltd, 2016

Reference Books & Web Resources

1. Ken Evans, “Programming of Computer Numerically Controlled Machines”, Industrial Press Inc. – 2007.
2. Peter Smid, “CNC Programming Handbook”, Industrial Press Inc. 2007.
3. Yusuf Altintas, “Manufacturing Automation”, Cambridge University Press, 2012.
4. G. E. Thyer, “Computer Numerical Control of Machine Tools”, Second Edition, B/H Newnes, 1991.
5. Graham T. Smith, “CNC Machining Technology”, Springer-Verlag London Limited, 1993.
6. FANUC Series 0, Maintenance Manual

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction to CNC Systems**	
1.1	Evolution of CNC Turning centre, Evolution of CNC Milling centre	1
1.2	Principles, specification, features, advantages and applications of CNC machines	1
1.3	Factors influencing the selection of CNC machines, Practical aspects of introducing CNC machines in manufacturing industry	1
1.4	Safety aspects of CNC machines	1
2	**Structure of CNC System**	
2.1	Machine physical architecture – Structural details	1
2.2	Types of loads on CNC machine	1
2.3	Types of guide ways – Friction guide ways, Antifriction guide ways	1
2.4	Elements for rotary motion to linear motion – Screw & nut, recirculating ball screw, recirculating ball screw, rack & pinion	2
2.5	Torque transmission elements – gears, timing belt, flexible coupling, bearing	1
2.6	Hydraulic and pneumatic systems in a CNC system	1
3	**Tooling for CNC Machines**	
3.1	Types of cutting tool, Tool selection	1
3.2	Tool holder, tool probing and pre-setting	1
3.3	Automatic turret changer, Tool monitoring system	1
4	**CNC Drives and Control**	
4.1	Spindle drive – Three phase induction motor – Construction, Characteristics, Speed control methods	2
4.2	VFD Axis Drive – AC Servo motor, Construction, Characteristics, Closed loop position control	2
4.3	Feedback devices – Rotary encoder, linear scale encoder, proximity sensor, synchronous resolver.	2
4.4	Introduction to functioning and programming of CNC Controller, PLC, Man machine interface.	2
4.5	Industry 4.0 for Machine tools	1
5	**CNC Part Programming**	
5.1	Part programming terminology – G and M codes	2

Module No.	Topic	No. of Periods
5.2	Types of interpolation, manual part programming: fixed cycle and canned cycle for turning and milling operations	2
5.3	Tool compensation	1
5.4	Computer assisted part programming	1
5.5	Introduction to CNC part programming using CAD/CAM tools.	1
6	**Design, Verification and Maintenance of CNC Machines**	
6.1	Selection and Integration of CNC components-Case study 3 axis CNC turning and milling Machine	1
6.2	Verification of technical and functional aspects, Verification of CNC machine during idle running	1
6.3	Verification of CNC machine tool and work piece accuracy	1
6.4	Analysis of dynamic behaviour of CNC machine	1
6.5	Maintenance requirements of CNC machine – Role of IOT in CNC maintenance sector, IOT based condition monitoring-Case study.	2
	Total	**36**

Course Designers:

1. Dr. K J Nagarajan, kjnmech@tce.edu
2. Mr. H Ramesh, rameshh@tce.edu

22MT550	CAD / CAM LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

Computer Aided Design (CAD) is the process of designing and developing computer assisted design tools in the design process. Computer Aided manufacturing (CAM) is concerned with use of computer to assist with manufacturing process through G codes and M codes.

Prerequisite

- 22ME160 - Engineering Graphics

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Develop the basics of CAD drawing of 2D models	TPS3	80	90
CO2	Develop the basics of CAD drawing of 3D models.	TPS3	80	90
CO3	Design part development drawing for given application.	TPS3	80	90
CO4	Develop and simulate the CNC program for mechanical operations like taper, turning, threading and curvature.	TPS3	80	90
CO5	Generate CNC code for milling and drilling operation	TPS3	80	90
CO6	Generate CNC program and interface with CNC machine/CNC simulator to draw the given pattern.	TPS3	80	90

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	M	-	S	-	-	-	S	-	-	M	S	S
CO2	S	S	M	-	S	-	-	-	S	-	-	M	S	S
CO3	S	S	M	-	S	-	-	-	S	-	-	M	S	S
CO4	S	S	M	-	S	-	-	-	S	-	-	M	S	S
CO5	S	S	M	-	S	-	-	-	S	-	-	M	S	S
CO6	S	S	M	-	S	-	-	-	S	-	-	M	S	S

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Experiments / Exercise	No. of Hours
1.	2D-drawings using sketcher options - 2 Exercises	2
2.	3D-modelling using form features - 2 Exercises	2
3.	Develop 3D model of plumber block.	2
4.	Develop 3D model of crankshaft	2
5.	Develop 3D model of IC engine piston.	2
6.	Obtain the drafting of the part developed.	2
7.	Write a manual CNC program for step and taper turning and simulate the operation	2
8.	Write a manual CNC program for step and taper turning and simulate the operation	2
9.	Complete the tool path simulation for drilling and pocket milling operations.	2
10.	Generate CNC program for profile milling, drilling and pocket operations using CAD/CAM package.	2
11.	Draw/Import the 2D diagram of the part using CAM package.	2
12.	Create a given sheet metal model (both unfold and finished) using 2D CAD and CAM software	2

Software required:

Siemens, Fusion 360, Denford FANUC offline software for Turning, MasterCAM software, AutoCAD

Course Designers:

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22MT560	INDUSTRIAL AUTOMATION LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

Industrial automation is the use of computer and machinery aided systems to operate the various industrial operations in a well-controlled manner. Depends on the operations involved, the industrial automation systems are majorly classified into two types, namely process plant automation and manufacturing automation. Earlier the purpose of automation was to increase productivity and to reduce the cost associated with human operators. However, today, the focus of automation has shifted to increasing quality and flexibility in a manufacturing process.

In industrial automation control, a wide number of process variables such as temperature, flow, pressure, distance, and liquid levels can be sensed simultaneously. All these variables are acquired, processed and controlled by complex microprocessor systems or PC based data processing controllers. The automated system needs special dedicated hardware and software products for implementing control and monitoring systems. In recent years, the number of such products has been developed from various vendors which providing their specializing software and hardware products. This course provides the practical skills on automation technologies which enable the students to design and develop the automated systems to meet out the requirements of digital manufacturing.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Design and verify the function of hydraulic and pneumatic circuits.	TPS3	80	80
CO2	Build programmable logic control for mechanical, hydraulic, pneumatic and electrical systems.	TPS3	80	80
CO3	Develop algorithm for Motion control applications	TPS3	80	80
CO4	Develop graphical user interface for industrial applications using HMI.	TPS3	80	80
CO5	Develop graphical user interface for industrial applications using SCADA.	TPS3	80	80
CO6	Program PLC for robot and Numerical Control.	TPS3	80	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	M	-	-	-	-	-	L	-	-	M	S	-
CO2	S	M	M	-	-	-	-	-	L	-	-	M	S	-
CO3	S	M	M	-	M	M	-	-	M	-	-	M	S	M
CO4	S	M	M	-	M	M	-	-	M	M	-	S	S	M
CO5	S	M	M	-	M	M	-	-	S	M	-	S	S	M
CO6	S	M	M	-	M	M	-	-	S	M	M	S	S	M

S – Strong M – Medium L – Low

List of Experiments

Expt. No.	Exercises / Experiments	No of Hours.	COs
1	**Design, Simulation and Implementation of Hydraulic Circuits** a. Design and Simulation of Manual and Electro Hydraulics circuits. b. Design and Implementation of Manual and Electro Hydraulics circuits with Trainer kit. c. Design and Implementation of Proportional hydraulics circuits using trainer kit. d. Implementation of hydraulics circuits using PLC. (4 exercises)	4	CO1, CO2
2	**Design, Simulation and Implementation of Pneumatic Circuits** a. Design and Simulation of Manual and Electro pneumatic circuits. b. Design and Implementation of Manual and Electro pneumatic circuits with Trainer kit. (2 exercises)	2	CO1, CO2
3	Exercises using PLC Bit logic Functions (2 Exercises)	2	CO2
4	Exercises using PLC Timer functions (2 Exercises)	2	CO2
5	Exercises using PLC Counter Functions (2 Exercises)	2	CO2
6	Exercises using PLC Move Function and arithmetic function (2 Exercises)	2	CO2
7	PLC Functions and Function blocks (1 Exercise)	2	CO2
8	Programming PLC Analog module	1	CO2
9	Programming with HMI and SCADA	2	CO4, CO5
10	Programming PLC-IOT module	1	CO2
11	Motion control programming for Industrial Robot applications	2	CO3, CO6
12	PLC program for Numerical control applications.	2	CO2, CO3, CO6
13	Industrial automation Mini Project.	-	CO1 to CO6
	TOTAL	**24**	

Reference Books

1. "**Indra Works 14VRS PLC Programming System Indra Logic 2G**" published by Bosch Rexroth Edition7- Application Description -R911343571.
2. "**Learn-/Training Document –S71200**", Siemens TIA Portal Module 011-001, Edition 09/2017 | Digital Factory, DF FA.
3. **S7-1500 Getting Started manual**, Siemens 05/2014, A5E03981761-AC.
4. KARL-HEINZ JOHN, **Programming Industrial automation systems**, Springer, 1995.

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CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

VI and VII Semester

For the students admitted from the
academic year 2022 - 2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF MECHATRONICS ENGINEERING

Vision:

"Be a globally renowned school of engineering in Mechatronics"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfil the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of B.E.

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze Complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Specific Outcomes (PSO) of B.E. Mechatronics Engineering

After the successful completion of the B.E. Mechatronics Engineering degree programme, the students will be able to:

PSO1: Design, develop and retrofit conventional mechanical system into low-cost automated system using sensors and controllers

PSO2: Design, develop and analyse mechatronics system using hardware and software tools.

SCHEDULING OF COURSES

Sem	Theory / Theory cum Practical / Laboratory Courses								CDIO / Audit Courses	Total Credits
I	22MA110 Calculus for Engineers BSC 4	22PH120 Physics BSC 3	22CH130 Chemistry BSC 3	22EG140 Technical English HSMC 2	22ME160 Engineering Graphics ESC 4	22EG170 English Laboratory HSMC 1	22PH180 Physics Laboratory BSC 1	22CH190 Chemistry Laboratory BSC 1	22ES150 Engineering Exploration ESC 2	21
II	22MT210 Matrices and Ordinary Differential Equations BSC 4	22MT220 Analog Electronics PCC 3	22MT230 Free Body Mechanics PCC 3	22MT240 Problem Solving using C ESC 3	22MT250 Manufacturing Process PCC 3	22MT260 Mechatronic Workshop ESC 1	22MT270 Manufacturing Laboratory PCC 1	22MT280 Mechatronic System Laboratory ESC 1	Audit Course 1	19
III	22MT310 Partial Differential Equations BSC 4	22MT320 Digital Electronics PCC 3	22MT330 Kinematics and Dynamics of Machinery ESC 3	22MT340 Thermal Fluid Systems PCC 3	22MT350 Electrical Machines ESC 3	22MT360 Thermal Engineering Laboratory PCC 1	22MT370 Electrical Machines Laboratory ESC 1	22MT380 Electronic Circuits and Digital Laboratory PCC 1	22ES390 Design Thinking ESC 3	22
IV	22MT410 Probability and Statistics BSC 4	22MT420 Microcontroller based system design PCC 3	22MT430 Power Electronics and Drives ESC 3	22MT440 Sensors and Measurements PCC 3	22MT450 Digital Signal Processing PCC 3	22MT460 Project Management HSMC 3	22MT470 Microcontroller Laboratory PCC 1	22MT480 Sensors and Measurements Laboratory PCC 1	Audit Course 2	21
V	22MT510 Control Systems PCC 4	22MT520 Design of Machine Elements PCC 3	22MT530 Industrial Automation PCC 3	22MT540 CNC Technology PCC 3	22MTPx0 Program Elective I PEC 3	22yyGx0 Inter disciplinary Elective IE 3	22MT5500 CAD / CAM Laboratory PCC 1	22MT560 Industrial Automation Laboratory PCC 1	22MT570 Project I PW 3	24
VI	22MT610 Accounting and Finance HSMC 4	22MT620 Industrial Robotics PCC 3	22MTPx0 Program Elective II PEC 3	22MTPx0 Program Elective III PEC 3	22MT630 Professional Communication HSMC 2	22yyFx0 Basic Science Elective BSE 3	22MT640 Control and Dynamics Laboratory PCC 1	22MT650 Robotics Laboratory PCC 1	22MT660 Project II PW 3	23
VII	22MT710 Mechatronics System Design PCC 4	22MTPx0 Program Elective IV PEC 3	22MTPx0 Program Elective V PEC 3	22MTPx0 Program Elective VI PEC 3	22MTPx0 Program Elective VII PEC 3	22MT720 System Integration Laboratory PCC 2	---	---	22MT730 Project III PW 3	21
VIII	22MTPx0 Program Elective VIII PEC 3	22MTPx0 Program Elective IX PEC 3	---	---	---	---	---	---	22MT810 Project IV PW 3	9
									Total Credits	**160**

