



SETHU INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)

Pulloor, Kariapatti, Virudhunagar (Dist.) -Pin: 626 115.

Department of Mechanical Engineering

(Accredited by NBA, New Delhi)

(Approved Research Centre by Anna University, Chennai)

REVISED 2021
CURRICULUM AND SYLLABUS
Choice Based Credit System
BATCH: 2023-2027

CHAIRPERSON
BOARD OF STUDIES

CHAIRMAN
ACADEMIC COUNCIL



SETHU INSTITUTE OF TECHNOLOGY

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Department Vision statement

- To promote excellence in education and research in mechanical engineering for the benefits of industry and society.

Department Mission Statement

1. To provide quality technical educational experience to enable the graduates to become leaders in their chosen profession.
2. To educate through modern teaching tools and experiential learning to produce proficient engineer.
3. To develop skills in recent technological trends and design software and to facilitate various co-curricular activities to enhance employability and entrepreneurship.
4. To establish collaboration with industries for transfer of technical knowledge.
5. To promote research activities among faculty members and students.
6. To offer beneficial services to the society.

Program Educational Objectives (PEOs)

After few years of graduation our Mechanical Engineering graduates are expected to:	
PEO I (Core Competency)	Develop technical competency to become professionals with expertise in core areas of mechanical engineering.
PEO II (Life Long Learning)	Practice Life Long Learning to solve real time problems and for career development.
PEO III (Professional and Ethical Skills)	Develop professional skills to meet the global standards with ethical and social responsibility.

PROGRAM OUTCOMES (PO's)	
Engineering Graduates will be able to:	
PO 1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems. [Engineering Knowledge]
PO 2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. [Problem Analysis]
PO 3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations. [Design/development of solutions]
PO 4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions. [Conduct Investigation of Complex Problems]
PO 5	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations. [Modern Tool Usage]
PO 6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice. [The Engineer and Society]
PO 7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development. [Environment and Sustainability]
PO 8	Apply ethical principles, and commit to professional ethics and responsibilities and norms of the engineering practice. [Ethics]
PO 9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. [Individual and Team work]
PO 10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions. [Communication]
PO 11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments. [Project Management and Finance]
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change. [Life-long learning]

PROGRAM SPECIFIC OUTCOMES (PSO's)	
PSO 1	Design, model and analyse mechanical systems and components using computer aided technologies.
PSO 2	Formulate, analyze and provide the solution to thermal engineering related problems with regards to environment and society.
PSO 3	Acquire the profession in industries through the intellectual knowledge of mechanical engineering and team work.



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(An Autonomous Institution)
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Department of Mechanical Engineering
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(Approved Research Centre by Anna University, Chennai)

REVISED 2021
CURRICULUM AND SYLLABUS
CHOICE BASED CREDIT SYSTEM
(SEMESTERS I TO V)
Batch: 2023-2027

OVERALL COURSE STRUCTURE – CREDIT DISTRIBUTION

Code	Category	Total No. of Courses	Credits	Percentage
BS	Basic Sciences	8	21	12.80
ES	Engineering Sciences	9	20.5	12.50
HSS	Humanities and Social Sciences	5	8.5	5.18
PC	Professional Core (Including Lab Courses)	28	65	39.63
PE	Professional Elective	6	18	10.98
OE	Open Elective	4	12	7.32
PW	Project Work & Seminar	3	13	7.93
MC	Mandatory Courses	9	3	1.83
AC	Audit Courses	2	-	-
UHV	Universal Human Values	1	3	1.83
	TOTAL	75	164	100

OVERALL CREDIT DISTRIBUTION – SEMESTER WISE

Semester	I	II	III	IV	V	VI	VII	VIII	TOTAL
Credits	20.5	17.5	23	21	26	25	17	14	164

SEMESTER – I

[illegible]

SEMESTER – II

[illegible]

SEMESTER – III

[illegible]

SEMESTER – IV

[illegible]

SEMESTER – V

[illegible]

SEMESTER – VI

[illegible]

SEMESTER – VII

[illegible]

SEMESTER – VIII

[illegible]

PROFESSIONAL ELECTIVE COURSES: VERTICALS
VERTICAL – 1: MODERN MOBILITY SYSTEMS

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV101	Automobile Engineering	3	0	0	3
2.	R21MEV102	Introduction to Aircraft industry and aircraft systems	3	0	0	3
3.	R21MEV103	E-Vehicle Technology	3	0	0	3
4.	R21MEV104	Renewable Powered Off Highway Vehicles and Emission Control Technology	3	0	0	3
5.	R21MEV105	Vehicle Health Monitoring, Maintenance and Safety	3	0	0	3
6.	R21MEV106	CFD Approach in Future Mobility	3	0	0	3
7.	R21MEV107	Hybrid and Electric Vehicle Technology	3	0	0	3
8.	R21MEV108	Thermal Management of Batteries and Fuel Cells	3	0	0	3

