DEPARTMENT OF MECHANICAL ENGINEERING

I TO VIII SEMESTER
CURRICULUM AND SYLLABI

Applicable to the students admitted to

R-2021: CBCS

Academic year 2021-2022 onwards

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

#60, Avadi – Vel Tech Road, Vel Nagar,
Avadi, Tamil Nadu 600062

LIST OF ABBREVIATIONS

S. No.	Abbreviations	Detailed Description
1	**HSMC**	Humanities & Social Science including Management Courses
2	**BSC**	Basic Science Courses
3	**ESC**	Engineering Science Courses
4	**PCC**	Professional Core Courses
5	**PEC**	Professional Elective Courses
6	**OEC**	Open Elective Courses
7	**PROJ**	Project Work
8	**EEC**	Employability Enhancement Courses
9	**MC**	Mandatory Courses

Category Based Credit Split-Up – Semester Wise

Semester	HSMC	BSC	ESC	PCC	PEC	OEC	Project /EEC	MC	Total Credit
1	3	12	10	-	-	-	-	1	26
2	3	4	9	8	-	-	-	1	25
3	-	4	4	14	-	-	-	0	22
4	-	3	-	17	-	-	1	0	21
5	-	-	-	17	3	3	1	-	24
6	-	-	-	13	3	3	2	-	21
7	-	-	-	15	3	-	2	-	20
8	-	-	-	-	6	-	6	-	12
Total credits	**6 (3.59 %)**	**23 (13.17 %)**	**23 (13.17 %)**	**84 (50.29 %)**	**15 (8.98 %)**	**6 (3.59 %)**	**12 (7.18 %)**	**2 (0.01%)**	**171**

B.E. – Mechanical Engineering Curriculum (R2021)

SEMESTER I

S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21EN11T	Communicative English	HSMC	40	60	100	3	0	0	3
2	21MA12T	Matrices and Differential Calculus	BSC	40	60	100	3	1	0	4
3	21PH13T	Engineering Physics I	BSC	40	60	100	3	0	0	3
4	21CY14T	Engineering Chemistry	BSC	40	60	100	3	0	0	3
5	21CS15IT	Problem Solving and Python Programming	ESC	50	50	100	2	0	4	4
6	21ME16T	Engineering Graphics	ESC	40	60	100	2	0	4	4
7	21MC04T	தமிழர் மரபு / Heritage of Tamils	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21BS17P	Physics and Chemistry Laboratory	BSC	60	40	100	0	0	4	2
9	21ME18P	Engineering Practices Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**26**

SEMESTER II

S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21EN21T	Technical English	HSMC	40	60	100	3	0	0	3
2	21MA22T	Vector Calculus and Complex Integration	BSC	40	60	100	3	1	0	4
3	21ME23T	Production Technology-I	PCC	40	60	100	3	0	0	3
4	21EE24T	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40	60	100	3	0	0	3
5	21ME25T	Engineering Materials & Metallurgy	PCC	40	60	100	3	0	0	3
6	21ME26T	Engineering Mechanics	ESC	40	60	100	3	1	0	4
7	21MC05T	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21ME27P	Production Technology–I Laboratory	PCC	60	40	100	0	0	4	2
9	21EE28P	Basic Electrical and Electronics Engineering Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**25**

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME31T	Engineering Thermodynamics	PCC	40	60	100	3	1	0	4
2	21ME32T	Fluid Mechanics and Machinery	PCC	40	60	100	3	0	0	3
3	21ME33T	Production Technology-II	PCC	40	60	100	3	0	0	3
4	21MA34T	Series, Transforms and Partial Differential Equations	BSC	40	60	100	3	1	0	4
5	21HE35IT	Electrical Drives and Controls	ESC	50	50	100	2	0	4	4
6	21MC01T	Constitution of India	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21ME37P	Production Technology-II Laboratory	PCC	60	40	100	0	0	4	2
8	21ME38P	Computer Aided Machine Drawing Laboratory	PCC	60	40	100	0	0	4	2
TOTAL										**22**

SEMESTER IV										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME41T	Computer Aided Design	PCC	40	60	100	3	0	0	3
2	21ME42T	Strength of Materials	PCC	40	60	100	3	0	0	3
3	21ME43T	Kinematics of Machinery	PCC	40	60	100	3	1	0	4
4	21ME44T	Thermal Engineering	PCC	40	60	100	3	0	0	3
5	21MA45T	Statistics and Numerical Methods	BSC	40	60	100	3	0	0	3
6	21MC02T	Environmental Sciences	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21ME47P	Fluid Mechanics and Machinery & Strength of Materials Laboratory	PCC	60	40	100	0	0	4	2
8	21ME48P	Thermal Engineering Laboratory	PCC	60	40	100	0	0	4	2
9	21EE01P	Mini Project - I	EEC	60	40	100	0	0	2	1
TOTAL										**21**

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME51T	Heat and Mass Transfer	PCC	40	60	100	3	0	0	3
2	21ME52T	Design of Machine Elements	PCC	40	60	100	3	1	0	4
3	21ME53T	Metrology and Measurements	PCC	40	60	100	3	0	0	3
4	21ME54T	Dynamics of Machines	PCC	40	60	100	3	0	0	3
5	-	Professional Elective - I	PEC	40	60	100	3	0	0	3
6	-	Open Elective - I	OEC	40	60	100	3	0	0	3
PRACTICAL										
7	21ME57P	Metrology and Measurements Laboratory	PCC	60	40	100	0	0	4	2
8	21ME58P	Kinematics and Dynamics Laboratory	PCC	60	40	100	0	0	4	2
9	21EE03P	Technical Seminar	EEC	100	-	100	0	0	2	1
TOTAL										**24**

SEMESTER VI										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME61T	Design of Transmission Systems	PCC	40	60	100	3	1	0	4
2	21ME62T	Conventional Automotive Testing and Certification	PCC	40	60	100	3	0	0	3
3	21ME63T	Finite Element Analysis	PCC	40	60	100	3	1	0	4
4	-	Professional Elective - II	PEC	40	60	100	3	0	0	3
5	-	Open Elective - II	OEC	40	60	100	3	0	0	3
PRACTICAL										
6	21ME66P	Computer Aided Manufacturing Laboratory	PCC	60	40	100	0	0	4	2
7	21EE02P	Mini Project - II	EEC	60	40	100	0	0	2	1
8	21EE04P	Internship	EEC	100	-	100	0	0	0	1
TOTAL										**21**

SEMESTER VII										
S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21ME71T	Engineering Failure Analysis	PCC	40	60	100	3	0	0	3
2	21ME72T	Process Planning and Cost Estimation	PCC	40	60	100	3	0	0	3
3	21ME73T	Product Design and Development	PCC	40	60	100	3	0	0	3
4	21ME74IT	Micro controller and Mechatronics	PCC	50	50	100	2	0	4	4
5	-	Professional Elective - III	PEC	40	60	100	3	0	0	3
PRACTICAL										
6	21ME76P	Simulation and Analysis Laboratory	PCC	60	40	100	0	0	4	2
7	21EE05P	Project Phase - I	PROJ	60	40	100	0	0	4	2
TOTAL										**20**

SEMESTER VIII										
S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	-	Professional Elective - IV	PEC	40	60	100	3	0	0	3
2	-	Professional Elective - V	PEC	40	60	100	3	0	0	3
PRACTICAL										
3	21EE06P	Project Phase - II	PROJ	60	40	100	0	0	12	6
TOTAL										**12**

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
Professional Elective I (V SEM)		
1.	21ME551PT	Automobile Engineering
2.	21ME552PT	Gas Dynamics and Jet Propulsion
3.	21ME553PT	Intellectual Property Rights
4.	21ME554PT	Composite materials and Nano Technology
5.	21ME555PT	Hydraulics and Pneumatics
Professional Elective II (VI SEM)		
6.	21HM641PT	Professional Ethics in Engineering
7.	21ME642PT	Elements for Green Manufacturing
8.	21ME643PT	Renewable Energy Sources
9.	21ME644PT	Computational Fluid Dynamics
10.	21ME645PT	Unconventional Machining Processes
Professional Elective III (VII SEM)		
11.	21AI04OT	Data Science
12.	21ME752PT	Refrigeration and Air conditioning
13.	21ME753PT	Computer Integrated Manufacturing
14.	21ME754PT	Industrial Corrosion and Tribology
15.	21ME755PT	Maintenance Engineering
Professional Elective IV (VIII SEM)		
16.	21ME811PT	Non Destructive Testing and Evaluation
17.	21HM812PT	Total Quality Management
18.	21ME813PT	Industrial Robotics
19.	21MB346PT	Supply Chain Management
20.	21ME815PT	Theory of Metal Cutting and Joining
Professional Elective V (VIII SEM)		
21.	21ME821PT	Power Plant Engineering
22.	21ME822PT	Micro Electro Mechanical Systems
23.	21ME823PT	Production Planning and Control
24.	21ME824PT	Advanced Manufacturing Management
25.	21ME825PT	Lean Manufacturing

LIST OF OPEN ELECTIVE COURSES

S. No	COURSE CODE	OFFERING DEPARTMENT	NAME OF THE COURSE
1	21CS01OT	CSE	Bio Python
2	21CS02OT		Cyber Security
3	21CS03OT		Java Programming
4	21CS04OT		Database System Design
5	21IT01OT	IT	Business Intelligence
6	21HI52T		Data Analytics
7	21IT03OT		Augmented Reality and Virtual Reality
8	21IT04OT		Introduction to Cloud Computing
9	21AI651PT	AI & DS	Advanced Python Programming
10	21AI31T		Introduction to Artificial Intelligence
11	21AI03OT		Machine Learning Techniques for Engineers
12	21ML33T		Python for Data Science
13	21EC01OT	ECE	Microcontroller System Design
14	21EC743PT		Digital Image Processing
15	21EC03OT		Internet of Things and Applications
16	21EC556PT		Automotive Electronics
17	21ME01OT	MECHANICAL	Industry 4.0
18	21ME02OT		Robotics and Industrial Automation
19	21ME03OT		3D Printing
20	21ME04OT		Fundamentals of Electric and Hybrid Vehicles
21	21CE01OT	CIVIL	Traffic Engineering and Management
22	21CE02OT		Air Pollution Control Engineering
23	21CE763PT		Municipal solid waste management
24	21CE04OT		Safety in Civil Engineering Practices
25	21BT01OT	BIOTECHNOLOGY	Basics of Environmental Biotechnology
26	21BT02OT		Introduction to Biofuels and Bioenergy
27	21BT03OT		Lifestyle Diseases: A Biotechnological Approach
28	21BT04OT		Biology for Engineers
29	21CH25T	CHEMICAL	Principles of Chemical Engineering
30	21CH02OT		Process Modeling and Simulation
31	21CH03OT		Energy Management and Audit
32	21CH04OT		Process Plant Utilities
33	21MB01OT	MBA	Business Intelligence for Administration
34	21MB02OT		Personality Development
35	21MB03OT		Entrepreneurship Development
36	21EN01OT	S & H	Foreign Language – French
37	21PH02OT		Fundamentals of Photovoltaic and its Applications
38	21CY03OT		Recent Trends in Batteries
39	21CY04OT		Green Chemistry

LIST OF HONORS COURSES

S. No	COURSE CODE	DEPARTMENT	NAME OF THE COURSE
1	21ME03HT	MECH	Characterisation of Materials
2	21ME04HT		Solar Energy Technology
3	21ME05HT		Product Life Cycle Management
4	21ME06HT		Marketing Management
5	21ME07HT		Introduction To Mechanical Micro Machining
6	21ME08HT		Principles of Industrial Engineering

LIST OF NPTEL COURSES

1	Mechanics of Fiber Reinforced Polymer Composite Structures
2	Welding Metallurgy
3	Fundamentals of Nuclear Power Generation
4	Fundamentals of Additive Manufacturing Technologies
5	Sustainable Energy Technology
6	Basics of Materials Engineering
7	Rapid Manufacturing
8	Introduction to Composites

I SEMESTER

SEMESTER I

S. No.	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total marks	Credits			
							L	T	P	C
THEORY										
1	21EN11T	Communicative English	HSMC	40	60	100	3	0	0	3
2	21MA12T	Matrices and Differential Calculus	BSC	40	60	100	3	1	0	4
3	21PH13T	Engineering Physics I	BSC	40	60	100	3	0	0	3
4	21CY14T	Engineering Chemistry	BSC	40	60	100	3	0	0	3
5	21CS15IT	Problem Solving and Python Programming	ESC	50	50	100	2	0	4	4
6	21ME16T	Engineering Graphics	ESC	40	60	100	2	0	4	4
7	21MC04T	தமிழர் மரபு / Heritage of Tamils	MC	40	60	100	1	0	0	1
PRACTICAL										
8	21BS17P	Physics and Chemistry Laboratory	BSC	60	40	100	0	0	4	2
9	21ME18P	Engineering Practices Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**26**

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21EN11T	Semester	I			
Category	HUMANITIES & SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)		L	T	P	C
Course Title	COMMUNICATIVE ENGLISH (COMMON FOR ALL BRANCHES)		3	0	0	3

COURSE OBJECTIVES:

- To exhibit the students of Engineering and Technology to develop their listening and to recall the pattern of listening.
- To facilitate the learners to develop speaking skills to convey their ideas and views in the real context.
- To develop their reading skills and grasp the central ideas of the text.
- To expose them to acquire writing technique with basic grammar.
- To motivate the students to use appropriate vocabulary in academic and categorize the inferences in writings.

PREREQUISITE:

- Foundation of language with Basic English Grammar.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C101. 1	***Listen*** to different talks and lectures and understand them easily.	K1
C101. 2	***Communicate*** their thoughts confidently using communicative strategies	K2
C101. 3	***Read*** and grasp different genres of texts effortlessly	K2
C101. 4	***Write*** grammatically correct academic, business and technical texts	K3
C101. 5	***Apply*** the appropriate vocabulary to communicate efficiently in all forms of communication.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C101. 1	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 2	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 3	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 4	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 5	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101. 6	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-
C101	-	-	-	-	-	-	-	-	1	3	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I BASIC GRAMMAR I AND READING FOR INFORMATION 9

PRACTICAL

LISTENING: Listening to short dialogues with good accent

SPEAKING : Introducing oneself - Exchanging personal information

TUTORIAL

READING : Reading short comprehension passages- practice skimming and scanning for specific information

WRITING: Parts of speech - Sentence patterns – Tenses – ‘wh’- questions - Yes/No questions -Countable and Uncountable nouns

VOCABULARY AND GRAMMAR: Affixation – word formation - Synonyms and Antonyms.

UNIT II BASIC GRAMMAR II AND SHARING INFORMATION 9

PRACTICAL

LISTENING : Listening to documentaries - inspiring speeches of great leaders and practicing opinion sharing

SPEAKING : Self-introduction - peer introduction - picture description - JAM

TUTORIAL

READING: Note-making- Critical reading finding key information in a given text - shifting facts from opinions and paraphrasing

WRITING: Autobiographical writing (writing about one’s leisure time activities, hometown - favourite place and school life) - Biographical writing (place, people)

VOCABULARY AND GRAMMAR: Compound Words – Guessing meaning of words contexts - One Word substitutes – Pronouns- Adjectives – Adverbs – Imperatives - Direct and Indirect questions.

UNIT III BASIC GRAMMAR III AND FREE WRITING 9

PRACTICAL

LISTENING : News Bulletins - Ted talks - telephonic conversations

SPEAKING : functions of Language - giving reasons - talking about future plans - comparing and contrasting - making suggestions

TUTORIAL

READING: Current Affairs - newspaper reading /magazines - loud in the classroom

WRITING: Coherence and cohesion in writing- cause and effect - compare & contrast and narrative & analytical paragraphs.

VOCABULARY AND GRAMMAR: Discourse marker - Reference words - Process description - Conjunctions – Prepositions - Articles - Degrees of comparison.

UNIT IV BASIC GRAMMAR IV AND FREE WRITING **9**

PRACTICAL

LISTENING : Listen to audio/ Conversation from BEC/IELTS /TOFEL.
SPEAKING : Interpersonal Skills: Role play/group discussion/debate/ conduct of meeting

TUTORIAL

READING: Reading different types of texts /genres/ for comprehension and pleasure – related with human values.
WRITING: Letter writing (informal letters) and formal letters – rejecting and accepting Letters - Personal emails and etiquette.
VOCABULARY AND GRAMMAR: Single Word substitutes - Use of abbreviations Acronyms - Cloze reading - interpreting visual materials - Jumbled sentences - Subject verb agreement - Modal verbs - Phrasal verbs.

UNIT V BASIC GRAMMAR V AND LANGUAGE DEVELOPMENT **9**

PRACTICAL

LISTENING : Listen to official meetings to know about the project proposal.
SPEAKING : Discussing the project and the proposals in the group - Creative writing and speaking - Poster making and description - project proposals.

TUTORIAL

READING: Reading comparison and contrast text with the deeper level of meaning **WRITING :** Essay writing - different types of essays - dialogue writing
VOCABULARY AND GRAMMAR: Word association (connotations) - Lexical items (fixed / semi fixed expressions) - Clause - Direct and indirect speech - Correction of errors.

Total: 45 Periods

Extensive Reading:

Kalam , Abdul. The Wings of Fire , Universities Press, Hyderabad. 19

LEARNING RESOURCES:

TEXT BOOKS:

1. Board of Editors, Department of English, Anna University, Chennai. Using English:A Course Book for Undergraduate Engineers and Technologists, Orient Black Swan: Chennai,2017.
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Black Swan Publications, Chennai,2011.

REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma, Technical Communication: English Skills for Engineers. Oxford University Press, NewDelhi.2011.

2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006

3. Rizvi M, Ashraf. Effective Technical Communication. Tata McGraw- Hill Publishing Company Limited, New Delhi, 2007.

4. Rutherford, Andrea J. Basic Communication Skills for Technology. Pearson Edition (II Edition), NewDelhi, 2001.

5. Mandel, Steve. *Effective Presentation Skills*. New Delhi: Viva Books Pvt. Ltd., 2004.

6. Kilmet, Stephen. "The Resume and "The Computerized Resume." In Writing for Design Professionals.

7. Writing Cover Letters-Kilmet, Stephen. "Cover Letter, "and" Enclosures and Attachments." in Writing for Design Professionals New York.

Course code	**21MA12T**	**Semester**	**I**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**MATRICES AND DIFFERENTIAL CALCULUS (COMMON FOR ALL BRANCHES)**		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

- To apply advanced matrix knowledge to solve engineering problems
- To improve their ability in solving geometrical applications of differential calculus
- To familiarize with the application of differential equations

PREREQUISITE:

- Basic Mathematics skills at 12^{th} level

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C102.1	***Solve*** Engineering problems using matrices.	K3
C102.2	***Use*** various test to discuss the convergence of infinite series.	K2
C102.3	***Apply*** the geometrical concepts to solve differential calculus.	K4
C102.4	***Compute*** partial derivatives of functions of several variables.	K2
C102.5	***Apply in Engineering many physical initial*** and boundary value problems can be described by ODE.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C102.1	3	3	-	-	-	-	-	-	-	-	-	-
C102.2	3	2	-	-	-	-	-	-	-	-	-	-
C102.3	3	3	-	-	-	-	-	-	-	-	-	-
C102.4	3	2	-	-	-	-	-	-	-	-	-	-
C102.5	3	2	-	-	-	-	-	-	-	-	-	-
C102	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I MATRICES 12

Matrix operations, special types of matrices, matrices as linear transformations, linear independence, Orthogonalization, Eigen values and Eigen vectors of a real matrix – Properties of Eigen values – Cayley – Hamilton theorem, Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations- Nature of quadratic forms.

UNIT II INFINITE SERIES 12

Sequences of real numbers-Series-General properties of series-Comparison test- Integral test, D' Alemberts ratio test and Cauchy's root test- Power series, radius and interval of convergence of power series, Convergence of exponential, logarithmic and Binomial Series, Properties of uniformly convergence series

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 12

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelops – Evolute as envelope of normals

UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 12

Limits and Continuity –Partial derivatives –Homogeneous Functions-Total derivative –Change of variables –Jacobian and properties –Taylor's series for functions of two variables –Maxima and minima of functions of two variables –Lagrange's method of undetermined multipliers.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS 12

Second and Higher Order Equations, homogeneous and non-homogeneous linear equations and linear systems with constant coefficients, method of variation of parameters, method of undetermined coefficients, Equations reducible to linear equations with constant coefficients-Simultaneous linear equations with constant coefficients.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2015.

REFERENCES:

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons. Singapore, 10th Edition, 2015.
2. M.K. Venkataraman, Engineering Mathematics- First Year, 2nd Edition, National Publishing., Chennai 2001.
3. T. Veerarajan, Engineering Mathematics-I, Tata McGraw Hill Publishing Co, New Delhi, 2017.

Course code	**21PH13T**	**Semester**	**I**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING PHYSICS I (COMMON FOR ALL BRANCHES)**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the importance of polarization, optical fiber and Lasers
- To familiar the knowledge of electromagnetic waves oscillations
- To understand the importance of quantum physics
- To cognize the basics of heat and thermodynamics
- To express the basics of crystal physics

PREREQUISITE:

- High School Maths and Physics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C103.1	***Utilize*** the concepts of polarization, optical fiber and Lasers for engineering applications	K3
C103.2	***Apply*** the knowledge of electromagnetic waves oscillations	K3
C103.3	***Understand*** the importance of quantum physics.	K2
C103.4	***Cognize*** the basics of heat and thermodynamics	K2
C103.5	***Express*** the basics of crystal physics	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C103.1	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C103.2	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C103.3	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C103.4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
C103.5	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
C103	2	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I PHOTONICS 9

Polarization and Fiber Optics: Electromagnetic waves - Production and analysis of linearly, elliptic and circularly polarized light-Polaroid and applications of polarization. Fiber optics - principle of operation – numerical aperture - acceptance angle and applications of fiber optics.

Optical Sources: Characteristics of Lasers - Spontaneous and Stimulated Emission of Radiation - Population Inversion - Einstein's Coefficients and Relation between them - Applications of Lasers.

UNIT II WAVES AND OSCILLATION 9

Oscillatory motion: Differential equation of SHM- Velocity and acceleration- Restoring Force- Frequency response - phase response and resonance-Analogy with LCR circuits and oscillators- Energy and energy loss- Damped oscillations- Significance in control systems - vibration and vibration isolation.

Wave motion: Definition of a plane progressive wave- Attenuation of waves- Phase Velocity- Introduction to numerical methods for solution of wave equation- Importance of spherical and plane wave fronts.

UNIT III QUANTUM MECHANICS 9

Need for Quantum Physics-Historical overviews - Matter waves - De-Broglie's concept of matter waves - Properties of matter waves - Photo electric effect - Heisenberg's uncertainty principle – Statement - Interpretation and application - Schrödinger's time dependent and time independent equations - Operators - Eigen values and Eigen functions - Expectation values -Physical significance of wave function-Quantum superposition and entanglement for Qbits (quantitatively)

UNIT IV HEAT AND THERMODYNAMICS 9

Heat and internal energy - Specific heat and calorimetry - Latent Heat coefficient of linear thermal expansion - Methods of measurement of thermal expansion - Thermal expansion - Applications - The bimetallic strip - Differential equation of one-dimensional heat flow - Lee's disc apparatus for determination of thermal conductivity - Thermal Insulation- Heat dissipation and heat sinking of electronic devices-solid state refrigerators (qualitatively)

UNIT V CRYSTAL PHYSICS 9

Introduction of Crystallography - Space Lattice - Unit Cell - Lattice Parameters – Crystal Systems - Bravais Lattices - Miller Indices and its applications - Crystal Planes and Directions- Inter Planar Spacing of Orthogonal Crystal Systems - Atomic Radius - Co-ordination Number and Packing Factor of SC, BCC, FCC – Crystal growth –Solution growth -Structure determination by x-ray diffraction method (cubic structure).

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Richard Wolfson, "Essential University Physics", Vols. 1 and 2. Pearson Education, Singapore, 2011.
2. Gaur R K, Gupta S L, "Engineering Physics", DhanpatRai Publications, 2013.

REFERENCES:

1. Halliday D., Resnick R. and Walker J., “Fundamentals of Physics”, Wiley Publications,2008.
2. Avadhanulu M. N., “Engineering Physics”, S. Chand & Co., 2007.
3. Purcell E. M., “Electricity and Magnetism – Berkeley Physics Course”, Vol. 2, Tata McGraw-Hill, 2008.
4. Paul A. Tipler and Geene Mosca, “Physics for Scientists and Engineers”, W.H. Freeman and Company, New York, 2004.

Course code	**21CY14T**	**Semester**	**I**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING CHEMISTRY (COMMON FOR ALL BRANCHES)**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To make the students conversant with water quality parameters and treatment techniques.
- To get the basic idea about the polymers, electrochemistry and corrosion.
- To deal with the information about various types of fuels and energy sources.

PREREQUISITE:

- Basic Chemistry Skills

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C104.1	***Understand*** the water related problems and their treatment techniques.	K2
C104.2	***Explain*** the applications of polymers and reinforced plastics.	K2
C104.3	***Acquire*** knowledge on electrochemistry and corrosion.	K2
C104.4	***Summarize*** the types of fuels and its production process and calculate the CV values.	K2
C104.5	***Classify*** the non-conventional energy sources and its applications.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C104.1	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.2	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.3	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.4	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104.5	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
C104	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I WATER AND ITS TREATMENT 9

Introduction - characteristics - alkalinity - types and determination - hardness - types expression of hardness - units - estimation of hardness of water by EDTA - numerical problems -boiler feed water-requirements-boiler troubles – scale & sludge -disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) -softening of hard water - external treatment process - demineralization and zeolite, internal treatment - boiler compounds (carbonate, phosphate, Calgon, sodium aluminate and colloidal conditioning methods) – desalination of brackish water – reverse osmosis.

UNIT II POLYMERS AND REINFORCED PLASTICS 9

Introduction - classification of polymers - Natural and synthetic - Thermoplastic and Thermosetting, Functionality - Degree of polymerization, Properties of polymers: Tg, Tacticity, Molecular weight - weight average, number average and polydispersity index. Types – addition, condensation and Copolymerization – free radical, cationic and anionic polymerization mechanism

- Preparation, properties and uses of PVC, Nylon- 6,6, Teflon and Epoxy resin. Plastics - Compounding of plastics – moulding methods – injection, extrusion and compression – Engineering plastics-applications-fibre-reinforced plastics (FRP) – carbon and glass– applications.

UNIT III ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential-oxidation potential-reduction potential - measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors- types: chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function Electroplating of Copper and electroless plating of nickel-Chemical conversion coatings-phosphate, chromate, chemical oxide, and anodized coatings.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum – refining- manufacture of synthetic petrol (Bergius process) – knocking - octane number- cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) – synthesis, advantages and commercial application of power alcohol and biodiesel. Combustion of fuels: Introduction - calorific value - higher and lower calorific values- theoretical calculation of calorific value –problems- ignition temperature - spontaneous ignition temperature - explosive range - flue gas analysis (ORSAT Method).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Energy-Types- Non-renewable energy- Nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries - primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells - H_2-O_2 fuel cell.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. P.C. Jain and Monika Jain, Engineering Chemistry, DhanpatRai, Publishing Company (P) Ltd., New Delhi, 2015.
2. S.S Dara&S.S Umare, A Text book of Engineering Chemistry, S.Chand & Company Ltd., New Delhi, 2015.

REFERENCES:

1. S. Vairam,P. Kalyani and Suba Ramesh., Engineering Chemistry, Wiley India Pvt. Ltd, New Delhi, 2013.
2. B.K.Sharma, Engineering Chemistry, Krishna Prakasan Media (P) Ltd., Meerut, 2014.
3. Prasanta Rath, Engineering Chemistry, Cengage Learning India Pvt. Ltd, Delhi, 2015.
4. Shikha Agarwal, Engineering Chemistry-Fundamentals and Applications, Cambridge University Press, Delhi, 2015.
5. V.R.Gowariker, N.V.Viswanathan, J.Sreedhar, Polymer Science, New Age International (P) Ltd., Publishers, New Delhi, 2011.

Course code	21CS15IT	Semester	I			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	PROBLEM SOLVING AND PYTHON PROGRAMMING (COMMON FOR ALL BRANCHES)		2	0	4	4

COURSE OBJECTIVES:

- To be familiar with the basics of algorithmic problem solving.
- To construct python programs with conditionals, loops and functions.
- To use python data structures-Lists, Tuples and Dictionaries.

PREREQUISITE:

- Basic Mathematics Skills and Computer Knowledge

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C105. 1	***Develop*** algorithmic solutions to simple computational problems	K3
C105. 2	***Construct*** simple Python programs for solving problems.	K3
C105. 3	***Build*** Python programs with conditionals and loops.	K3
C105. 4	***Demonstrate*** a Python program into functions.	K2
C105. 5	***Show*** compound data using Python lists, tuples, and dictionaries.	K2
C105. 6	***Read*** and write data from/to files in Python Programs.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C105. 1	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 2	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 3	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 4	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 5	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105. 6	3	2	1	-	-	-	-	-	-	-	-	-	2	2
C105	3	2	1	-	-	-	-	-	-	-	-	-	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT- I ALGORITHMIC PROBLEM SOLVING AND BASICS OF PYTHON 8

Algorithms-building blocks of algorithms (statements, state, control flow, functions), simple Strategies for developing algorithms (iteration, recursion)-pseudo code- flow chart-programming language. Introduction to Python-Features of Python-Python Interpreter: Interactive and script mode- Values and types, variables, Keywords, Identifiers, operators, precedence of operators, expression, Comments.

UNIT-II CONTROL FLOW, FUNCTIONS 8

Conditional statements-Iterative statements, Functions: Built-in functions, user defined function-Function Arguments-Fruitful functions and void functions- local and global variable - function composition- recursion-Lambda Functions.

UNIT-III MODULES, PACKAGES, STRINGS 4

Modules-Packages-Strings-string operations, string functions and methods.

UNIT-IV LISTS, TUPLES, DICTIONARIES 5

Lists- list operations, list methods, list loop, mutability, aliasing, cloning lists-Tuples-Tuple assignment, Operations on Tuples, Tuple as return value- Dictionaries- operations and methods-Sets-Operations on sets.

UNIT-V FILES AND EXCEPTIONS 5

Files –Types of files, file operations, file methods, format operator-command line arguments-Errors and Exceptions, handling exceptions.

List of Experiments: 30 Periods

1. Write a python program to demonstrate basic data types in python.
2. Write a python program using conditional statements.
3. Write a python program using Iterative statements.
4. Write a python program using built-in and user defined functions.
5. Write a python program using lambda functions and recursions.
6. Write a python program to demonstrate Strings and its Operations.
7. Write a python program to demonstrate lists, tuples and its operations.
8. Write a python program to demonstrate Sets and its operations.
9. Write a python program to demonstrate Dictionaries and its operations.
10. Write a python program to demonstrate Files and its Operations.

30 Periods

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Reema Thareja, “Python Programming using Problem Solving Approach”, OXFORD University Press, 2017.
2. Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist‘‘, 2nd edition, Updated for Python 3, Shroff/O‘Reilly Publishers, 2016.

REFERENCES:

1. Ashok Namdev Kamthane, Amit Ashok Kamthane, “Programming and Problem Solving with Python”, Mc-Graw Hill Education, 2018.
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd, 2016.
3. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.

Course code	**21ME16T**	**Semester**	**I**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING GRAPHICS (COMMON FOR ALL BRANCHES)**		**2**	**0**	**4**	**4**

COURSE OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
- To expose them to existing national standards related to technical drawings.

PREREQUISITE:

- Engineering Drawing Skills

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C106.1	***Familiarize*** with the fundamentals and standards of Engineering graphics.	K2
C106.2	***Develop*** freehand sketching of basic geometrical constructions and multiple views of objects.	K3
C106.3	***Draw*** orthographic projection of lines and plane surfaces.	K3
C106.4	***Construct*** projection of solids, Section and development of surfaces.	K3
C106.5	***Visualize*** isometric and perspective projections	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C106. 1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
C106. 2	3	3	-	-	-	-	-	-	-	-	-	1	1	-	-	-
C106. 3	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106. 4	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106. 5	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-
C106	3	3	2	-	-	1	-	1	-	1	-	1	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square, Triangle and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views– Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection– principles-Principal Planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method. Applications – Drawing interpretation and process planning, circuit design.

UNIT III PROJECTION OF SOLIDS 5+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method, auxiliary plane method. Applications – Engineering design, automotive modelling, X-rays.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Applications – Design of piping, Fabrication, body building, defect analysis.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6 + 12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones– combination of two solid objects in simple vertical positions – Perspective projection of simple solids–Prisms, pyramids and cylinders by visual ray method and vanishing point method. Applications–constructions, photography, animation and image processing.

Total: 90 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2010.
2. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 51th Edition, 2019.