CREDIT DISTRIBUTION

Degree: B.E. **Program: Mechatronics**

Sl. No.	Category		Credits	
			Regular Admission	Lateral Entry Admission
A.	**Foundation Courses (FC)**		**54 - 66**	**22 - 35**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	08 - 11
	b.	Basic Science Courses (BSC)	24 - 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 - 27	08 - 15
B.	**Professional Core Courses (PCC)**		**55**	**45**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 - 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 - 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 - 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 - 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 - 06
	b.	Basic Science Elective (BSE)	03 - 06	03 - 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

VI SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT610	Accounting and Finance	HSMC	3	1	0	4
22MT620	Industrial Robotics	PCC	3	0	0	3
22MTPx0	Program Elective II	PEC	3	0	0	3
22MTPx0	Program Elective III	PEC	3	0	0	3
22MT630	Professional Communication	HSMC	0	1	2	2
22yyFx0	Basic Science Elective	BSE	3	0	0	3
PRACTICAL						
22MT640	Control and Dynamics Laboratory	PCC	0	0	2	1
22MT650	Robotics Laboratory	PCC	0	0	2	1
PROJECT						
22MT660	Project II	PW	0	0	6	3
		Total	**15**	**2**	**12**	**23**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

VI SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT610	Accounting and Finance	3	40	60	100	27	50
22MT620	Industrial Robotics	3	40	60	100	27	50
22MTPx0	Program Elective II	3	40	60	100	27	50
22MTPx0	Program Elective III	3	40	60	100	27	50
22MT630	Professional Communication	3	40	60	100	27	50
22yyFx0	Basic Science Elective	3	40	60	100	27	50
PRACTICAL							
22MT640	Control and Dynamics Laboratory	3	60	40	100	18	50
22MT650	Robotics Laboratory	3	60	40	100	18	50
PROJECT							
22MT660	Project II	-	40	60	100	27	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

VII SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MT710	Mechatronics System Design	PCC	3	1	0	4
22MTPx0	Program Elective IV	PEC	3	0	0	3
22MTPx0	Program Elective V	PEC	3	0	0	3
22MTPx0	Program Elective VI	PEC	3	0	0	3
22MTPx0	Program Elective VII	PEC	3	0	0	3
PRACTICAL						
22MT720	System Integration Laboratory	PCC	0	0	4	2
PROJECT						
22MT730	Project III	PW	0	0	6	3
		Total	**15**	**1**	**10**	**21**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

VII SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MT710	Mechatronics System Design	3	40	60	100	27	50
22MTPx0	Program Elective IV	3	40	60	100	27	50
22MTPx0	Program Elective V	3	40	60	100	27	50
22MTPx0	Program Elective VI	3	40	60	100	27	50
22MTPx0	Program Elective VII	3	40	60	100	27	50
PRACTICAL							
22MT720	System Integration Laboratory	3	60	40	100	18	50
PROJECT							
22MT730	Project III	-	40	60	100	27	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

VIII SEMESTER

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
THEORY						
22MTPx0	Program Elective VIII	PEC	3	0	0	3
22MTPx0	Program Elective IX	PEC	3	0	0	3
PROJECT						
22MT810	Project IV	PW	0	0	6	3
		Total	**6**	**0**	**6**	**9**

HSMC : Humanities and Social Sciences including Management Courses

BSC : Basic Science Courses

ESC : Engineering Science Courses

PCC : Program Core Courses

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

VII SEMESTER

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
THEORY							
22MTPx0	Program Elective VIII	3	40	60	100	27	50
22MTPx0	Program Elective IX	3	40	60	100	27	50
PROJECT							
22MT810	Project IV	-	40	60	100	27	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

22MT610	ACCOUNTING AND FINANCE	Category	L	T	P	C	TE
		HSMC	3	1	0	4	Theory

Preamble

Engineering profession involves lots of decision making. The decisions may range from operation to non-operation. For taking decisions of these kinds an engineer needs among other things data about the organization's routine operations and non-routine operations. Accounting is a science which provides all the data by recording, classifying, summarizing and interpreting the various transactions taking place in an organization and thereby helps an engineer in taking vital decisions in an effective manner. Finance is an allied but a separate field relying on accounting, and enables engineers in taking useful financial and cost related decisions by providing well defined concepts, tools and techniques.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Prepare financial statements using common size statements, comparative statements and trend percentage methods	TPS 3	75	65
CO2	Prepare apportionment of overheads and cost sheet for the given direct and indirect costs.	TPS 3	75	65
CO3	Calculate material, labour and overhead cost variance by identify the reasons for the variances and deprecation for the assets.	TPS 3	75	65
CO4	Calculate various functional budgets, working capital and cash budget for manufacturing applications.	TPS 3	75	65
CO5	Compute the capital budgeting decisions by using pay back, accounting rate of return, net present value and internal rate of return methods.	TPS 4	60	65
CO6	Calculate the break-even points and margin of safety from the given statement.	TPS 3	75	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	L	-	-	L	M	-	S	L	-	-
CO2	S	M	L	-	-	-	-	L	-	-	S	-	-	-
CO3	S	M	L	-	-	-	-	L	-	-	S	-	-	-
CO4	S	M	L	-	-	-	-	L	-	-	S	L	-	-
CO5	S	S	M	L	L	-	-	L	M	-	S	M	-	-
CO6	S	M	L	-	L	-	-	L	M	L	S	M	-	-

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)							Assessment 2 (%)							Terminal (%)			
	CAT 1			Assignment 1			CAT 2				Assignment 2							
TPS	1	2	3	1	2	3	1	2	3	4	1	2	3	4	1	2	3	4
CO1	-	-	30	100			-	-	-	-	-	-	-	-	4	5	8	-
CO2	-	-	30				-	-	-	-	-	-	-	-	4	5	8	-
CO3	-	-	40				-	-	-	-	-	-	-	-	4	5	8	-
CO4	-	-	-	-	-	-	-	-	30	-	100				2	5	8	-
CO5	-	-	-	-	-	-	-	-	-	40					4	-	-	15
CO6	-	-	-	-	-	-	-	-	30	-					2	5	8	-

Syllabus

Financial Accounting - Introduction and Definition -Functions of accounting -Concepts and conventions of accounting -Financial statements and their analysis

Finance - Introduction and Definition-Objectives of financing-Profit maximization vs wealth maximization - Functions of finance - Basics of Goods and Services Tax - Constitutional Framework of GST - GST Model – CGST / IGST / SGST / UTGST

Cost Accounting - Meaning and importance – Cost - Elements of cost - Cost classification - Overheads - Allocation and apportionment of overheads - Preparation of Cost sheet - Conventional Vs activity-based costing - Cost drivers and their impact on costs of production

Standard costing - Meaning and definition-Importance - Variance analysis - calculation of material, labour and overhead variances - Depreciation and its types

Budget and Budgetary control – Introduction - Meaning - objectives of budgetary control - Preliminaries for operation of budgetary control-Budget - Types of budgets and their preparation

Working capital - Meaning and definition-Importance-Factors influencing working capital-components of working capital -Estimation of working capital requirements

Capital Budgeting - Introduction-Meaning and Definition-Importance –process of capital budgeting - Appraisal of capital budgeting decisions

Profit Volume Analysis – Cost – Volume ratio analysis - Marginal cost, Marginal cost statement and total cost -Break Even Analysis - Margin of Safety - Applications of Break Even Analysis.

Accounting software for balance sheet, Budgeting, Break even Analysis

Text Book(s)

1. M.C. Shukla, T.S. Grewal, S.C. Gupta: "**Advanced Accounts-volume-I**", Reprint, S Chand & Company Ltd. 2017

Reference Books and Web Resources

1. S.N. Maheswari, "**Financial Management, principles and practices**", Sultan Chand & Company Ltd. 2013.
2. Prasanna Chandra, "**Financial Management-Theory and Practice**". Sixth Reprint, Tata McGraw-Hill publishing company Limited, 2015.
3. P.S. Boopathi Manickam, "**Financial and Management Accounting**" PSG Publications, 2009
4. Ramachandra Aryasri, A, Ramana Moorthy, V.V, "**Engineering Economics and financial Accounting**", Tata McGraw hill, 2007.
5. S.N. Maheswari, "**Advanced accountancy**" Vikas publishing, 2007.
6. https://nptel.ac.in/courses/110/101/110101132/
7. https://nptel.ac.in/courses/110/101/110101131/
8. https://nptel.ac.in/courses/110/107/110107127/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Financial Accounting**	
1.1	Introduction and Definition	1
1.2	Functions of accounting	1
1.3	Concepts and conventions of accounting	1
2	**Finance**	
2.1	Introduction and Definition	1
2.2	Objectives of financial management	1
2.3	Functions of finance	1
2.4	Basics of Goods and Services Tax - Constitutional Framework of GST - GST Model – CGST / IGST / SGST / UTGST	1
3	**Financial statements**	
3.1	Comparative statement	2
3.2	Common size statement	2
3.3	Trend percentage	1
4	**Cost Accounting**	
4.1	Meaning and importance	1
4.2	Cost-Elements of cost-Cost classification	1
4.3	Overheads – Allocation and apportionment of overheads	2
4.4	Preparation of Cost sheet	2
4.5	Conventional Vs Activity based costing	1
4.6	Cost drivers and their impact on costs of production	1
5	**Standard costing**	
5.1	Meaning and definition-Importance	1
5.2	Variance Analysis, Calculation of material, labour and overhead variances.	2
5.3	Depreciation and its types	2
6	**Budget and Budgetary control**	
6.1	Introduction-Meaning -objectives of budgetary control	1
6.2	Preliminaries for operation of budgetary control	1
6.3	Budget-Types of budgets and their preparation	2

Module No.	Topic	No. of Periods
7	**Working capital**	
7.1	Meaning and definition-Importance	1
7.2	Factors influencing working capital	1
7.3	components of working capital	1
7.4	Estimation of working capital requirements	2
8	**Capital Budgeting**	
8.1	Introduction-Meaning and Definition-Importance – process of capital budgeting	1
8.2	Appraisal of capital budgeting decisions	2
8.3	Payback Period, ARR	2
8.4	NPV, IRR and PI methods	2
9	**Profit Volume Analysis**	
9.1	Marginal cost, Marginal cost statement and total cost	1
9.2	Break Even Analysis	2
9.3	Margin of Safety	2
9.4	Applications of Break Even Analysis	2
	Total	48

Course Designers:

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2. S. Rajkumar, srmech@tce.edu

22MT620	INDUSTRIAL ROBOTICS	Category	L	T	P	C	TE
		PCC	3	0	0	3	Theory

Preamble

Robotics is the interdisciplinary branch of engineering and science that includes mechanical engineering, electrical engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. In the 20th century, engineers have mastered almost all forms of motion control and have proven that robots and machines can perform almost any job made by humans. Industrial Robotics deals with the types of robots used in industries both industrial and mobile robots.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Review the Anatomy, types and applications of robots	TPS2	75	75
CO2	Compute the forward kinematic model (position and orientation) of multi DOF manipulator	TPS3	65	65
CO3	Compute the inverse kinematic model (joint angles) of 1 and 2 DOF manipulator	TPS3	65	65
CO4	Compute the forward and inverse dynamic model of two DOF manipulator (torque)	TPS3	65	65
CO5	Develop pendant program for palletizing and deburring application	TPS3	65	65
CO6	Implement Artificial Intelligence based robot picking	TPS2	75	75

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	-	L	-	-	-	-	-	-	M	M	M
CO2	S	S	S	-	S	-	-	-	-	-	-	M	M	M
CO3	S	S	S	-	S	-	-	-	-	-	-	M	M	M
CO4	S	S	S	-	S	-	-	-	-	-	-	M	M	M
CO5	S	S	S	-	S	-	-	-	-	-	-	M	M	M
CO6	S	S	S	-	L	-	-	-	-	-	-	M	M	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	60	-	-	-	-	-	-	-	-	-	-	-	20	-
CO2	-	-	20	-	100	-	-	-	-	-	-	-	-	-	25
CO3	-	-	20	-	-	-	-	-	-	-	-	-	-	-	25
CO4	-	-	-	-	-	-	-	-	40	-	-	50	-	-	10
CO5	-	-	-	-	-	-	-	-	40	-	-	50	-	-	10
CO6	-	-	-	-	-	-	-	-	20	-	-	-	-	-	10

Syllabus

Introduction to Industrial Robotics
Introduction – brief history, Robot – types – Industrial, Mobile; Classification and usage, configuration, Anatomy, Elements/subsystems of Robots, Point to point and continuous applications, Mobile manipulators, Grippers – Types; Application of robots in machining - Welding - Assembly - Material handling - Loading and unloading Inspection – Palletizing - Hostile and remote environments.

Representation and Transformation of joints, links
Mechanical Structure notations, Coordinate frames, Description of objects in space, Transformation and fundamental rotation matrices, Position and orientation of a rigid body, Homogeneous transformations, Representation of joints, link representation using D-H parameters, **Kinematics:** Forward kinematics of multi DOF manipulator - Inverse kinematics of 2DOF manipulator. **Dynamics:** Introduction – Manipulator dynamics – Lagrange - Euler formulation- Newton - Euler formulation. Examples of D-H parameters and link transforms. Introduction to Robo Analyser – Visualization of DH parameters. Introduction to Robot Operating System (ROS) – Demonstration.

Trajectory planning
Definitions and planning tasks, Joint techniques – Motion profiles- cubic polynomial motion, Cartesian Space techniques. Robot Controller – open, closed.

Robot Programming
Robot Programming: Manual programming – Teach Pendant, Online programming – Deburring, Palletizing and Inspection, Offline Programming – Welding.