REFERENCES:

1. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited,2015.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 3rd Edition, 2013.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to Semester End Examination on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. Students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

VEL TECH HIGH TECH
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Course code	21MC04T	Semester	I			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	தமிழர் மரபு		1	0	0	1

SYLLABUS **No. of Credits: 1**

அலகு 1 மமமொழி மற்றும் இலக்கியம்: 3

திராவிட மமாழிகள்- சங்க இலக்கியம்- திருக்குறள் மமலாண்மம கருத்துக்கள்; தமிழ் காப்பியங்கள்; ஐம்மபருங் காப்பியங்களில் தமிழர் பண்பாடு- தமிழகத்தில் சமண மபளத்த சமயங்களின் தாக்கம்

அலகு 2 பொறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வறை – சிற்பக் கறல: 3

ஐம்மபான் சிமலகள்: பழங்குடியினர் தயாரிக்கும் மகவிமன மபாருட்கள்; மதர் மசய்யும் கமல – சுடுமண் சிற்பங்கள்: இமச கருவிகள் – மிருதங்கம், பமற, வீமண, யாழ், நாதஸ்வரம்.

அலகு 3 நொட்டுப்புை கறலகள் மற்றும் வீை விறையொட்டுகள்: 3

மதருக்கூத்து, கரகாட்டம், வில்லுப்**பொ**ட்டு, ஒயிலாட்டம், சிலம்பாட்டம், நாட்டுப்புற பாடல்கள்.

அலகு 4 தமிழர்கைின் திறன கமகொட்பொடுகள்: 3

மதால்காப்பியமும் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புற மகாட்பாடுகள்: சங்ககால நகரங்களும் துமறமுகங்களும்.

அலகு 5 இந்திய கதசிய இயக்கம் மற்றும் இந்திய பண்பொட்டிற்கு தமிழர்கைின் பங்கைிப்பு: 3

இந்திய மருத்துவத்தில் சித்த மருத்துவம் மற்றும் ஆயுர்மவத மருத்துவத்தின் பங்கு: தமிழ் புத்தகங்களின் அச்சு வரலாறு.

Total: 15 Periods

அடிகுைைிப்புகள்

1) தமிழக வரலாறு – மக்களும் பண்பாடும் – மக. மக. பிள்மள (மவளியீடு தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்)
2) கீழடி மவமக நதிக்கமரயில் சங்ககால நகர நாகரிகம் (மதால்லியல் துமற மவளியீடு)
3) மபருமந – ஆற்றங்கமர நாகரிகம் (மதால்லியல் துமற)

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Course code	21MC04T	Semester	I			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	HERITAGE OF TAMILS (COMMON FOR ALL BRANCHES)		1	0	0	1

SYLLABUS **No. of Credits: 1**

UNIT 1 LANGUAGE AND LITERATURE 3

Dravidian Languages – Tamil as Classical Language – Sangam Literature- Aimperum kappiyangalil tamilar panbaadu ; Tamil Epics and Impact of Buddhism & Jainism in Tamil Land.

UNIT 2 HERITAGE – ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Art of Temple Making – Massive Terracotta Sculptures – Art of Temple Care Making; Making of Musical Instruments – Mridhangam, Parai, Veenai, Yazh, Nadhaswaram.

UNIT 3 FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Oyillatam, Silambattam, nattupura padalgal.

UNIT 4 THINAI CONCEPTS OF TAMIL 3

Sangam Literature – Education and Literacy During Sangam Age – Ancient Cities and Ports of Sangam Age – Export and Import during Sangam Age.

UNIT 5 CONTRIBUTIONS OF TAMIL TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Culturals Influence of Tamil over the Other Parts of India – Role of Siddha and Ayurvedha in Indigenous System of Medicine – History of Tamil Books.

Total: 15 Periods

REFERENCE:

1) Social Life of Tamils (Dr. K. K. Pillay) A Joint Publications of Tntb & Esc and Rmrl – (in Print)
2) Social Life of the Tamils – The Classical Period (Dr. S Singaravelu)
3) Historical Heritage of Tamils (Dr. S.V Subatamanian, Dr. K.D Thirunavukkarasu)

Course code	**21BS17P**	**Semester**	**I**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**PHYSICS AND CHEMISTRY LABORATORY (COMMON FOR ALL BRANCHES)**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To encourage the students to familiarize with experimental determination of velocity of ultrasonic waves and band gap determination.

PREREQUISITE:

- Basic measurement skills

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C108.1	***Estimate*** the various water quality parameters like alkalinity, hardness (total, temporary, & permanent), dissolved oxygen content, and chloride content.	K2
C108.2	***Investigate*** the metals and ions present in any given sample using various analytical techniques.	K2
C108.3	***Analyze*** the properties such as conductance of solutions, and redox potentials.	K2
C108.4	***Determine*** various moduli of elasticity and also various thermal and optical properties of materials.	K2
C108.5	***Determine*** the velocity of ultrasonic waves, band gap determination and viscosity of liquids.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C108.1	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.4	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108.5	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
C108	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

PHYSICS LABORATORY
LIST OF EXPERIMENTS
(Any SIX Experiments)

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Lee's disc Determination of thermal conductivity of a bad conductor
4. Laser- Determination of the wave length of the laser using grating, Estimation of laser parameters
5. Optical fibre -Determination of Numerical Aperture and acceptance angle
6. Ultrasonic interferometer - determination of the velocity of sound and compressibility of Liquids
7. Determination of Band gap of a semiconductor
8. Spectrometer- Determination of wavelength using gating

Total: 30 Periods

REFERENCES:

1. Physics Practicals, Department of Physics, Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College 2021
2. Wilson J.D. and Hernandez C.A., "Physics Laboratory Experiments", Houghton Mifflin Company, New York 2005

CHEMISTRY LABORATORY
LIST OF EXPERIMENTS
(Any SIX Experiments)

1. Determination of permanent, total and temporary hardness of water sample.
2. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
3. Determination of DO Content of water sample by Wrinkler's method.
4. Determination of chloride content of water sample by Argentometric method.
5. Determination of strength of given HCl using pH meter.
6. Estimation of Fe^{2+} by Potentiometric titration.
7. Determination of molecular weight of PVA using Ostwald viscometer.
8. Estimation of Iron content in water sample using spectrophotometer (1,10 – Phenanthroline/thiocyanate method).
9. Conductometric titrations of strong acid Vs strong base.
10. Determination of strength of acid in a mixture using conductivity meter.
11. Corrosion experiment-weight loss method.
12. Estimation of sodium and potassium present in water using flame photometer.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Jeffery G.H., Bassett J., Mendham J. and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
2. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.
3. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore (1994).

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Course code	21ME18P	Semester	I			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	ENGINEERING PRACTICES LABORATORY (COMMON FOR ALL BRANCHES)		0	0	4	2

COURSE OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

PREREQUISITE:

- Basic knowledge of engineering skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C109. 1	Demonstrate on Smithy operations, Foundry operations models and machine assembly practice of centrifugal pump and air-conditioner	K2
C109. 2	Experiment with pipe connections and plumbing works	K3
C109. 3	Make use of welding equipment to join the structures.	K3
C109. 4	Explain carpentry components, for the joint used in roofs, doors, windows and furniture.	K5
C109. 5	Develop sheet metal models, fitting models and do basic machining operations	K6

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C109. 1	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 2	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 3	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 4	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109. 5	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C109	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

I CIVIL ENGINEERING PRACTICE 12

Buildings:

a) Study of plumbing and carpentry components of residential and industrial buildings, Safety aspects.

Plumbing Works:

a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers and elbows in household fittings.
b) Study of pipe connections requirements for pumps and turbines.
c) Preparation of plumbing line sketches for water supply and sewage works.
d) Hands-on-exercise:
   Basic pipe connections-Mixed pipe material connection-Pipe connections with different joining components
e) Demonstration of plumbing requirements of high-rise buildings

Carpentry using Power Tools only:

a) Study of the joints in roofs, doors, windows and furniture.
b) Hands-on-exercise:
   Wood work, joints by sawing, Planning and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
b) Gas welding practice

Basic Machining:

a) Simple Turning and Taper turning
b) Drilling Practice

Sheet Metal Work:

a) Forming & Bending:
b) Model making – Trays and funnels.
c) Different type of joints.

Machine assembly practice:

a) Study of centrifugal pump
b) Study of air conditioner

Demonstration on:

a) Smithy operations, upsetting, swaging, setting down and bending. Example –Exercise – Production of hexagonal headed bolt.
b) Foundry operations like mould preparation for gear and step cone pulley.
c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

Total: 30 Periods

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE **14**

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.

2. Fluorescent lamp wiring.

3. Stair case wiring

4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.

5. Measurement of energy using single phase energy meter.

6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE **16**

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.

2. Study of logic gates AND, OR, EX-OR and NOT.

3. Generation of Clock Signal.

4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.

5. Measurement of ripple factor of HWR and FWR.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Chapman, W.A.J. Workshop Technology, Edward Arnold, 2001.

REFERENCES:

1. Raghuwanshi B.S., Workshop Technology Vol. I & II, DhanpathRai & Sons.
2. Kannaiah P. and Narayana K.L., Workshop Manual, 2 Edn, Scitech publishers.
3. John K.C., Mechanical Workshop Practice. 2nd Edn. PHI 2010.
4. JeyapoovanT. and Pranitha S., Engineering Practices Lab Manual, 3rd Edn. Vikas Pub.2008

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II SEMESTER

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SEMESTER II											
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**				
							L	**T**	**P**	**C**
THEORY											
1	21EN21T	Technical English	HSMC	40	60	100	3	0	0	3
2	21MA22T	Vector Calculus and Complex Integration	BSC	40	60	100	3	1	0	4
3	21ME23T	Production Technology-I	PCC	40	60	100	3	0	0	3
4	21EE24T	Basic Electrical, Electronics and Instrumentation Engineering	ESC	40	60	100	3	0	0	3
5	21ME25T	Engineering Materials & Metallurgy	PCC	40	60	100	3	0	0	3
6	21ME26T	Engineering Mechanics	ESC	40	60	100	3	1	0	4
7	21MC05T	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	MC	40	60	100	1	0	0	1
PRACTICAL											
8	21ME27P	Production Technology–I Laboratory	PCC	60	40	100	0	0	4	2
9	21EE28P	Basic Electrical and Electronics Engineering Laboratory	ESC	60	40	100	0	0	4	2
TOTAL										**25**

Course code	**21EN21T**	**Semester**	**II**			
Category	**HUMANITIES & SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)**		**L**	**T**	**P**	**C**
Course Title	**TECHNICAL ENGLISH (COMMON FOR ALL BRANCHES)**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To make the students of engineering and technology to enhance their ability on reading and comprehencing the different texts
- To improve their creative and critical thinking so as to use in demanding contexts
- To equip the learners with the skills of writing convincing job Applications and effective reports
- To develop their speaking skills to make technical presentations and participate in group discussions
- To facilitate them to hone their soft skills

PREREQUISITE:

- Technical writing and basic English grammar.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C201. 1	***Read*** and understand general and technical texts	K2
C201. 2	***Apply*** creative and critical thinking and communicate their ideas efficiently	K2
C201. 3	***Participate*** in group discussions and deliver short speeches effectively	K3
C201. 4	***Write*** effectively and persuasively in academic and workplace contexts	K3
C201. 5	***Experiment with*** the future challenges confidently and successfully	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C201. 1	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 2	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 3	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 4	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201. 5	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-
C201	-	-	-	-	-	-	-	-	1	3	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT-I TECHNICALWRITING AND VISUAL CONVERSION 9

PRACTICAL

LISTENING : Listening to pronunciation of longer words.

SPEAKING : Making out meaning of pictorial and graphical representations.

TUTORIAL

READING : Understanding logic and sequencing in reading inferring the exact meaning of text

WRITING : Extended Definition- Writing Instructions, Checklists & Recommendations- Reading short technical text from Journal.

VOCABULARY: Technical vocabulary- Regular and Irregular verbs.

UNIT- II TECHNICAL WRITING AND GUIDELINES PREPARATION 9

PRACTICAL

LISTENING : Comprehensive listening - Listening to telephonic conversations – short and long conversations from different domains, listening to various pre-recorded conversations and speeches.

SPEAKING : Delivering short speeches in the class.

TUTORIAL

READING : Technical reading on innovations and innovators.

WRITING : Conditional clauses, Numerical adjectives, Process Description

VOCABULARY: Collocation, Verbal Analogies.

UNIT-III TECHNICAL PROCESS WRITING 9

PRACTICAL

LISTENING : Listening to documentaries and making notes.

SPEAKING : Basic speaking practice based on BEC, IELTs, and TOFEL.

TUTORIAL

READING : longer text both general and technical –practice in speed reading

WRITING : Purpose statements, words are used as nouns and verbs- describing a process – use of sequence word - Interpretation of Graphs and Charts.

VOCABULARY: Sequence words –Misspelled words -Embedded sentences.

UNIT- IV TECHNICAL WRITING AND BUSINESS LETTERS 9

PRACTICAL

LISTENING : listening to native accents.

SPEAKING : Group Discussions - Process, Skills, Guidelines, Evaluation, Oral Presentation - Planning, Preparing, Organizing and Presenting.

TUTORIAL

READING : Reading for detailed comprehension.

WRITING : Cause and effect, impersonal passive voice, idioms and phrases, - Letter writing, job application, business correspondence (letters) – calling for quotations, placing order,complaint letters, preparing a memo, notice and e-mail itinerary.

VOCABULARY: clauses and If conditionals.

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UNIT-V TECHNICAL WRITING AND REPORT WRITING 9

PRACTICAL

LISTENING : TED /ink talks

SPEAKING : Starting a Career — vision statement, preparing logo and tagline, making short term and long-term goals, setting plans.

TUTORIAL

READING : Reading and understanding technical articles.

WRITING : Degrees of comparison, editing, Email etiquette, Mispronounced words – Report writing survey, feasibility, industrial visit, reporting various incidents and accidents, Minutes of meeting.

VOCABULARY: Reported speech.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Department of English, Anna University, Chennai. Mindscapes: English for Technologists and Engineers. Orient Black Swan, Chennai.
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Black Swan Publications, Chennai, 2011.

REFERENCE BOOKS:

1. Rizvi, M. Ashraf, "Effective Technical Communication", Tata McGraw— Hill,2006.
2. Ibbotson, Mark, "Cambridge English for Engineering", Cambridge University Reference Press, 2008
3. Richard Johnson-Sheehan, "Technical Communication Today"4th EditionBooks Longman Publishing Group, 2011.
4. Richard Johnson-Sheehan, "Technical Communication Today"4th EditionBooks Longman Publishing Group, 2011
5. Porter, Patricia A., and Margaret Grant, "Communicating Effectively in English: Ora1 Communication for Non-Native Speakers", 2nd Edition, Wadsworth, 1992.
6. Gopalaswamy, Ramesh & Ramesh Mahadevan. ACE of Soft Skills: Attitude, Communication and Etiquette for Success, New Delhi: Pearson, 2010.

Extensive Reading:

Wells, H G. The Time Machine, Peacock, India, 2008.

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Course code	**21MA22T**	**Semester**	**II**			
Category	**BASIC SCIENCE COURSE (BSC)**		**L**	**T**	**P**	**C**
Course Title	**VECTOR CALCULUS AND COMPLEX INTEGRATION (COMMON FOR ALL BRANCHES)**		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

- To improve their ability in vector calculus
- To expose to the ideas of analytic functions
- To solve differential equation using the concept of Laplace Transform.

PREREQUISITE:

- Mathematics skills at Sem-I level

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C202.1	***Apply*** the vector calculus concepts to solve engineering problems.	K3
C202.2	***Apply*** the concept of mapping to solve Linear equation.	K3
C202.3	***Apply*** the complex integration problem ideas to solve engineering problems.	K3
C202.4	***Understand*** the concepts of multiple integrals.	K2
C202.5	***Apply*** the concepts of Laplace transformation to solve Differential Equations.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C202.1	3	2	-	-	-	-	-	-	-	-	-	-
C202.2	3	2	-	-	-	-	-	-	-	-	-	-
C202.3	3	2	-	-	-	-	-	-	-	-	-	-
C202.4	2	2	-	-	-	-	-	-	-	-	-	-
C202.5	3	2	-	-	-	-	-	-	-	-	-	-
C202	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 4**

UNIT I VECTOR CALCULUS 12

Gradient, divergence, curl – Solenoidal and irrotational fields – Vector identities– Directional derivatives – Line, surface and volume integrals –Green's, Gauss divergence and Stoke's theorems (without proof) .

UNIT II ANALYTIC FUNCTIONS 12

Limit of a complex functions-Derivative of f(z)-Definition of Analytic Function – Cauchy Riemann equations – Properties of analytic functions - Determination of harmonic conjugate – Milne-Thomson's method – Conformal mappings: 1/z, az , az+b and bilinear transformation.

UNIT III COMPLEX INTEGRATION 12

Line integral – Cauchy's integral theorem (statements only) – Cauchy's integral formulae and its applications – Taylor's and Laurent's expansions (statements only) – Singularities – Poles and Residues – Cauchy's residue theorem (statement only) – Contour integration – Unit circle and semicircular contour.

UNIT IV MULTIPLE INTEGRALS 12

Double integration in Cartesian and polar coordinates – Change of order of integration – Area as double integral – Triple integration in Cartesian coordinates – Conversion from Cartesian to polar – Volume as a double and Triple Integral.

UNIT V LAPLACE TRANSFORMS 12

Definition-Conditions for existence- Transforms of elementary functions – Properties of Laplace Transform-Transforms of periodic functions – Transforms of derivatives and integrals– Inverse transforms – Convolution theorem– Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficients only- Unit step function and Unit impulse function [simple problems only]

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

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

REFERENCES:

1. E. Kreyszig, **Advanced Engineering Mathematics**, John Wiley & Sons. Singapore, 10thEdition, 2012.
2. M.K. Venkataraman, Engineering **Mathematics: Vol I and II**, National Publishing., Chennai 2001.
3. T. Veerarajan, **Engineering Mathematics**, Tata McGraw Hill Publishing Co, New Delhi, 2004.

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Course code	21ME23T	Semester	II			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	PRODUCTION TECHNOLOGY-I		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concepts of basic manufacturing processes and fabrication techniques, such as metal casting, metal joining, metal forming and manufacture of plastic components.

PREREQUISITE:

- Basic knowledge of engineering skills

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C203.1	Explain different metal casting processes, associated defects, merits and demerits	K2
C203.2	Compare different metal joining processes.	K2
C203.3	Summarize various hot working and cold working methods of metals.	K2
C203.4	Explain various sheet metal making processes.	K2
C203.5	Distinguish various methods of manufacturing plastic components.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C203.1	-	-	3	-	3	-	-	-	1	2	-	-	-	-	-	-
C203.2	-	-	3	2	3	2	-	-	1	2	-	-	-	-	-	-
C203.3	2	-	3	-	-	-	-	-	1	2	-	-	-	-	-	-
C203.4	2	-	3	-	-	-	-	-	1	2	-	-	-	-	-	-
C203.5	-	-	3	-	2		-	-	-	2	-	-	-	-	-	-
C203	2	-	3	2	3	2	-	-	1	2	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I METAL CASTING PROCESSES 9

Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding - sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell - investment – Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting; Defects in Sand casting- Testing and inspection of castings.

UNIT II JOINING PROCESSES 9

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding – Electro slag welding; Operating principle and applications of: Resistance welding - Plasma arc welding – Thermit welding – Electron beam welding – Friction welding and Friction Stir Welding; Brazing and soldering; Weld defects: types, causes and cure.

UNIT III METAL FORMING PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types --Hot and Cold extrusion.

UNIT IV SHEET METAL FORMING PROCESSES 9

Sheet metal characteristics – shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes-Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning–- Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming-Powder metallurgy-production of metal powders-stages in powder metallurgy.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics – working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding –Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. HajraChouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2018.
2. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2017.

REFERENCES:

1. Gowri P. Hariharan, A.SureshBabu, "Manufacturing Technology I", Pearson Education, 2018.
2. Paul Degarma E, Black J.T and Ronald A. Kosher, "Materials and Processes, in Manufacturing" Eight Edition, Prentice – Hall of India, 2017.
3. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH-2018.
4. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2017.
5. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2018.

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Course code	**21EE24T**	**Semester**	**II**			
Category	**ENGINEERING SCIENCE COURSE (ESC)**		**L**	**T**	**P**	**C**
Course Title	**BASIC ELECTRICAL, ELECRONICS AND INSTRUMENTATION ENGINEERING COMMON FOR (CSE, IT, AI&DS, BIOTECH, CIVIL, MECH, CSE(AI&ML))**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- The course is intended to introduce the students to basic theorems and laws in DC and AC circuits.
- This course aims at giving adequate exposure to students on the principles of electrical machines.
- The course will enable the students to acquire knowledge on fundamentals and applications of various electronic devices and measuring instruments.

PREREQUISITE:

- Engineering Physics, Mathematics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C204.1	***Impart*** knowledge on electrical circuit components, laws and theorems.	K2
C204.2	***Analyze*** the behavior of ac circuits components in power system	K3
C204.3	***Illustrate*** the working of various ac machines, dc machines and special machines along with its characteristics.	K2
C204.4	***Infer*** and ***relate*** the working and applications of various electronics devices and circuits.	K2
C204.5	***Categorize*** the specific instruments for electrical measurements.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
C204.1	3	2	-	-	-	-	-	-	2	-	1	1
C204.2	3	2	-	-	-	-	-	-	2	-	1	1
C204.3	3	2	-	-	-	-	-	-	2	-	1	1
C204.4	3	2	-	-	-	-	-	-	-	-	1	1
C204.5	3	2	-	-	-	-	-	-	2	-	1	1
C204	3	2	-	-	-	-	-	-	2	-	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I DC CIRCUITS 9

Basic circuit components (R, L & C) - Ohms Law - Kirchoff's Law – voltage and current division -source transformation-steady state solution of DC circuits - Nodal analysis, Mesh analysis- Thevenin's Theorem, Norton's Theorem, Maximum Power transfer -Superposition Theorem.

UNIT II AC CIRCUITS 9

Introduction to AC circuits – waveforms and RMS value – power and power factor, Analysis of single-phase ac circuits consisting of RL and RLC combinations -Resonance- Balanced and Unbalanced three-phase circuits-Star and Delta connections.

UNIT III ELECTRICAL MACHINES 9

Principles of operation and characteristics of DC machines, Construction and operation of Single-Phase transformer – Three phase transformer connections – Autotransformer. Construction and types of Single phase and Three phase Induction motor, Construction and working principle of Alternator, Stepper motors – Brushless DC Motors.

UNIT IV ELECTRONIC DEVICES & CIRCUITS 9

Types of Materials – Silicon & Germanium - PN Junction diodes – Structure, Operation and Characteristics – Display devices-LED, Laser diodes – Zener diode - Bipolar Junction Transistor – Characteristics and applications –Amplifiers - Basics, types and applications, Oscillators-Basics, types and its applications—D/A and A/D converters.

UNIT V MEASUREMENTS & INSTRUMENTATION 9

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive Thermoelectric, piezoelectric, photoelectric, Hall effect. Types and principle of indicating Instruments – Multimeters, Wattmeter, instrument transformers (CT and PT), Oscilloscopes.

TOTAL: 45 PERIODS

LEARNING RESOURCES:

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, ―Basic Electrical and Electronics Engineering, McGraw Hill Education (India) Private Limited, Third Reprint ,2016
2. Leonard S Bobrow, "Foundations of Electrical Engineering", Oxford University Press, 2013
3. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.

REFERENCES:

1. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
2. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Edition, 2006
3. N K De, Dipu Sarkar, "Basic Electrical Engineering", Universities Press (India)Private Limited 2016
4. David A. Bell, "Electronic devices and circuits", Oxford University higher education,5th edition2008.
5. Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First Indian Edition, 2006.

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Course code	**21ME25T**		**Semester**	**II**			
Category	**PROFESSIONAL CORE COURSE (PCC)**			**L**	**T**	**P**	**C**
Course Title	**ENGINEERING MATERIALS AND METALLURGY**			**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

The course objective of this course is to prepare the students for:

- To impart knowledge on the structure, properties, treatment, testing and applications of metals and non-metallic materials so as to identify and select suitable materials for various engineering applications.

PREREQUISITE:

- Engineering Physics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C205.1	***Understand*** the concept of crystal structures, alloys and phase diagram and construct the Iron-Iron carbon diagram.	K2
C205.2	***Explain*** isothermal transformation, continuous cooling diagrams and different heat treatment processes.	K2
C205.3	***Clarify*** the effect of alloying elements on ferrous and non-ferrous metals.	K2
C205.4	***Summarize*** the properties and applications of polymer ceramics, composites and nano materials.	K2
C205.5	***Applying*** the various testing procedures and failure mechanism in engineering field.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**
C205.1	3	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-
C205.2	3	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-
C205.3	3	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-
C205.4	3	-	-	-	-	-	-	-	-	-	-	1	2	1	-	-
C205.5	3	1	-	-	-	1	-	-	-	-	-	1	2	1	-	-
C205	3	1	-	-	-	1	-	-	-	-	-	1	2	1	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 3**

UNIT I CRYSTAL STRUCTURES & PHASE DIAGRAMS 9

Classification of Engineering Materials, Crystal Structure - BCC, FCC & HCP Structures - Crystallographic direction and planes, Crystal Systems, Crystal imperfections - Point, Line, Surface and Volume defects, Solid solutions - substitutional and interstitial - Hume Rothery Rules, Phase diagrams - Phase Rules - Binary Phase Diagram, Isomorphous Systems, Eutectic, eutectoid, peritectic, and peritectoid reactions, Iron – carbon equilibrium diagram, Microstructures in Iron-Carbon alloys, Classification of steel and cast Iron.

UNIT II HEAT TREATMENT 9

Importance of Heat Treatment - Annealing and types, Normalizing, Hardening of Steel, Tempering, Austempering and Martempering, TTT- Time Temperature Transformation Diagram (Isothermal Transformation diagram), CCT diagram – cooling curves superimposed on I.T. diagram, Hardenability, Jominy end quench test, Case hardening, Carburising, Nitriding, Cyaniding, Carbonitriding, Flame and Induction hardening, Precipitation / Age Hardening

UNIT III FERROUS AND NON-FERROUS METALS 9

Effect of alloying additions on steel, Classification of Steels - Plain Carbon Steels, HSLA, Maraging steels, Tool Steels, Stainless Steels - Properties & Applications, Classification of Cast Irons - White, Grey, Malleable, Spheroidal, Alloy Cast Iron - Properties &Applications, Copper and copper alloys, Aluminium and Aluminium Alloys, Bearing alloys, Mg Alloys, Ni- Based Super Alloys, Titanium Alloys, Shape Memory Alloys – Properties, Classifications and its applications.

UNIT IV INTRODUCTION TO NEW MATERIALS 9

Polymers – Properties and applications of various thermosetting and thermoplastic polymers(PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes), Engineering Ceramics – Properties and applications(Al2O3, SiC, Si3N4, PSZ and SIALON), Composites- Classifications and Applications of Composites (Metal Matrix and FRP), Nano Materials.

UNIT V MECHANICAL PROPERTIES & TESTING 9

Mechanisms of Plastic deformations, Slip and Twinning, Types of Fracture, Ductile and Brittle fracture, Griffith’s theory, Fatigue and Creep Failure Mechanisms, Testing of materials under tension, compression and shear loads, Hardness tests (Brinell, Vickers and Rockwell), Impact test- lzod and charpy, Fracture Toughness test.

Total: 45 Periods

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LEARNING RESOURCES:

TEXT BOOKS:

1. Avner, S.H., “Introduction to Physical Metallurgy”, McGraw Hill Book Company,1997.
2. Williams D Callister, “Material Science and Engineering” Wiley India Pvt Ltd, Revised Indian Edition 2014.

REFERENCES:

1. Kenneth G.Budinski and Michael K. Budinski, “Engineering Materials”, Prentice Hall
2. of India Private Limited, 2010.
3. Raghavan.V, “Materials Science and Engineering”, Prentice Hall of India Pvt. Ltd., 2015.
4. U.C.Jindal, “Material Science and Metallurgy”, First Edition, Dorling Kindersley, 2012
5. Upadhyay. G.S. and Anish Upadhyay, “Materials Science and Engineering”, Viva Books Pvt. Ltd., New Delhi, 2006.

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Course code	21ME26T	Semester	II			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	ENGINEERING MECHANICS (COMMON FOR MECH, CIVIL)		3	1	0	4

COURSE OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

PREREQUISITE:

- Engineering Physics, Mathematics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C206.1	***Illustrate*** the vectorial and scalar representation of forces and moments	K2
C206.2	***Analyze*** the rigid body in equilibrium	K4
C206.3	***Calculate*** dynamic forces exerted in rigid body	K4
C206.4	***Examine*** the friction and the effects by the laws of friction	K4
C206.5	***Evaluate*** the properties of surfaces and solids	K5

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C206.1	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
C206.2	3	3	2	1	-	1	-	-	-	-	-	1	-	2	-	-
C206.3	3	3	-	-	-	1	-	-	-	-	-	1	-	2	-	-
C206.4	3	3	-	-	-	1	-	-	-	-	-	1	-	2	-	-
C206.5	3	3	2	1	-	1	-	-	-	-	-	1	-	2	-	-
C206	3	3	2	1	-	1	-	-	-	-	-	1	-	2	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	No. of Credits: 4

UNIT I STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces - additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces – stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions.

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula – Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula –Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas –Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle- Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

Total: 60 Periods

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LEARNING RESOURCES:

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., “Vector Mechanics for Engineers (In SI Units): Statics and Dynamics”, 8th Edition, Tata McGraw-Hill Publishing company, New Delhi, 2004.
2. Bhavikatti, S.S and Rajashekarappa, K.G., “Engineering Mechanics”, New Age International (P) Limited Publishers, 2007.

REFERENCES:

1. Vela Murali, “Engineering Mechanics”, Oxford University Press, 2010.
2. Hibbeller, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11th Edition, Pearson Education 2010.
3. Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4th Edition, Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., “Engineering Mechanics- Statics - Volume 1, Dynamics- Volume2”, Third Edition, John Wiley & Sons,1993.
5. Rajasekaran S and Sankara subramanian G., “Engineering Mechanics Statics and Dynamics”, 3rdEdition, Vikas Publishing House Pvt. Ltd., 2005.

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Course code	21MC05T	Semester	II			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	தமிழரும் ததொழில்நுட்பமும்		1	0	0	1

SYLLABUS: **No. of Credits: 1**

அலகு 1 நெசவு மற்றும் பானை ந ◌ாழில்நுட்பம்: 3

சங்க காலத்தில் நெசவு நதாழில் – பாண்டங்களின் கீறல் குறியீடுகள்

அலகு 2 வடிவனமப்பு மற்றும் கட்டிட ந ◌ாழில்நுட்பம்: 3

சங்க காலத்தில் வடிவமைப்பு ை◌ற்றும் கட்டுை◌◌ானஙகள் – சிலப்பதிகாரத்தில் மைமட அமைப்பு பற்றிய விவரங்கள். ச&◌ோழர் கோலக் கட்டிடக்கலல, ை◌◌ாமை◌ல்லபுரம் சிற்பங்களும், மகாவில்களும்

அலகு 3 உற்பத் ◌ி ந ◌ாழில் நுட்பம்: 3

கப்பல் கட்டும் கமல – இரும்பு நதாழிற்சாமல – இரும்மப உருக்குதல் – சிலப்பதிகாரத்தில் ை◌ணிகளின் வமககள்

அலகு 4 வவளாண்னம மற்றும் ெ◌ீர்ப்பாசை ந ◌ாழில் நுட்பம்: 3

கடல் சார் அறிவு – ை◌ீன்வளம் – முத்து ை◌ற்றும் முத்துகுளி**த்**தல் – நபருங்கடல் குறித்த பண்மடய அறிவு

அலகு 5 அறிவியல் மிழ் மற்றும் கணினை◌ித் மிழ்: 3

தைிழின் வளர்ச்சி – தைிழ் நைன்நபாருட்கள் உருவாக்கம் – தைிழ் ை◌ின் நூலகம்

Total: 15 Periods

அடிக்குறிப்பு

1) தைிழக வரலாறு – ை◌க்களும் பண்பாடும் – மக . மக பிள்மள (நவளியீடு தைிழ்ெ◌◌ாடு பாடநூல் ை◌ற்றும் கல்வியில் பணிகள் கழகம்
2) கணினி தைிழ் – முமனவர் இல. சுந்தரம் (விகடன் பிரசுரம்)
3) கீழடி – மவமக ெ◌திக்கமரயில் சங்ககால ெ◌கர ெ◌◌ாகரிகம்

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Course code	**21MC05T**	**Semester**	**II**			
Category	**MANDATORY COURSE (MC)**		**L**	**T**	**P**	**C**
Course Title	**TAMILS AND TECHNOLOGY**		**1**	**0**	**0**	**1**

SYLLABUS: **No. of Credits: 1**

UNIT 1 WEAVING AND CERAMIC TECHNOLOGY: **3**

Weaving Industry During Sangam Age - Graffiti on Potteries.