Artificial Intelligence in Robotics
Artificial Intelligence – Types – Edge based; Cloud based, Security concerns - Consciousness, Scalability, Data Security. Case studies - Vision based robot picking, Collaborative Robots, Digital Twin Robots.

Text Book(s)

1. Dr Jisu Elsa Jacob, “Robotics Simplified: An Illustrative Guide to Learn Fundamentals of Robotics, Including Kinematics, Motion Control, and Trajectory Planning”, BPB Publications, 2022

Reference Books & Web Resources

1. Robotics, AI, and Humanity, Science, Ethics, and Policy, Springer, 2021
2. Shuai Li, Long Jin, Mohammed Aquil Mirza," Kinematic Control of Redundant Robot Arms Using Neural Networks", IEEE press, April 29, 2019.
3. John J Craig, "Introduction to Robotics, Mechanics and Control, third edition, Pearson education, 2005
4. K.S.Fu, R.C Gonzalez and C.S Lee, Robotics – Control, sensing Vision and Intelligence, Tata McGraw – Hill Editions, 2008.
5. S.K. Saha, "Introduction to Robotics", second edition, Mc Graw Hill education India Private limited, New Delhi, 2008.
6. Saeed B Niku, "Introduction to Robotics, Analysis, System, Applications," second edition, john Wiley, 2010.
7. Mikell P Groover, Mitchell Weiss, Roger N Nagel and Nicholas G Odrey, "Industrial Robotics – Technology, Programming and Applications", Tata McGraw Hill Edition, 2008.
8. Robert J Schiling, Fundamentals of Robotics: Analysis and Control", Indian reprint, Prentice hall of India Private Limited, 1996

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods	Course Outcome
1.0	**Introduction to Industrial Robotics**		CO1
1.1	Introduction – brief history	1	CO1
1.2	Robot – types – Industrial, Mobile	1	CO1
1.3	Classification and usage, configuration	1	CO1
1.4	Anatomy, Elements/subsystems of Robots	1	CO1
1.5	Point to point and continuous applications	1	CO1
1.6	Mobile manipulators, Grippers, – Types	1	CO1
1.7	Application of robots in machining - Welding - Assembly	1	CO1
1.8	Material handling - Loading and unloading Inspection, Palletizing - Hostile and remote environments	1	CO1
2.0	**Representation and Transformation of joints, links**		
2.1	Mechanical Structure notations, Coordinate frames	1	CO2
2.2	Description of objects in space, Transformation and fundamental rotation matrices	1	CO2
2.3	Position and orientation of a rigid body, Homogeneous transformations	1	CO2
2.4	Representation of joints	1	CO2
2.5	Link representation using D-H parameters	1	CO2
2.6	Forward kinematics of multi DOF manipulator	1	CO2
2.7	Inverse kinematics of 2DOF manipulator	1	CO3
2.8	Introduction – Manipulator dynamics	1	CO4
2.9	Lagrange - Euler formulation	1	CO4
2.10	Newton - Euler formulation	1	CO4
2.11	Examples of D-H parameters and link transforms	1	CO4
2.12	Visualization of DH parameters	1	CO4
2.13	Introduction to Robo Analyser	1	CO4
2.14	Introduction to Robot Operating System (ROS)-Demonstration	1	CO4
3.0	**Trajectory planning**		
3.1	Definitions and planning tasks	1	CO4
3.2	Joint techniques – Motion profiles-	1	CO4

Module No.	Topic	No. of Periods	Course Outcome
3.3	Cubic polynomial motion	1	CO4
3.4	Cartesian Space techniques	1	CO4
3.5	Robot Controller – open, closed	1	CO4
4.0	**Robot Programming**		
4.1	Robot Programming types	1	CO5
4.2	Teach Pendant Commands	1	CO5
4.3	Manual programming	1	CO5
4.4	Online programming – Deburring, Palletizing and Inspection	1	CO5
4.5	Offline Programming – Welding	1	CO5
5.0	**Artificial Intelligence in Robotics**		
5.1	Artificial Intelligence – Types – Edge based; Cloud based	1	CO6
5.2	Security concerns - Consciousness, Scalability, Data Security	1	CO6
5.3	Case studies - Vision based robot picking,	1	CO6
5.4	Collaborative Robots, Digital Twin Robots.	1	CO6
	Total	**36 hours**	

Course Designers:

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22MT640	CONTROL AND DYNAMICS LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

Dynamic response of a system is often a key factor in system's overall performance. The design of modern, quiet and efficient engineering systems requires a good understanding of dynamic response. Dynamics is the field of engineering concerned with predicting, measuring and analyzing the behavior responses such as force, torque, speed, mass, velocity and acceleration.

Control engineering concerns the design of automatic systems to control the behavior of machines and processes. Effective control system design is critical in achieving optimal performance from machines and processes, and is dependent on a good understanding of the dynamics of the system that is to be controlled. Therefore, understanding the natural link between the fields of dynamics and control plays a vital role in modern engineering systems.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Infer the force, torque and gyroscope effect in rotatingmachinery	TPS3	75	80
CO2	Test and observe the longitudinal, transverse and torsionalvibrations so as to avoid resonance	TPS3	75	80
CO3	Interpret the effect of unbalanced reciprocating and rotatingmasses	TPS3	75	80
CO4	Compare the Responses of First order and second ordersystems	TPS3	75	80
CO5	Compare the effect of Compensation, addition of poles, addition of zeros to the closed loop transfer function	TPS3	75	80
CO6	Design a controller for mechatronics systems	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	-	S	-	-	-	S	S	-	S	M	M
CO2	S	S	S	-	S	-	-	-	S	S	-	S	M	M
CO3	S	S	S	-	S	-	-	-	S	S	-	S	M	M
CO4	S	S	S	-	S	-	-	-	S	S	-	S	M	M
CO5	S	S	S	-	S	-	-	-	S	S	-	S	M	M
CO6	S	S	S	-	S	-	-	-	S	S	-	S	M	M

S – Strong M – Medium L – Low

List of Experiments

Sl. No.	Exercises / Experiments	No of Periods.
1.	Governors - Determination of sensitivity, effort, etc. for watt, porter, proell, Hartnell governors	2
2.	Cam - Study of jump phenomenon and drawing profile of the cam.	2
3.	Motorized Gyroscope-Determination of Gyroscopic couple Verification of Laws	2
4.	Turn table-Determination of Moment of Inertia of Disc and Ring	2
5.	Balancing of rotating masses (Static and Dynamic Balancing)	2
6.	Balancing of reciprocating masses.	2
7.	Whirling of Shaft – Determination of Critical Speed	2
8.	Determination of a Step & Impulse response for a first order, second order, Type 0, Type 1 and Type 2 systems	2
9.	Design a suitable compensator to obtain the open loop specifications using root locus and bode plot techniques.	2
10.	Compare the effect of addition of poles, addition of zeros to the forward path transfer function of a closed loop system	2
11.	Derive the simulation model for Open loop and closed loop systems, plot the step response, Study the effect of P, Pi, PD, PID control, and tune the controller using ZN Tuning rule.	2
12.	Design a controller for DC Motor speed control and verify its performance	2
13.	Design a controller for Inverted pendulum and verify its performance	2
14.	Design a controller for process control application.	2
	Total	**24**

Reference Books & Web Resources

1. Norman S. Nise, “Control System Engineering”, Eigthth Edition, John Wiley & Sons,2019.
2. Rattan.S.S, “Theory of Machines”, Fifth Edition, Tata McGraw–Hill Publishing Co., New Delhi,2018.
3. J. Nagrath and M. Gopal, “Control System Engineering”, New Age International Publisher, Sixth Edition, New Delhi, 2018.
4. John Joseph Uicker, Gordon Pennock, Joselph E.Shigley, “Theory of Machines andMechanisms”, Fourth Edition, Oxford University Press, 2014.
5. Rao and Dukkipati, R.V, “Mechanism and Machine Theory”, Second edition NewAge International (P) Ltd., 2010.
6. K. Ogata, “Modern Control Engineering”, Fifth Edition, Pearson Edition, 2009.

Course Designers:

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22MT650	ROBOTICS LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	2	1	Practical

Preamble

The fundamental concepts in robotics are its design, and control. An engineer should be able to model and control the robots through software and hardware.
This course provides in-depth knowledge on programming of robots, simulating them in a particular environment and designing them to perform a particular task. This course is useful for those students interested in control engineering, robotics and systems engineering.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Program and evaluate point-to-point motion for an industrial robot	TPS3	75	80
CO2	Program and evaluate continuous point motion for an industrial robot	TPS3	75	80
CO3	Simulate the function of a robotic cell for material handling application	TPS3	75	80
CO4	Simulate the function of a welding robotic cell	TPS3	75	80
CO5	Model, simulate and analyse the characteristics of a wheeled robot	TPS3	75	80
CO6	Develop path planning and navigation program for a mobile robot	TPS3	75	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	-	S	-	-	-	S	S	-	S	L	S
CO2	S	S	S	-	S	-	-	-	S	S	-	S	L	S
CO3	S	S	S	-	S	-	-	-	S	S	-	S	L	S
CO4	S	S	S	-	S	-	-	-	S	S	-	S	L	S
CO5	S	S	S	-	S	-	-	-	S	S	-	S	L	S
CO6	S	S	S	-	S	-	-	-	S	S	-	S	L	S

S – Strong M – Medium L – Low

List of Experiments

Sl. No.	Exercises / Experiments	No. of Hours	Cos
1	To simulate and analyse the forward and inverse kinematics of industrial robot using Robo Analyser	2	CO1
2	To program and evaluate the point to point motion (pick and place) of an industrial robot using MH5LS robot	2	CO1
3	To program and perform the continuous motion (Deburring operation) using GP12 robot	2	CO2
4	To program the Kobuki robot to perform collision avoidance operation using bumper	2	CO6
5	To model, simulate and analyse the characteristics of a robot gripper using 20 SIM software	2	CO5
6	To simulate the function of a material handling robotic cell in using RoboDK software	2	CO3
7	To simulate the function of a welding robotic cell using MOTOSIM software	2	CO4
8	To model, simulate and analyse the characteristics of a wheeled robot using 20 SIM software	2	CO5
9	To program and perform the inspection operation using MH5LS robot	2	CO1
10	To program and perform the Assembly operation using GP12 and MH5LF robot (Cooperative operation)	2	CO2
11	To program and evaluate the Kinect based 2D mapping using Kobuki Platform	2	CO6
12	To program and evaluate path planning using Kobuki Platform	2	CO6
	TOTAL	**24**	

Reference Books & Web Resources

1. Lab operation manual
2. YASKAWA Operation Manual
3. Kobuki Quick Start Guide
4. 20 SIM Manual by Controllab products
5. SIEMENS TIA Portal Manual

Course Designers:

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22MT710	MECHATRONICS SYSTEM DESIGN	Category	L	T	P	C	TE
		PCC	3	1	0	4	Theory

Preamble

A Mechatronic system design is a design process that is characterized by synergistic integration of mechanisms, sensors, actuators and control to perform complex tasks in a metaphysical environment.
An important characteristic of mechatronic devices and systems is their built-in intelligence, which results through a combination of precision mechanical and electrical engineering and real-time programming integrated with the design process. Mechatronics system design makes possible to understand the basic design process involved in mechatronics, selection of sensors and actuators, the interface issues and communication problems. Design of a mechatronic systems is introduced in this subject to illustrate the concepts.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Review the Mechatronic design process	TPS2	65	65
CO2	Develop bond graph for the particular mechatronic system	TPS3	75	65
CO3	Select the sensor and Actuator for a Mechatronic application	TPS3	75	65
CO4	Interface the selected sensor, Actuator and Controller	TPS3	75	65
CO5	Analyse and improve conventional designs by using the mechatronic design approach	TPS3	75	65
CO6	Develop a Mechatronic product for the given problem	TPS3	75	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	S	S	-	L		-	-	-	-	-	M	M	M
CO2	S	S	S	-	S		-	-	-	-	-	M	M	M
CO3	S	S	S	-	L		-	-	-	-	-	M	M	M
CO4	S	S	S	-	S		-	-	-	-	-	M	M	M
CO5	S	S	S	-	S		-	-	S	S	S	S	M	M
CO6	S	S	S	-	S		-	-	S	S	S	S	M	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2 *			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	60	-	-	-	-	-	-	-	-	-	-	-	20	-
CO2	-	-	20	-	-	100	-	-	-	-	-	-	-	-	20
CO3	-	-	20	-	-	-	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	-	-	-	-	50	-	-	10
CO5	-	-	-	-	-	-	-	-	-	-	-	50	-	-	10
CO6	-	-	-	-	-	-	-	-	100	-	-	-	-	-	20

* CAT 2 Assessment: Mini project on development of a Mechatronics System

Syllabus

Introduction to Mechatronic System Design:
Key elements – Mechatronics Design process –Design Parameters – Traditional and Mechatronics designs – Advanced approaches in Mechatronics - Industrial design and ergonomics, safety.

Modelling of Mechatronic Systems by Bond Graphs:
Introduction-model categories-fields of application, generalized variables in bond graph-Power variables – Energy variables, Basic components in Bond graph-1 Port components- 1 Port Resistor- 1 Port Capacitor – 1 Port Inductor, 2 Port components- Transformer - Gyrator, 3 Port Components – 0 Junction, 1 Junction, Model Development - Design examples.

Generalized Mechatronics Design Process:
Recognition of the Need, Conceptual Design and Functional Specification, First principle Modular Mathematical Modeling, Sensor and Actuator Selection – Selection Parameters – Selection of motor & gear combination, Selection of pulley & belt combination, Interface of Sensor, Microcontroller and Actuator – Issues. Communication protocols – Transmission Control Protocol/Internet Protocol (TCP/IP), ProfiBus, DeviceNet, FieldBus, Modbus.

Control System Design, Design Optimization, Prototyping, Hardware-in-the-loop Simulation, Deployment of Embedded Software, Deployment/Life Cycle, and Life Cycle Optimization. Integration of machine learning to develop Intelligent Mechatronic systems.

Problems on advanced systems:
Active suspension system– 3D Printer - Anti lock braking system – Automatic Washing Machine – Auto-focusing in Digital Cameras – Dish washing system - Computer Numerically Control (CNC) machine – Industrial Robot.

Case Study on Intelligent Mechatronic systems:
Robotic Surgery Systems, Self-Driving Cars, Quadcopter – Activity based Humanoid Robots

Text Book(s)

1. Satya Bir Singh," Mechatronics System Design and Solid Materials methods and Practices", CRC press, 2023

Reference Books & Web Resources

1. Dobrivojie Popovich, “Mechatronics in Engineering Design and Product Development”, CRC Press, First Edition, September 23, 2019.
2. Patrick O.J. Kaltjob “Mechatronic Systems and Process Automation: Model-Driven Approach and Practical Design Guidelines”, CRC Press, First Edition, March 22, 2018.
3. Shuvra Das., “Mechatronic Modeling and Simulation Using Bond Graphs”, CRC Press, 2009.
4. W. Bolton, “Mechatronics – Electronic control systems in Mechanical & Electrical Engineering”, Pearson Education Ltd., Second edition, 2011.
5. Shetty and Kolk, “Mechatronics System Design”, CENGAGE Learning, India, second edition, 2011.
6. Amalendu Mukherjee, Ranjit Karmakar, Arun kumar samantaray, “Bond Graph in Modeling, Simulation and Fault Identification” I.K International Pvt Ltd, Jan 2006.
7. Jacqueline Wilkie., Michael Johnson., Reza Katebi., “ Control Engineering an Introductory course “ Palgrave Publication, 2003.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	Course Outcome
1.0	**Introduction to Mechatronic System Design**		
1.1	Key elements – Mechatronics Design process	1	CO1
1.2	Design Parameters – Traditional and Mechatronics designs	1	CO1
1.3	Advanced approaches in Mechatronics	1	CO1
1.4	Industrial design and ergonomics	1	CO1
1.5	Safety	1	
2.0	**Modelling of Mechatronic Systems by Bond Graphs**		
2.1	Introduction-model categories-fields of application	1	CO2
2.2	Generalized variables in bond graph- Power variables – Energy variables	1	CO2
2.3	Basic components in Bond graph-1 Port components- 1 Port Resistor- 1 Port Capacitor – 1 Port Inductor	1	CO2
2.4	2 Port components- Transformer - Gyrator	1	CO2
2.5	3 Port Components – 0 Junction, 1 Junction	1	CO2
2.6	Model Development - Design examples	1	CO2
2.7	Tutorial Class: Problems on modelling Mechatronic Systems	2	CO2
3.0	**Generalized Mechatronics Design Process**		
3.1	Recognition of the Need, Conceptual Design and Functional Specification	1	CO3
3.2	First principle Modular Mathematical Modeling	1	CO3
3.3	Sensor and Actuator Selection	2	CO3
34	Selection Parameters – Selection of motor & gear combination	2	CO3
3.5	Selection of pulley & belt combination	1	CO3
3.6	Interface of Sensor, Microcontroller and Actuator	2	CO3
3.7	Issues	2	CO3

Module No.	Topic	No. of Hours	Course Outcome
3.8	Communication protocols – Transmission Control Protocol/Internet Protocol (TCP/IP)	1	CO4
3.9	ProfiBus, DeviceNet, FieldBus, Modbus	1	CO4
3.10	Control System Design	1	CO4
3.11	Design Optimization, Prototyping	1	CO4
3.12	Hardware-in-the-loop Simulation	1	CO4
3.13	Deployment of Embedded Software	1	CO4
3.14	Deployment/Life Cycle, and Life Cycle Optimization	1	CO4
3.15	Integration of machine learning to develop Intelligent Mechatronic systems.	2	CO4
4.0	**Problems on advanced systems**		
4.1	Active suspension system	1	CO5
4.2	3D Printer	1	CO5
4.3	Anti-lock braking system	1	CO5
4.4	Automatic Washing Machine	1	CO5
4.5	Auto-focusing in Digital Cameras	1	CO5
4.6	Dish washing system	1	CO5
4.7	Computer Numerically Control (CNC) machine	1	CO5
4.8	Industrial Robot	1	CO5
4.9	Tutorial Class: Discussion on Case study	2	CO5
5.0	**Case Study on Intelligent Mechatronic systems**		
5.1	Robotic Surgery Systems	1	CO6
5.2	Self-Driving Cars	1	CO6
5.3	Quadcopter	1	CO6
5.4	Activity based Humanoid Robots	2	CO6
	TOTAL	**48**	

Course Designers:

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22MT720	SYSTEM INTEGRATION LABORATORY	Category	L	T	P	C	TE
		PCC	0	0	4	2	Practical

Preamble

System integration is the process of bringing together the component sub-systems into one system and ensuring that the subsystems function together as a system. System integration involves integrating existing, often disparate systems in such a way "that focuses on increasing value to the customer such as improved product quality and performance, while at the same time providing value to the company by reducing operational costs and improving response time. In the modern world connected by Internet, the role of system integration engineers is important as more and more systems are designed to connect, both within the system under construction and to systems that are already deployed.

Cross-disciplinary integration of mechanical engineering, electrical and electronic engineering as well as recent advances in information engineering are becoming more and more crucial for future collaborative design, manufacture, and maintenance of a wide range of engineering products and processes. This course gives insight in to the integration of sensors and actuators with controller through communication networks in order to realize the new product and total automated system.

Prerequisite

- 22MT560 - Industrial Automation Laboratory

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Identify and select suitable sensors, actuators, controllers by their specifications.	TPS3	80	80
CO2	Integrate mechanisms with controller, sensor and actuator.	TPS3	80	80
CO3	Design a user interface to visualize and control the product and process.	TPS3	80	80
CO4	Configure electrical drives for mechatronics system integration	TPS3	80	80
CO5	Develop a software program to integrate all Mechatronics components using suitable communication protocol.	TPS3	80	80
CO6	Integrate sensor, actuator and controller with user interface through suitable communication protocol.	TPS3	80	80

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	M	-	-	-	-	-	L	-	-	L	S	-
CO2	S	M	M	-	-	-	-	-	L	-	-	L	S	-
CO3	S	M	M	-	M	M	-	-	M	-	-	L	S	M
CO4	S	M	M	-	M	M	-	-	M	M	-	S	S	M
CO5	S	M	M	-	M	M	-	-	S	M	-	S	S	M
CO6	S	M	M	-	M	M	-	-	S	M	M	S	S	M

S – Strong M – Medium L – Low

List of Experiments

Sl. No.	Exercises / Experiments	No. of Hours	Cos
I	**Mechanical System integration using Sensors, PLC, HMI and SCADA**	8	CO1-CO3
	Object sorting system		
	Industrial level control system		
	Conveyor system with pick and place robot control		
	Cooling fan control system		
	Hydraulic and pneumatic system integration		
	Mechanical System Integration - Project Module1	8	
II	**Electrical Drives configuration, programming and control**	8	CO4-CO5
	Variable Frequency drive (VFD)		
	Servo drive		
	Dc drive		
	PMSM-BLDC drive		
	Electrical Drives - Project Module 2	8	
III	**Sensor-Controller-Actuator integration using Communication protocols**	8	CO5-CO6
	Profibus		
	TCP/IP		
	Sercos		
	Profinet		
	Ethernet I/p		
	OPC/UA		
	Communication Protocol - Project Module 3	8	
	TOTAL	**48**	

Reference Books & Web Resources

1. Steve Mackay, Edwin Wright MIPENZ, Deon Reynders, John Park "**Practical Industrial Data Networks - Design, Installation, troubleshooting"**, IDC Technologies, Australia.
2. "**System development automation motion logic control**" published by Bosch Rexroth.
3. **S7-1500 Getting Started manual**, Siemens 05/2014, A5E03981761-AC
4. KARL-HEINZ JOHN, **Programming Industrial automation systems**, Springer,1995
5. Gary W. Johnson, Richard Jennings, **Labview Graphical Programming** , McGraw Hill education, fourth edition 2017.

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CURRICULUM AND DETAILED SYLLABI

for

B.E. Mechatronics Programme

Electives

For the students admitted from the
academic year 2022 - 2023 onwards

THIAGARAJAR COLLEGE OF ENGINEERING
(A Govt. Aided, Autonomous Institution affiliated to Anna University)
MADURAI – 625 015

THIAGARAJAR COLLEGE OF ENGINEERING, MADURAI – 625 015
DEPARTMENT OF MECHATRONICS ENGINEERING

Vision:

"Be a globally renowned school of engineering in Mechatronics"

Mission:

As a department, we are committed to

- Develop ethical and competent engineers by synergizing world class teaching, learning and research
- Establish state-of-art laboratories and to provide consultancy services to fulfil the expectations of industry and needs of the society
- Inculcate entrepreneurial qualities for creating, developing and managing global engineering ventures
- Motivate the students to pursue higher studies and research

Programme Outcomes (POs) of B.E.

PO1	**Engineering knowledge**	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems
PO2	**Problem analysis**	Identify, formulate, research literature, and analyze Complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO3	**Design/development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations
PO4	**Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
PO5	**Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations
PO6	**The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice
PO7	**Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development
PO8	**Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
PO9	**Individual and team work**	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	**Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO11	**Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
PO12	**Life-long learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Programme Specific Outcomes (PSO) of B.E. Mechatronics Engineering

After the successful completion of the B.E. Mechatronics Engineering degree programme, the students will be able to:

PSO1: Design, develop and retrofit conventional mechanical system into low-cost automated system using sensors and controllers

PSO2: Design, develop and analyse mechatronics system using hardware and software tools.

SCHEDULING OF COURSES

Sem	Theory / Theory cum Practical / Laboratory Courses								CDIO / Audit Courses	Total Credits
I	22MA110 Calculus for Engineers BSC 4	22PH120 Physics BSC 3	22CH130 Chemistry BSC 3	22EG140 Technical English HSMC 2	22ME160 Engineering Graphics ESC 4	22EG170 English Laboratory HSMC 1	22PH180 Physics Laboratory BSC 1	22CH190 Chemistry Laboratory BSC 1	22ES150 Engineering Exploration ESC 2	21
II	22MT210 Matrices and Ordinary Differential Equations BSC 4	22MT220 Analog Electronics PCC 3	22MT230 Free Body Mechanics PCC 3	22MT240 Problem Solving using C ESC 3	22MT250 Manufacturing Process PCC 3	22MT260 Mechatronic Workshop ESC 1	22MT270 Manufacturing Laboratory PCC 1	22MT280 Mechatronic System Laboratory ESC 1	Audit Course 1	19
III	22MT310 Partial Differential Equations BSC 4	22MT320 Digital Electronics PCC 3	22MT330 Kinematics and Dynamics of Machinery ESC 3	22MT340 Thermal Fluid Systems PCC 3	22MT350 Electrical Machines ESC 3	22MT360 Thermal Engineering Laboratory PCC 1	22MT370 Electrical Machines Laboratory ESC 1	22MT380 Electronic Circuits and Digital Laboratory PCC 1	22ES390 Design Thinking ESC 3	22
IV	22MT410 Probability and Statistics BSC 4	22MT420 Microcontroller based system design PCC 3	22MT430 Power Electronics and Drives ESC 3	22MT440 Sensors and Measurements PCC 3	22MT450 Digital Signal Processing PCC 3	22MT460 Project Management HSMC 3	22MT470 Microcontroller Laboratory PCC 1	22MT480 Sensors and Measurements Laboratory PCC 1	Audit Course 2	21
V	22MT510 Control Systems PCC 4	22MT520 Design of Machine Elements PCC 3	22MT530 Industrial Automation PCC 3	22MT540 CNC Technology PCC 3	22MTPx0 Program Elective I PEC 3	22yyGx0 Inter disciplinary Elective IE 3	22MT5500 CAD / CAM Laboratory PCC 1	22MT560 Industrial Automation Laboratory PCC 1	22MT570 Project I PW 3	24
VI	22MT610 Accounting and Finance HSMC 4	22MT620 Industrial Robotics PCC 3	22MTPx0 Program Elective II PEC 3	22MTPx0 Program Elective III PEC 3	22yyFx0 Basic Science Elective BSE 3	22MT640 Control and Dynamics Laboratory PCC 1	22MT650 Robotics Laboratory PCC 1	22EG660 Professional Communication HSMC 2	22MT670 Project II PW 3	23
VII	22MT710 Mechatronics System Design PCC 4	22MTPx0 Program Elective IV PEC 3	22MTPx0 Program Elective V PEC 3	22MTPx0 Program Elective VI PEC 3	22MTPx0 Program Elective VII PEC 3	22MT720 System Integration Laboratory PCC 2	---	---	22MT770 Project III PW 3	21
VIII	22MTPx0 Program Elective VIII PEC 3	22MTPx0 Program Elective IX PEC 3	---	---	---	---	---	---	22MT870 Project IV PW 3	9
									Total Credits	**160**