UNIT 2 DESIGN AND CONSTRUCTION TECHNOLOGY: **3**

Dravidian Architecture; Contemporary Architecture; Cholar kala kattida kalai, Pallava Architecture; Motifs; Temple Architecture.

UNIT 3 MANUFACTURING TECHNOLOGY: **3**

Metallurgical Studies- Iron Industry Steel; Beads Making Industry.

UNIT 4 AGRICULTURE AND IRRIGATION TECHNOLOGY: **3**

Agriculture in Ancient Tamil Era; Land Classification; Crops; Irrigation; Crop Rotation; Marketing; Agriculture in Tamil Literature.

UNIT 5 SCIENTIFIC TAMIL & TAMIL COMPUTING: **3**

Digitalization of Tamil Books

Total: 15 Periods

REFERENCES

1) Historical Heritage of the Tamils (Dr. S. Subatamanian, Dr. K. D Thirunavukkarasu) (Published By: International of Tamil Studies)
2) The Contributions of Tamil to Indian Culture (Dr. M. Valarmathi) (Published By: International Institute of Tamil Studies.)
3) Keeladi - 'Sangam City Civilization on the Banks of River Vaigai' (Jointly Published By: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

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Course code	21ME27P	Semester	II			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRODUCTION TECHNOLOGY-I LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To Study and practice the various operations that can be performed in lathe, shaper, drilling, milling machines etc. and to equip with the practical knowledge required inthe core industries.

PREREQUISITE:

- Basic engineering knowledge

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C208.1	Demonstrate the safety precautions exercised in the mechanical workshop.	K2
C208.2	Show the workpiece as per given shape and size using Lathe.	K2
C208.3	Join two metals using arc welding.	K2
C208.4	Use sheet metal fabrication tools and make simple tray and funnel.	K2
C208.5	Use different molding tools, patterns and prepare sand molds.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3	PSO-4
C208.1	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C208.2	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C208.3	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C208.4	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C208.5	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-
C208	3	-	-	-	-	2	2	-	2	1	1	2	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS	**No. of Credits: 2**

S.NO.	**EXPERIMENT**
1.	Taper Turning
2.	External Thread cutting
3.	Internal Thread Cutting
4.	Eccentric Turning
5.	Knurling
6.	Square Head Shaping
7.	Hexagonal Head Shaping
8.	Fabrication of simple structural shapes using Gas Metal Arc Welding
9.	Joining of plates and pipes using Gas Metal Arc Welding/ Arc Welding/ Submerged arc welding
10.	Preparation of green sand molds
11.	Manufacturing of simple sheet metal components using shearing and bending operations.
12.	Manufacturing of sheet metal components using metal spinning on a lathe
13.	Study of construction features and manufacturing methods – Head stock, Tail stock, Carriage, Cross slide, Compound rest, Belt, Guide ways, Feed gear box, Apron gearbox.

TOTAL: 60 PERIODS

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LEARNING RESOURCES:

TEXT BOOKS:

1. Hajra Chouldhary S.K and Hajra Choudhury. AK., "Elements of workshop Technology", volume I and II, Media promoters and Publishers Private Limited, Mumbai, 2018.
2. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2017.

REFERENCES:

1. Gowri P. Hariharan, A.Suresh Babu, "Manufacturing Technology I", Pearson Education, 2018.
2. Rao, P.N. "Manufacturing Technology Foundry, Forming and Welding", 4th Edition, TMH- 2018.
3. Roy. A. Lindberg, "Processes and Materials of Manufacture", PHI / Pearson education, 2017.
4. Sharma, P.C., "A Text book of production Technology", S.Chand and Co. Ltd., 2018.

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Course code	21EE28P	Semester	II			
Category	ENGINEERING SCIENCE COURSE (ESC)		L	T	P	C
Course Title	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY COMMON FOR (AI&DS, MECH)		0	0	4	2

COURSE OBJECTIVES:

- Provide hands on experience with generators and motors.
- Understand the working of dc/ac motors and generators
- Learn the uses of transformer
- Understand the working of transducers and amplifiers

PREREQUISITES:

- Engineering Physics and Engineering Mathematics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C209.1	***Perform*** experiments to know the working of DC motors / Generators / Transformers.	K2
C209.2	***Illustrate*** the load characteristics of DC motors / Generators / Transformers.	K3
C209.3	***Draw*** the characteristics of diodes and transistors for different configuration.	K2
C209.4	***Design*** bridge network circuit to measure the values of passive component.	K3
C209.5	***Illustrate*** the characteristics of amplifier and ADC converters.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
C209.1	2	1	-	-	-	-	-	-	2	-	-	-
C209.2	2	1	-	-	-	-	-	-	2	-	-	-
C209.3	2	1	-	-	-	-	-	-	2	-	-	-
C209.4	2	1	-	-	-	-	-	-	2	-	-	-
C209.5	2	1	-	-	-	-	-	-	2	-	-	-
C209	2	1	-	-	-	-	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

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SYLLABUS **No. of Credits: 2**

LIST OF EXPERIMENT

1. Open circuit and load test on shunt generators
2. Load test on DC Shunt & DC Series motor
3. Speed control of DC shunt motor (Armature, Field control)
4. Load test on single phase transformer
5. Load test on single phase Induction Motor
6. Load test on three phase squirrel cage Induction motor
7. Study of DC & AC motor starters
8. VI Characteristics of Semiconductor diode and Zener diode.
9. Characteristics of a NPN Bipolar Junction Transistor under common emitter, commoncollector and common base configurations.
10. Measurement of passive (R, L, C) elements using Bridge Networks
11. Design and plot the characteristics of instrumentation amplifier.
12. Design and test the analog to digital converter.

TOTAL: 60 PERIODS

LEARNING RESOURCES:

TEXT BOOKS:

1. D P Kothari and I.J Nagarath, ―Basic Electrical and Electronics Engineering‖, McGrawHill Education(India) Private Limited, Third Reprint ,2016
2. D.V.S. Moorthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2007.

REFERENCES:

1. N K De, Dipu Sarkar, "Basic Electrical Engineering", Universities Press (India)PrivateLimited 2016
2. David A. Bell ,"Electronic devices and circuits", Oxford University higher education,5th edition2008.
3. Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First IndianEdition, 2006.

III SEMESTER

SEMESTER III										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME31T	Engineering Thermodynamics	PCC	40	60	100	3	1	0	4
2	21ME32T	Fluid Mechanics and Machinery	PCC	40	60	100	3	0	0	3
3	21ME33T	Production Technology-II	PCC	40	60	100	3	0	0	3
4	21MA34T	Series, Transforms and Partial Differential Equations	BSC	40	60	100	3	1	0	4
5	21HE35IT	Electrical Drives and Controls	ESC	50	50	100	2	0	4	4
6	21MC01T	Constitution of India	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21ME37P	Production Technology-II Laboratory	PCC	60	40	100	0	0	4	2
8	21ME38P	Computer Aided Machine Drawing Laboratory	PCC	60	40	100	0	0	4	2
TOTAL										**22**

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Course code	**21ME31T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**ENGINEERING THERMODYNAMICS**		**3**	**1**	**0**	**4**

COURSE OBJECTIVES:

- To familiarize the students to understand the fundamental laws of thermodynamics and thermodynamic properties
- To impart knowledge on pure substances, Gas behavior, thermodynamic relations and Psychrometry

PREREQUISITE:

- Mathematics, Physics, Chemistry

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C301.1	***Explain*** the first law of thermodynamics for simple open and closed systems under steady and unsteady conditions.	K2
C301. 2	***Solve*** second law of thermodynamics to open and closed systems and calculate entropy and availability.	K3
C301.3	***Relate*** Rankine cycle to steam power plant and compare few cycle improvement methods	K3
C301.4	***Apply*** simple thermodynamic relations for ideal and real gases	K3
C301.5	***Calculate*** the properties of gas mixtures and moist air and its use in psychometric processes	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C301.1	3	2	-	-	-	-	-	-	-	-	-	-	-	1	-
C301. 2	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-
C301.3	3	2	1	-	-	1	-	-	-	-	-	1	2	1	-
C301.4	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
C301.5	3	2	2	-	-	1	-	-	-	-	-	1	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I BASIC CONCEPTS AND FIRST LAW 9 +3

Basic concepts - concept of continuum, comparison of microscopic and macroscopic approach. Path and point functions. Intensive and extensive, total and specific quantities. System and their types. Thermodynamic Equilibrium State, path and process. Quasi-static, reversible and irreversible processes. Heat and work transfer, definition and comparison, sign convention. Displacement work and other modes of work .P-V diagram. Zeroth law of thermodynamics – concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales. First law of thermodynamics –application to closed and open systems – steady and unsteady flow processes.

UNIT II SECOND LAW AND AVAILABILITY ANALYSIS 9+3

Heat Reservoir, source and sink. Heat Engine, Refrigerator, and Heat pump. Statements of second law and its corollaries. Carnot cycle Reversed Carnot cycle, Performance. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for - pure substance, ideal gases - different processes, principle of increase in entropy. Applications of II Law. High- and low-grade energy. Available and non-available energy of a source and finite body. Energy and irreversibility. Expressions for the energy of a closed system and open systems. Energy balance and entropy generation. Irreversibility. I and II law Efficiency. Negentropy

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE 9+3

Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams. p-v-T surface. Use of Steam Table and Mollier Chart. Determination of dryness fraction. Application of I and II law for pure substances. Ideal and actual Rankine cycles, Cycle Improvement Methods - Reheat and Regenerative cycles, Economiser, preheater, Binary and Combined cycles.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS 9+3

Properties of Ideal gas- Ideal and real gas comparison- Equations of state for ideal and real gases- Reduced properties. Compressibility factor-.Principle of Corresponding states. -Generalised Compressibility Chart and its use-. Maxwell relations, Tds Equations, Difference and ratio of heat capacities, Energy equation, Joule-Thomson Coefficient, Clausius Clapeyron equation, Phase Change Processes, Phase change materials and its applications. Simple Calculations.

UNIT V GAS MIXTURES AND PSYCHROMETRY 9+3

Mole and Mass fraction, Dalton’s and Amagat’s Law. Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function. Psychrometric properties, Psychrometric charts. Property calculations of air vapour mixtures by using chart and expressions. Psychrometric process – adiabatic saturation, sensible heating and cooling, humidification, dehumidification, evaporative cooling and adiabatic mixing. Simple Applications

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. P.K. Nag, “Engineering Thermodynamics”, 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
2. R.K.Rajput, “A Text Book of Engineering Thermodynamics”,FifthEdition,2017.

REFERENCES:

1. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
2. Borgnakke & Sonnatag, “Fundamental of Thermodynamics”, 8th Edition, 2016.
3. Chattopadhyay, P, "Engineering Thermodynamics", Oxford University Press, 2016.
4. Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, 8th Edition
5. Yunus a. Cengel&michael a. Boles, “Thermodynamics”, 8th edition 2015.

Course code	**21ME32T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**FLUID MECHANICS AND MACHINERY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To inculcate the knowledge of fluids flow phenomena in various hydraulic Machines.

PREREQUISITE:

- Concepts of Engineering mechanics, basic physics and Newton's Law

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C302. 1	***Understand*** the mathematical knowledge to predict the properties and characteristics of a fluid.	K2
C302. 2	***Solve*** problems of major and minor losses associated with pipe flow in piping networks.	K3
C302. 3	***Identify and*** mathematically predict the nature of physical quantities	K3
C302. 4	***Examine*** the performance of pumps	K3
C302. 5	***Calculate*** the performance of turbines	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C302. 1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	1
C302. 2	3	2	1	-	-	-	-	-	-	-	-	1	-	-	-
C302. 3	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
C302. 4	3	2	1	-	-	-	-	-	-	-	-	1	1	-	1
C302. 5	3	2	1	-	-	-	-	-	-	-	-	1	1	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapor pressure, surface tension and capillarity. Flow characteristics – concept of control volume - application of continuity equation, energy equation and momentum equation. Manometer, Archimedes principle, Meta centre, metacentric height.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 9

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Darcy Weisbach equation –friction factor- Moody diagram- commercial pipes- minor losses – Flow through pipes in series and parallel, D Alembert's Paradox

UNIT III DIMENSIONAL ANALYSIS 9

Need for dimensional analysis – methods of dimensional analysis – Similitude –types of similitude - Dimensionless parameters- application of dimensionless parameters – Model analysis.

UNIT IV PUMPS 9

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle- work done by the impeller - performance curves - Reciprocating pump-working principle – Rotary pumps –classification

UNIT V TURBINES 9

Classification of turbines – heads and efficiencies – velocity triangles. Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines- working principles - work done by water on the runner – draft tube. Specific speed - unit quantities – performance curves for turbines governing of turbines.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.
2. R K Bansal, "A Textbook of Fluid Mechanics and Machinery", New Delhi

REFERENCES:

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery", 2011.
4. Fluid Mechanics: Fundamentals and Applications Book by John Cimbala and Yungus A. Cengel, 4th Edition 28 May 2019.

WEB REFERENCES:

1. http:// nptel.ac.in/courses/112105171/7\1
2. http:// web.mit.edu/html/ncfmf.html

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Course code	**21ME33T**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRODUCTION TECHNOLOGY-II**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- This course aims at providingthe concept and basic mechanics of metal cutting, working of standard machine tools such as lathe, shaping and allied machines, milling, drilling and allied machines, gear making methods, grinding and allied machines and broaching.
- The course is intended to introduce the students to basic concepts of Computer Numerical Control (CNC) of machine tools and CNC Programming.
- The course will impart the students to know the basic concept of non-traditional machining processes and additive manufacturing processes to solve Engineering problems in modern industries.

PREREQUISITE:

- Production Technology I Knowledge

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C303.1	***Explain*** the mechanism of material removal processes.	K2
C303.2	***Outline*** the constructional and operational features of centre lathe, semiautomatic lathe and automats.	K2
C303.3	***Discuss*** the CNC machining centers with its part programming fundamentals and write a simple manual part program.	K2
C303.4	***Describe*** the constructional and operational features of shaper, drilling, milling, and gear manufacturing processes.	K2
C303.5	***Explain*** the types of grinding and other super finishing processes apart from broaching processes.	K2
C303.6	***Recognize*** the knowledge of Non-Traditional Machining Process and Additive Manufacturing process	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C303.1	2	1	-	-	-	-	-	1	-	-	-	-	2	-	-
C303.2	2	1	-	-	1	-	-	1	-	-	-	1	2	1	1
C303.3	2	1	-	-	1	-	-	1	-	-	-	1	2	1	1
C303.4	2	1	-	-	1	-	-	1	-	-	-	1	2	1	1
C303.5	2	1	-	-	1	-	-	1	-	-	-	1	2	1	1
C303.6	2	1	-	-	1	-	-	1	-	-	1	1	2	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I THEORY OF METAL CUTTING 9

Mechanics of chip formation, Types of chip - Cutting tools-Nomenclature of single point cutting tool- Forces in machining -Orthogonal metal cutting-Cutting tool materials-Thermal aspects- Tool wear-Tool life- Surface finish- Cutting fluids and Machinability.

UNIT II TURNING MACHINES WITH CENTER 9

Centre lathe-constructional features, specification, operations - Taper turning methods, thread cutting methods-Special attachments -Machining time and power estimation - Capstan and turret lathes-tool layout - Automats-single spindle- Swiss type-automatic screw type -multi spindle- CNC- Lathe center- CNC Lathe- part programming fundamentals -part programming.

UNIT III FUNCTIONS AND STORAGE CLASSES 9

Reciprocating machine tool : Shaper–Hole machining : Drilling, Reaming, tapping and boring- Milling: types, cutting and operations- CNC- Milling center-CNC Lathe part programming fundamentals- Part programming- Gear cutting, forming, shaping- Hobbing and generation - Concept of jigs, fixtures and its applications.

UNIT IV ABRASIVE PROCESS, BROACHING AND SUPER FINISHING PROCESSES 9

Abrasive processes: grinding wheel, specifications and selection-types of grinding process- Pedestal grinding-cylindrical grinding- surface grinding-centerless grinding and internal grinding- Typical applications -concepts of surface integrity- broaching machines: broach construction- push, pull, surface and continuous broaching machines- Abrasive finishing processes- honing, lapping and super finishing.

UNIT V MODERN MACHINING PROCESSES 9

Non-Traditional machining: principle, need, futures and limitations-Types: mechanical, electrical, electro chemical and thermal energy-based processes- Equipment, Advantages, Applications and Limitations. Rapid Prototyping: Stereo-lithography - Fused Deposition modelling, Selective laser sintering - 3D Printing and Rapid Tooling Techniques-Equipment, futures and limitations.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Hajra Choudhury, "Elements of Workshop Technology", Vol.II., Media Promoters 2014
2. Rao. P.N “Manufacturing Technology - Metal Cutting and Machine Tools", 3rd Edition, Tata McGraw-Hill, New Delhi, 2013.

REFERENCES:

1. Richerd R Kibbe, John E. Neely, Roland O. Merges and Warren J.White “Machine Tool Practices”, Prentice Hall of India, 1998

2. Geofrey Boothroyd, "Fundamentals of Metal Machining and Machine Tools", Mc Graw Hill, 1984
3. HMT, "Production Technology", Tata McGraw Hill, 1998.
4. Roy. A.Lindberg, “Process and Materials of Manufacture,” Fourth Edition, PHI/Pearson Education 2006
5. James Brown, ―Advanced Machining Technology Handbook‖, McGraw Hill Book Company, New York, 1998.
6. Ian Gibson, David W.Rosen, Brent Stucker, Additive manufacturing technologies; rapid prototyping to direct digital manufacturing, Springer,2010

Course code	21MA34T	Semester	III			
Category	BASIC SCIENCE COURSE(BSC)		L	T	P	C
CourseTitle	SERIES,TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS (COMMON TO MECHANICAL, CIVIL, CHEMICAL		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To develop Z transform techniques for discrete time systems.

PREREQUISITE:

- Mathematics skills at Sem-II level

COURSE OUTCOMES:

CO. No	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C304.1	***Understand*** how to solve the given standard partial differential equations.	K2
C304.2	***Solve*** differential equations using Fourier series analysis which plays a vital role in engineering applications.	K3
C304.3	***Appreciate*** the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.	K2
C304.4	***Understand*** the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.	K2
C304.5	***Use*** the effective mathematical tools for the solutions of partial differential equations by using Z transform techniques for discrete time systems.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C304.1	3	3	-	-	-	-	-	-	-	-	-	-
C304.2	3	2	-	-	-	-	-	-	-	-	-	-
C304.3	3	2	-	-	-	-	-	-	-	-	-	-
C304.4	3	2	-	-	-	-	-	-	-	-	-	-
C304.5	3	3	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction-Formation of partial differential equations Solutions of a partial differential equation-Linear Equations of the first order– Nonlinear equations of the first order Charpit’s method Linear partial Differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 12

Introduction - Euler’s Formulae - Conditions for a Fourier Expansion-Functions having points of discontinuity-Change of interval – Odd and even functions–Half range sine series–Half range cosine series–Parseval’s Formula-Complex form of Fourier series–Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Introduction - Method of separation of variables–Vibrations of a stretched string-Wave equation [Fourier Series Method Only]– One dimensional equation of heat conduction–Steady state solution of two-dimensional equation of heat conduction - Laplace’s equation in polar coordinates.

UNIT IV FOURIER TRANSFORMS 12

Introduction-Statement of Fourier integral theorem–Fourier transforms – Properties of Fourier transforms–Convolution theorem–Parseval’s identity for Fourier transform-Relation between Fourier and Laplace transforms.

UNIT V TRANSFORMS AND DIFFERENCE EQUATIONS 12

Introduction – Definition of Z-transforms – Some standard Z-transforms–Damping rule-Some standard results-Shifting to the right and left – Multiplication by n-Initial and Final value theorem –Inverse Z-transform (using partial fraction and residues) – Convolution theorem–Convergence of Z-transforms-Evaluation of inverse Z-transforms [using partial and residue method only]-Application of difference equations.

Total:60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B. S. Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. Narayanan S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

REFERENCES:

1. Erwin Kreyszig,"Advanced Engineering Mathematics ",10th Edition, John Wiley, India, 2016.
2. B.V.Ramana, “Higher Engineering Mathematics”, McGrawHill Education Pvt. Ltd, New Delhi, 2016.
3. Wylie, R.C.and Barrett,L.C.,“Advanced Engineering Mathematics”,Tata McGraw Hill Education Pvt. Ltd, 6th Edition, NewDelhi, 2012.

Course code	21HE35IT		Semester	III			
Category	ENGINEERING SCIENCE COURSE(ESC)			L	T	P	C
Course Title	ELECTRICAL DRIVES AND CONTROLS			2	0	4	4

COURSE OBJECTIVES:

- This course aims at giving adequate exposure to students about the concept of DC, Synchronous motor and induction motor drive used in automation.
- The course will enable the students to understand the concept of how to control the various types of drives.

PREREQUISITE:

- Basic Electrical, Electronics and Instrumentation Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C305.1	***Classify*** types of electric drives systems based on nature of loads, control objectives, performance and reliability. Combine concepts of DC machines Control and power electronics to cater to the need of automations in industries.	K2
C305.2	***Combine*** concepts of AC machines Control and power electronics to cater to the need of automations in industries.	K2
C305.3	***Select*** most suitable type and specification of motor drive combination for efficient conversion and control of electric power any applications.	K2
C305.4	***Analyze*** the performance of DC drives	K3
C305.5	***Analyze*** the performance of AC drives	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C305.1	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
C305.2	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
C305.3	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
C305.4	3	2	1	-	-	2	-	-	2	1	1	2	2	1	-
C305.5	3	2	1	-	-	2	-	-	2	1	1	2	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT I INTRODUCTION TO ELECTRICAL DRIVES **6**

Basic Elements of Electric Drives - Classification- Factors affecting the choice of drive: Different classes of duty cycle of motors, Selection of power rating for drive motors with regard to thermal overloading and Load variation factors.

UNIT II DRIVE MOTORS CHARACTERISTICS **6**

Mechanical characteristics- Speed- Torque characteristics of various types of load and drive motors- Braking of electrical motors- DC motors and AC motors.

UNIT III D C DRIVES **6**

Speed control of DC series and shunt motors – Armature control and Field control-Ward Leonard drives–converter fed and chopper fed Drive– Four quadrant operation– Closed loop control.

UNIT IV AC DRIVES **6**

Induction motor fundamentals– voltage control and variable frequency control (AC chopper, Inverter fed induction motor drives)– Rotor resistance control– slip power recovery scheme-Synchronous motor fundamentals– Open loop, closed loop variable frequency control– Voltage and Current source fed synchronous motor.

UNIT V APPLICATIONS **6**

Digital technique in speed control– Advantages and limitations– Microprocessor based control of drives – Selection of Motor and Drive System for Industrial Applications: Cranes and Electric Traction, Air compressors, Paper and Pulp Industry, Textile Industry, Steel Industry.

Total: 30 Periods

LAB -LIST OF EXPERIMENTS:

1. Study of VI characteristics of SCR and MOSFET
2. Step up and Step down MOSFET based Choppers.
3. Simulation of DC-DC converters.
4. Simulation of AC to DC fully controlled converter
5. Simulation of AC voltage controller.
6. Position control of DC Motor.
7. Speed control of BLDC motor.
8. Study of Speed control of single-phase induction motor using microcontroller.
9. Speed control of Inverter fed induction motor drives.
10. Speed control of Slip ring Induction motor using rotor resistance control.
11. No load and blocked rotor test on a 3- ϕ induction motor
12. V and inverted V curve of synchronous machines.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. B.L Therajaand A.KTheraja, "A Text Book of Electrical Technology", Vol.2,
2. Vedham Subramanyam, "Electric Drives Concept and Applications", 2nd Edition, TataMcGraw-Hill Publishing Company

REFERENCES:

1. S.K. Pillai, "A First Course on Electrical Drives",2nd Edition, New Age International Publishers, 2004.
2. I.J. Nagrath and D.P. Kothari, "Electrical Machines", 3rd Edition, Tata McGraw-Hill Publishing Company, 2010.
3. G.KDubey, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2007.

Course code	21MC01T		Semester	III			
Category	MANDATORY COURSE (MC)			L	T	P	C
Course Title	CONSTITUTION OF INDIA			2	0	0	0

COURSE OBJECTIVES:

- To understand the importance of constitution.
- To understand the autonomous nature of constitutional bodies like Supreme Court and high court, controller and auditor general of India and election commission of India.

PREREQUISITE:

- Civic Knowledge.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C306.1	***Understand*** historical background of the constitutional making and its importance for building a democratic India, the structure of Indian government, the structure of state government, the local Administration	K2
C306.2	***Understand*** the directive principle of state policy, and strengthening of the constitutional institutions.	K2
C306.3	***Analyze*** the role of Governor and Chief Minister, role of state election commission, the decentralization of powers.	K2
C306.4	***Understand*** the Public Election Process.	K2
C306.5	***Know*** the Special Provisions for Various category of People.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C306.1	-	-	-	-	-	3	-	2	-	-	-	1	-	-	-
C306.2	-	-	-	-	-	2	-	2	-	-	-	1	-	-	-
C306.3	-	-	-	-	-	2	-	2	-	-	-	1	-	-	-
C306.4	-	-	-	-	-	1	-	2	-	-	-	1	-	-	-
C306.5	-	-	-	-	-	1	-	2	-	-	-	1	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 0**

UNIT I INTRODUCTION TO INDIAN CONSTITUTION 6

The Necessity of the Constitution, The Societies before and after the Constitution adoption. **Introduction to the Indian constitution,** The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India.

UNIT II FUNDAMENTAL RIGHTS AND DIRECTIVE PRINCIPLES 6

Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building. Directive Principles of State Policy (Art. 36-51).

UNIT III UNION EXECUTIVE AND STATE EXECUTIVE 6

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Parliamentary Terminologies**.** Supreme Court of India, State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts.

UNIT IV ELECTIONS, AMENDMENTS AND EMERGENCY PROVISIONS 6

Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments Important Constitutional Amendments. Emergency Provisions, types of Emergencies and its consequences.

UNIT V DIRECTIVE PRINCIPLES & FUNDAMENTAL DUTIES 6

Fundamental Duties (Art. 51A), Basic Features of Constitution & Constitutional **special provisions:** Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. N. Shukla, Constitution of India, Eastern Book Agency, 2014.
2. P. Jain, Indian Constitutional Law, Lexis Nexis, 2013.
3. M. Seervai, Constitutional Law of India, Universal Law Publishing Co., Reprint 2013.

REFERENCES:

1. Glanville Austin, Indian Constitution – cornerstone of the Nations, Oxford University Press, 1999.
2. M. Bakshi, The Constitution of India, Universal Law Publishing Co., 2014.
3. D. Basu, Shorter Constitution of India (14th Ed. 2008, reprint 2010).

Course code	**21ME37P**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PRODUCTION TECHNOLOGY-II LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To Study and acquire knowledge on various basic machining operations in special purpose machines and its applications in real life manufacture of components in the industry
- The lab course will impart the students to know the basic concept of additive manufacturing processes to solve Engineering problems in modern industries.

PREREQUISITE:

- Theoretical Knowledge in Production Technology II

COURSE OUTCOMES

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C307.1	***Use*** dynamometer to measure cutting forces.	K3
C307.2	***Apply*** milling machine to perform contour milling	
C307.3	To ***experiment*** with different machine tools to manufacture gears	K3
C307.4	Ability to ***use*** different machine tools for finishing operations	K3
C307.5	To manufacture tools by ***employ*** tool & cutter grinder	K3
C307.6	***Illustrate*** rapid machining processes	K2
C307.7	***Develop*** CNC part programming	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C307.1	3	2	1	-	1	-	-	1	1	-	-	1	-	1	1
C307.2	3	2	1	-	1	-	-	1	1	-	-	1	-	1	-
C307.3	3	2	1	-	1	-	-	1	1	-	-	1	-	1	-
C307.4	3	2	1	-	1	-	-	1	1	-	-	1	-	1	-
C307.5	3	2	1	-	1	-	-	1	1	-	-	1	-	1	-
C307.6	2	2	1	-	1	-	-	1	1	-	-	1	2	-	-
C307.7	3	2	1	-	1	-	-	1	1	-	-	1	3	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

LIST OF EXPERIMENTS

1. Measurement of cutting forces in Milling / Turning Process
2. Contour milling using vertical milling machine
3. Spur gear cutting in milling machine
4. Helical Gear Cutting in milling machine
5. Gear generation in hobbing machine
6. Gear generation in gear shaping machine
7. Plain Surface grinding
8. Cylindrical grinding
9. Centreless Grinding
10. Tool angle grinding with tool and Cutter Grinder
11. Study of Rapid prototyping
12. CNC Part Programming

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Laboratory Manual prepared by Department of Mechanical Engineering, VTHT, Chennai.

Course code	**21ME38P**	**Semester**	**III**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**COMPUTER AIDED MACHINE DRAWING LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To acquire the knowledge of drafting software.
- To understand Parametric Modelling Fundamentals, Procedure, and "Shape before Size" Approach
- To understanding of orthographic projections of machine parts with and without sectioning (3-D to 2-D conversion)
- To develop an ability to create 3D Modelling of machine components.

PREREQUISITE:

- Drafting and Machine Drawing skills.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C308.1	Understand engineering drawings for the machine components as per Indian Standard Code of practice using a drafting software	K2
C308.2	Draw split muff, protected type flanged, pin type flexible, and universal couplings in 2D.	K3
C308.3	Understand the concept involved in 3D machine component drawing, assembly conditions	K3
C308.4	Ability to ensure manufacturability and proper assembly of components and assemblies.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C308.1	3	2	-	-	-	-	-	-	-	-	-	1	3	2	-
C308.2	3	2	-	-	-	-	-	-	-	-	-	-	2	1-	-
C308.3	2	2	2	2	2	-	-	-	1	2	2	-	3	2	-
C308.4	2	2	3	1	1	-	-	-	2	2	-	2	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 2**

CYCLE I DRAWING STANDARDS & FITS AND TOLERANCES 12

1. Code of practice for Engineering Drawing, BIS specifications –
2. Welding symbols, riveted joints, keys, fasteners –
3. Reference to hand book for the selection of standard components like bolts, nuts, screws, keys etc. –
4. Limits, Fits – Tolerance of individual dimensions – Specification of Fits –
5. Preparation of production drawings and reading of part and assembly drawings,
6. basic principles of Geometric Dimensioning & Tolerancing (GD&T)

CYCLE II INTRODUCTION TO 2D DRAFTING 16

1. Drawing, Editing, Dimensioning, Layering, Hatching, Block, Array, Detailing, Detailed drawing.
2. Bearings - Bush bearing, Plummer block
3. Valves – Safety and non-return valves.

CYCLE III 3D GEOMETRIC MODELING AND ASSEMBLY 32

Sketcher - Datum planes – Protrusion – Holes - Part modeling – Extrusion – Revolve – Sweep – Loft – Blend – Fillet - Pattern – Chamfer - Round - Mirror – Section - Assembly

1. Couplings – Flange, Universal, Gear couplings
2. Joints – Knuckle, Gib & cotter, sleeve & cotter joints
3. Engine parts – Piston, connecting rod, Disk Brake, stuffing box
4. valve - ball valve & butterfly valve, single-plate clutch
5. Mechanical Tools - Stillson Wrench
6. Miscellaneous machine components – Screw jack, machine vice, tail stock

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Machine Drawing by K.L.Narayan, P.Kannaiah and K.Venkata Reddy, 3rd edition, New Age publications 2006.
2. Machine Drawing with Auto CAD, (1st edition) by GowthamPohit and Goutam Ghosh, Pearson Education, Delhi, 2004.

REFERENCES:

1. Machine Drawing, by R.K.Dhawan, S.Chand Publications, New Delhi, 1996.
2. Machine Drawing by K.C.John, PHI Learning Pvt.Ltd.,New Delhi, 2009.

IV SEMESTER

SEMESTER IV										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME41T	Computer Aided Design	PCC	40	60	100	3	0	0	3
2	21ME42T	Strength of Materials	PCC	40	60	100	3	0	0	3
3	21ME43T	Kinematics of Machinery	PCC	40	60	100	3	1	0	4
4	21ME44T	Thermal Engineering	PCC	40	60	100	3	0	0	3
5	21MA45T	Statistics and Numerical Methods	BSC	40	60	100	3	0	0	3
6	21MC02T	Environmental Sciences	MC	40	60	100	2	0	0	0
PRACTICAL										
7	21ME47P	Fluid Mechanics and Machinery & Strength of Materials Laboratory	PCC	60	40	100	0	0	4	2
8	21ME48P	Thermal Engineering Laboratory	PCC	60	40	100	0	0	4	2
9	21EE01P	Mini Project - I	EEC	60	40	100	0	0	2	1
TOTAL										**21**

Course code	**21ME41T**	**Semester**	**IV**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**COMPUTER AIDED DESIGN**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide an overview of how computers are being used in mechanical component design.
- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

PREREQUISITE:

- Engineering Graphics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C401.1	***Apply*** the fundamental concepts of computer graphics and its tools in a generic framework.	K2
C401.2	***Create*** and manipulating geometric models using curves, surfaces and solids.	K2
C401.3	***Apply*** concept of CAD systems for 3D modelling and visual realism.	K2
C401.4	***Create*** and add geometric tolerances in assembly modelling.	K2
C401.5	***Apply*** standard CAD practices in engineering design.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C401.1	2	1	-	-	-	-	-	-	-	-	-	1	2	1	1
C401.2	2	1	-	-	-	-	-	-	-	-	-	1	2	1	1
C401.3	2	1	-	-	-	-	-	-	-	-	-	1	2	1	1
C401.4	2	1	-	-	-	-	-	-	-	-	-	1	2	1	1
C401.5	2	1	-	-	-	-	-	-	-	-	-	1	2	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I FUNDAMENTALS OF COMPUTER GRAPHICS 9

Product cycle- Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations- homogeneous coordinates - graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation.