CREDIT DISTRIBUTION

Degree: B.E. **Program: Mechatronics**

Sl. No.	Category		Credits	
			Regular Admission	Lateral Entry Admission
A.	**Foundation Courses (FC)**		**54 - 66**	**22 - 35**
	a.	Humanities and Social Sciences including Management Courses (HSMC)	09 - 12	08 - 11
	b.	Basic Science Courses (BSC)	24 - 27	06 - 09
	c.	Engineering Science Courses (ESC)	21 - 27	08 - 15
B.	**Professional Core Courses (PCC)**		**55**	**45**
C.	**Professional Elective Courses (PEC)**		**24 - 39**	**24 - 39**
	a.	Programme Specific Elective (PSE)	15 - 24	15 - 24
	b.	Programme Elective for Expanded Scope (PEES)	09 - 15	09 - 15
D.	**Open Elective Courses (OEC)**		**06 - 12**	**06 - 12**
	a.	Interdisciplinary Elective (IE)	03 - 06	03 - 06
	b.	Basic Science Elective (BSE)	03 - 06	03 - 06
E.	**Project Work (PW)**		**12**	**12**
F.	**Internship and Mandatory Audit Courses as per Regulatory authorities**		Non-Credit and not included in CGPA	
	Minimum Credits to be earned for the award of the Degree		**160**	**120**
			From A to E and the successful completion of F	

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

COURSES OF STUDY

(For the candidates admitted from 2022 - 2023 onwards)

Course Code	Name of the Course	Category	No. of Hours / Week			Credits (C)
			L	T	P	
22MTGA0	Mechatronics	IE	3	0	0	3
22MTGB0	Value Engineering	IE	3	0	0	3
22MTPA0	Design and Analysis of Experiments	PSE	3	0	0	3
22MTPB0	Semiconductor Manufacturing	PSE	3	0	0	3
22MTPC0	Industry 4.0	PSE	3	0	0	3
22MTPD0	Electric Vehicle Technology	PSE	3	0	0	3
22MTPE0	Drone Technology	PSE	3	0	0	3
22MTPF0	OOP using C++ (TCP)	PSE	1	0	4	3
22MTRA0	Machine Vision using Machine Learning (TCP)	PEES	1	0	4	3

PSE : Programme Specific Elective

PEES : Programme Elective for Expanded Scope

IE : Interdisciplinary Elective

L : Lecture

T : Tutorial

P : Practical

Note:

1 Hour Lecture/Tutorial is equivalent to 1 credit

2 Hours Practical is equivalent to 1 credit

THIAGARAJAR COLLEGE OF ENGINEERING: MADURAI – 625 015.

B.E. DEGREE (Mechatronics) PROGRAMME

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022 - 2023 onwards)

Course Code	Name of the Course	Duration of TE in Hrs.	Marks			Min. Marks for Pass	
			CA*	TE#	Max. Marks	TE#	Total
22MTGA0	Mechatronics	3	40	60	100	27	50
22MTGB0	Value Engineering	3	40	60	100	27	50
22MTPA0	Design and Analysis of Experiments	3	40	60	100	27	50
22MTPB0	Semiconductor Manufacturing	3	40	60	100	27	50
22MTPC0	Industry 4.0	3	40	60	100	27	50
22MTPD0	Electric Vehicle Technology	3	40	60	100	27	50
22MTPE0	Drone Technology	3	40	60	100	27	50
22MTPF0	OOP using C++ (TCP)	3	50	50	100	22.5	50
22MTRA0	Machine Vision using Machine Learning (TCP)	3	50	50	100	22.5	50

***** CA – Continuous Assessment:

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

TE - Terminal Examination

22MTGA0	MECHATRONICS	Category	L	T	P	C	TE
		IE	3	0	0	3	Theory

Preamble

The synergistic fusion of computer science, information technology, mechanical and electrical engineering, and control systems using numerical approaches is known as mechatronics. Its goal is to build intelligent products. It entails researching common applications of mechatronics include sensors, actuators, regulating mechanisms and algorithms. Mechatronics may be used to build specific applications through the harmonious integration of several elements.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Identify the Elements of a Mechatronics system.	TPS 3	80	70
CO2	Explain the use of sensors in Mechatronics system.	TPS 2	80	70
CO3	Explain the Functions of electrical, mechanical, hydraulic and pneumatic actuator used in Mechatronics systems.	TPS 3	70	65
CO4	Describe the Function of controllers in Mechatronics system.	TPS 2	80	70
CO5	Develop a program using PLC to implement Bottle Filling Station.	TPS 3	70	65
CO6	Select the suitable actuator, sensors and controller system for Automatic Washing Machine.	TPS 3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	-	-	-	-	L	S
CO2	M	L	-	-	-	-	-	-	-	-	-	-	-	L
CO3	S	M	L	-	-	-	-	-	-	-	-	-	L	S
CO4	M	L	-	-	-	-	-	-	-	-	-	-	-	L
CO5	S	M	L	-	L	-	-	-	-	-	-	-	-	S
CO6	S	M	L	-	M	-	-	-	-	L	-	-	-	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
CO1	-	30	-	-	-	100	-	10	-	-	-	-	-	10	-
CO2	-	20	-	-	-	-	-	-	-	-	-	-	-	20	-
CO3	-	20	-	-	-	-	-	10	-	-	-	-	-	20	-
CO4	-	20	-	-	-	-	-	20	-	-	-	-	-	10	-
CO5	10	-	-	-	-	-	30	-	-	-	-	-	-	-	20
CO6	-	-	-	-	-	-	30	-	-	-	-	100	-	-	20

Syllabus

Introduction: Components used in mechatronics systems - Electrical, Mechanical, Electronics systems, Electro Mechanical systems, Intelligent Mechatronics Systems

Sensor System: Performance terminology – Selection of Sensors, Types of sensors, Position Sensors - Potentiometer, Strain Gauge, Proximity sensor, Hall effect sensors, Optical encoders, Infrared Sensors, Inertial Measurement unit (IMU), LIDAR; Tactile Sensors - Temperature Sensor - Thermistors, Thermocouples, Bimetallic strips, RTD, Optical sensors – RGB Camera, Thermal Camera.

Actuation System: Mechanical Actuating Systems - Cams, Gears, Ratchet and Pawl, Belt & Pulley; chain drives. Electrical Actuating Systems - Solenoids, DC Motors, Servomotors, Stepper motors - Pneumatic and Hydraulic systems – Single and double acting cylinders, rotational actuators. Hydraulic circuits, Selection of Actuators.

Control: Types - open loop and closed loop system, ON – OFF Control - PID controller. PLC - Principle of operation - input and outputs - programming language - ladder diagram – timer – counter.

Case Studies: Automatic Washing machine – Building Management Systems - Cruise control – Wiper motion control -IOT interfaced Mechatronics system– Vision based surveillance robot.

Text Book(s)

1. Devdas Shetty, Richard A Kolk, “Mechatronics System Design”, Cengage Learning, 2010.
2. Allie Weaver, “Mechatronics: Engineering Fundamentals”, Murphy & Moore Publishing, 2022.
3. W. Bolton, “Mechatronics – Electronic control systems in Mechanical & Electrical Engineering”, Pearson Education Ltd., 2015.

Reference Books and Web Resources

1. Frank D Petruzella, “Programmable logic controllers”, Fourth edition, McGraw Hill higher education ,2016.
2. Richard C. Dorf, Robert H. Bishop, “Modern Control Systems” Twelfth Edition, Pearson Education, 2014.
3. Mechatronics, IIT Roorkee, Prof. Pushparaj Mani Pathak, https://nptel.ac.in/courses/112107298

Course Contents and Lecture Schedule

Module No.	Topic	No. of Lectures	CO
1.0	**Introduction**		
1.1	Components used in mechatronics systems	1	CO1
1.2	Mechanical	1	CO1
1.3	Electrical	1	CO1
1.4	Electronics systems	1	CO1
1.5	Electro Mechanical systems	1	CO1
1.6	Intelligent Mechatronics Systems.	2	CO1
2.0	**Sensor System**		

Module No.	Topic	No. of Lectures	CO
2.1	Performance terminology	1	CO2
2.2	Selection of Sensors	1	CO2
2.3	Types of sensors, Position Sensors - Potentiometer, Strain Gauge, Proximity sensor, Hall effect sensors, Optical encoders, Infrared Sensors	2	CO2
2.4	Inertial Measurement unit (IMU), LIDAR, Tactile Sensors	2	CO2
2.5	Temperature Sensor - Thermistors, Thermocouples, Bimetallic strips, RTD	2	CO2
2.6	Optical sensors – RGB Camera, Thermal Camera.	3	CO2
3.0	**Actuation System**		
3.1	Mechanical Actuating Systems - Cams, Gears	1	CO3
3.2	Ratchet and Pawl, Belt & Pulley	1	CO3
3.3	Chain drives	2	CO3
3.4	Electrical Actuating Systems - Solenoids, DC Motors	1	CO3
3.5	Servomotors, Stepper motors	1	CO3
3.6	Pneumatic and Hydraulic systems – Single and double acting cylinders	1	CO3
3.7	Rotational actuators	1	CO3
3.8	Hydraulic circuits	1	CO3
3.9	Selection of Actuators.	1	CO3
4.0	**Control**		
4.1	Types - open loop and closed loop system	1	CO4
4.2	ON – OFF Control - PID controller	1	CO4
4.3	PLC - Principle of operation	1	CO5
4.4	Input and outputs - programming language	1	CO5
4.5	Ladder diagram	1	CO5
4.6	Timer – counter	1	CO5
5.0	**Case Studies**		
5.1	Automated Washing machine – Building Management Systems	1	CO6
5.2	Cruise control – Wiper motion control	1	CO6
5.3	IOT interfaced mechatronics system	1	CO6
5.4	Vision based surveillance robot	1	CO6
Total		**36 Hours**	

Course Designers:

1. Mr. M A Ganesh, ganeshma2015@tce.edu
2. Dr. S Julius Fusic, sjf@tce.edu

22MTGB0	VALUE ENGINEERING	Category	L	T	P	C	TE
		IE	3	0	0	3	Theory

Preamble

New Product development is on rise and developing these products without compromising quality and cost is a challenge. In such development, it has become necessary to reduce the cost or eliminate the unnecessary cost, while improving the product performance or otherwise quality. This course deals with improving the quality in terms of the requirements of customers at the same or reduced cost by ensuring adequate system performance. Value engineering is a systematic approach for value improvement and contains seven broader phases. Hence, for product development, both cost and quality related issues need to be tackled concurrently.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the Value engineering methodology	TPS2	75	65
CO2	Recognize the various phases of value engineering	TPS2	75	65
CO3	Perform functional cost worth analysis and Life cycle costing	TPS3	75	65
CO4	Create the ideas for New Product Development	TPS3	75	65
CO5	Analyse the functional importance and functional cost	TPS3	60	65
CO6	Recommend the present facts and present costs	TPS3	75	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	M	-	-	-	-	-	-	-	-	-	-	-	-
CO2	M	M	-	-	-	-	-	-	-	-		-	-	-
CO3	M	S	S	-	-	-	-	-	-	-	M		M	-
CO4	M	S	S	M	-	-	-	-	-	-	M	M	M	M
CO5	M	S	S	M	M	-		M	-	-	M	-	-	-
CO6	M	S	S	M	M	-	-	-	-	-	-	M	-	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	-	10
CO2	-	-	40	-	50	-	-	-	-	-	-	-	-	-	15
CO3	-	-	40	-	-	50	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	-	40	-	-	40	-	-	20
CO5	-	-	-	-	-	-	-	-	40	-	-	40	-	-	20
CO6	-	-	-	-	-	-	-	-	20	-	-	20	-	-	15

Syllabus

Introduction: Value Engineering (VE) and Value Analysis (VA) - Life Cycle of a product- Methodology of value engineering – Difference from the conventional methods of cost reduction.

Unnecessary costs reasons- Quantitative definition of value- Use value and Prestige value - Estimation of product Quality/performance-Types of functions- Relationship between Use functions and Esteem Functions in product design – Direct and indirect cost, Functional cost and Functional Worth –Effect of Value improvement on profitability-Test for poor value –Aims of Systematic Approach.

VE Job Plan: Functional approach to value improvement - various phases and techniques of Job Plan – Factors governing project selection – Types of Projects-Life Cycle Costing (LCC) for managing the Total Value- Concepts in LCC – Present value concept-Annuity concept- Net Present Value-Payback Period-Return on Investment (ROI)- Internal rate of return on Investment (IRR)-Examples and Illustrations. Creative thinking and creative judgment - positive or constructive discontent - Tangible and Intangible costs of implementation - False material - labour and overhead saving – Relationship between savings and probability of success - Reliability Estimation-System reliability- Reliability elements in series and parallel.

Various phases: General Phase-Information Phase – Type of costs- Function Phase – Evaluation of Functional Relationships- Checks for consistency-Function –cost-weight-matrix-Value Improvement Production (VIP) Index – High cost and Poor value areas-Creativity/Speculation Phase – Rules of creativity-Brainstorming- Idea activators- Result accelerators – Evaluation Phase – Estimation of costs of ideas- Evaluation by comparison – Functional Analysis System Technique (FAST)

Mini Project presentation and Case Studies.

Text Book(s)

1. Value Engineering – A How to Manual by S S Iyer, 3rd edition, New Age Publishers, Chennai, 2019

Reference Books & Web Resources

1. Value engineering, Mukhopadhyaya, Anil Kumar, Response Books, New Delhi ,2009
2. Techniques of training in value Engineering- a trainer's manual, R.G. Chaudari, Notion press, Chennai, 2018
3. Richard J Park, "Value Engineering – A Plan for Inventions", St. Lucie Press, London, 1999
4. Profit Improvement through Value Analysis, value Engineering and Purchase Price Analysis, A.D. Raven, (1971), Cassell and Co. London.
5. Arthur E Mudge, "Value Engineering", McGraw Hill Book Company, 1989.
6. NPTEL Value Engineering course videos https://nptel.ac.in/courses/112107282

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours
1	**Introduction**	
1.1	Value Engineering and Value analysis	1
1.2	Life cycle of a product	1
1.3	Value Engineering methodology	2

1.4	Difference from the conventional methods of Cost reduction	1
2	**Reasons for unnecessary costs**	
2.1	Definition of value	1
2.2	Use value and Prestige value	1
2.3	Estimation of Quality /Performance	1
2.4	Types of functions	1
2.5	Relationship between Use functions and Esteem Functions in product design	2
2.6	Direct and indirect cost, Functional cost and Functional Worth	2
2.7	Effect of Value improvement on profitability	1
2.8	Test for poor value	1
2.9	Aims of Systematic Approach. Functional approach to value improvement	1
3	**VE Job Plan**	
3.1	Functional approach to value improvement	1
3.2	Orientation and Information Phases	2
3.3	Techniques of Job Plan	1
3.4	Factors governing project selection – Types of Projects	1
3.5	Life Cycle Costing (LCC) for managing the Total Value-Concepts in LCC –	1
3.6	Present value concept -Annuity concept- Net Present value	1
3.7	Payback period, Return on Investment (ROI) -Internal rate of return on Investment (IRR)-Examples and Illustrations	2
4	**Various phases**	
4.1	Creative thinking and creative judgment- positive or constructive discontent	2
4.2	Tangible and Intangible costs of implementation-False material-labour and overhead saving	1
4.3	Relationship between savings and probability of success-Reliability Estimation-System reliability- Reliability elements in series and parallel.	1
4.4	General Phase-Information Phase – Type of costs - Function Phase	1
4.5	Evaluation of Functional Relationships - Checks for consistency- Function – cost-weight-matrix - VIP Index – High cost and Poor value areas-	1
4.6	Evaluation Phase – Estimation of costs of ideas- Evaluation by comparison.	1
4.7	Functional Analysis System Technique (FAST)	2
4.7	Mini Project presentation and Case Studies	2
	Total	**36**

Course Designers:

1. Dr. M Palaninatharaja, pnatharaja@tce.edu
2. Mr. S Rajkumar, srmech@tce.edu

22MTPA0	DESIGN AND ANALYSIS OF EXPERIMENTS	Category	L	T	P	C	TE
		PSE	3	0	0	3	Theory

Preamble

This course is an introduction to the statistical design of experiments and the role of random effects in data analysis. This course is created to provide an understanding of how experiments should be designed so that when the data are collected that can be used in a variety of experimental situations. A strategically planned and structured experiment may provide a great deal of information about the effect on a response variable due to one or more factors.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the process for experimental designs	TPS2	80	70
CO2	Perform ANOVA and Interpret results that influence the experiments	TPS3	70	65
CO3	Design the full factorial and fractional factorial experiments	TPS3	70	65
CO4	Optimize process parameters by applying experimental techniques.	TPS3	70	65
CO5	Perform robust design through Taguchi method.	TPS3	70	65
CO6	Interpret results using statistical packages.	TPS3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	-	-	-	-	S	M
CO2	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO3	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO4	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO5	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO6	M	L	-	-	-	-	-	-	-	-	-	-	L	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	10	-
CO2	-	-	40	-	-	50	-	-	-	-	-	-	-	-	20
CO3	-	-	40	-	-	50	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	-	40	-	-	-	-	-	20
CO5	-	-	-	-	-	-	-	-	30	-	-	-	-	-	15
CO6	-	-	-	-	-	-	-	-	30	-	-	100	-	-	15

Syllabus

Basic statistics: Mean - Standard Deviation - variance Variability – causes – Errors-hypothesis testing- statistical tests – t tests, z tests, chi-square tests

Introduction to experimental design: Basic techniques - Standard types of experimental design. Steps for Planning, Conducting and Analyzing an experiment – ANOVA – Model adequacy checking-Random effects model-attribute data analysis - Repetition and replication-Randomized complete block design-Latin square design.

Introduction to Factorial Design: The 2^k Factorial Design - Confounding and Aliasing in 2^k Factorial Design 3-level and Mixed-level full Factorials and Fractional Factorials- Simple Linear Regression - Response Surface Methods and Designs - Robust Parameter Designs - Experiments with Random Factors - Box Plot Designs.

Main and Interaction effects: Fixed effects and random effects model - Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments - Taguchi Method, Robust design noise factors, Signal to noise ratios, Inner/outer Orthogonal Array design – experimental analysis using statistical packages

Text Book(s)

1. Douglas C Montgomery (2019), Design and Analysis of Experiments, 10th edition, John Wiley & Sons

Reference Books & Web Resources

1. Colin Hardwick (2019), Practical Design of Experiments - Doe Made Easy, Lulu.com
2. Angela Dean, Daniel Voss, Danel Draguljic (2017), Design and Analysis of Experiments, Second Edition, Springer Texts in Statistics, Springer.
3. John Lawson (2015), Design and Analysis of Experiments with R, Texts in Statistical Science, Chapman & Hall / CRC.
4. Roger Mead, S. G. Gilmour, A. Mead (2012), Statistical Principles for the Design of Experiments, Cambridge Series in Statistica l and Probabilistic Mathematics, Cambridge University Press.
5. Raymond H. Myers, Douglas C. Montgomery, Christine M. Anderson-Cook (2009), Response Surface Methodology, Third Edition, John Wiley & Sons

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours
1	**Basic statistics-Mean-Standard Deviation-variance Variability**	2
2	Hypothesis testing-statistical tests-t test, z test, chi-square tests	2
3	Causes – Errors	1
4	Introduction to experimental design - Basic techniques	2
5	Standard types of experimental design	1
6	**Steps for Planning, Conducting and Analyzing an experiment**	1
7	ANOVA	2
8	Model adequacy checking-Random effects model-attribute data analysis - Repetition and replication	2
9	Randomized complete block design-Latin square design-Graeco latin square design	1
10	Introduction to Factorial Design	1
11	The 2k Factorial Design	2
12	Confounding and Aliasing in 2k Factorial Design 3-level and Mixed-level Factorials	2
13	Fractional Factorials	1
14	Simple Linear Regression	1
15	Response Surface Methods	1
16	**Robust Parameter Designs**	1
17	Experiments with Random Factors-Nested and Split Plot Designs	1
18	Main and Interaction effects	1
19	Fixed effects and random effects model	1
20	Design of experiments using Orthogonal Arrays,	1
21	Data analysis from Orthogonal experiments	1
22	Taguchi Method	2
23	Robust design noise factors	1
24	**Signal to noise ratios**	1
25	Inner/outer OA design.	2
26	Performing experimental analysis using statistical packages	2
	Total	**36**

Course Designers:

1. Dr. M Palaninatharaja, pnatharaja@tce.edu
2. Dr. H Ramesh, rameshh@tce.edu

22MTPB0	SEMICONDUCTOR MANUFACTURING	Category	L	T	P	C	TE
		PSE	3	0	0	3	Theory

Preamble

Semiconductor technology is the engine room of the New Economy. For 45 years there was a continuous improvement in IC functional capability with smaller size, increased reliability and lower cost. This course will teach the key fabrication technologies and the scientific foundations that carries fabrication of Transistors, ICs, Facilities required for Semiconductor Manufacturing, and microelectronics well into MEMS technology.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the silicon wafer manufacturing and IC fabrication techniques.	TPS2	70	75
CO2	Select suitable oxidation, doping and lithography processes for semiconductor manufacturing.	TPS3	65	75
CO3	Explain the etching, depositing, metallization and polishing processes for IC fabrication.	TPS3	65	75
CO4	Develop yield models of wafer production.	TPS3	65	75
CO5	Explain fabrication of IC and packaging	TPS2	70	75
CO6	Select appropriate process for MEMS fabrication.	TPS3	65	75

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	L	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	M	L	-	-	-	-	-	-	-	-	-	-	M	L
CO3	M	L	-	-	-	-	L	-	-	-	-	-	M	L
CO4	L	-	-	-	-	L	-	-	-	-	-	-	M	L
CO5	M	L	-	-	-	L	L	-	-	-	-	-	-	-
CO6	M	L	-	-	-	L	L	-	-	-	-	-	M	L

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	25			100			-	-	-	-	-	-	-	10	-
CO2	35						-	-	-	-	-	-	-	-	20
CO3	40						-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	40			100			-	-	20
CO5	-	-	-	-	-	-	20						-	10	-
CO6	-	-	-	-	-	-	40						-	-	20

Syllabus

Development of ICs- Introduction, Integrated Circuits, Device Miniaturization, Challenges in IC Manufacturing, IC manufacturing stages.

Silicon Wafer Manufacturing - Wafer Specification, Polysilicon Manufacture, Single crystal Si Manufacturing – Czochralski crystal growth Technique, Float Zone Technique, Wafer Manufacturing.

Integrated Circuit Fabrication: Fabrication overview, Layering, Patterning, Doping, Heat treatment, MOSFET Fabrication.

Oxidation and Doping: Oxidation, Types of oxidation processes, oxide furnaces, doping techniques, thermal diffusion, ion implantation.

Lithography: Introduction, Process overview, photoresists, Mask Making, Photoresist Application, Alignment and Exposure, Developing, Lithography Advances

Etching and Doping: Etching Basics, Wet Etching, Dry Etching, Deposition – Chemical Vapour Deposition (CVD) - LPCVD, PECVD, APCVD, Molecular Beam Epitaxy, Deposited Si.

Metallization and Polishing: Basics, Materials, Techniques, Planarization, copper dual Damnascene process.

IC process Control: Process Evaluation, Electrical Measurements, Thickness measurement, Defect Detection, Fab Yield, Wafer sort yield, Yield Models and Fabrication costs.

IC Architecture and Packaging: IC components, Packaging, Clean room contamination, clean room design and Materials

MEMS fabrication: Introduction to bulk micromachining and surface micromachining, fabrication micro cantilever by bulk micromachining and surface micromachining, comparison between bulk and surface micromachining

Text Book(s)

1. Parasuraman Swaminathan, Semiconductor Materials, devices and Fabrication, 1st edition, Wiley, 2019
2. Peter Van Zant, Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th edition, McGraw-Hill, 2013

Reference Books & Web Resources

1. Gary S May, Costas J Spanos, Fundamentals of semiconductor Manufacturing and process control, Wiley Interscience, 2006
2. Simon M. Sze, Gary S May, Fundamentals of semiconductor fabrication, Wiley student edition, 2012
3. James D Plummer, Michael D Deal, Peter B Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, 1st edition, Pearson India, 2009
4. Vijay K Varadhan, K.J. Vinoy, S.Gopalakrishnan, Smart Material Systems and MEMS – Design and Development Methodologies, 1st edition, John Wiley and Sons, 2006
5. Julian W Gadner, Vijay K Varadhan, Osama O Awadelkarim, Microsensors, MEMS and Smart Devices, 1st edition, John Wiley & sons Ltd, 2001
6. Simon. M. Sze, Yiming Li, Kwok K. Ng, Physics of Semiconductor Devices, 4th Edition., Wiley India, 2021.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Development of ICs**	
1.1	Introduction, Integrated Circuits, Device Miniaturization, Challenges in IC Manufacturing, IC manufacturing stages.	1
1.2	**Silicon Wafer Manufacturing -** Wafer Specification, Polysilicon Manufacture	1
1.3	Single crystal Si Manufacturing – Czochralski crystal growth Technique, Float Zone Technique, Wafer Manufacturing.	2
1.4	**Integrated Circuit Fabrication** - Fabrication overview, Layering, Patterning, Doping	1
1.5	Heat treatment, MOSFET Fabrication.	1
2	**Oxidation and Doping**	
2.1	Oxidation, Types of oxidation processes, oxide furnaces,	1
2.2	Doping techniques, thermal diffusion, and ion implantation.	2
2.3	**Lithography-**Introduction, Process overview, photoresists, Mask Making, Photoresist Application	1
2.4	Alignment and Exposure, Developing, Lithography Advances	2
3	**Etching and Doping**	
3.1	Etching Basics, Wet Etching, Dry Etching	1
3.2	Deposition – Chemical Vapour Deposition (CVD) - LPCVD, PECVD, APCVD, Molecular Beam Epitaxy, Deposited Si	2
3.3	**Metallization and Polishing-**Basics, Materials,	1
3.4	Planarization, copper dual Damnascene process	2
4	**IC process Control**	
4.1	Process Evaluation	1
4.2	Electrical Measurements	1
4.3	Thickness measurement	1
4.4	Defect Detection	1
4.5	Fab Yield, Wafer sort yield	1
4.6	Yield Models and Fabrication costs	2
5	**IC Architecture and Packaging**	
5.1	IC components	1
5.2	Packaging	1
5.3	Clean room contamination	2
5.4	Clean room design and Materials	2
6	**MEMS fabrication**	
6.1	Introduction to bulk micromachining and surface micromachining	1
6.2	Fabrication micro cantilever by bulk micromachining and surface micromachining	2
6.3	Comparison between bulk and surface micromachining.	2
	Total	**36**

Course Designers:

1. Dr. G Kumaraguruparan, gkgmech@tce.edu
2. Mr. M M Devarajan, mmdmech@tce.edu

22MTPC0	INDUSTRY 4.0	Category	L	T	P	C	TE
		PSE	3	0	0	3	Theory

Preamble

Industry 4.0 refers to a new phase in the Industrial Revolution that places strong emphasis on interconnectivity, automation, machine learning, and real-time data. Industry 4.0, which includes Industrial internet of things(IIOT) and smart manufacturing, combines physical production and operations with smart digital technology, machine learning, and big data to create a more holistic and better-connected ecosystem for companies that focus on manufacturing and supply chain management. This course focusses on the components and applications of industry 4.0 for manufacturing sector.