UNIT II GEOMETRIC MODELING 9

Representation of curves - Hermite cubic spline curve, Bezier curve, B-spline curves, Surface Modeling – Surface Entities, Representation of Surface, Bezier Surface, B-Spline Surface and Coons Surface. Solid Modeling - Solid Entities, Solid Representation, Boundary Representation (BRep), Sweeps Representation, Constructive Solid Geometry (CSG).

UNIT III VISUAL REALISM 9

Need for hidden surface removal, The Depth - Buffer Algorithm, Properties that help in reducing efforts, Scan Line coherence algorithm, Span - Coherence algorithm, Area-Coherence Algorithms, Warnock's Algorithm, Priority Algorithms– shading – coloring – computer animation.

UNIT IV PART ASSEMBLY 9

Mass properties - Assembly modeling – Inference of position and orientation – Functional importance of various types of fits – Geometric Dimensioning and Tolerancing, Tolerance stacking – types and remedies**.**

UNIT V CAD STANDARDS 9

Standards for computer graphics- Graphical Kernel System (GKS) - Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, ACIS and DXF - communication standards

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007.
2. P. N. Rao, CAD/CAM: Principles and Applications, Tata McGraw Hill, 2010.

REFERENCES:

1. Computer Aided Design and Manufacturing, NPTEL Course Contents & Videos, MHRD.
2. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.
3. Chris McMahon and Jimmie Browne “CAD/CAM Principles, practice and manufacturing Management “Pearson education Asia, 2001.
4. Donald Hearn and M. Pauline Baker “Computer Graphics”’. Prentice Hall, Inc, 1994.
5. Foley, Wan Dam, Feiner and Hughes – “Computer graphics principles & practice”, Pearson Education - 2003.
6. William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

Course code	21ME42T	Semester	IV			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**STRENGTH OF MATERIALS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand and familiarize the mechanical behaviour of materials about the stress, Strain, shear force, bending moment, deflection and slopes in various types of beams for different loading Conditions.

PREREQUISITE:

- Engineering Mechanics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C402.1	***Understand*** the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.	K2
C402.2	***Draw*** the shear force &bending moment diagrams for various beams, compute bending stress, and shear stress at various points in beams.	K3
C402.3	***Calculate*** the slope and deflection in beams using different methods.	K3
C402.4	***Apply*** basic equation of simple torsion in designing of shafts and helical spring.	K3
C402.5	***Calculate*** the stresses and strain associated with thin wall spherical & cylindrical pressure vessels.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C402.1	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-
C402.2	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-
C402.3	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-
C402.4	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-
C402.5	3	2	-	-	-	1	-	-	-	-	-	1	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Elastic constants – Volumetric strains – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Flitched beams.

UNIT III DEFLECTION OF BEAMS AND COLUMNS 10

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy.

Columns – Theory of Columns – long column and short column – Euler's formula – Rankine's formula – Secant formula – beam column.

UNIT IV TORSIONAND SPRINGS 8

Torsion formulation stresses and deformation in circular and hollows shafts – Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs.

UNIT V THIN CYLINDERS AND SPHERES 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi, 2019.
2. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 7th Edition, 2018.
3. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt Ltd., New Delhi, 2017.
4. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2016.
5. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009.

REFERENCES:

1. Strength of Materials, NPTEL Course Contents & Videos, MHRD.
2. Singh. D.K., “Strength of Materials”, Ane Books Pvt Ltd., New Delhi, 2021.
3. Egor. P.Popov “Engineering Mechanics of Solids” Prentice Hall of India, New Delhi,2015.
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing co. Ltd., New Delhi, 2005.
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013.
6. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

Course code	21ME43T	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	KINEMATICS OF MACHINERY		3	1	0	4

COURSE OBJECTIVES:

- To understand the basic components and layout of linkages in the assembly of a system machine.
- To understand the motion resulting from a specified set of linkages, design few linkage mechanisms and cam mechanisms for specified output motions.
- To understand the basic concepts of toothed gearing, kinematics of gear trains and the effects of friction in motion transmission & in machine components.

PREREQUISITE:

- Basic Engineering knowledge and Engineering Mechanics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C403.1	***Explain*** the basics of mechanism.	K2
C403.2	***Understand*** friction, belt drives in machine elements.	K2
C403.3	***Solve*** velocity and acceleration in simple mechanisms.	K3
C403.4	***Develop*** CAM profiles.	K3
C403.5	***Solve*** problems on gears and gear train components.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C403.1	2	1	-	-	-	-	-	-	-	1	-	1	-	1	-
C403.2	2	1	-	-	-	-	-	-	-	1	-	1	-	1	-
C403.3	3	3	2	-	-	-	-	-	-	1	-	1	-	1	-
C403.4	3	3	2	-	-	-	-	-	-	1	-	1	-	1	-
C403.5	3	3	2	-	-	-	-	-	-	1	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 4

UNIT I BASICS OF MECHANISMS 9+3

Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, Mobility – Kutzbach criterion, Gruebler's criterion – Grashof's Law – Kinematic inversions of four-bar chain and slider crank chains – Limit positions – Mechanical advantages – Transmission Angle –Description of some common mechanisms – Quick return mechanisms, Universal Joint– rocker mechanisms.

UNIT II KINEMATICS OF LINKAGE MECHANISMS 9+3

Displacement, velocity and acceleration analysis of simple mechanisms – Graphical method– Velocity and acceleration polygons – Velocity analysis using instantaneous centres – kinematic analysis of simple mechanisms – Coincident points – Coriolis component of Acceleration – Introduction to linkage synthesis problem.

UNIT III KINEMATICS OF CAM MECHANISMS 9+3

Classification of cams and followers – Terminology and definitions – Displacement diagrams – Uniform velocity, parabolic, simple harmonic and cycloidal motions – Derivatives of follower motions – Layout of plate cam profiles – Specified contour cams – Circular arc and tangent cams – Pressure angle and undercutting – sizing of cams.

UNIT IV GEARS AND GEAR TRAINS 9+3

Law of toothed gearing – Involutes and cycloidal tooth profiles – Spur Gear terminology and definitions – Gear tooth action – contact ratio – Interference and under cutting. Helical, Bevel, Worm, Rack and Pinion gears [Basics only]. Gear trains – Speed ratio, train value – Parallel axis gear trains – Epicyclic Gear Trains.

UNIT V FRICTION IN MACHINE ELEMENTS 9+3

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Bearings and lubrication – Friction clutches – Belt and rope drives – Friction in brakes – Band and Block brakes.

TOTAL: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt.Ltd., New Delhi, 2006.
2. Rattan, S.S, “Theory of Machines”, 5th Edition, Tata McGraw-Hill, 2019.
3. Uicker J J, Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Edition, Oxford university Press, 2017.
4. F.B.Sayyad, “Kinematics of Machinery”, MacMillan Publishers Pvt Ltd., Tech-max Educational resources, 2011.

REFERENCES:

1. Kinematics of Machines, NPTEL Course Contents & Videos, MHRD.
2. Cleghorn.W.L, “Mechanisms of Machines”, Oxford University Press, 2014.
3. Robert L. Norton, “Kinematics and Dynamics of Machinery”, Tata McGraw-Hill, 2013.
4. Wilson and Sadler, “Kinematics and Dynamics of Machinery”, Pearson, 2008.
5. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
6. John Hannah and Stephens R.C., "Mechanics of Machines", Viva Low-Prices Student Edition, 1999.
7. Allen S.Hall Jr., “Kinematics and Linkage Design”, Prentice Hall,1961.

Course code	21ME44T	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	THERMAL ENGINEERING		3	0	0	3

COURSE OBJECTIVES:

- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes.
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration &Air conditioning systems.

(Use of standard refrigerant property data book, Steam Tables, Mollier diagram and Psychrometric chart permitted).

PREREQUISITE:

- Basic Engineering Skills and Engineering Thermodynamics.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C404.1	***Solve*** problems in single stage and multistage air compressors.	K3
C404.2	***Apply*** thermodynamic concepts to different air standard cycles and solve problems.	K3
C404.3	***Identify*** the functioning and features of IC engines, components, auxiliaries and performance calculations.	K3
C404.4	***Solve*** problems in boilers, steam nozzle and steam turbines, Velocity diagram for steam turbines.	K3
C404.5	***Solve*** problems using refrigerant table/ charts and psychrometric charts.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C404.1	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C404.2	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C404.3	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C404.4	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C404.5	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I AIR COMPRESSOR 8

Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors, Multistage air compressor and inter cooling –work of multistage air compressor.

UNIT II GAS POWER CYCLES 8

Otto, Diesel, Dual, Brayton cycles, Calculation of mean effective pressure and air standard efficiency - Comparison of cycles.

UNIT III INTERNAL COMBUSTION ENGINES 9

Classification - components and their function. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Simple and complete carburettor. MPFI, Diesel pump and injector system. Battery and Magneto ignition system - principles of combustion and knocking in SI and CI Engines. Lubrication and Cooling systems. Performance calculation, Sterling Engine (Description only).

UNIT IV BOILERS, STEAM NOZZLES AND TURBINES 9

Classification and working principle of boilers – performance. Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, super saturated flow. Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations – Governors.

UNIT V REFRIGERATION AND AIR CONDITIONING 11

Refrigerants - vapour compression refrigeration cycle- super heat, sub cooling – performance calculations - working principle of vapour absorption system, Ammonia –Water, Lithium bromide – water systems (Description only). Air conditioning system - processes, types and working principles. Concept of RSHF, GSHF, ESHF- cooling load calculations. Air conditioning equipment's – air cleaning and air filters – humidifiers and dehumidifiers – air washers

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Rajput. R. K., “Thermal Engineering” S.Chand Publishers, 2017.
2. Kothandaraman.C.P., Domkundwar.S, Domkundwar.A.V., “A course in thermal Engineering", Fifth Edition, Dhanpat Rai & sons, 2016.

3. Cengel, Y and M. Boles, Thermodynamics - An Engineering Approach, Tata McGraw Hill,8th Edition, 2015.

REFERENCES:

1. Applied Thermodynamics, Refrigeration & Air Conditioning, NPTEL Course Contents & Videos, MHRD.
2. Sarkar, B.K, "Thermal Engineering" Tata McGraw-Hill Publishers, 2007.
3. Arora.C.P, "Refrigeration and Air Conditioning", Tata McGraw-Hill Publishers, 2008.
4. Ganesan V "Internal Combustion Engines", Third Edition, Tata Mc Graw-Hill, 2012.
5. Rudra Moorthy R, "Thermal Engineering", Tata McGraw-Hill, New Delhi, 2003.
6. Ramalingam. K.K., "Thermal Engineering", SCITECH Publications (India) Pvt. Ltd., 2009.

Course code	21MA45T	Semester	IV			
Category	BASIC SCIENCE COURSE (BSC)		L	T	P	C
Course Title	STATISTICS AND NUMERICAL METHODS		3	1	0	4

COURSE OBJECTIVES:

- To provide the necessary basic concepts of a few statistical methods.
- To understand and implement various concepts of numerical analysis.
- To identify the areas applied in numerical interpolation, differential equations and method of finding solutions.

PREREQUISITE:

- Ordinary differential equations
- Multivariable calculus

COURSE OUTCOME:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C405.1	***Analyze*** the different samples of data at different level of significance using various hypothesis testing.	K2
C405.2	***Design*** experiments using suitable ANOVA techniques and draw conclusions.	K2
C405.3	***Learn*** how to obtain numerical solution of nonlinear equations using bisection, Newton – Raphson and fixed-point iteration methods.	K3
C405.4	***Use*** interpolation methods to solve problems.	K3
C405.5	***Apply*** the numerical techniques for solutions of ordinary differential equations	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
C405.1	2	1	1	1	-	-	-	-	-	-	-	-	-	-
C405.2	2	1	-	1	-	-	-	-	-	-	-	-	-	-
C405.3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C405.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
C405.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-

Note: - 1: Slight 2: Moderate 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I TESTING OF HYPOTHESIS **9+3**

Large sample test based on Normal distribution for single mean and difference of means – Tests based t, Chi-square and F distributions for testing means and variances – Contingency table (Test for Independency) – Goodness of fit.

UNIT II DESIGN OF EXPERIMENTS **9+3**

One way and Two way classifications - Completely randomized design – Randomized block design –Latin square design –2^2factorial design.

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS **9+3**

Newton Raphson method – Gauss elimination method – pivoting – Gauss Jordan methods – Crout's method – Iterative methods of Gauss Jacobi and Gauss Seidel – Matrix inversion by Gauss Jordan method – Eigen values of a matrix by power method, Jacobi method.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION **9+3**

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – numerical integration, Newton-Cotes formulae- Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATION **9+3**

Taylor's series method – Euler's method – Modified Euler's method – Heun's method - Fourth order Runge-Kutta method for solving first order equations – Milne's predictor corrector methods for solving first order equations.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Steven C Chapra and Raymond P Canale, Numerical Methods for Engineers, McGraw Hill Education, New Delhi, 2012.
2. Manish Goyal, "Statistics and Numerical methods" , Lakshmi Publications, 2016.

REFERENCES:

1. Johnson R.A., and Gupta. C.B., "Miller and Freund's Probability and Statistics for Engineers",11th Edition,Pearson Education, , Asia, 2011.
2. Walpole R.E., Myers. R.H., Myers. S.L., and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2011.
3. Jain, M. K., Iyengar, S. R. K. and Jain, R. K., Numerical Methods for Scientific and Engineering Computation, New Age International Publishers (2008).
4. Grewal. B. S., "Numerical Methods in Science and Engineering", 40th Edition, Khanna Publishers, 2007.

Course code	21MC02T	Semester	IV			
Category	MANDATORY COURSE (MC)		L	T	P	C
Course Title	ENVIRONMENTAL SCIENCES (COMMON FOR ALL BRANCHES EXCEPT CHEMICAL)		2	0	0	0

COURSE OBJECTIVES:

- To study the nature, interrelationship between living organism and environment, biodiversity, natural resources, pollution control and waste management.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To appreciate the importance of environment by assessing its impact on the human world.

PREREQUISITE:

- Basic awareness on environment.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C406.1	***Illustrate*** the interrelationship between living organism and environment.	K2
C406.2	***Relate*** Public awareness, environmental pollution and its problem.	K2
C406.3	***Classify*** the dynamic processes and the features of natural resources.	K2
C406.4	***Measure*** the development and improvement in standard of living.	K2
C406.5	***Summarize*** the knowledge about human health and welfare.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C406.1	1	-	-	-	-	-	1	-	-	-	-	-
C406.2	2	-	-	-	-	-	1	-	-	-	-	-
C406.3	1	-	-	-	-	-	1	-	-	-	-	-
C406.4	1	-	-	-	-	-	2	1	-	-	-	1
C406.5	1	-	-	-	-	-	1	1	-	-	-	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 0

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) –Introduction to biodiversity definition: genetic, species and ecosystem diversity –biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity –threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts –endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds, etc., Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II NATURAL RESOURCES 6

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources. Field study of local area to document environmental assets – river / forest / grassland /
hill / mountain.

UNIT III ENVIRONMENTAL POLLUTION AND DISASTER MANAGEMENT 6

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution(c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards, accidents and holocaust – solid waste management: causes, effects and control measures of municipal solid wastes- E waste and Scrap tyres – Recycling of Plastic, Glass and Paper wastes- role of an individual in prevention of pollution – pollution case studies –disaster management: floods, earthquake, cyclone and landslides- case studies. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 6

From unsustainable to sustainable development- Equitable use of resources for sustainable lifestyles – urban problems related to energy –water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies –

role of nongovernmental organization- environmental ethics: Issues and possible solutions – principles of green chemistry–climate change, global warming, acid rain, ozone layer depletion, case studies. – wasteland reclamation – consumerism and waste products –environment protection act – Air (Prevention and Control of Pollution) act – Water(Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – environmental impact assessment- enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – women and child welfare – HIV/AIDS –SARS- Covid-19- role of information technology in environment and human health – Case studies.

Total: 30 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Benny Joseph, Environmental Science and Engineering, Tata McGraw-Hill, New Delhi, 2014.
2. Anubha Kaushik, and Kaushik, C. P., Environmental Science and Engineering, New Age International Publishers, 6thEdition, 2019.

REFERENCES:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd Edition, University Grants Commission, Universities Press, 2013.
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Pearson Education, 2004.
3. Tyler Miller, G., and Scott E. Spoolman, Environmental Science, Cengage Learning India Pvt, Ltd, Delhi, 2014.

Course code	**21ME47P**	**Semester**	**IV**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**FLUID MECHANICS & MACHINERY AND STRENGTH OF MATERIALS LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To study the mechanical properties of materials when subjected to different types of loading.
- To verify the principles studied in Fluid Mechanics theory by performing experiments in lab.

PREREQUISITE:

- Fluid Mechanics and Machinery.
- Engineering Materials and Metallurgy.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C407.1	***Perform*** Tension, Torsion, Hardness, Compression, and Deformation test on Solid materials.	K3
C407.2	***Use*** the measurement equipment's for flow measurement.	K3
C407.3	***Perform*** test on different fluid machinery.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C407.1	3	2	1	-	1	-	-	1	1	1	-	1	-	2	-
C407.2	3	2	1	-	1	-	-	1	1	1	-	1	-	2	-
C407.3	3	2	1	-	1	-	-	1	1	1	-	1	-	2	-

Note: - 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS **No. of Credits: 2**

STRENGTH OF MATERIALS LABORATORY **30 Hours**

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminium rods
3. Torsion test on mild steel rod
4. Impact test on metal specimen
5. Hardness test on metals - Brinnell and Rockwell Hardness Number
6. Deflection test on beams
7. Compression test on helical springs
8. Strain measurement using Rosette strain gauge
9. Effect of hardening- Improvement in hardness and impact resistance of steels.

FLUID MECHANICS & MACHINES LABORATORY **30 Hours**

LIST OF EXPERIMENTS

1. Determination of the Coefficient of discharge of given Orifice meter and Venturi meter
2. Calculation of the rate of flow using Rotameter.
3. Determination of friction factor for a given set of pipes.
4. Conducting experiments and drawing the characteristic curves of centrifugal pump/ submergible pump
5. Conducting experiments and drawing the characteristic curves of reciprocating pump.
6. Conducting experiments and drawing the characteristic curves of Gear pump.
7. Conducting experiments and drawing the characteristic curves of Pelton wheel.
8. Conducting experiments and drawing the characteristics curves of Francis turbine and Kaplan turbine.
9. Conducting the performance analysis of a blower.

TOTAL: 60 Hours

LEARNING RESOURCES:

REFERENCES:

1. Fluid Mechanics and Machinery & Strength of Materials Laboratory Manual, Department of Mechanical Engineering, Vel Tech High Tech Dr.Rangarajan Dr.Sakunthala Engineering College, Chennai 600 062.
2. Modi P.N. and Seth S.M., "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2017.
3. Subramanya K, "Fluid Mechanics and Hydraulic Machines", Tata McGraw Hill Edu. Pvt. Ltd., 2011

Course code	21ME48P	Semester	IV			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	THERMAL ENGINEERING LABORATORY		0	0	4	2

COURSE OBJECTIVES:

- To study the working principle of IC engines (both SI and CI engines), performance and characteristics.
- To analyse the modes of heat transfer.

PREREQUISITE:

- Basic knowledge on IC engines, refrigeration, psychrometry, modes of heat transfer

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C408.1	***Explain*** the valve timing diagram and port timing diagram of IC Engines.	K3
C408.2	***Compute*** the performance of IC engines, flash and fire points of oil.	K4
C408.3	***Apply*** the heat balance test on 4 – stroke Diesel Engine.	K4
C408.4	***Predict*** the performance of steam turbines and generators.	K4
C408.5	***Calculate*** the COP of refrigeration unit.	K4
C408.6	***Calculate*** the heat transfer coefficient in convection, conduction and radiation and correlate with theoretical values.	K4

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C408.1	2	1	-	-	1	-	-	1	1	1	-	1	-	1	-
C408.2	3	2	1	-	1	-	-	1	1	1	-	1	-	1	-
C408.3	3	2	1	-	1	-	-	1	1	1	-	1	-	1	-
C408.4	3	2	1	-	1	-	-	1	1	1	-	1	-	1	-
C408.5	3	2	1	-	1	-	-	1	1	1	-	1	-	1	-
C408.6	3	2	1	-	1	-	-	1	1	1	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 2**

I.C ENGINES LAB

1. Determination of flash point and fire point of various fuels / lubricants.
2. Determination of viscosity using redwood viscometer.
3. Valve timing and Port timing diagrams.
4. Performance test on 4 – stroke Diesel Engine.
5. Heat balance test on 4 – stroke Diesel Engine.
6. Morse test on Multi-cylinder Petrol Engine.
7. Retardation test on a Diesel Engine.

STEAM LAB

1. Study on Steam Generators and Turbines.
2. Performance and Energy Balance Test on a Steam Generator.
3. Performance and Energy Balance Test on Steam Turbine.

REFRIGERATION AND AIR CONDITIONING LAB

1. Determination of COP of a refrigeration system.
2. Experiments on Psychrometric processes.
3. Performance test on a reciprocating air compressor.
4. Performance test in a Fluidized Bed Cooling Tower.

HEAT TRANSFER LAB

1. Thermal conductivity measurement using guarded plate apparatus.
2. Thermal conductivity measurement of pipe insulation using lagged pipe apparatus.
3. Determination of heat transfer coefficient under natural convection from a vertical cylinder.
4. Determination of heat transfer coefficient under forced convection from a tube.
5. Heat transfer from pin-fin apparatus (natural & forced convection modes).
6. Determination of Stefan – Boltzmann constant.
7. Determination of emissivity of a grey surface.
8. Effectiveness of Parallel / Counter flow heat exchanger.

TOTAL: 60 Periods

LEARNING RESOURCES:

REFERENCES:

1. Thermal Engineering Laboratory Manual, Department of Mechanical Engineering, Vel Tech High Tech Dr.Rangarajan Dr. Sakunthala Engineering College, Chennai 600 062.
2. Arora.C.P, "Refrigeration and Air Conditioning", Tata McGraw-Hill Publishers, 2008.
3. Ganesan V "Internal Combustion Engines", Third Edition, Tata Mc Graw-Hill 2012.
4. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition, 2015.

Course code	21EE01P	Semester	IV			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	MINI PROJECT – I		0	0	2	1

COURSE OBJECTIVES:

- To introduce real project-based learning

PREREQUISITE:

- All Core Courses

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C409.1	***Elaborate*** specific problem statements in the practical world difficulties with reasonable assumptions and constraints.	K6
C409.2	***Organize*** literature survey and patent search in the area of interest.	K3
C409.3	***Perform*** experiments, design and error analysis.	K4
C409.4	***Ascertain*** the results and arrive at scientific conclusions, products and solution.	K5
C409.5	***Document*** the results in the form of technical report and presentation	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C409.1	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C409.2	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C409.3	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C409.4	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C409.5	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 1**

Students are motivated and advised to carry out the projects in the following domains, but not limited with

- Mechanical Engineering Design
- Manufacturing Engineering
- Industrial Engineering
- Thermal Engineering
- Reverse Engineering
- Renewable Energy Sources
- Industrial Automation and Robotics
- Mechatronics
- Refrigeration and Air Conditioning
- Metrology and Measurements
- Composites and Nano Technology
- Emerging Technologies in Mechanical Engineering, etc.

Total: 30 Periods

LEARNING RESOURCES:

OFF-LINE RESOURCES:

1. Journal papers in Library
2. Knowledge Resource Centre.

ONLINE RESOURCES:

1. https://www.sciencedirect.com/
2. https://www.tandfonline.com/
3. https://link.springer.com/
4. https://swayam.gov.in/nc_details/NPTEL
5. https://library.annauniv.edu/
6. https://www.youtube.com/
7. https://www.ncbi.nlm.nih.gov/
8. https://www.ncbi.nlm.nih.gov/pmc/
9. https://mtccindia.res.in/
10. https://www.atcc.org/

V SEMESTER

SEMESTER V										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME51T	Heat and Mass Transfer	PCC	40	60	100	3	0	0	3
2	21ME52T	Design of Machine Elements	PCC	40	60	100	3	1	0	4
3	21ME53T	Metrology and Measurements	PCC	40	60	100	3	0	0	3
4	21ME54T	Dynamics of Machines	PCC	40	60	100	3	0	0	3
5	-	Professional Elective - I	PEC	40	60	100	3	0	0	3
6	-	Open Elective - I	OEC	40	60	100	3	0	0	3
PRACTICAL										
7	21ME57P	Metrology and Measurements Laboratory	PCC	60	40	100	0	0	4	2
8	21ME58P	Kinematics and Dynamics Laboratory	PCC	60	40	100	0	0	4	2
9	21EE03P	Technical Seminar	EEC	100	-	100	0	0	2	1
TOTAL										**24**

VEL TECH HIGH TECH
Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE
An Autonomous Institution
Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai
Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	**21ME51T**	**Semester**	**V**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**HEAT AND MASS TRANSFER**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis, sizing of heat exchangers and to understand the basic concepts of mass transfer.

PREREQUISITE:

- Engineering Thermodynamics and Thermal Engineering.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C501.1	***Apply*** heat conduction equations to different surface configurations under steady state &transient conditions and solve problems.	K3
C501.2	***Apply*** free, forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems.	K3
C501.3	***Explain*** the phenomena of boiling and condensation, apply LMTD and NTU methods of thermal analysis to different types of heat exchanger configurations and solve problems.	K3
C501.4	***Explain*** basic laws for Radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems.	K3
C501.5	***Apply*** diffusive and convective mass transfer equations and correlations to solve problems for different applications.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C501.1	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C501.2	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C501.3	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C501.4	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C501.5	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I CONDUCTION **9**

General Differential equation of Heat Conduction– Cartesian and Polar Coordinates – One Dimensional Steady State Heat Conduction –– plane and composite systems – Conduction with Internal Heat Generation – Extended Surfaces – Unsteady Heat Conduction – Lumped Analysis – Semi Infinite and Infinite Solids –Use of Heisler's charts – Applications

UNIT II CONVECTION **9**

Free and Forced Convection -Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes– Applications

UNIT III PHASE CHANGE HEAT TRANSFER AND HEATEXCHANGERS **9**

Nusselt's theory of condensation - Regimes of Pool boiling and Flow boiling. Correlations in boiling and condensation. Heat Exchanger Types - Overall Heat Transfer Coefficient – Fouling Factors - Analysis – LMTD method - NTU method–Applications

UNIT IV RADIATION **9**

Black Body Radiation – Grey body radiation - Shape Factor – Electrical Analogy – Radiation Shields. Radiation through gases. Radiation Cooling System – Applications

UNIT V MASS TRANSFER **9**

Basic Concepts – Diffusion Mass Transfer – Fick's Law of Diffusion – Steady state Molecular Diffusion – Convective Mass Transfer – Momentum, Heat and Mass Transfer Analogy – Convective Mass Transfer Correlations – simultaneous heat and mass transfer – Applications

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Yunus A. Cengel, "Heat Transfer A Practical Approach", Tata McGraw Hill, 5th Edition, 2015.
2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010.

REFERENCES:

1. Introduction to Heat and Mass Transfer, NPTEL Course Contents & Videos, MHRD.
2. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & sons, 2014.
3. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012.
4. R.C.Sachdeva, “Fundamentals of Engineering Heat& Mass transfer”, New Age International Publishers, 2009.
5. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi, 2002.
6. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.

Course code	21ME52T		Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)			L	T	P	C
Course Title	DESIGN OF MACHINE ELEMENTS			3	1	0	4

COURSE OBJECTIVES:

- To design shafts and couplings for various applications.
- To design bolted and welded joints for various kinds of loads.
- To design helical, leaf springs, flywheels and bearings for various applications.

PREREQUISITE:

- Strength of Materials, Material Science and Kinematics of machinery.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C502.1	***Design*** machine members subjected to static and variable loads.	K3
C502.2	***Design*** shafts and couplings for various applications.	K3
C502.3	***Design*** bolted and welded joints for various kinds of loads.	K3
C502.4	***Design*** helical and leaf springs	K3
C502.5	***Select*** sliding and rolling contact bearings.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C502.1	3	3	2	-	-	-	-	-	-	1	1	1	1	2	-
C502.2	3	3	2	-	-	-	-	-	-	1	1	1	1	2	-
C502.3	3	3	2	-	-	-	-	-	-	1	1	1	1	2	-
C502.4	3	3	2	-	-	-	-	-	-	1	1	1	1	2	-
C502.5	3	3	2	-	-	-	-	-	-	1	1	1	1	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I FUNDAMENTAL CONCEPTS IN DESIGN 9+3

Machine Design philosophy and Procedures –Factors influencing machine design, selection of materials based on mechanical properties – Preferred numbers– Direct, Bending and torsional loading – Factor of Safety and Factors governing selection of factor of Safety – Combined loads – Principal stresses – Creep strain and Creep Curve – Eccentric loading – curved beams – crane hook and ‘C’ frame- theories of failure – Design based on strength and stiffness – Stress Concentration Causes & Remedies - Fluctuating stresses – Endurance limit– Design for finite and infinite life under variable loading .

UNIT II SHAFTS AND COUPLINGS 9+3

Design of solid and hollow shafts - Materials for shafts; strength of shafts under torsion and bending; factor of safety in shafts: fatigue strength reduction factors, modified moments of inertia of shaft section; stiffness of shafts: factors affecting shaft deflection. Complete design calculation and checking of stress concentration- Shaft vibrations - Design of Rigid and flexible couplings.

UNIT III TEMPORARY AND PERMANENT JOINTS 9+3

Threaded fasteners - Bolted joints – Simple and eccentrically loaded bolted joints - Welded joints – Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads.

UNIT IV ENERGY STORING ELEMENTS 9+3

Types of springs, design of helical and concentric springs–surge in springs, Design of laminated springs - Flywheels considering stresses in rims and arms for engines and presses - Solid and Rimmed flywheels.

UNIT V BEARINGS 9+3

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Sommerfeld Number, Raimondi & Boyd graphs, Selection of Rolling Contact bearings - Seals and Gaskets.

TOTAL: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Shigley J.E and Mischke C. R, “Mechanical Engineering Design”, Sixth Edition, Tata Mc Graw - Hill, 2010.
2. Bhandari V.B, “Design of Machine Elements”, Second Edition, Tata McGraw-Hill Book Co, 2020.

REFERENCES:

1. Design of Machine Elements, NPTEL Course Contents & Videos, MHRD.
2. Sundararaja moorthy T. V, Shanmugam N, "Machine Design", Anuradha Publications, Chennai, 2018.
3. Orthwein W, “Machine Component Design”, Jaico Publishing Co, 2013.
4. Ugural A.C, “Mechanical Design” – An Integral Approach, Mc Graw - Hill Book Co, 2015.

Course code	21ME53T	Semester	V			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**METROLOGY AND MEASUREMENTS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To provide knowledge on various Metrological equipment available and correct procedure to be adopted to measure the dimension of the components.

PREREQUISITE:

- Scientific study of measurement.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C503.1	***Describe*** the concepts of measurements to apply in various metrological instruments.	K2
C503.2	***Outline*** the principles of linear and angular measurement tools used for industrial applications.	K2
C503.3	***Explain*** the procedure for conducting computer aided inspection.	K2
C503.4	***Demonstrate*** the techniques of form measurement used for industrial components.	K2
C503.5	***Explain*** various measuring techniques of mechanical properties in industrial applications.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C503.1	3	2	-	-	1	-	-	-	-	-	-	1	-	1	-
C503.2	3	2	-	-	1	-	-	-	-	-	-	1	-	1	-
C503.3	3	2	-	-	1	-	-	-	-	-	-	1	-	1	-
C503.4	3	2	-	-	1	-	-	-	-	-	-	1	-	1	-
C503.5	3	2	-	-	1	-	-	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	**No. of Credits: 3**

UNIT I BASICS OF METROLOGY 9

Introduction to Metrology – Need – Elements – Work piece, Instruments – Persons – Environment – their effect on Precision and Accuracy – Errors – Errors in Measurements – Uncertainty–Types – Control – Types of standards- Inspection and Quality Control.

UNIT II LINEAR AND ANGULAR MEASUREMENTS 9

Linear Measuring Instruments – Vernier caliper, Micrometer, Vernier height gauge, Depth Micrometer, Bore gauge, Strain gauge, Telescoping gauge; Gauge blocks – Use and precautions, Comparators – Working and advantages; Opto-mechanical measurements using measuring microscope and Profile projector - Angular measuring instruments - Bevel protractor, Clinometer, Angle gauges, Precision level, Sine bar, Autocollimator, Angle dekkor, Alignment telescope - Applications

UNIT III ADVANCES IN METROLOGY 9

Basic concept of lasers Advantages of lasers – Laser scan micrometers; laser Interferometers – types – DC and AC Lasers interferometer – Applications – Straightness – Alignment; Ball bar tests, Computer Aided Metrology- Basic concept of CMM – Types of CMM – Constructional features – Probes – Accessories – Software – Applications – Multisensor CMMs.

Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.

UNIT IV FORM MEASUREMENT AND NANO IMPACT ON METROLOGY 9

Principles and Methods of straightness – Flatness measurement – Thread measurement, gear measurement, surface finish measurement, Roundness measurement – Applications, Nanometrology

UNIT V MEASUREMENT OF POWER, FLOW AND TEMPERATURE 9

Force, torque, power - mechanical, Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturi meter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability.

Total:45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Dotson Connie, “Dimensional Metrology”, Cengage Learning, First edition, 2012.
2. Mark Curtis, Francis T. Farago, “Handbook of Dimensional Measurement”, Industrial Press, Fifth edition, 2013.
3. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2009.
4. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.

REFERENCES:

1. Engineering Metrology and Introduction on Mechanical Measurements, NPTEL Course Contents & Videos, MHRD.
2. Venkateshan, S. P., “Mechanical Measurements”, Second edition, John Wiley &Sons, 2015.
3. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.
4. Raghavendra, Krishnamurthy, “Engineering Metrology & Measurements”, Oxford Univ. Press, 2013
5. AmmarGrous, J “Applied Metrology for Manufacturing Engineering”, Wiley-ISTE, 2011.
6. ldPeckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
7. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
8. Alan S. Morris, “The essence of Measurement”, Prentice Hall of India 1996.

Course code	21ME54T	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	DYNAMICS OF MACHINES		3	0	0	3

COURSE OBJECTIVES:

- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms.
- To understand the effect of Dynamics of undesirable vibrations.
- To understand the principles in mechanisms used for speed control and stability control.

PREREQUISITE:

- Engineering Mechanics and Kinematics of Machinery.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C504.1	***Calculate*** static and dynamic forces of mechanisms.	K3
C504.2	***Calculate*** the balancing masses and their locations of reciprocating and rotating masses.	K3
C504.3	***Compute*** the frequency of free vibration.	K3
C504.4	***Compute*** the frequency of forced vibration and damping coefficient.	K3
C504.5	***Calculate*** the speed, lift of the governor and estimate the gyroscopic effect on automobiles, ships and airplanes.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C504.1	3	3	2	1	-	-	-	1	1	-	-	1	1	2	-
C504.2	3	3	2	1	-	-	-	1	1	-	-	1	1	2	-
C504.3	3	3	2	1	-	-	-	1	1	-	-	1	1	2	-
C504.4	3	3	2	1	-	-	-	1	1	-	-	1	1	2	-
C504.5	3	3	2	1	-	-	-	1	1	-	-	1	1	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I FORCE ANALYSIS 9

Dynamic force analysis – Inertia force and Inertia torque– D Alembert's principle –Dynamic Analysis in reciprocating engines – Gas forces – Inertia effect of connecting rod– Bearing loads – Crank shaft torque – Turning moment diagrams –Fly Wheels – Flywheels of punching presses- Dynamics of Cam- follower mechanism.

UNIT II BALANCING 9

Static and dynamic balancing – Balancing of rotating masses – Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V- engines – Partial balancing in engines – Balancing of linkages – Balancing machines-Field balancing of discs and rotors.

UNIT III FREE VIBRATION 9

Basic features of vibratory systems – Degrees of freedom – single degree of freedom – Free vibration– Equations of motion – Natural frequency – Types of Damping – Damped vibration– Torsional vibration of shaft – Critical speeds of shafts – Torsional vibration – Two and three rotor torsional systems.

UNIT IV FORCED VIBRATION 9

Response of one degree freedom systems to periodic forcing – Harmonic disturbances – Disturbance caused by unbalance – Support motion – transmissibility – Vibration isolation. Vibration measurement–Vibration meter – Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters – Digital data Acquisition systems.

UNIT V MECHANISM FOR CONTROL 9

Governors – Types – Centrifugal governors – Gravity controlled and spring controlled centrifugal governors – Characteristics – Effect of friction – Controlling force curves. Gyroscopes – Gyroscopic forces and torques – Gyroscopic stabilization – Gyroscopic effects in Automobiles, ships and airplanes.

TOTAL: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. S Balaguru, “Dynamics of Machines”, Cengage India, 2019.
2. Rattan, S.S, “Theory of Machines”, 4^{th} Edition, Tata McGraw-Hill, 2014.
3. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, 4^{th}Edition, Oxford University Press, 2014.
4. Dr Sadhu Singh, “Dynamics of Machines”, S.K Katarina & Sons, 2011.
5. F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources, 2011.
6. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3^{rd} Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.

REFERENCES:

1. Dynamics of Machines, NPTEL Course Contents & Videos, MHRD.
2. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press,2014.
3. Khurmi, R.S, “Theory of Machines”, S Chand Publications, 2005.
4. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
6. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
Professional Elective I (V SEM)		
1.	21ME551PT	Automobile Engineering
2.	21ME552PT	Gas Dynamics and Jet Propulsion
3.	21ME553PT	Intellectual Property Rights
4.	21ME554PT	Composite materials and Nano Technology
5.	21ME555PT	Hydraulics and Pneumatics

Course code	21ME551PT	Semester	V			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**AUTOMOBILE ENGINEERING**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the construction and working principle of various parts of an automobile.
- To understand the assembling and dismantling of engine parts and transmission system.

PREREQUISITE:

- Basic Engineering Skills and Thermal Engineering

COURSEOUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C551.1	***Indicate*** the various parts of the automobile and their functions and materials.	K2
C551.2	***Discuss*** the engine auxiliary systems and engine emission control.	K2
C551.3	***Express*** the working of different types of transmission systems.	K2
C551.4	***Explain*** the types and working of Steering, Brakes and Suspension Systems.	K2
C551.5	***Select*** the possible alternate sources of energy for IC Engines.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C551.1	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-
C551.2	3	2	-	-	-	-	1	-	-	-	-	1	-	1	-
C551.3	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-
C551.4	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-
C551.5	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I VEHICLE STRUCTURE AND ENGINES 9

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, Vehicle aerodynamics (various resistances and moments involved), IC engines –components and its functions, material selection and working principle.

UNIT II ENGINE AUXILIARY SYSTEMS 9

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and common rail direct injection system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine emission control by three-way catalytic converter system, Radiators and Coolant pumps.

UNIT III TRANSMISSION SYSTEMS 9

Clutch-types and construction, gear boxes- manual and automatic, gear shift mechanisms, over drive, transfer box, fluid flywheel, torque converter, propeller shaft, slip joints, universal joints, Differential and rear axle, Hotchkiss Drive and Torque Tube Drive.

UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 9

Steering geometry and types of steering gear box-Power Steering, Types of Front Axle, Types of Suspension Systems, Pneumatic and Hydraulic Braking Systems, Antilock Braking System (ABS), electronic brake force distribution (EBD) and Traction Control.

UNIT V ALTERNATIVE ENERGY SOURCES 9

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- Engine modifications required –Performance, Combustion and Emission Characteristics of SI and CI engines with these alternate fuels - Electric and Hybrid Vehicles– Types – main components – working principles – Design requirement for electric vehicles. Fuel Cell–Fuel cell Characteristics- Fuel cell types- Half reactions of fuel cell.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers, 2020.
2. S.K. Gupta, "A Textbook of Automobile Engineering", Second edition, S. CHAND Publishers, 2020.
3. Jain K.K. and Asthana R.B, "Automobile Engineering", 1st edition, Tata McGraw Hill Education, 2017.
4. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 1999.

REFERENCES:

1. Fundamentals of Automotive Systems, NPTEL Course Contents & Videos, MHRD.
2. Ganesan V. "Internal Combustion Engines", Fourth Edition, Tata McGraw-Hill, 2017.
3. William H Crouse, Donald L Anglin, Automotive Mechanics, 10th edition, McGraw – Hill, 2017.
4. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.
5. Martin W, Stockel and Martin T Stockle, "Automotive Mechanics Fundamentals," The Goodheart - Will Cox Company Inc, USA,1978.
6. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 1989.

Course code	21ME552PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	GAS DYNAMICS AND JET PROPULSION		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic difference between incompressible and compressible flow.
- To understand the phenomenon of shock waves and its effect on flow.
- To gain basic knowledge about jet propulsion and Rocket Propulsion.

PREREQUISITE:

- Thermodynamics, Thermal Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C552.1	***Discuss*** the basic fundamentals of compressible and incompressible flow concepts	K3
C552.2	***Apply*** the effect of friction (Fanno flow) and heat transfer (Rayleigh flow) in compressible flow and solve Fanno and Rayleigh flow problems	K3
C552.3	***Apply*** the concept of shock waves and its effects	K3
C552.4	***Discuss*** the propulsive methods, concept of air-craft propulsion system	K3
C552.5	***Explain*** the propulsive methods, concept of rocket propulsion system	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C552.1	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C552.2	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C552.3	3	2	1	-	-	-	-	-	-	-	-	1	-	1	-
C552.4	3	2	1	-	-	-	1	-	-	-	-	1	-	1	-
C552.5	3	2	1	-	-	-	1	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I BASIC CONCEPTS AND ISENTROPIC FLOWS 9

Energy and momentum equations of compressible fluid flows – Stagnation states, Mach waves and Mach cone – Effect of Mach number on compressibility – Isentropic flow through variable ducts – Nozzle and Diffusers.

UNIT II FLOW THROUGH DUCTS 9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties. Choking. Isothermal flow with friction.

UNIT III NORMAL AND OBLIQUE SHOCKS 9

Governing equations – Variation of flow parameters across the normal and oblique shocks – Prandtl – Meyer relations – Applications – Supersonic wind tunnels.

UNIT IV JET PROPULSION 9

Theory of jet propulsion – Thrust equation – Thrust power and propulsive efficiency – Operating principle, cycle analysis and use of stagnation state performance of ram jet, turbojet, turbofan and turbo prop engines – Air craft combustors.

UNIT V SPACE PROPULSION 9

Types of rocket engines – Propellants-feeding systems – Ignition and combustion – Theory of rocket propulsion – Performance study – Staging – Terminal and characteristic velocity – Applications – space flights.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Anderson, J.D., "Modern Compressible flow", 3rd Edition, McGraw Hill, 2012.
2. Yahya, S.M. "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 2002.

REFERENCES:

1. Gas Dynamics and Air Craft Propulsion, NPTEL Course Contents & Videos, MHRD.
2. Cohen. H., G.E.C. Rogers and Saravana, "Gas Turbine Theory", Longman Group Ltd.,1980.
3. Ganesan. V., "Gas Turbines", Tata McGraw Hill Publishing Co., New Delhi, 2010.
4. Shapiro. A.H.,"Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York, 1953.
5. Sutton. G.P., "Rocket Propulsion Elements", John wiley, New York,2010.
6. Zucrow. N.J., "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, 1970.

Course code	21ME553PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	INTELLECTUAL PROPERTY RIGHTS		3	0	0	3

COURSE OBJECTIVES:

- To acquaint the basic concepts of Intellectual Property Rights.
- To develop expertise in IPR related issues and sensitize the learners with the emerging issues in IPR and the rationale for the protection of IPR.

PREREQUISITE:

- Professional Ethics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C553.1	***Imbibe*** the knowledge of Intellectual Property and its protection through various laws.	K2
C553.2	***Explain*** the knowledge of IPR for professional development.	K2
C553.3	***Recognize*** a platform for protection and compliance of Intellectual Property Rights & knowledge.	K2
C553.4	***Locate*** awareness amidst academia and industry of IPR and Copyright compliance.	K2
C553.5	***Deliver*** the purpose and function of IPR and patenting.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C553.1	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C553.2	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C553.3	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C553.4	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C553.5	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property – Meaning and practical aspects of Patents, Copyrights, Geographical Indications, IPR in India and Abroad.Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II INTELLECTUAL PROPERTY RIGHTS 9

The IPR tool kit, Patents, the patenting process, Patent cooperation treaties: International Treaties and conventions on IPRs: Trade Related Aspects of Intellectual Property Rights Agreement, Patent Cooperation Treaty, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT III INTELLECTUAL PROPERTY PROTECTIONS 9

PR of Living Species, protecting inventions in biotechnology, protections of traditional knowledge, biopiracy and documenting traditional knowledge, Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection. Case studies: The basmati rice issue, revocations of turmeric patent, revocation of neem patent.

UNIT IV EXERCISING AND ENFORCING OF INTELLECTUAL PROPERTY RIGHTS 9

Rights of an IPR owner, licensing agreements, criteria for patent infringement. Case studies of patent infringement, IPR –contract, unfair competitions and control, provisions in TRIPS.

UNIT V ROLE OF PATENTS IN PRODUCT DEVELOPMENT COMMERCIALIZATION 9

Recent changes in IPR laws impacting patents and copy rights, intellectual cooperation in the science and allied industry. Patentable and non-patentable research. Case studies.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. P.B. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy. Tata McGraw Hill, 2001.
2. Prabuddha Ganguli. Intellectual Property Rights: Unleashing the Knowledge Economy. McGraw Hill Education, 2011.

REFERENCES:

1. Steve Smith, “The Quality Revolution”, 1st ed., Jaico Publishing House, 2002.
2. Kompal Bansal and Praishit Bansal. Fundamentals of IPR for Engineers, 1st Edition, BS Publications, 2012.
3. Prabhuddha Ganguli. Intellectual Property Rights. 1st Edition, TMH, 2012.
4. R Radha Krishnan & S Balasubramanian. Intellectual Property Rights. 1st Edition, Excel Books, 2012.
5. M Ashok Kumar &Mohd. Iqbal Ali. Intellectual Property Rights. 2nd Edition, Serial Publications, 2011.
6. VinodV. Scople, Managing Intellectual Property. Prentice Hall of India PvtLtd, 2012.
7. Deborah E. Bouchoux. Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets. Cengage Learning, 3rd ed. Edition, 2012.
8. Edited by Derek Bosworth and Elizabeth Webster, “The Management of Intellectual Property”, Edward Elgar Publishing Ltd., 2013.
9. B.S. Patil, “Legal Aspects of Building and Engineering Contracts”, 1974.
10. Wadhera (2004), “Intellectual Property Rights”, Universal Law Publishing Co.

Course code	**21ME554PT**	**Semester**	**V**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**COMPOSITE MATERIALS AND NANO TECHNOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- Study of different composite materials and finding its mechanical strength.
- Fabrication of FRP and other composites by different manufacturing methods.
- Introduce them the various methods of developing nano materials.
- Make them understand characterization of nano materials.

PREREQUISITE:

- Engineering Materials and Metallurgy and Production Technology

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C554.1	***Explain*** the mechanical strength of the composite material.	K2
C554.2	***Describe*** the fabrication of FRP and other composites by different manufacturing methods.	K2
C554.3	***Classify*** on nano materials.	K2
C554.4	***Discuss*** on the development of a Nano material.	K2
C554.5	***Illustrate*** the characterization of Nano materials.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C554.1	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C554.2	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C554.3	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C554.4	2	1	-	-	-	-	-	-	-	-	-	1	-	1	-
C554.5	3	2	-	-	-	-	-	-	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO COMPOSITE MATERIALS 9

Definition-Matrix materials – polymers – metals-ceramics - Reinforcements: Particles, whiskers, inorganic fibers, metal filaments-ceramic fibers-fiber fabrication-natural composite wood, Jute Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites

UNIT II MANUFACTURING OF COMPOSITES 9

Manufacturing of Polymer Matrix Composites (PMCs)-hand lay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) - solid state, liquid state, vapour state processing, manufacturing of Ceramic Matrix Composites (CMCs)–hot pressing reaction bonding process-infiltration technique, direct oxidation-interfaces

UNIT III INTRODUCTION TO NANOMATERIALS 9

Amorphous, Crystalline, microcrystalline, quasicrystalline and nanocrystalline materials- historical development of nanomaterials – Nanomaterials classification (Gleiter's Classification) – properly changes done to size effects, Hall – petch, inverse Hall- petch effects - polymeric nanostructures.

UNIT IV ZERO-DIMENSIONAL NANO MATERIALS 9

Nanoparticles – properties – processing – liquid state processing - Sol-gel process, wet chemical synthesis – vapour state processing, Aerosol processing, solid state processing – mechanical, mechanochemical synthesis – Application of nanoparticle. Quantum Dots – Quantum confinement – Pauli's exclusion principle – processing – Optical lithography – MOCVD – Droplet epitaxy - Applications.

UNIT V CHARACTERIZATION OF NANOMATERIALS 9

Nano indentation – types of nano indenter – force actuation- displacement measurement- factors affecting nano indentation- Atomic Force Microscope (AFM) – Scanning Tunneling Microscope (STM) – Electrostatic Force Mode (EFM) – Magnetic Force Mode (MFM) – Scanning Electron Microscope (SEM) – Transmission Electron Microscope (TEM).

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Gibson RF, Principles of Composite Material Mechanics, CRC press,4th Edition,2015.
2. Carl C. Koch (ed.), "Nanostructured Materials", Processing, Properties and Potential Applications, Noyes Publications, Norwich, New York, U.S.A.

REFERENCES:

1. Introduction to Composites and Nanomaterials, NPTEL Course Contents & Videos, MHRD.
2. Issac M Daniel and OriIshai, “Engineering Mechanics of Composite Materials”, Oxford University Press - 2006, First Indian Edition-2007
3. Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rd Edition,2007.
4. Mark Ratner and Daniel Ratner, “Nano Technology”, Pearson Education, New Delhi, 2003.
5. Charles P. Poole Jr., Frank J. Ownes, “Introduction to Nanotechnology”, Wiley Inter science, 2003.

Course Code	21ME555PT	Semester	V			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	HYDRAULICS AND PNEUMATICS		3	0	0	3

COURSE OBJECTIVES

- To provide knowledge on the application of fluid power in process, construction and manufacturing Industries.
- To understand the fluid and components utilized in modern industrial fluid power system.
- To develop a measurable degree of competence in the design, construction and operation of fluid power circuits.

PREREQUISITE

- Fluid Mechanics

COURSE OUTCOMES

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C555.1	***Summarize*** the features and functions of Hydraulic motors, actuators and Flow control valves.	K2
C555.2	***Apply*** different theories related to Fluid power and operation of different types of pumps.	K3
C555.3	**Experiment** with different types of Hydraulic circuits and systems	K3
C555.4	***Build*** the working of different pneumatic circuits and systems	K3
C555.5	***Utilize*** the various trouble shooting methods and applications of hydraulic and pneumatic systems.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C555.1	3	2	1	-	1	-	-	-	-	-	-	1	1	1	-
C555.2	3	2	1	-	1	-	-	-	-	-	-	1	1	1	-
C555.3	3	2	1	-	1	-	-	-	-	-	-	1	1	1	-
C555.4	3	2	1	-	1	-	-	-	-	-	-	1	1	1	-
C555.5	3	2	1	-	1	-	-	-	-	-	-	1	1	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I FLUID POWER PRINICIPLES AND HYDRAULIC PUMPS 9

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power: Pumping Theory – Pump Classification – Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

UNIT II HYDRAULIC ACTUATORS AND CONTROL COMPONENTS 9

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components: Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories: Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

UNIT III HYDRAULIC CIRCUITS AND SYSTEMS 9

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double-Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

UNIT IV PNEUMATIC AND ELECTRO PNEUMATIC SYSTEMS 9

Properties of air – Perfect Gas Laws – Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

UNIT V TROUBLE SHOOTING AND APPLICATIONS 9

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

TOTAL: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Jagadeesha. T., “Pneumatics Concepts, Design and Applications “, Universities Press, 2015.
2. Anthony Esposito, “Fluid Power with Applications”, Pearson Education 2009.
3. Srinivasan.R., “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.
4. Majumdar S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw-Hill, 2001.
5. Vickers, Industrial Hydraulics Manual, 1992.

REFERENCES:

1. Hydraulics and Pneumatics, NPTEL Course Contents & Videos, MHRD.
2. Anthony Lal, “Oil hydraulics in the service of industry”, Allied publishers, 1982.
3. Dudelyt, A. Pease and John T. Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.
4. Majumdar S.R., “Pneumatic systems – Principles and maintenance”, Tata McGraw Hill, 1995.
5. Michael J, Prinches and Ashby J. G, “Power Hydraulics”, Prentice Hall, 1989.
6. Shanmugasundaram.K, “Hydraulic and Pneumatic controls”, Chand & Co, 2006.

Course code	21ME57P	Semester	V			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	METROLOGY AND MEASUREMENTS LABORATORY		0	0	4	2

COURSE OBJECTIVES:

- To familiar with different measurement equipment's and to make effective use of the same in industries for quality inspection.

PREREQUISITE:

- Scientific study of measurement.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C507.1	***Calibrate*** the Vernier, micrometer using slip gauges, other linear measurements and setting up the comparator for the inspection.	K3
C507.2	***Measure*** the angular measurements using angular instruments.	K3
C507.3	***Measure*** the gear tooth profile and screw thread parameters using Contact and non- contact instruments.	K3
C507.4	***Measure*** the force, torque, and temperature using thermocouple.	K3
C507.5	***Measure*** prismatic components using Coordinate Measuring Machine	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C507.1	3	2	1	-	1	-	-	-	-	-	1	1	1	2	-
C507.2	3	2	1	-	1	-	-	-	-	-	1	1	1	2	-
C507.3	3	2	1	-	1	-	-	-	-	-	1	1	1	2	-
C507.4	3	2	1	-	1	-	-	-	-	-	1	1	1	2	-
C507.5	3	2	1	-	1	-	-	-	-	-	1	1	1	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

List of Experiments	**No. of Credits: 2**

1. Calibration and use of measuring instruments – Vernier caliper, micrometer, Vernier height gauge – using gauge blocks
2. Calibration of depth micrometer
3. Calibration of plug gauge using laser micrometer
4. Calibration of LVDT for displacement measurement
5. Measurement of angles using bevel protractor, sine bar and sine center
6. Measurement of gear parameters by gear tooth Vernier caliper
7. Measurement of bore diameter using bore gauge and telescopic gauge
8. Measurement of linear dimensions using Comparators (Mechanical, Electrical, Pneumatic)
9. Measurement of screw thread parameters using Floating Carriage Micrometer
10. Measurement of force
11. Measurement of torque
12. Measurement of temperature
13. Measurement of features in a prismatic component using Coordinate Measuring Machine (CMM)
14. Non-contact (Optical) measurement using Toolmaker's microscope / Profile projector
15. Measurement of Surface finish in components manufactured using various processes (turning, milling, grinding, etc.,) using stylus-based instruments.
16. Testing of straightness of a machine tool guide way using Autocollimator.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Gupta. I.C., “Engineering Metrology”, Dhanpatrai Publications, 2005.
2. Jain R.K. “Engineering Metrology”, Khanna Publishers, 2009.

REFERENCES:

1. Alan S. Morris, “The essence of Measurement”, Prentice Hall of India, 1996.
2. Beckwith, Marangoni, Lienhard, “Mechanical Measurements”, Pearson Education, 2014.
3. Charles Reginald Shotbolt, “Metrology for Engineers”, 5th edition, Cengage Learning EMEA,1990.
4. Donald Peckman, “Industrial Instrumentation”, Wiley Eastern, 2004.
5. Raghavendra, Krishnamurthy “Engineering Metrology & Measurements”, Oxford Univ. Press.

Course code	21ME58P	Semester	V			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**KINEMATICS AND DYNAMICS LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To supplement the principles learnt in kinematics and Dynamics of Machinery.
- To understand how certain measuring devices are used for dynamic testing.

PREREQUISITE:

- Kinematics of Machinery

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C508.1	***Explain*** gear parameters, kinematics of mechanisms, gyroscopic effect and working of lab equipment's.	K2
C508.2	***Develop*** a model of a mechanical system using a free body diagram.	K3
C508.3	***Determine*** mass moment of inertia of mechanical element	K3
C508.4	***Develop*** equations of motion for translational and rotational mechanical systems.	K3
C508.5	***Calculate*** the frequency of the shafts, balancing masses and the concept governor effort.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C508.1	3	2	2	1	1	-	-	1	1	1	-	-	-	1	-
C508.2	3	2	2	1	1	-	-	1	1	1	-	-	-	1	-
C508.3	3	2	2	1	1	-	-	1	1	1	-	-	-	1	-
C508.4	3	2	2	1	1	-	-	1	1	1	-	-	-	1	-
C508.5	3	2	2	1	1	-	-	1	1	1	-	-	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

List of Experiments	**No. of Credits: 2**

1. a) Study of gear parameters.
   b) Experimental study of velocity ratios of simple, compound, Epicyclic and differential gear trains.
2. a) Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
   b) Kinematics of single and double universal joints.
3. a) Determination of Mass moment of inertia of Fly wheel and Axle system.
   b) Determination of Mass Moment of Inertia of axisymmetric bodies using Turn Table apparatus.
   c) Determination of Mass Moment of Inertia using bifilar suspension and compound pendulum.
4. Motorized gyroscope – Study of gyroscopic effect and couple.
5. Governor - Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
6. Cams – Cam profile drawing, Motion curves and study of jump phenomenon
7. a) Single degree of freedom Spring Mass System – Determination of natural Frequency and verification of Laws of springs – Damping coefficient determination.
   b) Multi degree freedom suspension system – Determination of influence coefficient.
8. a) Determination of torsional natural frequency of single and Double Rotor systems.
   b) Undamped and Damped Natural frequencies.
9. Vibration Absorber – Tuned vibration absorber.
10. Vibration of Equivalent Spring mass system – Undamped and damped vibration.
11. Whirling of shafts – Determination of critical speeds of shafts with concentrated loads.
12. a) Balancing of rotating masses.
    b) Balancing of reciprocating masses.
13 a) Transverse vibration of Free-Free beam – with and without concentrated masses.
   b) Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.
   c) Determination of transmissibility ratio using vibrating table.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. F. B. Sayyad, “Dynamics of Machinery”, McMillan Publishers India Ltd., Tech-Max Educational resources,2011.
2. Rattan, S.S, “Theory ofMachines”,4th Edition, Tata McGraw-Hill, 2014.
3. Uicker, J.J., Pennock G.R and Shigley,J.E., “Theory of Machines and Mechanisms”, 4thEdition, Oxford University Press, 2014.

REFERENCES:

1. Cleghorn. W. L, “Mechanisms of Machines”, Oxford University Press, 2014.
2. Ghosh. A and Mallick, A.K., “Theory of Mechanisms and Machines", 3rd Edition Affiliated East-West Pvt. Ltd., New Delhi, 2006.
3. Khurmi, R.S “TheoryofMachines”,14 Edition, S Chand Publications,2005.
4. Rao.J.S. and Dukkipati.R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., NewDelhi, 1992.
5. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
6. V.Ramamurthi, "Mechanics of Machines", Narosa Publishing House, 2002.

Course code	21EE03P	Semester	V			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	TECHNICAL SEMINAR		0	0	2	1

COURSE OBJECTIVES:

- To inculcate the habit of critical thinking
- To emphasise the importance of reading and effective writing
- To expose meta-disciplinary research works
- To cultivate a scholarly habit

PREREQUISITE:

- Professional Communication Skill and Technical Writing Skill

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C509.1	***Define*** a compelling and viable problem, question, or project by exploring the purpose and philosophy on topics in technology	K2
C509.2	***Learn*** to infuse material from primary and secondary sources with their own ideas in research papers	K2
C509.3	***Understand*** the stages of writing process which strengthens the technical and workplace writing tasks	K2
C509.4	***Demonstrate*** an ability to synthesize and assess arguments in scholarly articles and monographs professionally	K3
C509.5	**Develop** Presentation and Communication skills.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C509.1	2	2	-	-	-	-	-	-	3	2	-	2	2	2	2
C509.2	2	2	-	-	-	-	-	-	3	2	-	2	2	2	2
C509.3	2	2	-	-	-	-	-	-	3	2	-	2	2	2	2
C509.4	2	2	-	-	-	-	-	-	3	2	-	2	2	2	2
C509.5	2	2	-	-	-	-	-	-	3	2	-	2	2	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 1**

Students are advised to prepare and present Seminar in the following domains, but not limited with

- Mechanical Engineering Design
- Manufacturing Engineering
- Industrial Engineering
- Thermal Engineering
- Reverse Engineering
- Renewable Energy Sources
- Industrial Automation and Robotics
- Mechatronics
- Refrigeration and Air Conditioning
- Metrology and Measurements
- Composites and Nano Technology
- Emerging Technologies in Mechanical Engineering, etc.

Total: 30 Periods

LEARNING RESOURCES:

OFF-LINE RESOURCES:

1. Journal papers in Library
2. Knowledge Resource Centre.

ONLINE RESOURCES:

1. https://www.sciencedirect.com/
2. https://www.tandfonline.com/
3. https://link.springer.com/
4. https://swayam.gov.in/nc_details/NPTEL
5. https://library.annauniv.edu/
6. https://www.youtube.com/
7. https://www.ncbi.nlm.nih.gov/
8. https://www.ncbi.nlm.nih.gov/pmc/
9. https://mtccindia.res.in/
10. https://www.atcc.org/

VI SEMESTER

SEMESTER VI										
S. No.	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	21ME61T	Design of Transmission Systems	PCC	40	60	100	3	1	0	4
2	21ME62T	Conventional Automotive Testing and Certification	PCC	40	60	100	3	0	0	3
3	21ME63T	Finite Element Analysis	PCC	40	60	100	3	1	0	4
4	-	Professional Elective - II	PEC	40	60	100	3	0	0	3
5	-	Open Elective - II	OEC	40	60	100	3	0	0	3
PRACTICAL										
6	21ME66P	Computer Aided Manufacturing Laboratory	PCC	60	40	100	0	0	4	2
7	21EE02P	Mini Project - II	EEC	60	40	100	0	0	2	1
8	21EE04P	Internship	EEC	100	-	100	0	0	0	1
TOTAL										**21**

Course code	21ME61T	Semester	VI			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	DESIGN OF TRANSMISSION SYSTEMS		3	1	0	4

COURSE OBJECTIVES:

- To gain knowledge on the principles and procedure for the design of Mechanical power Transmission components.
- To understand the standard procedure available for Design of Transmission of Mechanical elements.
- To learn to use standard data and catalogues.

PREREQUISITE:

- Design of Machine Elements

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C601.1	***Apply*** the concepts of design to belts and chain drives.	K3
C601.2	***Utilize*** the concept to the spur gears and helical gears for design.	K3
C601.3	***Apply*** the concept to the bevel, worm and cross helical gears for design.	K3
C601.4	***Develop*** the concept for design the gear box.	K3
C601.5	***Select*** the concepts of design to brakes and clutches.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C601.1	3	2	2	-	-	-	-	-	-	-	-	1	-	2	-
C601.2	3	2	2	-	-	-	-	-	-	-	-	1	-	2	-
C601.3	3	2	2	-	-	-	-	-	-	-	-	1	-	2	-
C601.4	3	2	2	-	-	-	-	-	-	-	-	1	-	2	-
C601.5	3	2	2	-	-	-	-	-	-	-	-	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 4

UNIT I DESIGN OF FLEXIBLE ELEMENTS 12

Belt drives: Design using Basic equations, Design of Flat belts and pulleys, Selection of V belts and pulleys, Selection of Transmission chains and Sprockets.

UNIT II SPUR GEARS AND PARALLEL AXIS HELICAL GEARS 12

Speed ratios and number of teeth-Force analysis -Tooth stresses, Dynamic effects – Fatigue strength – Factor of safety – Gear materials, Design of straight tooth spur based on strength and wear considerations, Design of helical gears based on strength and wear considerations, Pressure angle in the normal and transverse plane, Equivalent number of teeth-forces for helical gears.

UNIT III BEVEL, WORM AND CROSS HELICAL GEARS 12

Straight bevel gear: Tooth terminology, tooth forces and stresses, equivalent number of teeth, Estimating the dimensions of pair of straight bevel gears, Worm Gear: Merits and demerits terminology. Thermal capacity, materials, forces and stresses, efficiency, estimating the size of the worm gear pair, Cross helical: Terminology-helix angles, Estimating the size of the pair of cross helical gears.

UNIT IV GEAR BOXES 12

Geometric progression – Standard step ratio, Ray diagram, kinematics layout -Design of sliding mesh gear box, Design of multi speed gear box for machine tool applications, Constant mesh gear box – Speed reducer unit, Variable speed gear box - Planetary gear box, Gear box applications.