Prerequisite

- Nil

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain different technologies used in industry 4.0 and its applications.	TPS2	80	70
CO2	Perform AI and ML based analytics in Industry 4.0 frame work.	TPS3	70	65
CO3	Develop Cyber physical systems for industrial 4.0 applications	TPS3	70	65
CO4	Solve interoperable issues in connected factory using OPC, OPC-UA and TSN.	TPS3	70	65
CO5	Illustrate AR based operation and Maintenance sequence in Factory.	TPS3	70	65
CO6	Develop cloud-based database for Smart Manufacturing systems.	TPS3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	S	M
CO2	S	M	L	-	-	-	-	-	-	-	-	-	L	M
CO3	S	M	L	-	-	-	-	-	-	-	-	-	L	M
CO4	S	M	L	-	-	-	-	-	-	-	-	-	L	M
CO5	S	M	L	-	-	-	-	-	-	-	-	-	L	M
CO6	S	M	L	-	-	-	-	-	-	-	-	-	L	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	10	-
CO2	-	-	40	-	-	50	-	-	-	-	-	-	-	-	20
CO3	-	-	40	-	-	50	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	-	40	-	-	40	-	-	20
CO5	-	-	-	-	-	-	-	-	30	-	-	40	-	-	15
CO6	-	-	-	-	-	-	-	-	30	-	-	20	-	-	15

Syllabus

Introduction to Industry 4.0: The different Industrial revolutions-definition of Industry 4.0-comparision of industry 4.0 factory and existing factory-Difference between conventional automation and industry 4.0-Drivers, Enablers, compelling forces and challenges for Industry 4.0- Digitalization and the Networked Economy- Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation-Developments in industry 4.0.

Basic principles and components of Industry 4.0: Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services (IOS)- Big Data- Cyber-Physical Systems- Smart Manufacturing- Smart Logistics- Customization of products- Digital Twins- Cloud applications in manufacturing.

Cyber physical systems (CPS): Core elements of CPS -control theory and real time requirements-self organization principles-communication in cyber physical systems- Modelling, programming and model-integrated development of CPS- AI and ML based analytics.

Interoperability: Communication standards for Industry 4.0: Industrial communication Networks- Reference Architecture Model Industry 4.0 (RAMI4.0) - Basics on Service oriented Architecture- Introduction into Open platform communications (OPC) - Classic OPC vs. OPC-Unified Architecture (UA) - OPC Services- System Architecture- OPC- UA and the Cloud-Time Sensitive Networking (TSN)-architecture-Standards-Benefits of adopting TSN. Case study on OPC-UA applications

Connected Factory: Virtualization-Augmented Reality (AR) in Manufacturing-integrating design and manufacturing-Data Visualization-Work piece traceability using QR codes, RFID and beacon tags -big data in production- Cloud-based Enterprise resource planning (ERP) and Manufacturing Execution system (MES) solutions.

Text Book(s)

1. Simon Introduction to industrial internet of things and industry 4.0 by Sudip Misra, Chandana Roy and Anandarup Mukherjee, CRC Press,2020.

Reference Books & Web Resources

1. “Industry 4.0: The Industrial Internet of Things”, by Alasdair Gilchrist (Apress), 2016.
2. “Industrial Internet of Things: Cyber manufacturing Systems “by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer),2017
3. Hands-on Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0 ,Giacomo veneri, Antonio capasso,Packt,2018.
4. Hand book of Industry 4.0 and SMART Systems, Diego Galar Pascual, Pasquuale Daponte, Uday Kumar, CRC Press, 2019.
5. https://nptel.ac.in/courses/106105195

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1.	**Introduction to Industry 4.0**	
1.1	The different Industrial revolutions-definition of Industry 4.0	1
1.2	comparison of industry 4.0 factory and existing factory-Difference between conventional automation and industry 4.0	1
1.3	Drivers, Enablers, compelling forces and challenges for Industry 4.0- Digitalization and the Networked Economy	1
1.4	Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation-Developments in industry 4.0.	1
2.	**Basic principles and components of Industry 4.0**	
2.1	Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services	1
2.2	Big Data- Cyber-Physical Systems-	1
2.3	Smart Manufacturing- Smart Logistics	1
2.4	Customization of products- Digital Twins	1
2.5	Cloud applications in manufacturing	1
3.	**Cyber physical systems (CPS)**	
3.1	Core elements of CPS, Control theory and real time requirements	2
3.2	Self-organization principles-communication in cyber physical systems	1
3.3	Modelling, programming and model-integrated development of CPS, AI and ML based analytics	3
4.	**Interoperability: Communication standards for Industry 4.0**	
4.1	Industrial communication Networks-Ethernet I/P, Profinet, Profibus, Device net, Ethercat	2
4.2	Industry 4.0 Reference Architecture Model RAMI4.0	1
4.3	Basics on Service oriented Architecture	1
4.4	Introduction into OPC- Classic OPC vs. OPC-UA- OPC Services-System Architecture	2
4.5	OPC-UA and the Cloud	1
4.6	Time Sensitive Networking (TSN)-architecture-Standards-Benefits of adopting TSN	1
4.7	Case study on OPC-UA applications.	2
5.	**Connected factory**	
5.1	Virtualization-AR in Manufacturing	2
5.2	Integrating design and manufacturing, Data visualization	4
5.3	Work piece traceability using QR codes, RFID and beacon tags	2
5.4	Big data in production	1
5.5	Cloud-based ERP and MES solutions	2
	Total	**36**

Course Designers:

1. Dr. H Ramesh, rameshh@tce.edu
2. Dr. S Julius Fusic, sjf@tce.edu

22MTPD0	ELECTRIC VEHICLE TECHNOLOGY	Category	L	T	P	C	TE
		PSE	3	0	0	3	Theory

Preamble

High-efficiency, clean, and safe transportation has been the focus of transportation-related research and development efforts in recent decades. It has often been suggested that in the near future, fuel cell, hybrid, and electric cars would replace conventional automobiles. Details on vehicle system analysis, fuel cell applications in vehicles, ICE-based drive trains, EV design, HEV configurations, electric propulsion systems, energy storage systems, series/parallel/mild hybrid electric drive train design methodologies, regenerative braking, and fuel cell hybrid electric drive train design are covered in the course. It highlights the drive train system as a whole rather than simply individual parts.

Prerequisite

- 22MT430 - Power Electronics and Drives

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Illustrate the electric vehicle components	TPS 3	80	70
CO2	Explain the working of power converters in electric vehicles.	TPS 2	80	70
CO3	Calculate the power rating of e-vehicle.	TPS 3	80	70
CO4	Elaborate the electric train topology	TPS 2	80	70
CO5	Configure battery management system for e-vehicle	TPS 3	70	65
CO6	Select the appropriate components for electric car	TPS 3	70	65

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	S	M	L	-	-	-	-	-	-	-	-	-	S	M
CO2	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO3	S	M	L	-	-	-	-	L	-	-	-	-	S	M
CO4	M	L	-	-	-	-	-	-	-	-	-	-	L	L
CO5	S	M	L	-	L	-	-	-	-	-	-	-	S	M
CO6	S	M	L	-	M	-	-	-	-	L	-	-	S	M

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	-	10
CO2	-	-	40	-	-	-	-	-	-	-	-	-	-	-	10
CO3	-	-	40	-	-	-	-	-	-	-	-	-	-	-	20
CO4	-	-	-	-	-	-	-	-	20	-	-	-	-	-	20
CO5	-	-	-	-	-	-	-	-	40	-	-	50	-	-	20
CO6	-	-	-	-	-	100	-	-	40	-	-	50	-	-	20

Syllabus

Introduction: Introduction – need for electric vehicle-Comparison of Electric Vehicle over conventional vehicle – Various types of Electric vehicle- Hybrid Electric Vehicles - Types of EVs, Hybrid Electric Drive-train - Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies.

Electric Vehicle Modelling: Tractive effort- Modelling vehicle acceleration- Modelling electric vehicle range- Rolling resistance- transmission efficiency- body mass consideration and vehicle chassis modelling.

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives - Induction Motor drives - Permanent Magnet Motor drives – d-q frame, Voltage equations-BLDC motor drives- Switch Reluctance Motor drives, drive system efficiency- Types of Braking System-Regenerative braking system-Servo braking system.

Vehicle motor drives & control: DC-DC converter- step up and step down – DC to AC Converter- Single phase and Three phase inverter- sliding mode control- PID based control.

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis - Building mSnP battery pack, Building nPmS battery pack, Passive balancing, Active balancing, Cell equalisation, Failures in battery pack.

Case Studies: Design of Electric Bicycle- Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Book(s)

1. John G. Hayes and A. Goodarzi Electric Powertrain - Energy Systems, Power electronics and drives for Hybrid, electric and fuel cell vehicles, Wiley Publication,

Reference Books & Web Resources

1. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, John Wiley & Sons Inc 2017.
2. James Larminie, John Lowry- Electric Vehicle Technology Explained, 2nd Edition, John Wiley & Sons Inc 2012.
3. https://nptel.ac.in/courses/108/106/108106170/

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction**	
1.1	Need for electric vehicle-Comparison of Electric Vehicle over conventional vehicle.	1
1.2	Various types of Electric vehicle	1
1.3	Hybrid Electric Vehicles	1
1.4	Types of EVs, Hybrid Electric Drive-train	1
1.5	Basic concept of electric traction	1
1.6	Introduction to various electric drive-train topologies	1
1.7	Self-diagnose in electric vehicles.	1
2	**Electric Vehicle Modelling**	
2.1	Tractive Effort, Modelling vehicle acceleration	2
2.2	Modelling electric vehicle range	1
2.3	Rolling resistance- transmission efficiency	1
2.4	Body mass consideration, Vehicle chassis modelling	2
3	**Electric Propulsion unit**	
3.1	Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives	2
3.2	Induction Motor drives	1
3.3	Permanent Magnet Motor drives – BLDC motor drives- Switch Reluctance Motor drives	1
3.4	Drive system efficiency	1
3.5	Types of Braking System-Regenerative braking system- Servo braking system	1
4	**Vehicle motor drives & control**	
4.1	DC-DC converter- four quadrant operation	1
4.2	step up and step-down chopper with RLE loads	1
4.3	DC to AC Converter	1
4.4	Single phase and Three phase inverter with RLE loads	1
4.5	Sliding mode control- PID based control.	1
5	**Energy Storage System**	
5.1	Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, selection of battery and its electrical consideration	1
5.2	Battery based energy storage and its analysis	1
5.3	Fuel Cell based energy storage and its analysis	1
5.4	Super Capacitor based energy storage and its analysis	2
5.5	Building mSnP battery pack, Building nPmS battery pack.	1
5.6	Passive balancing, Active balancing, Cell equalisation, Failures in battery pack	1
6	**Case Studies**	
6.1	Design of Electric Bicycle	1
6.2	Design of a Hybrid Electric Vehicle (HEV)	2
6.3	Design of a Battery Electric Vehicle (BEV)	2
	Total	**36**

Course Designers:

1. Dr. S Julius Fusic, sjf@tce.edu
2. Dr. H Ramesh, rameshh@tce.edu

22MTPE0	DRONE TECHNOLOGY	Category	L	T	P	C	TE
		PSE	3	0	0	3	Theory

Preamble

This course covers the basics of drone technology, including its history, types, components, and regulations. Students will learn about drone design, assembly, and motor technology, as well as flight mechanics and controller selection. They'll also explore various drone applications such as GPS navigation, camera systems, agriculture, delivery services, and industry trends.

Prerequisite

- NIL

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the dynamics involved with the development of drones	TPS2	75	75
CO2	Illustrate the function and terminology of drone components.	TPS2	75	75
CO3	Simulate the stability of the drone using simulation software.	TPS3	65	70
CO4	Measure the time of flight, stability and endurance of drone	TPS2	75	75
CO5	Select the components to build a drone for real world applications.	TPS3	65	70
CO6	Develop a drone for real world applications	TPS3	65	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	L	-	-	-	-	L	M	M	S
CO2	M	L	-	-	-	-	-	-	-	-	L	M	M	S
CO3	S	M	L	-	-	-	-	-	-	-	L	S	M	S
CO4	M	L	L	-	M	-	-	-	-	-	L	M	M	S
CO5	S	M	L	-	-	-	-	-	-	-	L	S	M	S
CO6	S	M	L	-	S	-	-	-	L	L	S	S	M	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Assessment 1 (%)						Assessment 2 (%)						Terminal (%)		
	CAT 1			Assignment 1			CAT 2			Assignment 2					
TPS	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
CO1	-	20	-	-	-	-	-	-	-	-	-	-	-	10	-
CO2	-	40	-	-	-	-	-	-	-	-	-	-	-	20	-
CO3	-	-	40	-	-	-	-	-	-	-	-	-	-	-	10
CO4	-	-	-	-	-	-	-	-	20	-	-	-	-	-	20
CO5	-	-	-	-	-	-	-	-	40	-	-	-	-	-	20
CO6	-	-	-	-	-	100	-	-	40	-	-	100	-	-	20

Syllabus

Introduction to Drones: Definition and history of drones, Types of drones and their applications, Drone components and terminology, Regulations and Guidelines for drone usage.

Flight Mechanics and Dynamics: Basic definitions: viscosity, Mach number and speed of sound, Bernoulli's equation, aerodynamics nomenclature, air foil, wind tunnel testing: air foil shape, flight simulator. Static stability, Dynamic stability, lateral stability, longitudinal stability, directional stability

Drone Design and Assembly: Design considerations for drone airframe and propulsion systems, Selecting and assembling drone components such as motors, batteries, flight controllers, and cameras, Basic wiring and soldering techniques.

Drone Motors and Electronic Speed Controller (ESC): Working, Types: Brush and Brushless Motors, motor sizing and identification, mounting patterns and thread size, Thrust to Weight ratio, KV ratings, advanced motor selection, ESC.

Applications of Drone: Overview of commercial and industrial drone applications, Case studies and examples of successful drone deployments, GPS based navigation system, Drone Camera Systems, Agro application, Drone Delivery, Future trends and developments in the drone industry.

Text Book(s)

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Garvit Pandya, "Basics of Unmanned Aerial Vehicles: Time to Start Working on Drone Technology". (2021).

Reference Books & Web Resources

1. Zavrsnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

Course Contents and Lecture Schedule

Module No.	Topic	No. of Periods
1	**Introduction to Drones**	
1.1	Definition and history of drones	2
1.2	Types of drones and their applications	2
1.3	Drone components and terminology	2
1.4	Regulations and Guidelines for drone usage	2
2	**Flight Mechanics and Dynamics**	
2.1	Basic definitions: viscosity, Mach number and speed of sound	2
2.2	Bernoulli's equation, aerodynamics nomenclature, air foil	2
2.3	Wind tunnel testing: air foil shape, flight simulator	2
2.4	Static stability, Dynamic stability, lateral stability, longitudinal stability, directional stability.	2
3	**Drone Design and Assembly**	
3.1	Design considerations for drone airframe and propulsion systems	2
3.2	Selecting and assembling drone components (motors, batteries, flight controllers, cameras)	1
3.3	Basic wiring and soldering techniques	1
4	**Drone Motors and ESC**	
4.1	Working principles of drone motors and ESC	2
4.2	Types: Brush and Brushless Motors	2
4.3	Motor sizing and identification	2
4.4	Mounting patterns and thread size	1
4.5	Thrust to Weight ratio, KV ratings	1
4.6	Advanced motor selection, Electronic Speed Controller (ESC)	1
5	**Applications of Drone**	
5.1	Overview of commercial and industrial drone applications	1
5.2	Case studies and examples of successful drone deployments	1
5.3	GPS based navigation system, Drone Camera Systems	2
5.4	Agro application, Drone Delivery	2
5.5	Future trends and developments in the drone industry	1
	Total	**36**

Course Designers:

1. Dr. M Rajalakshmi, mrimect@tce.edu
2. Mr. M A Ganesh, ganeshma2015@tce.edu

22MTPF0	OOP USING C++	Category	L	T	P	C	TE
		PSE	1	0	4	3	Practical

Preamble

Object-Oriented Programming (OOP) have proved to be effective solutions in handling the inherent complexity of software design, development, testing and maintenance. Instead of viewing a program as a series of steps to be carried out, it views it as a group of objects that have certain properties and can take certain actions. Many object-oriented languages have become available and have been widely adopted. For an Engineer, solving any real time problem is not just about designing an algorithm and solving it, but also the ability to select appropriate data structures to solve the problem efficiently. This course introduces the concept of OOP using C++ along with ability to manipulate data using data structures.

Prerequisite

- 22MT240 - Problem Solving using C

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the programming concepts of C++	TPS2	80	80
CO2	Develop a C++ program for solving engineering problems	TPS3	70	70
CO3	Explain the various concepts in Object Oriented Programming	TPS2	80	80
CO4	Apply the concept Object Oriented Programming and develop program in C++ for solving engineering problems	TPS3	70	70
CO5	Analyze and debug the developed C++ program	TPS3	70	70
CO6	Implement linear and nonlinear data structures for a given application	TPS3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO2	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO3	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO4	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO5	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO6	S	M	L	-	S	-	-	-	S	M	-	-	M	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Continuous Assessment Test (CAT)								Terminal (%)
	CAT 1 (T)			CAT 2			Experiments	Model Exam	
TPS	1	2	3	1	2	3	3	3	3
CO1	-	30	-	-	-	-	100	100	100
CO2	-	20	20	-	-	20			
CO3	-	30	-	-	30	30			
CO4	-	-	-	-	-	-			
CO5	-	-	-	-	-	20			
CO6	-	-	-	-	-	-			

Syllabus

Introduction to Object Oriented Programming (OOP): Procedural Languages - The Object-Oriented approach - Characteristics of Object-Oriented Languages – Objects - Classes - Inheritance – Reusability – Creating New Data Types - Polymorphism and Overloading

C++ Programming Basics: C++ programming basics – Pre-processor Directives – Header Files – Namespace – Manipulators – Loops – Structures – Functions – Inline Functions - Arrays – Strings – Pointers

OOP using C++: Objects and Classes - C++ Objects as Physical Objects - Objects as Data Types - Constructors - Destructors - Structures and Classes

Overloading: Operator Overloading - Overloaded Functions - Overloading Unary & binary operators - Data Conversion

Inheritance: Derived Class and Base Class - Class Hierarchies - Public and Private Inheritance - Levels of Inheritance - Multiple Inheritance - Classes within Classes Inheritance – UML Diagram

Memory Management – new, delete operators – Virtual Functions – Friend Functions – Static Functions – Function Templates – Exceptions

Data Structures: Linear Data structures – Stacks – Queues – Linked Lists; Non-Linear Data structures – Trees – Applications

Text Book(s)

1. E. Balagurusamy, Object-Oriented Programming with C++, 8th edition, Mc Graw Hill, 2020

Reference Books & Web Resources

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, 4th edition, Pearson Education, 2014
2. Robert Lafore, Object-Oriented Programming in C++, Pearson Education, 2002
3. Programming in C++ in Swayam:
4. NPTEL Course https://swayam.gov.in/nd1_noc20_cs07/preview
5. C++ Programming in Tutorials Point: https://www.tutorialspoint.com/cplusplus/index.htm

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours		Course Outcome
		Theory	Practical	
1	**Introduction to Object Oriented Programming (OOP)**	2	-	CO1, CO3
2	**C++ Programming Basics:**	-	-	-
2.1	C++ programming basics – Pre-processor Directives – Header Files – Namespace – Manipulators	2	-	CO1
2.2	Loops – Structures – Functions – Inline Functions – Arrays – Strings – Pointers	2	-	CO1
2.3	Programs to apply the concept of C++ to solve engineering problems	-	4	CO2, CO5
3	**C++ OOP**	-	-	-
3.1	Objects and Classes – C++ Objects as Physical Objects – Objects as Data Types – Constructors – Destructors – Structures and Classes	3	-	CO3
3.2	Overloading	3	-	CO3
3.3	Inheritance	2	-	CO3
3.4	Memory Management – new, delete operators – Virtual Functions – Friend Functions – Static Functions –	2	-	CO1, CO3
3.5	Function Templates – Exceptions	2	-	CO1, CO3
3.6	C++ Programs using the various concepts of OOP to solve engineering problems	-	12	CO4, CO5
4	**Data Structures**	-	-	-
4.1	Linear Data structures – Stacks – Queues – Linked Lists	3	-	CO6
4.2	Non-Linear Data structures – Trees	3	-	CO6
4.3	C++ Programs to implement Linear and nonlinear data structures	-	8	CO6
	Total	**24**	**24**	

Course Designer(s):

1. Mr. S A R Sheik Masthan, sarsmech@tce.edu

22MTRA0	MACHINE VISION USING MACHINE LEARNING	Category	L	T	P	C	TE
		PEES	1	0	4	3	Practical

Preamble

Machine learning techniques, has revolutionized various industries, from healthcare to autonomous vehicles, and continues to drive innovation across diverse domains. This course is designed to provide the students with a comprehensive understanding of both the theoretical foundations and practical applications of machine vision using machine learning approaches. Through a blend of lectures, hands-on exercises, and projects, students will delve into the core concepts, algorithms, and tools essential for developing intelligent systems capable of understanding and extracting insights from visual data.

Prerequisite

- 22MT450 - Digital Signal Processing

Course Outcomes

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

CO	Course Outcome Statement	TCE Proficiency Scale	Expected Proficiency (in %)	Expected Attainment Level (in %)
CO1	Explain the components of a machine vision system and their functions	TPS 2	80	80
CO2	Develop machine vision system using image processing techniques	TPS 3	70	70
CO3	Enhance the image using machine learning and deep learning methods	TPS 3	70	70
CO4	Generate custom dataset for training and testing	TPS 3	70	70
CO5	Evaluate the machine learning models for quality inspection	TPS 3	70	70
CO6	Deploy the machine learning model in Raspberrypi and Jetson Nano boards	TPS 3	70	70

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	M	L	-	-	-	-	-	-	-	-	-	-	L	M
CO2	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO3	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO4	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO5	S	M	L	-	S	-	-	-	S	M	-	-	M	S
CO6	S	M	L	-	S	-	-	-	S	M	-	-	M	S

S – Strong M – Medium L – Low

Assessment Pattern

CO	Continuous Assessment Test (CAT)								Terminal (%)
	CAT 1			CAT 2			Experiments	Model Exam	
TPS	1	2	3	1	2	3	3	3	3
CO1	-	30	-	-	-	-	100	100	100
CO2	-	30	-	-	-	-			
CO3	-	40	-	-	40	-			
CO4	-	-	-	-	-	-			
CO5	-	-	-	-	30	30			
CO6	-	-	-	-	-	-			

Syllabus

Machine Vision System: Components of Machine Vision System – Image Sensors – working principle – Optics foundation – laws of imaging – special lens types – Illumination techniques – light sources – front and back lighting

Image Processing Techniques: Point operation – local operation – Filtering – neighbourhood operation - space and frequency domain operations – Geometric transformations

Machine Learning Techniques: Supervised learning – Nearest neighbours – Support Vector Machines - Unsupervised learning – Clustering – K means

Deep Learning Techniques: Convolution Neural Network (CNN) - Single Stage detector - Two Stage detector

Dataset Preparation: Custom dataset preparation steps – preprocessing – image augmentation

Implementation: Introduction to OpenCV, TensorFlow and PyTorch. Training vision models in Google Colab, Loading vision models in Raspberrypi and Jetson Nano microcontroller boards.

Applications and case study: Quality Inspection - Parts Counting – Surface and Print Defect Identification – Measurement and Gauging - Presence Verification - Surveillance - Bar Code Identification - Character Recognition - Object classification - Face recognition

Text Book(s)

1. Richard Szeliski, “Computer Vision: Algorithms and Applications”, II edition, Springer, 2022
2. Christian Demant, Bernd Streicher-Abel, Carsten Garnica, “Industrial Image Processing”, II Edition, Springer, 2013

Reference Books & Web Resources

1. NPTEL Course: Deep Learning for Computer Vision - Prof. Vineeth N Balasubramanian - IIT Hyderabad
   https://onlinecourses.nptel.ac.in/noc21_cs93/preview

Course Contents and Lecture Schedule

Module No.	Topic	No. of Hours	
		Theory	Practical
1	**Machine Vision System**	-	-
1.1	Components of Machine Vision System – Image Sensors – working principle – Optics foundation – laws of imaging – special lens types	2	-
1.2	Illumination techniques – light sources – front and back lighting	1	-
2	**Image Processing Techniques**	-	-
2.1	Point operation – local operation – Filtering – neighbourhood operation	1	-
2.2	space and frequency domain operations – Geometric transformations	2	
	Experiments in space and frequency domain filtering	-	2
	Experiments in geometric transformation	-	2
	Experiments in surface and print defect identification	-	2
	Experiments in gauging and measurement	-	2
3	**Machine Learning Techniques**	-	-
3.1	Supervised learning – Nearest neighbours – Support Vector Machines	2	-
3.2	Unsupervised learning – Clustering – K means	2	-
4	**Deep Learning Techniques**	-	-
4.1	Convolution Neural Network (CNN)	2	-
4.2	Single Stage detector - Two Stage detector	2	-
5	**Dataset Preparation**	2	-
5.1	Custom dataset preparation steps – preprocessing – image augmentation	2	-
	Experiments in data set preparation, image labelling and annotation	-	2
	Experiments in character recognition, extraction	-	2
	Experiments in binary classification	-	2
	Experiments in multi class and multi label classification	-	4
6	**Implementation:**	-	-
6.1	Introduction to OpenCV, TensorFlow and PyTorch. Training vision models in Google Colab	2	-
6.2	Loading vision models in Raspberrypi and Jetson Nano microcontroller boards.	2	-
7	**Applications and case study:**	-	-
	Closed Loop Vision Systems – Quality Inspection - Gauging – Presence Verification – Surveillance – Bar Code Identification – Character Recognition – Image classification – Face recognition	2	-
	Implementation of trained models in Raspberrypi and Jetson Nano boards	-	6
	TOTAL	**24**	**24**

Course Designers:

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