UNIT V CLUTCHES AND BRAKES 12

Design of plate clutches –axial clutches-cone clutches, internal expanding rim clutches-Electromagnetic clutches, Brakes: Role & types of brakes, Self-energizing and de-energizing brakes, Thermal Considerations in Brakes, Band & Block brakes- external shoe brakes -Internal expanding shoe brake, Design of disc brakes.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Bandari V.B, "Design of Machine Elements", 4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi, 2017.
2. Richard G Budynas, J Keith Nisbett, "Shigley's Mechanical Engineering Design", 10th Edition, McGraw Hill Publishers Co. Ltd., 2017.

REFERENCES:

1. Robert L Norton, "Machine Design - An Integrated Approach", 5th Edition, Pearson Education, 2018.
2. Faculty of Mechanical Engineering, PSG College of Technology, "PSG Design Data Book", Kalaikathir Achagam, 2019.
3. "Gear and Gear Unit Design", NPTEL Course, MHRD.
4. Bernard Hamrock, Steven Schmid, Bo Jacobson, "Fundamentals of Machine Elements", 3rd Edition, Tata McGraw-Hill Book Co., 2014.
5. Robert C. Juvinall and Kurt M. Marshek, "Fundamentals of Machine Design", Wiley India Edition, 2016.
6. Alfred Hall, Halowenko, A and Laughlin, H., "Machine Design", Tata McGraw-Hill Book Co. (Schaum's Outline), 2017.
7. V. Jayakumar, "Design of Transmission Elements", 7th Edition, Laxmi Publications, 2015.

Course code	**21ME62T**	**Semester**	**VI**				
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**	
Course Title	**CONVENTIONAL AUTOMOTIVE TESTING AND CERTIFICATION**		**3**	**0**	**0**	**3**	

COURSE OBJECTIVES:

- To illustrate the Automotive Testing and Certification of passenger vehicles.

PREREQUISITE:

- Thermal Engineering.
- Automobile Engineering.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C602.1	***Illustrate*** the Automotive Testing and Certification of passenger vehicles.	K2
C602.2	***Understand*** the need of vehicle testing and certification.	K2
C602.3	***Classify*** the testing of vehicle for noise, emission and performance.	K2
C602.4	***Explain*** the procedure for active and passive safety tests of vehicle.	K2
C602.5	***Perform*** the tests to be done on the vehicle lighting system.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C602.1	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C602.2	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C602.3	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C602.4	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-
C602.5	3	2	1	-	-	-	-	-	-	-	-	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION AND ENGINE TESTING 9

Need of vehicle testing and homologation, Vehicle testing organizations, Hierarchy of testing: Individual component approval, System level approval and Whole vehicle approval. Classification of vehicles (including M, N and O layout), regulations overview (ECE, EEC, FMVSS, AIS, CMVR, ADR), Laboratory testing of basic engine parameters: Measurement of BHP, IHP, Engine testing on dynamometers, different types of dynamometers, hydraulic, eddy current etc., engine analyzers - for petrol and diesel engines, FIP calibrating and testing.

UNIT II VEHICLE TESTING: PART 1 9

Vehicle testing on chassis dynamometers: Two wheel & four-wheel dynamometers, Driving Cycles- USA, Japan, Euro and India. Test procedures – European driving cycles, Modified Indian Driving Cycle, SHED (Sealed Housing for. Evaporative Determination), vehicle testing lanes - side slip testers. CMVR physical verification, Vehicle weighment, Coast down test, Brake test, ABS, Turning circle diameter test, Steering effort test, Wheel Alignment testing, Wheel Balancing, Speedometer calibration, Pass by noise test, External projection test, Wheel guards, Hood latch test, Tell-tale symbols, Gradeability test, Accelerator control system.

UNIT III VEHICLE TESTING: PART 2 9

Horn installation, Rear view mirror installation, Installation requirements for lighting & signaling devices, Windscreen Wiping system. Vertical orientation for dipped beam - head lamp, Interior Fittings, Driver's field of vision (M1 category), Steering Impact test (GVW < 1500 kg), Body block test, Head form test, Crash test, side impact test, rollover test, Bumper Testing, Vehicle - mass emission, Evaporative emission (petrol vehicles only), Broad band / Narrow band EMI test, Safety belt assemblies, Crash test with Dummy, Fire resistance test, OBD I.

UNIT IV VEHICLE COMPONENT RELATED TEST PART 1 9

Size and Ply rating of tyres, Safety Glasses: 1. Windscreen laminated safety glass 2. Side window / door glass 3. Back light / rear toughened glass; Windscreen wiping system, Wiper Blade, Reflector, Horn, Automotive lamps, Hydraulic brake hose, Hydraulic brake fluid, Wheel rims, Rear View Mirror Specifications (Exterior), Rear View Mirror Specifications (Interior), Wheel nuts, wheel discs & hub caps, Door locks & door retention.

UNIT V VEHICLE COMPONENT RELATED TEST PART 2 9

Performance requirements for Lighting & Signaling devices, Head lamp assembly (Glass lens), Head lamp assembly (Plastic lens), Head lamp + Front Position lamp / Front Direction Indicator lamp / Front Fog lamp, Rear combination lamp (each additional function), Independent Front Position lamp / Front Direction Indicator lamp / Front Fog lamp, Rear combination lamp (single function), Fuel tank : Metallic, Plastic (excluding fire resistance test), Bumper (F&R), Warning Triangles, Safety belt assemblies, Safety belt anchorages, Seat anchorages, Head restraints and Air bag test. Vehicle battery testing and its procedure.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Automotive technology, Dr. N.K.Giri, Khanna publishers 2002.
2. Motor vehicle inspection, W. H. Crouse and L. Anglin, McGraw Hill Book Co 1978.
3. Vehicle Technology Technical Foundations of Current and Future Motor Vehicles Dieter Schramm, Benjamin Hesse, Niko Maas, Michael Unterreiner 2020.
4. Raymond M.Branch and R.Matthew Brach, "Vehicle Accident Analysis and Reconstruction Methods", SAE International 2011.

REFERENCES:

1. Paul Degobert, “Automobiles and Pollution” SAE Publications, 1991.
2. Robert Bosch, Automotive Handbook, Bently Publishers,2004.
3. Automotive Industry Standard (AIS) and Motor Vehicle Manuals.
4. B.P. Pundir, “Engine Emissions - Pollutant Formation and Advances in Control Technology” Narosa Publishing house Pvt. Ltd, 2011.
5. Eran Sher “Handbook of Air Pollution from Internal Combustion Engines- Pollutant Formation and Control” Academic Press, 1998.
6. Federal Motor Vehicle Safety Standards (FMVSS) available in webpage https://en.wikipedia.org/wiki/Federal_Motor_Vehicle_Safety_Standards.
7. The Central Motor Vehicles Rules, 1989 available in webpage http://www.tn.gov.in/sta/Cmvr1989.pdf.

Course code	21ME63T	Semester	VI			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	FINITE ELEMENT ANALYSIS		3	1	0	4

COURSE OBJECTIVES:

- To introduce the concepts of Mathematical Modelling of Engineering Problems.
- To appreciate the use of FEM to a range of Engineering Problems.

PREREQUISITE:

- Engineering Mechanics.
- Strength of Materials.
- Design of Machine Elements

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C603.1	***Outline*** the mathematical models for Boundary Value Problems and their numerical solution.	K2
C603.2	***Apply*** concepts of Finite Element Analysis to solve one dimensional problem.	K3
C603.3	***Determine*** field variables for two-dimensional scalar variable problems.	K3
C603.4	***Determine*** field variables for two-dimensional vector variable problems.	K3
C603.5	***Apply*** the need for Iso-parametric transformation and the use of numerical integration.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C603.1	3	2	1	-	-	-	-	-	-	-	-	1	1	2	-
C603.2	3	3	2	-	-	-	-	-	-	-	-	1	1	2	-
C603.3	3	3	2	1	-	-	-	-	-	-	-	1	1	2	-
C603.4	3	3	2	1	-	-	-	-	-	-	-	1	1	2	-
C603.5	3	3	2	1	-	-	-	-	-	-	-	1	1	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 4

UNIT I INTRODUCTION **12**

Engineering design analysis-meaning and purpose -Historical Background - Creations of Key points, Lines, Surfaces – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT II ONE-DIMENSIONAL PROBLEMS **12**

General procedure of FEM, Skeletal and continuum structures - One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices - Solution of problems from solid mechanics and heat transfer. Transverse deflections and Natural frequencies of beams. Beam stiffness matrix, Truss element.

UNIT III TWO-DIMENSIONAL SCALAR VARIABLE PROBLEMS **12**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation – Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems - Thermal problems.

UNIT IV TWO-DIMENSIONAL VECTOR VARIABLE PROBLEMS **12**

Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations - Plate and shell elements.

UNIT V ISO-PARAMETRIC FORMULATION **12**

Natural co-ordinate systems – Iso parametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems - Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Reddy. J.N., “An Introduction to the Finite Element Method”, 3^{rd} Edition, Tata McGraw, 2018.
2. Rao, S.S., The Finite Element Method in Engineering, 6^{th} Edition, Butterworth - Heinemann, 2018.
3. Larry J Segerlind, “Applied Finite Element Analysis”, Wiley publisher, 2nd Edition, 2011.
4. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, International Edition, Pearson Education Limited, 2014.

REFERENCES:

1. David Hutton, Fundamentals of Finite Element Analysis‖, Tata McGraw Hill, 2005.
2. “Finite Element Method”, NPTEL Course, MHRD.
3. Dhanaraj. R and Prabhakaran Nair. K, Finite Element Analysis‖, Oxford Publications, 2015.
4. Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, Concepts and Applications of Finite Element Analysis‖, 4th Edition, Wiley Student Edition, 2004.
5. Seshu.P, Text Book of Finite Element Analysis‖, PHI Learning Pvt. Ltd., NewDelhi, 2012.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Engineering Stream Courses
		PROFESSIONAL ELECTIVE II
1	21HM641PT	Professional Ethics in Engineering
2	21ME642PT	Elements for Green Manufacturing
3	21ME643PT	Renewable Energy Sources
4	21ME644PT	Computational Fluid Dynamics
5	21ME645PT	Unconventional Machining Processes

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Course code	**21HM641PT**	**Semester**	**VI**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**PROFESSIONAL ETHICS IN ENGINEERING (COMMON TO MECH,CHEMICAL,ECE & IT)**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

PREREQUISITE:

- Basic Engineering Knowledge.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C641.1	***Outline*** the importance of human values, harmony and ethical behaviour in real life situations.	K2
C641.2	***Explain*** the ethical sensitivity, Increased knowledge of relevant standards of conduct, improve ethical judgment, improve ethical will power.	K2
C641.3	***Summarize*** the real-world problems that improve the world around us.	K2
C641.4	***Illustrate*** the safety of the people who will be affected by the products that the designs and the responsibilities, rights to be maintained for safety aspects.	K2
C641.5	***Understand*** the ethics of engineering, including students, academics, and researchers, and is indispensable for those involved in international and cross-cultural environments.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C641.1	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C641.2	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C641.3	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C641.4	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C641.5	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS **No. of Credits: 3**

UNIT I HUMAN VALUES **10**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management - The role of engineers in modern society - social expectations.

UNIT II ENGINEERING ETHICS **9**

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION **9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law - Research ethics - the challenger case study.

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS **9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

UNIT V GLOBAL ISSUES **8**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors Moral Leadership –Code of Conduct – Corporate Social Responsibility

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. M. Govindarajan, S. Natarajan, V. S. Senthil Kumar, Engineering Ethics, Prentice Hall of India, New Delhi, 2013.
2. Mike W. Martin and Roland Schinzinger, Ethics in Engineering, Tata McGraw Hill, New Delhi, 2014.

REFERENCES:

1. Charles B. Fleddermann, Engineering Ethics, Pearson Prentice Hall, New Jersey, 2011.
2. "Ethics in Engineering Practice", NPTEL Course, MHRD.
3. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, Engineering Ethics - Concepts and Cases, Cengage Learning, 2013.
4. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers, Oxford University Press, Oxford, 2001.
5. John R Boatright, Ethics and the Conduct of Business, Pearson Education, New Delhi, 2016.
6. Laura P. Hartman and Joe Desjardins, Business Ethics: Decision Making for Personal Integrity and Social Responsibility, Mc Graw Hill education, India Pvt. Ltd, New Delhi, 2017.

Course code	21ME642PT	Semester	VI			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	ELEMENTS OF GREEN MANUFACTURING		3	0	0	3

COURSE OBJECTIVES:

- To expose for the basics of environmental sustainability, impact assessment and environmental based improvements towards lean manufacturing systems.
- To analyze various machineries with intent to conserve energy, hazardous and solid wastes.
- To impart the knowledge about the need, procedure and benefits of Green-Co rating.

PREREQUISITE:

- Production Technology.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C642.1	***Understand*** the Concepts of environmental sustainability and environmental impact assessment.	K2
C642.2	***Explain*** the suitable schemes towards design of green manufacturing requirements.	K2
C642.3	***Elaborate*** the manufacturing processes towards conservation of energy.	K2
C642.4	***Discuss*** about the manufacturing processes towards minimization or prevention of hazardous and solid wastes.	K2
C642.5	***Summarize*** the need, types and benefits of green co-rating.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C642.1	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C642.2	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C642.3	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C642.4	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-
C642.5	3	2	-	-	-	1	-	3	-	-	-	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 3

UNIT I ENVIRONMENTAL SUSTAINABILITY AND IMPACT ASSESSMENT 9

Environmental impact assessment objectives – Legislative development – European community directive – Hungarian directive. Strategic environmental assessment and sustainability appraisal. Regional spatial planning and environmental policy.

UNIT II LEAN MANUFACTURING AND GREEN ENERGY SYSTEM 9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing. World energy consumption – Greenhouse effect, Global warming. Energy conservation and measurement principles with their applicability in engineering and process industries.

UNIT III ENERGY SAVING MACHINERY AND COMPONENTS 9

Electricity Billing: Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption. Selection of fans, pumps and Compressors – Performance Evaluation – Cause for inefficient operation – scope for energy conservation.

UNIT IV HAZARDOUS AND SOLID WASTE MANAGEMENT 9

Hazardous waste: definition, terminology, classification and Sources – Need for hazardous waste management: Need, Handling, methods of collection, storage and transport with suitable examples. Solid waste management: Need, Waste prevention and Life cycle assessment. Collection, storage, reuse and recycling of solid waste with suitable examples.

UNIT V GREEN CO-RATING 9

Ecological Footprint - Need for Green Co-Rating – Green Co-Rating System – Intent – System Approach – Weightage- Assessment Process – Types Of Rating – Green Co-Benefits – Case Studies of Green Co-Rating.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Ronald G. Askin and Jeffrey B. Goldberg, "Design and Analysis of Lean Production Systems", John Wiley and Sons, 2003.
2. Stephen Doven, "Environment and Sustainability Policy: Creation, implementation, Evaluation", The Federation Press, 2005.
3. "Green Co Case Study Booklet", CII – Sohrabji Godrej Green Business Centre, 2015.

REFERENCES:

1. Clive George, Collin.C, Kirkpolarice. H, "Impact Assessment and sustainable development", Edward Elgar Publishing 2007.
2. "Sustainability through Green Manufacturing Systems", NPTEL Course, MHRD.
3. "Green Manufacturing: Case Studies in Lean and Sustainability, Association for Manufacturing Excellence", CRC press, 2007.
4. Chaigier N.A. "Energy Consumption and Environment", Mc Graw Hill, 2007.
5. Hamies, "Energy Auditing and Conservation, Methods Measurements, management and Case Study", Hemisphere, Washington, 1980.
6. Bhide A.D., Sundaresan B.B., "Solid Waste Management – Collection Processing and Disposal", Mudrashilpa offset printers, Nagpur, 2001.

Course code	21ME643PT	Semester	VI			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	RENEWABLE ENERGY SOURCES		3	0	0	3

COURSE OBJECTIVES:

- To Analyse the current energy scenario of India and World.
- To Evaluating the possible renewable energy sources and its location & applications.

PREREQUISITE:

- Basic Environmental science.
- Thermal Engineering.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C643.1	***Describe*** the current energy scenario of India and World.	K2
C643.2	***Explain*** about the principles in solar energy absorption and its suitable technologies for harnessing them.	K2
C643.3	***Elaborate*** the importance of wind energy and deploy appropriate devices for energy generation.	K2
C643.4	***Summarize*** about the biomass energy conversion and recovery.	K2
C643.5	***Outline*** the appropriate engineering principles for tapping energy from ocean and geothermal resources.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C643.1	3	2	-	-	-	1	1	-	-	-	-	1	-	2	-
C643.2	3	2	-	-	-	1	3	-	-	-	-	1	-	2	-
C643.3	3	2	-	-	-	1	3	-	-	-	-	1	-	2	-
C643.4	3	2	-	-	-	1	3	-	-	-	-	1	-	2	-
C643.5	3	2	-	-	-	1	3	-	-	-	-	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 3

UNIT I ENERGY SCENARIO **9**

Indian energy scenario in various sectors – domestic, industrial, commercial, agriculture, transportation and others – Present conventional energy status – Present renewable energy status- Potential of various renewable energy sources-Global energy status-Per capita energy consumption in various countries - Future energy plans.

UNIT II SOLAR ENERGY **9**

Solar radiation – Measurements of solar radiation and sunshine – Solar thermal collectors – Flat plate and concentrating collectors – Solar thermal applications – Solar thermal energy storage – Fundamentals of solar photovoltaic conversion – Solar cells – Solar PV Systems – Solar PV applications.

UNIT III WIND ENERGY **9**

Wind data and energy estimation – Betz limit - Site selection for wind farms – characteristics Horizontal axis wind turbine – components - Vertical axis wind turbine – Wind turbine generators and its performance – Hybrid systems – Environmental issues – Applications.

UNIT IV BIO-ENERGY **9**

Bio resources – Biomass direct combustion – thermochemical conversion - biochemical conversion-mechanical conversion - Biomass gasifier - Types of biomass gasifiers - Cogeneration –- Carbonisation – Pyrolysis - Biogas plants – Digesters –Biodiesel production – Ethanol production - Applications.

UNIT V OCEAN, GEOTHERMAL AND MODERN FORMS OF ENERGY **9**

Small hydro - Tidal energy – Wave energy – Open and closed OTEC Cycles – Limitations – Geothermal energy – Geothermal energy sources - Types of geothermal power plants – Applications - Environmental impact. Gravity battery - Modern renewable energy sources.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. G.D. Rai, Non-Conventional Energy Sources, Standard Publishers Distributors, 1992.
2. John Twidell, Tony Weir, and Anthony D. Weir, Renewable Energy Resources, Taylor & Francis, 2006.
3. Godfrey Boyle, Renewable Energy, power for a sustainable future, Oxford University Press, 2012.
4. Fang Lin You, Hong ye, Renewable Energy Systems, Advanced conversion technologies and applications, CRC Press, 2012.

REFERENCES:

1. Bent Sorensen, "Renewable Energy", 5th Edition, Academic Press, 2017.
2. Renewable Energy Engineering, NPTEL Course, MHRD.
3. B.H. Khan, Non-Conventional Energy Resources‖, McGraw Hill, 2009.
4. G.N. Tiwari, Solar Energy – Fundamentals Design, Modelling and applications, Alpha Science, 2015.
5. N.K. Bansal, Non-Conventional Energy Resources, Vikas Publishing House, 2014.
6. G Sargsyam, M Bhatia, S G Banerjee, K Raghunathan and R Soni, Unleashing the Potential of Renewable Energy in India, World bank report, Washington D.C, 2011.
7. S.P. Sukhatme, Solar Energy: Principles of Thermal Collection and Storage‖, Tata McGraw Hill, 2009.

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Course code	21ME644PT	Semester	VI			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**COMPUTATIONAL FLUID DYNAMICS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce Governing Equations of viscous fluid flows.
- To introduce numerical Modeling and its role in the field of fluid flow and heat transfer.

PREREQUISITE:

- Fundamentals of partial differential equations.
- Heat Transfer.
- Fluid Mechanics.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C644.1	***Apply*** the governing equation to formulate numerical solution by using initial and boundary conditions.	K3
C644.2	***Analyze*** one dimensional unsteady problem using finite difference method.	K3
C644.3	***Apply*** the governing equations to formulate numerical solution for diffusion problems using finite volume method.	K3
C644.4	***Solve*** the convective heat transfer problems using finite volume method.	K3
C644.5	***Solve*** heat conduction in flow and turbulence problems using various models.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C644.1	3	2	2	-	-	2	2	-	-	-	-	1	2	1	1
C644.2	3	2	2	-	-	2	2	-	-	-	-	1	2	1	1
C644.3	3	2	2	-	-	2	2	-	-	-	-	1	2	1	1
C644.4	3	2	2	-	-	2	2	-	-	-	-	1	2	1	1
C644.5	3	2	2	-	-	2	2	-	-	-	-	1	2	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 3

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE METHOD 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT III FINITE VOLUME METHOD (FVM) FOR DIFFUSION 9

Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems. One dimensional unsteady heat conduction through Explicit, Crank –Nicolson and fully implicit schemes.

UNIT IV FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V CALCULATION FLOW FIELD BY FVM 9

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants. Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. T.J. Chung, Computational Fluid Dynamics, Cambridge University, Press, 2002.
2. Ghoshdastidar, P.S., computer Simulation of flow and heat transfer, Tata McGraw Hill Publishing Company Ltd., 1998.
3. Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
4. Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.

REFERENCES:

1. Muralidhar, K., and Sundararajan, T., computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995.
2. Ghoshdastidar P.S., Heat Transfer, Oxford University Press, 2005.
3. “Computational Fluid Dynamics”, NPTEL Course, MHRD.
4. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing co. Ltd., New Delhi,2005.
5. Prodip Niyogi, Chakrabarty.S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
6. Introduction to Computational Fluid Dynamics Anil W. Date Cambridge University Press, 2005.

Course code	21ME645PT	Semester	VI			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	UNCONVENTIONAL MACHINING PROCESSES		3	0	0	3

COURSE OBJECTIVES:

- To familiarize students with various non-traditional machining processes, the various process parameters and their influence on performance with their applications.
- To compare the various non-traditional machining process, economics and environmental aspects of non-traditional machining processes.

PREREQUISITE:

- Production Technology – II.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C645.1	***Understand*** the need for unconventional machining processes and its classification.	K2
C645.2	***Compare*** various thermal energy and electrical energy based unconventional machining processes.	K2
C645.3	***Summarize*** various chemical and electro-chemical energy based unconventional machining processes.	K2
C645.4	***Explain*** various nano abrasives based unconventional machining processes.	K2
C645.5	***Distinguish*** various recent trends based unconventional machining processes.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C645.1	3	2	-	-	-	-	-	-	-	-	1	1	-	2	-
C645.2	3	2	-	-	-	-	-	-	-	-	1	1	-	2	-
C645.3	3	2	-	-	-	-	-	-	-	-	1	1	-	2	-
C645.4	3	2	-	-	-	-	-	-	-	-	1	1	-	2	-
C645.5	3	2	-	-	-	-	-	-	-	-	1	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial.

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Non-Traditional Machining Process (NTMP) – Need – Classifications, advantages, disadvantages and applications. Abrasive Jet Machining (AJM) – Water Jet Machining (WJM) – Abrasive Water Jet Machining (AWJM) - Ultrasonic Machining (USM) -Working Principles – equipment used – Process parameters – MRR- Applications.

UNIT II THERMAL AND ELECTRICAL ENERGY BASED PROCESSES 9

Electric Discharge Machining (EDM) – Wire-cut EDM (WEDM) – Working Principle-equipments-Process Parameters-Surface Finish and MRR- Electrode / Tool – Power and control Circuits-Tool Wear – Dielectric fluids – Flushing – Applications-Super drill- Laser Beam Machining and drilling, (LBM), Plasma Arc Machining (PAM) and Electron Beam Machining (EBM). Principles – Equipment –Types – Applications.

UNIT III CHEMICAL AND ELECTRO-CHEMICAL ENERGY BASED PROCESSES 9

Chemical machining (CHM) and Electro-Chemical machining (ECM) - Etchants – Maskant - techniques of applying maskants - Principles of ECM – equipment's - Electrical circuit-Process Parameters – Surface finish and MRR-Applications. Electro Chemical Grinding (ECG) and Electro Chemical Honing (ECH).

UNIT IV ADVANCED FINISHING PROCESSES 9

Abrasive Flow Machining (AFM), Chemo- Mechanical Polishing (CMP), Magnetic Abrasive Finishing (MAF), Magneto Rheological Finishing (MRF), Magneto Rheological Abrasive Flow Finishing (MRAFF) - working principles, equipment's, effect of process parameters, advantages, limitations and applications.

UNIT V RECENT TRENDS IN NON-TRADITIONAL MACHINING PROCESSES 9

Recent developments in non-traditional machining processes, their working principles, equipment, effect of process parameters, advantages, limitations and applications. Comparison of non-traditional machining processes - Economics and environmental impacts of non-traditional machining processes.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Vijay.K. Jain “Advanced Machining Processes” Allied Publishers Pvt. Ltd., New Delhi, 2007.
2. Pandey P.C. and Shan H.S. “Modern Machining Processes” Tata McGraw-Hill, New Delhi, 2007.

REFERENCES:

1. Benedict. G.F. “Non-traditional Manufacturing Processes”, Marcel Dekker Inc., New York, 1987.
2. “Non-traditional Manufacturing”, NPTEL Course, MHRD.
3. Mc Geough, “Advanced Methods of Machining”, Chapman and Hall, London, 1998.
4. Paul De Garmo, J.T.Black, and Ronald. A.Kohser, “Material and Processes in Manufacturing” Prentice Hall of India Pvt. Ltd., 8thEdition, New Delhi , 2001.

Course code	**21ME66P**	**Semester**	**VI**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**COMPUTER AIDED MANUFACTURING LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- Applying the fundamental working principle of CNC machine tool.
- Programming G & M Code programming and simulate the CNC program.
- Generating part programming data through CAM software.
- Integrating CNC and unconventional machine tools.
- Applying the principles of Additive Manufacturing process.

PREREQUISITE:

- Production Technology -II.

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C606.1	***Apply*** the fundamental working principle of CNC machine tool.	K3
C606.2	***Develop*** G & M Code programming and simulate the CNC program.	K3
C606.3	***Generate*** part programming data through CAM software.	K3
C606.4	***Integrate*** CNC and unconventional machine tools.	K3
C606.5	***Apply*** the principles of Additive Manufacturing process.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
C606.1	3	3	2	-	2	2	1	-	1	-	1	1	2	2	1
C606.2	3	3	2	-	2	2	1	-	1	-	1	1	2	2	1
C606.3	3	3	2	-	2	2	1	-	1	-	1	1	2	2	1
C606.4	3	3	2	-	2	2	1	-	1	-	1	1	2	2	1
C606.5	3	3	2	-	2	2	1	-	1	-	1	1	2	2	1

Note: 1: Slight, 2: Moderate, 3: Substantial.

List of Experiment **No. of Credits: 2**

Manual Part Programming: - CNC Machining & Turning Centre:

1. CNC manual part programming for linear cutting.
2. CNC manual part programming for circular cutting.
3. CNC manual part programming for cutter radius compensation.
4. CNC manual part programming for canned cycle operations.
5. CNC manual part programming for straight turning.
6. CNC manual part programming for taper turning.
7. CNC manual part programming for radial turning.
8. CNC manual part programming for thread cutting.
9. CNC manual part programming for rough and finish turning cycle.
10. CNC manual part programming for drilling and tapping cycle.

Computer Aided Part Programming:

11. Generate Cutter Location (CL) data and post process data using CAM packages for Machining and Turning Centre.

Study Experiments:

12. Study of CNC Electric Discharge Machining (EDM) or CNC EDM wire-cut.
13. Study of Additive Manufacturing Process: Fused Deposition Modelling (FDM), Stereolithography (SLA), Selective Laser Sintering (SLS), Laminated Object Manufacturing (LOM).

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Ibrahim Zeid “Mastering CAD CAM” Tata McGraw-Hill Publishing Co.2007.
2. Yoram koren, Computer control of manufacturing systems, 2017.

REFERENCES:

1. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008.
2. N Mehta, Machine tools design and numerical control, 3rd edition, 2017.

Course code	21EE02P	Semester	VI			
Category	**EMPLOYABILITY ENHANCEMENT COURSE (EEC)**		**L**	**T**	**P**	**C**
Course Title	**MINI PROJECT – II**		**0**	**0**	**2**	**1**

COURSE OBJECTIVES:

- To introduce real project based self-learning.
- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews & viva voce examination.
- To communicate the project work to the society through journal publication.

PREREQUISITE:

- All Professional Core & Elective Courses.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C607.1	***Elaborate*** specific problem statements in the practical world difficulties with reasonable assumptions and constraints.	K6
C607.2	***Organize*** literature survey and patent search in the area of interest.	K3
C607.3	***Perform*** experiments, design and error analysis.	K4
C607.4	***Ascertain*** the results and arrive at scientific conclusions, products and solution.	K5
C607.5	***Document*** the results in the form of technical report, presentation and journal publication.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C607.1	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C607.2	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C607.3	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C607.4	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1
C607.5	3	3	2	2	2	1	1	1	3	2	2	2	2	2	1

Note: 1: Slight, 2: Moderate, 3: Substantial.

DOMAIN **No. of Credits: 1**

Projects can be carried out in the following domains, but not limited with

1. Mechanical Engineering Design
2. Manufacturing Engineering
3. Industrial Engineering
4. Thermal Engineering
5. Reverse Engineering
6. Renewable Energy Sources
7. Industrial Automation and Robotics
8. Mechatronics
9. Refrigeration and Air Conditioning
10. Metrology and Measurements
11. Composites and Nano Technology
12. Emerging Technologies in Mechanical Engineering, etc.

Total: 30 Periods

LEARNING RESOURCES:

OFFLINE RESOURCES:

1. Journal papers in Library
2. Knowledge Resource Centre

ONLINE RESOURCES:

1. https://www.sciencedirect.com/
2. https://www.tandfonline.com/
3. https://link.springer.com/
4. https://swayam.gov.in/nc_details/NPTEL
5. https://library.annauniv.edu/
6. https://www.youtube.com/
7. https://www.ncbi.nlm.nih.gov/
8. https://www.ncbi.nlm.nih.gov/pmc/
9. https://mtccindia.res.in/
10. https://www.atcc.org/

VEL TECH HIGH TECH
Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE
An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21EE04P	Semester	VI			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	INTERNSHIP		0	0	2	1

COURSE OBJECTIVES:

- To expose with the industry environment and to take up on-site assignment as trainees or interns.

PREREQUISITE:

- Basic fundamental knowledge of professional core and elective courses.

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C608.1	***Utilize*** industrial practices and to work in teams	K3
C608.2	***Solve*** contemporary issues	K3
C608.3	***Demonstrate*** & communicate effectively	K2
C608.4	***Analyze*** the impact of engineering solutions in a global, economic, environmental and societal context	K4
C608.5	***Appraise*** to engage in research and to involve in life-long learning	K5

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO. No.	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C608.1	3	3	3	2	1	1	1	1	2	2	2	2	2	3	2
C608.2	3	3	3	2	1	1	1	1	2	2	2	2	2	3	2
C608.3	3	3	3	2	1	1	1	1	2	2	2	2	2	3	2
C608.4	3	3	3	2	1	1	1	1	2	2	2	2	2	3	2
C608.5	3	3	3	2	1	1	1	1	2	2	2	2	2	3	2

Note: 1: Slight, 2: Moderate, 3: Substantial.

Course Requirements:	**No. of Credits: 1**

1. Minimum Two weeks of work at industry site.
2. Supervised by an expert at the industry.

Evaluation Method:

2. Submission of internship report & internship certification.
3. Presentation & Viva Voce.

Total: Minimum 2 weeks

VII SEMESTER

SEMESTER VII										
S. No	Course Code	Course Title	Category	CIE Marks	SEE Marks	Total Marks	Credits			
							L	T	P	C
THEORY										
1	21ME71T	Engineering Failure Analysis	PCC	40	60	100	3	0	0	3
2	21ME72T	Process Planning and Cost Estimation	PCC	40	60	100	3	0	0	3
3	21ME73T	Product Design and Development	PCC	40	60	100	3	0	0	3
4	21ME74IT	Micro controller and Mechatronics	PCC	50	50	100	2	0	4	4
5	-	Professional Elective - III	PEC	40	60	100	3	0	0	3
PRACTICAL										
6	21ME76P	Simulation and Analysis Laboratory	PCC	60	40	100	0	0	4	2
7	21EE05P	Project Phase - I	PROJ	60	40	100	0	0	4	2
TOTAL										**20**

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Course code	21ME71T	Semester	VII			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	ENGINEERING FAILURE ANALYSIS		3	0	0	3

COURSE OBJECTIVES:
- To explain the importance of failure study of mechanical components.
- To discuss about various material characterization tools and analyze the failure.
- To equip students with knowledge on (i) how to design against failures and (ii) skills required in carrying out failure analysis.

PREREQUISITE:
- Engineering Mechanics
- Engineering materials and metallurgy

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C701.1	***Explain*** different types of failure of engineering materials and their characteristic features.	K2
C701.2	***Calculate*** stresses/displacements around the crack tip for different modes of fracture.	K3
C701.3	***Apply*** various theories of failure to the components subjected to multidirectional loading.	K3
C701.4	***Design*** for failure against fracture, wear and creep loading	K3
C701.5	***Develop*** expertise on the experimental techniques and simulations utilized for failure analysis of various components.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C701.1	3	1	1	-	2	-	-	-	-	-	-	-	1	1	1
C701.2	3	1	1	-	2	-	-	-	-	-	-	-	1	1	1
C701.3	3	3	3	-	2	-	-	-	-	-	-	-	3	3	3
C701.4	3	3	3	-	2	-	-	-	-	-	-	-	3	3	3
C701.5	3	3	2	-	2	-	-	-	-	-	-	-	2	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I **INTRODUCTION** **9**

Material failure modes and their identification; Tools for failure analysis: Optical microscopy, Transmission Electron Microscopy, Scanning Electron Microscopy. Systematic approach to failure analysis.

UNIT II **STRESS AND DISPLACEMENT AROUND THE CRACK TIP** **9**

Brittle and Ductile Fracture-Modes of Fracture-Weakness of the components due to Flaws-Need for Linear Elastic Fracture Mechanics (LEFM) - Evaluation of Structural Design-Stress and displacement around the crack tip in K-annulus for Mode-I and Mode-II plane crack problems- Stress and displacement around the crack tip in K-annulus for Mode III crack problems.

UNIT III **FATIGUE ANALYSIS** **9**

Loading under high cycle fatigue conditions, Test methods, S-N-P curves, endurance diagrams, influence factors - Low cycle fatigue, fretting fatigue; Fatigue design for combined stress; cumulative damage and life prediction. Creep loading. Failures related to corrosion and wear. service failures during high temperature service.

UNIT IV **FAILURE AND FRACTURE MECHANISMS** **9**

Fracture processes, Meaning of ductile and brittle fracture, Effect of strain rate and temperature. Fracture mechanics and Failures, Linear elastic fracture mechanics, fracture mechanics principles in design practice, Elastic Plastic fracture mechanics, Examples of crack-growth Analysis for cyclic loading.

UNIT V **FAILURES IN JOINTS AND FASTENERS** **9**

Welded constructions and screw fastenings, Environmental degradation, Embrittlement of metals and alloys. Contemporary issues

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Arthur J. McEvily, “Metal Failures: Mechanisms, Analysis, Prevention”, 2nd edition, John Wiley & Sons Inc. USA, 2013.
2. Charlie R. Brooks and Ashok Choudhury, “Failure Analysis of Engineering Materials”, 1st Edition, McGraw-Hill Education, 2002.
3. Tribikram Kundu, “Fundamentals of Fracture Mechanics”, Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2012.

REFERENCES:

1. Hock-Chye Qua, “Applied Engineering Failure Analysis: Theory and Practice”, CRC press, Taylor & Francis, U.K, 2017.
2. F.C. Campbell, “Fatigue and Fracture: Understanding the basic”, 1st edition, ASM International, 2012.
3. Abdel Salam Hamdy Makhlouf, Mahmood Aliofkhazraei, “Handbook of Materials Failure Analysis with Case Studies from the Aerospace”, BH, Elsevier, U.K, 2016.

Course code	**21ME72T**	**Semester**	**VII**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**PROCESS PLANNING AND COST ESTIMATION**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the process planning concepts
- To make cost estimation for various products after process planning

PREREQUISITE:

- Production Technology
- Computer Aided Design

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C702.1	***Select*** the process, equipment and tools for various industrial products.	K2
C702.2	***Prepare*** process planning activity chart.	K2
C702.3	***Explain*** the concept of cost estimation.	K2
C702.4	***Compute*** the job order cost for different type of shop floor.	K3
C702.5	***Calculate*** the machining time for various machining operations.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C702.1	3	2	-	-	-	-	-	-	1	1	2	1	-	2	-
C702.2	3	2	-	-	-	-	-	-	1	1	2	1	2	2	2
C702.3	3	2	-	-	-	-	-	-	1	1	2	1	-	3	-
C702.4	3	3	-	-	-	-	-	-	1	1	2	1	-	3	-
C702.5	3	3	-	-	-	-	-	-	1	1	2	1	-	3	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION TO PROCESS PLANNING **9**

Introduction- methods of process planning-Drawing Interpretation-Material evaluation – steps in process selection-. Production equipment and tooling selection.

UNIT II PROCESS PLANNING ACTIVITIES **9**

Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods – Set of documents for process planning-Economics of process planning-case studies.

UNIT III INTRODUCTION TO COST ESTIMATION **9**

Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of overhead charges-Calculation of depreciation cost.

UNIT IV ESTIMATION OF PRODUCTION COST **9**

Estimation of production cost for - Casting processes. Estimation in welding shop - Arc welding - Gas Welding - Flame cutting. Estimation of metal forming- Forging- Forging losses. Estimation in Foundry shop– Moulding- pattern making. Manufacturing cost estimation of welding processes- Manufacturing cost estimation of foundry processes shop.

UNIT V ESTIMATION OF MACHINING TIME AND COST **9**

Estimation of Machining time – Lathe operations, Drilling, Milling, Shaping, Planning and Grinding. Cost estimation for machining processes. Machining time and cost calculation - shaping process, Milling process, Drilling process - Machining time and cost calculation - CNC Turning, CNC Milling. Standard time Calculation.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Peter scalon, “Process planning, Design/Manufacture Interface”, Butterworth-Heinemann Ltd, 2003.
2. Sinha B.P, “Mechanical Estimating and Costing”, Tata-McGraw Hill publishing co, 1995.

REFERENCES:

1. Chitale A.K. and Gupta R.C., “Product Design and Manufacturing”, 5th Edition, Publisher Prentice Hall India Learning Private Limited, 2011.
2. Banga TR and Sharma SC, “Mechanical Estimating and Costing: Including Contracting”, Khanna Publishers, 2003.
3. Phillip F. Ostwald and Jairo Munoz, “Manufacturing Processes and systems”, 9th Edition, John Wiley, 2008.
4. Mikell P.Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 4th Edition, 2016.

Course code	21ME73T	Semester	VII			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	PRODUCT DESIGN AND DEVELOPMENT		3	0	0	3

COURSE OBJECTIVES:

- Applying the principles of generic development process and setting product specification for new product design and development.
- Generating, selecting, screening, and testing concepts for new product design and development.

PREREQUISITE:

- Production Technology
- Design of Machine Elements
- Design of Transmission Systems

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
	On successful completion of this Course, students will be able to	
C703.1	***Apply*** the principles of generic development process to set product specification for new product design and development.	K3
C703.2	***Generate*** concepts for new product design and development.	K3
C703.3	***Implement*** the principles of product architecture and industrial design to design and develop new products.	K2
C703.4	***Select*** the principles of DFMA and Prototyping for new product development.	K2
C703.5	***Adapt*** the concepts of economics principles, project management practices in the development of new product	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C703.1	3	3	3	2	-	-	-	-	-	-	-	-	2	2	2
C703.2	3	3	3	2	-	-	-	-	-	-	-	-	2	2	2
C703.3	3	3	3	2	-	-	-	-	-	-	-	-	2	2	2
C703.4	3	3	3	2	-	-	-	-	-	-	-	-	2	2	2
C703.5	3	3	3	2	-	-	-	-	-	-	-	-	2	2	2

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Introduction – Characteristics of Successful Product Development – Duration and cost of Product Development – Challenges – Generic Development Process – Concept Development: the Front End Process – Adaptation of the Generic Product Development Process – Product Development Process Flow – Product Development Organization.

UNIT II PRODUCT PLANNING, IDENTIFYING CUSTOMER NEEDS, PRODUCT SPECIFICATION 9

Product Planning Process: Identification of opportunities; evaluation and prioritization of projects; allocation of resources & plan timing; completion of pre-project planning. Identification of Customer Needs: Collection of raw data from customers; interpretation of raw data of customer needs; organization of the needs into a hierarchy; establishment of relative importance of needs. Product Specifications: Establishment of Target Specifications, Setting-up of Final Specifications.

UNIT III CONCEPT GENERATION, SELECTION, TESTING 9

Concept Generation: clarification of the problem; searching externally; searching internally, systematic exploration. Concept Selection: concept screening steps; concept scoring steps. Concept Testing: Defining the purpose of concept test; choosing a survey population; format; communicating the concept; measuring the customer response; interpretation of results.

UNIT IV PRODUCT ARCHITECTURE, INDUSTRIAL DESIGN, DESIGN FOR MANUFACTURING 9

Product Architecture: Types of modularity – Implications – Establishing the Architecture – Platform Planning. Industrial Design: Assessing the need – Impact – Design Process. Design for Manufacturing: estimation of manufacturing costs; reduction of costs of components, assembly, supporting production; other factors.

UNIT V PROTOTYPING AND MANAGING PRODUCTS 9

Prototype Basics – Principles of Prototyping – Prototyping Technologies – Planning for Prototypes.

Management of Projects: Understanding and representing Tasks – Baseline Project Planning – Accelerating Projects – Project Execution – Postmortem Project Evaluation.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Karl Ulrich,Steven Eppinger and Maria C. Yang, “Product Design and Development”, McGraw-Hill Education, 2020.
2. Ulrich K.T. and Eppinger S.D., “Product Design and Development”, McGraw-Hill, 2016.

REFERENCES:

1. Andrea Belz, “Product Development- The McGraw-Hill 36-Hour Course”, Mcgraw-hill, 2011.
2. Rosenthal S. “Effective Product Design and Development” Irwin Professional Publishing, 1992.
3. Pugh S. “Total Design : Integrated Methods for Successful Product Engineering”, Addison Wesley Publishing, 2010.

Course code	21ME74IT	Semester	VII			
Category	PROFESSIONAL CORE COURSE (PCC)		L	T	P	C
Course Title	MICRO CONTROLLER AND MECHATRONICS		2	0	4	4

COURSE OBJECTIVES:

- To impart knowledge about the elements and techniques involved in Mechatronics systems which are very much essential to understand the emerging field of automation.

PREREQUISITE:

- Hydraulics and Pneumatics
- Basic Electrical, Electronics and Instrumentation Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C704.1	***Discuss*** the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical, Electronic Systems and sensor technology.	K2
C704.2	***Describe*** the architecture of Microprocessor and Microcontroller, Pin Diagram, Addressing Modes of Microprocessor and Microcontroller.	K2
C704.3	***Discuss*** Programmable Peripheral Interface, Architecture of 8255 PPI, and various device interfacing	K2
C704.4	***Explain*** the architecture, programming and application of programmable logic controllers to problems and challenges in the areas of Mechatronic engineering.	K3
C704.5	***Summarize*** various Actuators and Mechatronics system using the knowledge and skills acquired through the course and also from the given case studies	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C704.1	2	1	1	-	-	-	-	-	-	-	-	-	3	3	-
C704.2	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-
C704.3	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-
C704.4	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-
C704.5	2	1	1	-	-	-	-	-	-	-	-	-	2	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 4**

UNIT I INTRODUCTION **6**

Introduction to Mechatronics – Systems – Concepts of Mechatronics approach – Need for Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics. Sensors and Transducers: Static and dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance sensors – Strain gauges – Eddy current sensor – Hall effect sensor – Temperature sensors – Light sensors

UNIT II MICROPROCESSOR AND MICROCONTROLLER **6**

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram. Introduction to Raspberry Pi

UNIT III PROGRAMMABLE PERIPHERAL INTERFACE **6**

Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT IV PROGRAMMABLE LOGIC CONTROLLER **6**

Introduction – Basic structure – Input and output processing – Programming – Mnemonics – Timers, counters and internal relays – Data handling – Selection of PLC.

UNIT V ACTUATORS AND MECHATRONIC SYSTEM DESIGN **6**

Types of Stepper and Servo motors – Construction – Working Principle – Advantages and Disadvantages. Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Engine Management system – Automatic car park barrier.

Total: 30 Periods

LIST OF EXPERIMENTS

1. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.
2. Stepper motor interface.
3. Traffic light interface.
4. Speed control of AC and DC motor.
5. Study of various types of transducers.
6. Design of hydraulic, pneumatic and electro-pneumatic circuits.
7. Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.
8. Study of PLC and its applications.
9. Study of image processing technique.
10. Introduction to Arduino Programming
11. Introduction to Raspberry Pi
12. Line Following Robot

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering" Pearson, 2015
2. Godfrey C. Onwubolu, "Mechatronics: Principles and Applications", Elsevier Science, 2022.

REFERENCES:

1. DeSilva, C.W., Farbod Khoshnoud, Li, M. and Halgamuge, S.K, "Mechatronics: Fundamentals and Applications", CRC Press, Taylor & Francis Group, 2016.
2. Robert H. Bishop, "Mechatronics: Principles and Applications", CRC Press, 2018
3. Robert H Bishop, "Mechatronic System Control, Logic, and Data Acquisition", Taylor & Francis, 2017.
4. Sergey Edward Lyshevski, "Mechatronics and Control of Electromechanical Systems", CRC Press, 2017.
5. Cesare Onwubolu Godfrey C Fantuzzi, "Mechatronics: Principles and applications", S.L.: Butterworth-Heinemann Ltd., 2020.

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
PROFESSIONAL ELECTIVE - III		
1	21AI04OT	Data Science
2	21ME752PT	Refrigeration and Air conditioning
3	21ME753PT	Computer Integrated Manufacturing
4	21ME754PT	Industrial Corrosion and Tribology
5	21ME755PT	Maintenance Engineering

Course code	21AI04OT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	DATA SCIENCE		3	0	0	3

COURSE OBJECTIVES:

- To describe the life cycle of Data Science and computational environments for datascientists using Python.
- To describe the fundamentals for exploring and managing data with Python.
- To examine the various data analytics techniques for labelled/columnar data using Python.
- To demonstrate a flexible range of data visualizations techniques in Python.
- To describe the various Machine learning algorithms for data modelling with Python.

PREREQUISITE:

- Basic Mathematics Skills
- Basic knowledge of Python

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C751.1	***Understand*** the basic concept of Data Science.	K2
C751.2	***Make use of*** knowledge on NumPy to write program on array operations.	K2
C751.3	***Understand*** the concepts of Pandas.	K2
C751.4	***Write*** program retrieve data from an index labeled Library using Pandas.	K3
C751.5	***Construct*** code to combine two Datasets.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C751.1	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
C751.2	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
C751.3	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-
C751.4	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
C751.5	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO DATA SCIENCE 9

Introduction to Data Science and its importance - Data Science and Big data-, The life cycle of Data Science- The Art of Data Science - Work with data – data Cleaning, data Munging, data manipulation. Establishing computational environments for data scientists using Python with IPython and Jupyter.

UNIT II TOWARDS DATA SCIENCE USING NUMPY 9

Understanding Data Types in Python - The Basics of NumPy Arrays - Computation on NumPy Arrays: Universal Functions - Aggregations: Min, Max, and Everything in Between Computation on Arrays: Broadcasting-Comparisons, Masks, and Boolean Logic Fancy Indexing-Sorting Arrays.

UNIT III PYTHON LIBRARIES FOR DATA WRANGLING 9

Installing and Using Pandas, Introducing Pandas Objects, Data Indexing and Selection. Operating on Data in Pandas, Handling Missing Data.

UNIT IV DATA MANIPULATION 9

Hierarchical Indexing Combining Datasets: Concat and Append, Combining Datasets: Merge and Join. Aggregation and Grouping, Pivot Tables, Vectorized String Operations, Working with Time Series-General Matplotlib Tips, Simple Line Plots, Simple Scatter Plots.

UNIT V DATA VISUALIZATION 9

Visualizing Errors Density and Contour Plots, Histograms, Binnings, and Density, Customizing Plot Legends Customizing Colorbars, Multiple Subplots, Text and Annotation, Customizing Ticks Customizing Matplotlib: Configurations and Stylesheets, Geographic Data with Basemap.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Python Data Science Handbook-Essential Tools for Working with Data, Jake Vander Plas, O'Reilly Media, 2020.
2. Data Science from Scratch: First Principles with Python, Joel Grus, O'Reilly, 2018.

REFERENCES:

1. Python for Data Analysis, Wes Mckinney, O'Reilly Media, 2013.
2. Field Cady, “Data Science Hand Book”, John Wiley & Sons, 2017.
3. Fundamentals of Data Science, Samuel Burns, Amazon KDP printing and Publishing, 2019.
4. Doing Data Science, Straight Talk from The Frontline, Cathy O'Neil and Rachel Schutt. O'Reilly. 2014.
5. Tony Ojeda, Sean Patrick Murphy, Benjamin Bengfort, Abhijit Dasgupta, “Practical Data Science Cookbook”, Packt Publishing Ltd., 2014.
6. Nathan Yau, “Visualize This: The Flowing Data Guide to Design, Visualization, and Statistics”, Wiley, 2011.
7. Shai Vaingast, “Beginning Python Visualization Crafting Visual Transformation Scripts”, Apress, 2nd edition, 2014

Course code	21ME752PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	REFRIGERATION AND AIR CONDITIONING		3	0	0	3

COURSE OBJECTIVES:

- To understand the underlying principles of operations in different Refrigeration & Air conditioning systems and components.
- To provide knowledge on design aspects of Refrigeration & Air conditioning systems

PREREQUISITE:

- Thermodynamics
- Thermal Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C752.1	***Explain*** the basic concepts of Refrigeration	K2
C752.2	***Apply*** the Vapor compression Refrigeration systems concept to solve problems	K3
C752.3	***Discuss*** the various types of Refrigeration systems	K2
C752.4	**Select** the Psychrometric properties and its use in psychrometric processes	K3
C752.5	**Apply** the concepts of Air conditioning and to solve problems	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C752.1	3	2	2	-	-	-	1	-	-	-	-	-	-	2	-
C752.2	3	2	2	-	-	-	1	-	-	-	-	-	-	2	-
C752.3	3	2	2	-	-	-	1	-	-	-	-	-	-	2	-
C752.4	3	2	2	-	-	-	1	-	-	-	-	-	-	2	-
C752.5	3	2	2	-	-	-	1	-	-	-	-	-	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Introduction to Refrigeration - Unit of Refrigeration and C.O.P.– Ideal cycles- Refrigerants Desirable properties – Classification - Nomenclature - ODP & GWP.

UNIT II VAPOUR COMPRESSION REFRIGERATION SYSTEM 9

Vapor compression cycle : p-h and T-s diagrams - deviations from theoretical cycle – sub cooling and super heating- effects of condenser and evaporator pressure on COP- multi pressure system - low temperature refrigeration - Cascade systems – problems. Equipment: Type of Compressors, Condensers, Expansion devices, Evaporators.

UNIT III OTHER REFRIGERATION SYSTEMS 9

Working principles of Vapour absorption systems and adsorption cooling systems – Steam jet refrigeration- Ejector refrigeration systems- Thermoelectric refrigeration- Air refrigeration - Magnetic - Vortex and Pulse tube refrigeration systems.

UNIT IV PSYCHROMETRIC PROPERTIES AND PROCESSES 9

Properties of moist Air-Gibbs Dalton law, Specific humidity, Dew point temperature, Degree of saturation, Relative humidity, Enthalpy, Humid specific heat, Wet bulb temperature Thermodynamic wet bulb temperature, Psychrometric chart; Psychrometric of air-conditioning processes, mixing of air streams.

UNIT V AIR CONDITIONING SYSTEMS AND LOAD ESTIMATION 9

Air conditioning loads: Outside and inside design conditions; Heat transfer through structure, Solar radiation, Electrical appliances, Infiltration and ventilation, internal heat load; Apparatus selection; fresh air load, human comfort & IAQ principles, effective temperature & chart, calculation of summer & winter air conditioning load; Classifications, Layout of plants; Air distribution system; Filters; Air Conditioning Systems with Controls: Temperature, Pressure and Humidity sensors, Actuators & Safety controls.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Arora, C.P., "Refrigeration and Air Conditioning", 4th edition, McGraw Hill, New Delhi, 2019.
2. R.K. Rajput., "A Textbook of Refrigeration & Air Conditioning", S.K. Kataria & Sons, 2019.

REFERENCES:

1. ASHRAE Hand book, Fundamentals, 2021.
2. Jones W.P, "Air conditioning engineering", 5th edition, Elsevier Butterworth-Heinemann, 2020.
3. R.S.Khurmi, "A Textbook of Refrigeration and Air Conditioning", Revised Edition, Chand Publications, 2019.
4. Domkundwar., "A Course in Refrigeration & Air Conditioning", Dhanapat, 2016.

Course code	21ME753PT	Semester	VII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	COMPUTER INTEGRATED MANUFACTURING		3	0	0	3

COURSE OBJECTIVES:

- To understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning.
- To impart knowledge on Manufacturing cost.
- To introduce the concept of plant Layout & Material Handling system.

PREREQUISITE:

- Production Technology
- Computer Aided Design

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C753.1	***Explain*** the basic concepts of CAD, CAM and computer integrated manufacturing systems	K2
C753.2	***Summarize*** the production planning and control and computerized process planning	K2
C753.3	***Differentiate*** the different coding systems used in group technology	K2
C753.4	***Explain*** the concepts of Flexible Manufacturing System (FMS) and Automated Guided Vehicle (AGV) system	K2
C753.5	***Classify*** robots used in industrial applications	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C753.1	-	3	2	-	2	-	-	-	1	1	2	1	1	2	-
C753.2	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-
C753.3	-	3	2	-	2	-	-	-	1	1	2	1	1	2	1
C753.4	-	3	2	-	2	-	-	-	1	1	2	1	1	3	1
C753.5	-	3	2	-	2	-	-	-	1	1	2	1	1	3	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system – Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In-Time Production.

UNIT II PRODUCTION PLANNING AND COMPUTER AIDED PROCESS PLANNING 9

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement Planning (MRP) – Capacity Planning- Control Systems - Shop Floor Control - Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III CELLULAR MANUFACTURING 9

Group Technology(GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 9

Types of Flexibility - Flexible Manufacturing Systems (FMS) - the FMS concept - transfer systems - head changing FMS - FMS Application & Benefits - FMS Planning and Control - Quantitative analysis in FMS - Simple Problems - Artificial Intelligence and Expert system in CIM.
Automated Guided Vehicle System (AGVS) - AGVS Application - Vehicle Guidance technology - Vehicle Management & Safety.

UNIT V INDUSTRIAL ROBOTICS 9

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Mikell P.Groover, “Automation, Production Systems and Computer Integrated Manufacturing”, Prentice Hall of India, 4th Edition, 2016.
2. Radhakrishnan P, Subramanyan S. and Raju V., “CAD/CAM/CIM”, New Age International Publishers, 4th Edition, 2018.

REFERENCES:

1. Rao. P, N Tewari & T.K. Kundra, “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Company, 2017
2. Kant Vajpayee S, “Principles of Computer Integrated Manufacturing”, Prentice Hall India, 1998.

Course code	**21ME754PT**	**Semester**	**VII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**INDUSTRIAL CORROSION AND TRIBOLOGY**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To introduce the thermodynamic and electrochemical aspects of corrosion
- To impart knowledge on the corrosion mechanism and corrosion testing methods for advanced engineering materials.
- To develop a solution-oriented approach by in depth knowledge of Industrial Tribology
- To address the underlying concepts, methods and application of Industrial Tribology.

PREREQUISITE:

- Fluid mechanics

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C754.1	***Describe*** the forms, mechanism, and kinetics of corrosion	K2
C754.2	***Impart*** knowledge on the corrosion mechanism and corrosion testing methods for advanced engineering materials	K2
C754.3	***Explain*** about the Introduction to Tribology.	K2
C754.4	***Define*** friction and wear using tribology.	K2
C754.5	***Understand*** the concepts of hydrostatic and hydrodynamic lubrication.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C754.1	3	2	1	-	-	2	1	3	1	-	-	1	1	-	-
C754.2	3	2	1	-	-	2	1	3	1	-	-	1	1	-	-
C754.3	3	2	1	-	-	2	1	3	1	-	-	1	1	-	-
C754.4	3	2	1	-	-	2	1	3	1	-	-	1	1	-	-
C754.5	3	2	1	-	-	2	1	3	1	-	-	1	1	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I BASICS OF CORROSION 9

Thermodynamics and electrochemical aspects of corrosion; EMF and galvanic series; Pourbaix diagram; Evans diagram; Corrosion mechanism – kinetics of activation polarization, kinetics of passivation polarization, mixed potential theory, diffusion, limiting current tendency; Corrosivity and passivity.

UNIT II FORMS OF METALLIC CORROSION 9

Uniform, pitting, crevice, intergranular, stress corrosion, corrosion fatigue, dealloying, high-temperature, biological, liquid metal attach, and exfoliation; Atmospheric corrosion of metallic materials: Steel (marine environment, nuclear power plants), aluminum alloy (marine environment), and magnesium alloys (biological medium).

UNIT III INTRODUCTION TO TRIBOLOGY 9

Tribology in design, tribology in industry Viscosity, flow of fluids, viscosity and its variation absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers, Tribological considerations Nature of surfaces and their contact; Physic mechanical properties of surface layer, Geometrical properties of surfaces, methods of studying surfaces; Study of contact of smoothly and rough surfaces.

UNIT IV FRICTION AND WEAR 9

Role of friction and laws of static friction, causes of friction, theories of friction, Laws of rolling friction; Friction of metals and non-metals; Friction measurements. Definition of wear, mechanism of wear, types and measurement of wear, friction affecting wear, Theories of wear; Wear of metals and non-metals.

UNIT V HYDROSTATIC AND HYDRODYNAMIC LUBRICATION 9

Principle of hydrostatic lubrication, General requirements of bearing materials, types of bearing materials and other applications, Principle of hydrodynamic lubrication, Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions- Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Mars G Fontana, Corrosion Engineering, McGraw Hill (3rd Edition). 2017
2. Introduction to Tribology, Halling , Wykeham Publications Ltd.2010.

REFERENCES:

1. H.G.Phakatkar and R.R.Ghorpade, "Tribology", Nirali Publications, 2019
2. Uhlig's, "Corrosion Handbook", Wiley-3rd Edition, 2011
3. R. Winston Revie and Herbert H. Uhlig, "Corrosion and Corrosion Control: An Introduction to Corrosion Science and Engineering", Wiley, 4th Edition, 2008
4. Washington D.C.,"Research Opportunities in Corrosion Science and Engineering", National Academic Press,2011
5. Sushil Kumar Srivatsava, "Tribology in Industry", S. Chand &Co, 2004.

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21ME755PT	Semester	VII			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**MAINTENANCE ENGINEERING**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To enable the student to understand the principles, functions and practices adapted in industry for the successful management of maintenance activities.
- To explain the different maintenance categories like Preventive maintenance, condition monitoring and repair of machine elements
- To illustrate some of the simple instruments used for condition monitoring in industry

PREREQUISITE:

- Dynamics of Machinery

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C755.1	***Understand*** the basic concept of maintenance, functions and practices of maintenance planning	K2
C755.2	***Explain*** the different maintenance categories like Preventive maintenance	K2
C755.3	***Understand*** the concept of misalignment and imbalance	K2
C755.4	***Explain*** different maintenance systems and the steps involved in establishing a maintenance plan.	K2
C755.5	***Determine*** the optimal inspection frequency for maximization of profit and minimization of down.	K2
C755.6	***Explain*** the repair methods for Material handling equipment, for beds, slide ways, spindles, gears, lead screws and bearings	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C755.1	2	-	1	-	-	-	1	-	-	-	-	1	-	2	-
C755.2	2	-	1	-	-	-	1	-	-	-	-	1	-	2	-
C755.3	2	-	1	-	-	-	1	-	-	-	-	1	-	2	-
C755.4	2	-	1	1	-	1	1	-	-	-	-	1	-	2	-
C755.5	2	-	1	1	-	1	1	-	-	-	-	1	-	2	-
C755.6	2	-	1	1	-	1	1	-	-	-	-	1	-	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I PRINCIPLES AND PRACTICES OF MAINTENANCE PLANNING 9

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity– Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

UNIT II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE 9

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

UNIT III CONDITION MONITORING 9

Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis- real time analysis- vibration limits- vibration severity criteria -vibration severity charts

UNIT IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9

Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – non-destructive testing - radio graphic inspection-ultrasonic testing Logical fault location methods – Sequential fault location.

UNIT V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT 9

Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Srivastava S.K. "Industrial Maintenance Management", S. Chand and Co., 2002.
2. Venkataraman. K "Maintenance Engineering and Management", PHI Learning, Pvt. Ltd., 2010
3. Bhattacharya S.N., "Installation, Servicing and Maintenance", S. Chand and Co., 2013

REFERENCES:

1. R. Keith Mobley, "Maintenance Engineering Handbook" sixth edition, McGraw-Hill, 2002.
2. Abdul Raouf, Daoud Ait-Kadi, Jezdimir Knezevic, Mohamed Ben-Daya, Salih O. Duffuaa Create citation, "Handbook of Maintenance Management and Engineering Haroun" Sringer, 2014.
3. Davies, "Handbook of Condition Monitoring", Chapman &Hall, 2012.

Course code	**21ME76P**	**Semester**	**VII**			
Category	**PROFESSIONAL CORE COURSE (PCC)**		**L**	**T**	**P**	**C**
Course Title	**SIMULATION AND ANALYSIS LABORATORY**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

PREREQUISITE:

- Strength of Materials
- Design of Machine Elements
- Design of Transmission systems
- Finite Element Analysis

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C706.1	***Examine*** stresses and strains in plates, brackets, and beams to grasp structural integrity and identify potential failure points under diverse loading conditions.	K3
C706.2	***Investigate*** heat transfer phenomena, considering material properties and thermal gradients, to analyze thermal stresses and strains and ensure structural integrity under varying temperature conditions.	K3
C706.3	***Evaluate*** natural frequencies of 2D components and beams to understand dynamic behavior and address resonance issues, aiding in the design of structures resilient to dynamic loads and vibrations.	K3
C706.4	***Conduct*** mode shape analysis to visualize and interpret vibrational characteristics, aiding in identifying critical deformation modes and optimizing designs for enhanced performance and reliability.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C706.1	3	2	-	-	-	-	-	-	-	-	-	1	3	3	3
C706.2	3	2	-	-	-	-	-	-	-	-	-	-	3	2	3
C706.3	3	2	2	2	2	-	-	-	1	2	2	-	3	3	3
C706.4	3	2	3	1	1	-	-	-	2	2	-	2	3	2	3

Note: 1: Slight, 2: Moderate, 3: Substantial

LIST OF EXPERIMENTS **No. of Credits: 2**

A. SIMULATION

1 MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables.

2 Use of Mat lab to solve simple problems in vibration.

3 Mechanism Simulation using Multibody Dynamic software.

B. ANALYSIS

4 Force and Stress analysis using link elements in Trusses, cables etc.

5 Stress and deflection analysis in beams with different support conditions.

6 Stress analysis of flat plates and simple shells.

7 Stress analysis of axi–symmetric components.

8 Thermal stress and heat transfer analysis of plates.

9 Thermal stress analysis of cylindrical shells.

10 Vibration analysis of spring-mass systems.

11 Model analysis of beams.

12 Harmonic, transient, and spectrum analysis of simple systems.

Total: 60 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. K.L.Narayan, P.Kannaiah and K.Venkata Reddy, "Production Drawing 3rd edition, New Age publications 2009.
2. Gowtham Pohit, Goutam Ghosh, "Machine Drawing with Auto CAD", (1st edition), Pearson Education, Delhi, 2004.

REFERENCES:

1. Huei-Huang Lee, Finite Element Simulations with ANSYS Workbench 2023, ISBN: 978-1-63057-615-8
2. Kent L. Lawrence, ANSYS Tutorial Release 2023, ISBN: 978-1-63057-613-4

VEL TECH HIGH TECH

Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE

An Autonomous Institution

Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai

Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	**21EE05P**	**Semester**	**VII**			
Category	**EMPLOYABILITY ENHANCEMENT COURSE (EEC)**		**L**	**T**	**P**	**C**
Course Title	**PROJECT PHASE - I**		**0**	**0**	**4**	**2**

COURSE OBJECTIVES:

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

PREREQUISITE:

- Engineering Thermodynamics, Heat and Mass Transfer, Production Technology, Strength of Materials, Computer Aided Design, Design of Machine Elements, Dynamics of Machines, Design of Transmission Systems, Automotive Testing and Certification, Finite Element Analysis etc.,

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C707.1	***Apply*** the fundamental concept learnt during the theory courses to solve industrial problems	K3
C707.2	***Analyse*** the current status based on the information available in the literature or data obtained in the laboratory/ industry	K4
C707.3	***Develop*** material and energy balance for process calculations	K3
C707.4	***Design*** equipment for Mechanical process industries	K3
C707.5	***Inspect*** the economics of a process through cost estimation	K4
C707.6	***Identify*** industrial problem, design process to carry out the process in an economically feasible way	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C707.1	3	3	2	2	3	3	3	3	3	3	2	2	2	2	2
C707.2	2	2	3	3	3	2	3	2	3	3	3	3	2	2	3
C707.3	3	3	3	2	3	3	2	3	3	2	3	3	3	3	3
C707.4	3	3	3	3	3	2	2	3	3	3	2	2	3	3	3
C707.5	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
C707.6	2	2	3	2	2	2	2	2	2	3	2	3	3	3	3

Note: 1: Slight, 2: Moderate, 3: Substantial

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.

Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

No. of hours: 60 Periods

Students are advised to carry out the projects in the following domains, but not limited with

- Mechanical Engineering Design
- Manufacturing Engineering
- Industrial Engineering
- Thermal Engineering
- Reverse Engineering
- Renewable Energy Sources
- Industrial Automation and Robotics
- Mechatronics
- Refrigeration and Air Conditioning
- Metrology and Measurements
- Composites and Nano Technology
- Finance Management
- Logistics
- Supply Chain Management
- Emerging Technologies in Mechanical Engineering, etc.

VIII SEMESTER

SEMESTER – VIII										
S. No	**Course Code**	**Course Title**	**Category**	**CIE Marks**	**SEE Marks**	**Total Marks**	**Credits**			
							L	**T**	**P**	**C**
THEORY										
1	-	Professional Elective - IV	PEC	40	60	100	3	0	0	3
2	-	Professional Elective - V	PEC	40	60	100	3	0	0	3
PRACTICAL										
3	21EE06P	Project Phase - II	PROJ	60	40	100	0	0	12	6
TOTAL										**12**

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
Professional Elective - IV		
1	21ME811PT	Non Destructive Testing and Evaluation
2	21HM812PT	Total Quality Management
3	21ME813PT	Industrial Robotics
4	21MB346PT	Supply Chain Management
5	21ME815PT	Theory of Metal Cutting and Joining

Course code	**21ME811PT**	**Semester**	**VIII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**NON DESTRUCTIVE TESTING AND EVALUATION**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To study and understand the various Non-Destructive Evaluation and Testing methods, theory and their industrial applications.

PREREQUISITE:

- Production Technology I & II

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C811.1	***Explain*** the fundamental concepts of NDT	K2
C811.2	***Classify*** different methods of NDE	K2
C811.3	***Describe*** the concept of Thermography and Eddy current testing	K2
C811.4	***Discuss*** the concept of Ultrasonic Testing and Acoustic Emission	K2
C811.5	***Summarize*** the concept of Radiography	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**	**PSO-3**
C811.1	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
C811.2	2	1	1	-	-	-	-	-	-	-	-	-	-	1	1
C811.3	2	1	1	-	-	-	-	-	-	-	-	-	-	1	1
C811.4	2	1	1	-	-	-	-	-	-	-	-	-	-	1	1
C811.5	2	1	1	-	-	-	-	-	-	-	-	-	-	1	1

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	**No. of Credits: 3**

UNIT I OVERVIEW OF NDT 9

NDT Versus Mechanical testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.

UNIT II SURFACE NDE METHODS 9

Liquid Penetrant Testing - Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Leak Testing. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 9

Thermography- Principles, Contact and non-contact inspection methods- Lock-in Thermography, Techniques for applying liquid crystals, Advantages and limitation - infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.

UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 9

Ultrasonic Testing- Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A-Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Ultraviolet Inspection method. Acoustic Emission Technique - Principle, AE parameters, Applications.

UNIT V RADIOGRAPHY (RT) 9

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Vol. 17, 2021.
2. Baldev Raj, T.Jayakumar, M.Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.

REFERENCES:

1. NDT Handbook, ASNT, American Society for Non Destructive Testing, Columbus, Ohio,Vol.1-7, 2016.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010
3. Charles, J. Hellier, Handbook of Nondestructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005

Course code	21HM812PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	TOTAL QUALITY MANAGEMENT (COMMON FOR MECHANICAL, BIOTECH, CHEMICAL, ECE, IT)		3	0	0	3

COURSE OBJECTIVES:

- To facilitate the understanding of Quality Management principles and process.

PREREQUISITE:

- Basic Engineering Knowledge

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C812.1	***Understand*** quality concepts and philosophies of TQM	K2
C812.2	***Apply*** TQM principles and concepts of continuous improvement	K3
C812.3	***Apply*** and analyze the quality tools, management tools and statistical fundamentals to improve quality	K3
C812.4	***Understand*** the TQM tools as a means to improve quality	K2
C812.5	***Remember*** and understand the quality systems and procedures adopted	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C812.1	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C812.2	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C812.3	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C812.4	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-
C812.5	3	-	-	-	-	2	1	-	2	1	1	1	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Introduction- Benefits of ISO Registration- ISO 9000 Series of Standards- Sector-Specific Standards- AS 9100, TS16949 and TL 9000- ISO 9001 Requirements- Implementation- Documentation- Internal Audits- Registration- ISO 14000 Series Standard- Concepts of ISO 14001- Requirements of ISO 14001- Benefits of EMS. Case studies of TQM implementation in manufacturing and service sectors including IT.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Poornima M Charantimath, "Total Quality Management", Pearson Education, Fourth Edition, 2022.
2. Dale H.Besterfiled, Carol B.Michna, Glen H. Besterfield, Mary B.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, "Total Quality Management", Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.

REFERENCES:

1. Joel.E. Ross, "Total Quality Management – Text and Cases", Routledge, 2017.
2. Kiran.D.R, "Total Quality Management: Key concepts and case studies", Butterworth – Heinemann Ltd, 2016.
3. Itay Abuhav, "ISO 9001: 2015 - A Complete Guide to Quality Management Systems", CRC press, 2017.
4. https://archive.nptel.ac.in/courses/110/104/110104080/

Course code	**21ME813PT**	**Semester**	**VIII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**INDUSTRIAL ROBOTICS**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

PREREQUISITE:

- Kinematics of Machinery
- Computer Aided Design

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C813.1	***Explain*** the concepts of industrial robots, classification, specifications and coordinate systems. Also summarize the need and application of robots in different sectors.	K2
C813.2	***Illustrate*** the different types of robot drive systems as well as robot end effectors.	K2
C813.3	***Apply*** the different sensors and image processing techniques in robotics to improve the ability of robots.	K3
C813.4	***Develop*** robotic programs for different tasks and familiarize with the kinematics motions of robot.	K3
C813.5	***Examine*** the implementation of robots in various industrial sectors and interpolate the economic analysis of robots.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C813.1	3	2	2	1	1	-	-	-	-	-	1	1	3	2	-
C813.2	3	3	3	2	1	2	1	-	1	-	1	1	3	2	-
C813.3	3	3	3	2	1	1	1	-	1	-	1	1	3	2	-
C813.4	2	2	2	2	1	1	1	2	1	1	1	1	3	2	-
C813.5	3	3	3	2	1	1	1	2	1	1	1	1	3	2	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I FUNDAMENTALS OF ROBOT 9

Robot - Definition - Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification- Specifications- Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions- Need for Robots- Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 9

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors- Grippers: Mechanical, Pneumatic, Hydraulic, Magnetic, Vacuum; Two Fingered and Three Fingered Grippers; Internal and External Grippers; Selection and Design Considerations

UNIT III SENSORS 9

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors, binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT IV MACHINE VISION 9

Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis- Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

UNIT V ROBOT PROGRAMMING 9

Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple programs. Safety Considerations for Robot Operations - Economic Analysis of Robots.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Groover M.P., "Industrial Robotics -Technology Programming and Applications", McGraw Hill 2017.
2. 1. John J. Craig, "Introduction to Robotics: Mechanics and Control" Pearson, 2018.

REFERENCES:

1. Antoni Grau, Zhuping Wang, "Industrial Robotics: New Paradigms", Intech Open, 2020.
2. A.K. Gupta, S.K. Arora, Jean Riescher Westcott, "Industrial Automation and Robotics", David Pallai, Mercury Learning and Information, 2016.
3. P.Jaganathan, "Robotics (Industrial Robotics)" Lakshmi Publications, 2017.
4. Ramachandran Nagarajan, "Introduction to Industrial Robotics", Pearson Education, 2016.
5. F. C. Park and K. M. Lynch (2017), Introduction to Robotics Mechanics, Planning, And Control, First Edition, Cambridge University Press

Course code	21MB346PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	SUPPLY CHAIN MANAGEMENT		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of supply chain management.
- To explain about the strategies utilized in supply chain management for competitive advantage.

PREREQUISITE:

- Total Quality Management

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C814.1	***Understand*** the fundamentals of supply chain	K2
C814.2	***Identify*** core strategic sourcing	K2
C814.3	***Describe*** models for supply chain network	K2
C814.4	***Describe*** demand, inventory and supply in supply chain management	K2
C814.5	***Explore*** current trends in supply chain, including it and agile supply chains	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C814.1	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
C814.2	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
C814.3	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
C814.4	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-
C814.5	-	2	1	-	-	-	-	-	-	-	-	-	1	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

UNIT II STRATEGIC SOURCING 9

Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base Supplier Development - World Wide Sourcing.

UNIT III SUPPLY CHAIN NETWORK 9

Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models. Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees.

UNIT IV PLANNING DEMAND, INVENTORY AND SUPPLY 9

Managing supply chain cycle inventory. Uncertainty in the supply chain –- Analyzing impact of supply chain redesign on the inventory - Risk Pooling - Managing inventory for short life - cycle products - multiple item -multiple location inventory management. Pricing and Revenue Management.

UNIT V CURRENT TRENDS 9

Supply Chain Integration - Building partnership and trust in SC Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. SC Restructuring - SC Mapping -SC process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains - Reverse Supply chain. Agro Supply Chains.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Sunil Chopra and Peter Meindl, “Supply Chain Management-Strategy Planning and Operation”, PHI Learning, Pearson Education, Sixth edition, 2015.
2. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, “Principles of Supply Chain Management- A Balanced Approach”, South-Western, Cengage, 2018.

REFERENCES:

1. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management”, PHI, 2018.
2. Janat Shah, “Supply Chain Management – Text and Cases”, Pearson Education, 2016.
3. Ballou Ronald H, “Business Logistics and Supply Chain Management, Pearson Education”, 5th Edition, 2007.

Course code	**21ME815PT**	**Semester**	**VIII**			
Category	**PROFESSIONAL ELECTIVE COURSE (PEC)**		**L**	**T**	**P**	**C**
Course Title	**THEORY OF METAL CUTTING AND JOINING**		**3**	**0**	**0**	**3**

COURSE OBJECTIVES:

To provide students with a foundational understanding of metal cutting methodologies, including the structure, working principles, and forces associated with both single point and multipoint cutting tools. Additionally, it seeks to familiarize students with concepts such as tool life, machinability, wear, and the impact of heat during cutting processes.

PREREQUISITE:

- Production Technology I & II

COURSE OUTCOMES:

CO. No.	**Course Outcomes**	**Blooms level**
On successful completion of this Course, students will be able to		
C815.1	***Impart*** the knowledge of basic methodology of metal cutting.	K2
C815.2	***Educate*** the student about the structure, working, forces involved in single point and multipoint cutting tools.	K2
C815.3	***Understand*** the concepts of tool life, machinability, wear, influence of heat	K2
C815.4	***Understand*** the theoretical aspects of welding technology in depth	K2
C815.5	***Describe*** the basic metallurgy of melted and HAZ of a metal or alloy, Identify the cause of welding defects and avoid them	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C815.1	2	1	-	-	1	-	-	-	-	-	-	-	2	1	-
C815.2	2	1	-	-	1	-	-	-	-	-	-	-	2	1	-
C815.3	2	1	-	-	1	-	-	-	-	-	-	-	2	1	-
C815.4	2	1	-	-	1	-	-	-	-	-	-	-	2	1	-
C815.5	2	1	-	-	1	-	-	-	-	-	-	-	2	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I MECHANICS OF METAL CUTTING 9

Geometry of Metal Cutting Process, Chip thickness ratio, radius of chip curvature, cutting speed, feed and depth of cut –chip breakers. Orthogonal and Oblique cutting processes– Forces and energy calculations (Merchant's Analysis) – Power consumed. Effect of Cutting variables on Forces, Force measurement using Dynamometers.

UNIT II SINGLE AND MULTI POINT CUTTING TOOL 9

Various systems of Specifications - Single point Cutting Tool Geometry, Built-Up Edge Formation Theories. Single Point Contact Tools, Throwaway Inserts. Drill Geometry, Rake & Relief Angles, Twist Drill - Milling Cutters- Grinding: Grinding Wheel Specifications, Mechanics, Effect of Grinding Conditions on Wheel Wear, Grinding Ratio, Depth of Cut, Speed, Machining Time, Temperature, Power.

UNIT III TOOL WEAR THEORIES AND METAL CUTTING TEMPERATURE 9

Adhesion, Abrasive, Diffusion; Wear Mechanisms, Forms, Tool Life Criteria, Machinability Index. Sliding Contact Types, Real Area, Friction Laws, Frictional Force Nature; Tool Angle Effect, Mean Co-effect. Heat Sources, Metal Conditions Influence, Temperature Distribution, Zones, Experimental Techniques, Tool-Work Thermocouple, Cutting Fluids: Functions, Types, Properties, Selection.

UNIT IV WELDING PROCESSES OVERVIEW 9

Welding Processes Classification, Common Concerns, Fusion Weld Types, Joint Types, Design Considerations, Heat Effects, Weldability, Joinability, Welding Terms, Definitions, Welding Positions, Welding Symbols Elements, Construction, Checks Prior to Weld Joint Preparation, Joint Preparation Checks, Preheating, Interpass Heating, Post Weld Heating, Heating Processes, Post Heat Treatments, Insulation of Heated Joints.

UNIT V WELDING METALLURGY 9

Solidification of Weld Metal and Metallurgical Issues: Principles, Modes, Weld Structure, Grain Refinement, Inoculation, Arc Pulsation, External Excitation. Heat-Affected Zone and Weld Metal: Transformations in HAZ, Factors Affecting Microstructure, Mechanical Properties, Reactions in Weld Pool. Metallurgical Issues in Weld Joint: Mechanisms, Causes, Remedies for Cold Cracking, Solidification Cracking, Nonmetallic Inclusions, Lamellar Tearing, Hydrogen Damage, Banding, Segregation

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. David A. Stephenson, John S. Agapiou, Metal Cutting Theory and Practice, CRC Press, Taylor & Francis Group, Third Edition, 2016.
2. Winston A. Knight, Geoffrey Boothroyd, Fundamentals of Metal Machining and Machine Tools, CRC Press, Taylor & Francis Group, Third Edition, 2019.

REFERENCES:

1. Bhattacharya.A., "Metal Cutting Theory and practice", Central Book Publishers, India, 2012.
2. Boothroid D.G. & Knight W.A., "Fundamentals of machining and machine tools", Marcel Dekker, Newyork, 2005
3. B L Juneja and G S Sekhon., "Fundamentals of Metal Cutting and Machine Tools", New Age International Publisher, 2017.
4. D.L. Olson, T.A. Siewert, S. Liu, G.R. Edwards, ASM Handbook vol.6, "Welding Brazing & Soldering", 2010

LIST OF PROFESSIONAL ELECTIVE COURSES

S. No	COURSE CODE	COURSE TITLE
Professional Elective V (VIII SEM)		
1	21ME821PT	Power Plant Engineering
2	21ME822PT	Micro Electro Mechanical Systems
3	21ME823PT	Production Planning and Control
4	21ME824PT	Advanced Manufacturing Management
5	21ME825PT	Lean Manufacturing

Course code	21ME821PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	POWER PLANT ENGINEERING		3	0	0	3

COURSE OBJECTIVES:

- To Provide an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

PREREQUISITE:

- Thermodynamics
- Thermal Engineering

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C821.1	***Solve*** rankine cycle and explain the layout, construction and working of the components inside a thermal power plant	K3
C821.2	***Calculate*** power cycle and elaborate the layout, construction and working of the components inside a Diesel, Gas and Combined cycle power plants.	K3
C821.3	***Summarize*** the layout, construction and working of the components inside nuclear power plants.	K2
C821.4	***Outline*** the layout, construction and working of the components inside Renewable energy power plants.	K2
C821.5	***Identify*** the costs of electrical energy production & explain the applications of power plants while extend their knowledge to power plant economics and environmental hazards.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C821.1	3	2	1	-	-	3	3	-	-	-	-	-	-	-	-
C821.2	3	2	1	-	-	3	3	-	-	-	-	-	-	-	-
C821.3	3	2	1	-	-	3	3	-	-	-	-	-	-	-	-
C821.4	3	2	1	-	-	3	3	-	-	-	-	-	-	-	-
C821.5	3	2	1	-	-	3	3	-	-	-	-	-	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS		No. of Credits: 3
UNIT I	**COAL BASED THERMAL POWER PLANTS**	**9**

Rankine cycle - improvisations, Layout of modern coal power plant, Super Critical Boilers, FBC Boilers, Turbines, Condensers, Steam & Heat rate, Subsystems of thermal power plants – Fuel and ash handling, Draught system, Feed water treatment. Binary Cycles and Cogeneration systems.

UNIT II DIESEL, GAS TURBINE AND COMBINED CYCLE POWER PLANTS 9

Otto, Diesel, Dual & Brayton Cycle - Analysis & Optimization. Components of Diesel and Gas Turbine power plants. Combined Cycle Power Plants. Integrated Gasifier based Combined Cycle systems.

UNIT III NUCLEAR POWER PLANTS 9

Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANada Deuterium-Uranium reactor (CANDU), Breeder, Gas Cooled and Liquid Metal Cooled Reactors. Safety measures for Nuclear Power plants.

UNIT IV POWER FROM RENEWABLE ENERGY 9

Hydro Electric Power Plant - principle, construction and working. Wind Mill - principle, types. Tidal Power plant- Solar Photo Voltaic (SPV), Solar Thermal. Geo Thermal power plant, Biogas and Fuel Cell power systems – Working principle, components, Types - Hydrogen-Oxygen Fuel Cell, Alkaline Fuel Cell, Phosphoric acid Fuel cell.

UNIT V ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS 9

Power tariff types, Load distribution parameters, load curve, Comparison of site selection criteria, Capital & Operating Cost of different power plants. Pollution control technologies including Waste Disposal Options for different Power Plants.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", 4th Edition, Tata McGraw – Hill Publishing Company Ltd., 2017.
2. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 2014.

REFERENCES:

1. El-Wakil. M.M., "Power Plant Technology", Tata McGraw – Hill Publishing Company Ltd., 2010.
2. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2012.
3. Rajput. R.K., "Power Plant Engineering", 5th Edition, Laxmi Publications, 2016.

Course code	21ME822PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	MICRO ELECTRO MECHANICAL SYSTEMS		3	0	0	3

COURSE OBJECTIVES:

- Selecting suitable material for MEMS and Microsystems, and explain the scaling laws involved in miniaturization.
- Applying the working principle of electrostatic and thermal based MEMS sensors and actuators in the design of MEMS devices.
- Applying the working principle of piezo-resistive, piezo-electric and magnetic effect in the design of MEMS devices.
- Designing the elements of Micro-fluidic systems, and select suitable MEMS devices for Industrial applications.

PREREQUISITE:

- Micro Controller and Mechatronics

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C822.1	***Select*** suitable material for MEMS and Microsystems, and explain the scaling laws involved in miniaturization.	K2
C822.2	***Explain*** the various micro-manufacturing processes.	K2
C822.3	***Apply*** the working principle of electrostatic and thermal based MEMS sensors and actuators in the design of MEMS devices.	K2
C822.4	***Apply*** the working principle of piezo-resistive, piezo-electric and magnetic effect in the design of MEMS devices.	K2
C822.5	***Design*** the elements of Micro-fluidic systems, and select suitable MEMS devices for Industrial applications.	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C822.1	3	-	-	-	-	-	-	-	-	-	-	1	3	-	-
C822.2	3	-	1	-	-	-	-	-	-	-	-	-	2	-	-
C822.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
C822.4	3	-	3	-	-	-	-	-	-	-	3	-	2	-	-
C822.5	3	-	3	-	-	-	-	-	2	-	-	2	-	-	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I BASIC ENGINEERING FOR MEMS 9

History of MEMS Development, Multidisciplinary Nature of Microsystems, Energy Domains, Scaling Laws in Miniaturization, Essential Electrical and Mechanical Concepts in MEMS, Materials for MEMS and Microsystems.

UNIT II MICROMANUFACTURING TECHNIQUES 9

Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition-Sputtering, Deposition by Epitaxy, Etching, Bulk Micro manufacturing, Micromachining Processes, LIGA Process, Microsystem Assembly and Testing.

UNIT III ELECTROSTATIC AND THERMAL BASED MEMS 9

Introduction to Electrostatic Sensors and Actuators, Parallel-Plate Capacitor, Application of Parallel-Plate Capacitors, Interdigitated Finger Capacitors, Applications of Comb-Drive Devices, Introduction to Thermal Sensors and Actuators, Sensors and Actuators Based on Thermal Expansion, Thermocouples, Thermal Resistors, Shape Memory Alloy, Applications of Thermal Sensors and Actuators.

UNIT IV PIEZO-RESISTIVE / ELECTRIC AND MAGNETIC BASED MEMS 9

Introduction to Piezoresistive & Piezoelectric effects, Piezoresistive & Piezoelectric materials, Stress Analysis of Mechanical Elements, Applications of Piezoresistive & Piezoelectric Sensors and Actuators, Essential Concepts and Principles of Magnetic Sensors and Actuators, Fabrication of Micro Magnetic Components, Applications of Magnetic Sensors and Actuators.

UNIT V MICROFLUIDICS AND APPLICATIONS OF MEMS 9

Microfluidics - Fluid Mechanics Concepts, Design and Fabrication of Channels, Valves, Pumps, Case Studies - Accelerometer, Gyros, RF MEMS and MOEMS.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Chang Liu, “Foundations of MEMS”, Pearson Education, 2012.
2. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture”, McGraw Hill Education, 2008.

REFERENCES:

1. Marc J. Madou, “Fundamentals of Microfabrication and Nanotechnology”, CRC Press, 2011.
2. Mohamed Gad-el-Hak, “The MEMS handbook: MEMS Applications”, CRC press, 2006.
3. Nitaigour Premchand Mahalik, “MEMS”, McGraw Hill Education, 2007.
4. Stephen D Senturia, “Microsystem Design”, Kluwer Academic Publishers, 2001.
5. Thomas M. Adams and Richard A. Layton, “Introductory MEMS: Fabrication and Applications”, Springer, 2010

Course code	21ME823PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	PRODUCTION PLANNING AND CONTROL		3	0	0	3

COURSE OBJECTIVES:

- To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control.
- To know the recent trends like Manufacturing Requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

PREREQUISITE:

- Production Technology
- Process Planning and Cost Estimation

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C823.1	***Introduce*** production planning and control activities.	K2
C823.2	***Understand*** work study methods and tools.	K2
C823.3	***Explain*** the concept of product planning.	K2
C823.4	***Apply*** production scheduling.	K3
C823.5	***Summarize*** Inventory Control and Manufacturing Requirements.	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C823.1	-	3	2	-	2	-	-	-	1	1	2	1	1	2	-
C823.2	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-
C823.3	-	3	2	-	2	-	-	-	1	1	2	1	1	2	-
C823.4	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-
C823.5	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION 9

Objectives and benefits of planning and Control-Functions of production Control-Types of production-job- batch and Continuous-Product development and Design-Marketing aspect - Functional aspects-Operational Aspect-Durability and dependability aspect aesthetic aspect. Profit consideration-Standardization, Simplification & specialization- Break Even Analysis-Economics of a new design.

UNIT II WORK STUDY AND ERGONOMICS 9

Method study, basic Procedure-Selection-Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards –Ergonomics – principles – applications.

UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9

Product Planning-Extending the original product information- Value Analysis-Problems in lack of product planning-Process planning and routing-Pre requisite information needed for process planning-Steps in process planning-Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi-product system.

UNIT IV PRODUCTION SCHEDULING 9

Production Control Systems-Loading and scheduling-Master Scheduling-Scheduling rules-Gantt Charts-Perpetual Loading-Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling-Product sequencing – Production Control systems- Periodic batch control-Material requirement planning kanban – Dispatching-Progress reporting and expediting-Manufacturing lead time-Techniques for aligning completion times and due dates.

UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PPC 9

Inventory control - Purpose of holding stock - Effect of demand on inventories - Ordering procedures. Two bin system - Ordering cycle system-Determination of Economic order quantity and economic lot size- ABC analysis - Recorder procedure-Introduction to computer integrated production planning systems- elements of JUST IN TIME SYSTEMS-Fundamentals of MRP II and ERP.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. D R Kiran, "Production Planning and Control : A Comprehensive Approach", BS Publications, 2018
2. Martand Telsang, "Industrial Engineering and Production Management", S. Chand and Company, 2018.

REFERENCES:

1. Chary. S.N., "Theory and Problems in Production & Operations Management", Tata McGraw Hill, 2000.
2. Jain. K.C. & Aggarwal. L.N., "Production Planning Control and Industrial Management", Khanna Publishers, 2002.
3. Kanishka Bedi, "Production and Operations management", 2nd Edition, Oxford university press, 2007.
4. B. Mahadevan, "Operations Management Theory and Practice" Pearson, 2010

VEL TECH HIGH TECH
Dr. RANGARAJAN Dr. SAKUNTHALA ENGINEERING COLLEGE
An Autonomous Institution
Approved by AICTE-New Delhi, Affiliated to Anna University, Chennai
Accredited by NBA, New Delhi & Accredited by NAAC with "A" Grade & CGPA of 3.27

Course code	21ME824PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	ADVANCED MANUFACTURING MANAGEMENT		3	0	0	3

COURSE OBJECTIVES:

- To study the various tools for lean manufacturing (LM).
- To apply the above tools to implement LM system in an organization.

PREREQUISITE:

- Production Technology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C824.1	***Understand*** the concept of various unit-processes in micro machining.	K2
C824.2	***Describe*** the concept of Nano polishing	K2
C824.3	***Outline*** the applications of micro machined components	K2
C824.4	***Obtain*** knowledge on Material management	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C824.1	-	3	2	-	2	-	-	-	1	1	2	1	1	2	-
C824.2	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-
C824.3	-	3	2	-	2	-	-	-	1	1	2	1	1	2	-
C824.4	-	3	2	-	2	-	-	-	1	1	2	1	1	3	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS	No. of Credits: 3

UNIT I MICRO MACHINING I **9**

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT II MICRO MACHINING II **9**

Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining –Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT III NANO POLISHING **9**

Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – Chemo mechanical Polishing.

UNIT IV RECENT TRENDS AND APPLICATIONS **9**

Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications

UNIT V MATERIALS MANAGEMENT **9**

Supply chain management, Purchasing, stores and vendor selection, Inventory Models, Selective Inventory Control, MRP, MRP-II, Lot size Techniques, Just - In - Time system of manufacturing, Kaizen, Total Productive Maintenance (TPM), BPR, SCM, ERP etc.& Case Studies.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Charry S.N., “Production & Operations Management”, Tata McGraw Hill Edu Pvt Ltd, 5th Edition, 2019
2. Jain V. K., “Micro Manufacturing Processes”, CRC Press, Taylor & Francis Group, 2012

REFERENCES:

1. Bandyopadhyay. A.K., “Nano Materials, New age international publishers”, New Delhi, 2010.
2. Jain V.K., “Introduction to Micro machining”, Narosa Publishing House, 2011.
3. Jain V.K., “Advanced Machining Processes”, Allied Publishers, Delhi, 2002.
4. Janocha H., “Actuators – Basics and applications”, Springer publishers, 2012.
5. Angelos P. Markopoulos, J. Paulo Davim, “Advanced Machining Processes”, CRC Press, 2019.

Course code	21ME825PT	Semester	VIII			
Category	PROFESSIONAL ELECTIVE COURSE (PEC)		L	T	P	C
Course Title	LEAN MANUFACTURING		3	0	0	3

COURSE OBJECTIVES:

- To study the various tools for lean manufacturing (LM).
- To apply the above tools to implement LM system in an organization.

PREREQUISITE:

- Production Technology

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C825.1	***Understand*** the concept of Lean manufacturing and its tool	K2
C825.2	***Describe*** cellular Manufacturing, JIT and TPM	K2
C825.3	***Outline*** set up time reduction, TQM, 5S, VSM	K2
C825.4	***Obtain*** knowledge how to implement the lean six sigma	K2
C825.5	***Explore*** various case studies of lean manufacturing	K2

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-2
C825.1	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
C825.2	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
C825.3	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
C825.4	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-
C825.5	2	1	1	-	-	-	-	-	-	-	-	-	-	1	-

Note: 1: Slight, 2: Moderate, 3: Substantial

SYLLABUS **No. of Credits: 3**

UNIT I INTRODUCTION TO LEAN MANUFACTURING 9

Conventional Manufacturing versus Lean Manufacturing – Principles of Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools. Core Quality Tools – APQP, FMEA, MSA, SPC, PPAP.

UNIT II CELLULAR MANUFACTURING, JIT, TPM 9

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.

UNIT III SET UP TIME REDUCTION, VSM 9

Set up time reduction – Definition, philosophies and reduction approaches - Value stream mapping - Procedure and principles.

UNIT IV SIX SIGMA 9

Six Sigma – Definition, basic tools - problem solving approach, statistical considerations, variability reduction, design of experiments – Six Sigma implementation- Various quality cost, cost of poor quality

UNIT V CASE STUDIES 9

Various case studies of implementation of lean manufacturing in Toyota Production System, Healthcare, Food Processing, Aerospace Industry, Electronics Manufacturing, Automotive Component Manufacturing and Lean Supply Chain Management at Amazon.

Total: 45 Periods

LEARNING RESOURCES:

TEXT BOOKS:

1. Anupam Agrawal, Vivek Sharma, and Vinod Kumar, "Lean Management: Principles, Tools, and Techniques", CRC Press, 2019
2. Bhisham C. Gupta and Aditya Gupta, "Lean Six Sigma for Supply Chain Management", published by CRC Press, 2016

REFERENCES:

1. Ronald G. Askin & Jeffrey B. Goldberg, “Design and Analysis of Lean Production Systems”, John Wiley & Sons, 2003
2. Mikell P. Groover, “Automation, Production Systems, and Computer-Integrated Manufacturing”, Pearson, 2015.
3. Ammar Kaka and Shyam Tagade ,"Lean Manufacturing: Implementation Strategies That Work" McGraw-Hill Education, 2006

Course code	21EE06P	Semester	VIII			
Category	EMPLOYABILITY ENHANCEMENT COURSE (EEC)		L	T	P	C
Course Title	PROJECT PHASE - II		0	0	12	6

COURSE OBJECTIVES:

- The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

PREREQUISITE:

- Engineering Thermodynamics, Heat and Mass Transfer, Production Technology, Strength of Materials, Computer Aided Design, Design of Machine Elements, Dynamics of Machines, Design of Transmission Systems, Automotive Testing and Certification, Finite Element Analysis etc.,

COURSE OUTCOMES:

CO. No.	Course Outcomes	Blooms level
On successful completion of this Course, students will be able to		
C803.1	***Apply*** the fundamental concept learnt during the theory courses to solve industrial problems	K3
C803.2	***Analyse*** the current status based on the information available in the literature or data obtained in the laboratory/ industry	K4
C803.3	***Develop*** material and energy balance for process calculations	K3
C803.4	***Design*** equipment for Mechanical process industries	K3
C803.5	***Inspect*** the economics of a process through cost estimation	K4
C803.6	***Identify*** industrial problem, design process to carry out the process in an economically feasible way	K3

COURSE OUTCOMES MAPPING WITH PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
C803.1	3	3	2	2	3	3	3	3	3	3	2	2	2	2	2
C803.2	2	2	3	3	3	2	3	2	3	3	3	3	2	2	3
C803.3	3	3	3	2	3	3	2	3	3	2	3	3	3	3	3
C803.4	3	3	3	3	3	2	2	3	3	3	2	2	3	3	3
C803.5	3	3	3	3	3	3	3	3	2	2	3	3	2	3	3
C803.6	2	2	3	2	2	2	2	2	2	3	2	3	3	3	3

Note: 1: Slight, 2: Moderate, 3: Substantial

Each student is required to submit a report on the project assigned to him by the department. The report should be based on the information available in the literature or data obtained in the laboratory/industry.

Students, in addition to the home problem will be permitted to undertake industrial/ consultancy project work, outside the department, in industries/Research labs for which proportional weightage will be given in the final assessment.

No. of hours: 180 Periods

Students are advised to carry out the projects in the following domains, but not limited with

- Mechanical Engineering Design
- Manufacturing Engineering
- Industrial Engineering
- Thermal Engineering
- Reverse Engineering
- Renewable Energy Sources
- Industrial Automation and Robotics
- Mechatronics
- Refrigeration and Air Conditioning
- Metrology and Measurements
- Composites and Nano Technology
- Finance Management
- Logistics
- Supply Chain Management
- Emerging Technologies in Mechanical Engineering, etc.