VERTICAL – 2: PRODUCT AND PROCESS DEVELOPMENT

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV201	Value Engineering	3	0	0	3
2.	R21MEV202	Additive Manufacturing	3	0	0	3
3.	R21MEV203	CAD/CAM	3	0	0	3
4.	R21MEV204	Design For X	3	0	0	3
5.	R21MEV205	Ergonomics in Design	3	0	0	3
6.	R21MEV206	New Product Development	3	0	0	3
7.	R21MEV207	Precision Manufacturing	3	0	0	3
8.	R21MEV208	Production Planning and Control	3	0	0	3

VERTICAL – 3: ROBOTICS AND AUTOMATION

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV301	Sensors and Instrumentation	3	0	0	3
2.	R21MEV302	Electrical Drives and Actuators	3	0	0	3
3.	R21MEV303	Augmented based application and programming methods for robotics	3	0	0	3
4.	R21MEV304	Smart Mobility and Intelligent Vehicles	3	0	0	3
5.	R21MEV305	AI & Expert systems	3	0	0	3
6.	R21MEV306	AI& Drone Technologies	3	0	0	3
7.	R21MEV307	Industry 4.0	3	0	0	3

VERTICAL – 4: DIGITAL AND GREEN MANUFACTURING

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV401	Digital Manufacturing and IoT	3	0	0	3
2.	R21MEV402	Industrial Design & Rapid Prototyping Techniques	3	0	0	3
3.	R21MEV403	Industrial Robotics	3	0	0	3
4.	R21MEV404	Green Manufacturing Design and Practices	3	0	0	3
5.	R21MEV405	Environment Sustainability and Impact Assessment	3	0	0	3
6.	R21MEV406	Energy Management	3	0	0	3
7.	R21MEV407	Supply Chain Management	3	0	0	3

VERTICAL – 5: PROCESS EQUIPMENT AND PIPING DESIGN

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV501	Design of Pressure Vessels	3	0	0	3
2.	R21MEV502	Failure Analysis and NDT Techniques	3	0	0	3
3.	R21MEV503	Material Handling and solid Processing Equipment	3	0	0	3
4.	R21MEV504	Rotating Machinery Design	3	0	0	3
5.	R21MEV505	Thermal and Fired Equipment design	3	0	0	3
6.	R21MEV506	Industrial Layout Design and Safety	3	0	0	3
7.	R21MEV507	Design Codes and Standards	3	0	0	3

VERTICAL – 6: CLEAN AND GREEN ENERGY TECHNOLOGIES

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV601	Bioenergy Conversion Technologies	3	0	0	3
2.	R21MEV602	Carbon Footprint estimation and education techniques	3	0	0	3
3.	R21MEV603	Energy Conservation in Industries	3	0	0	3
4.	R21MEV604	Energy Efficient Buildings	3	0	0	3
5.	R21MEV605	Energy Storage Device	3	0	0	3
6.	R21MEV606	Non Conventional Energy Sources	3	0	0	3
7.	R21MEV607	Equipment for pollution Control	3	0	0	3

VERTICAL – 7: COMPUTATIONAL ENGINEERING

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV701	Computational Solid Mechanics	3	0	0	3
2.	R21MEV702	Computational Fluid Dynamics	3	0	0	3
3.	R21MEV703	Theory on Computation and Visualization	3	0	0	3
4.	R21MEV704	Computational Bio Mechanics	3	0	0	3
5.	R21MEV705	Advanced Statistics and Data Analytics	3	0	0	3
6.	R21MEV706	CAD and CAE	3	0	0	3
7.	R21MEV707	Machine Learning for Intelligent Systems	3	0	0	3

VERTICAL – 8: DIVERSIFIED COURSES GROUP 1

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV801	Automobile Engineering	3	0	0	3
2.	R21MEV802	Measurements and Controls	3	0	0	3
3.	R21MEV803	Design Concepts in Engineering	3	0	0	3
4.	R21MEV804	Composite Materials and Mechanics	3	0	0	3
5.	R21MEV805	Power Plant Engineering	3	0	0	3
6.	R21MEV806	Refrigeration and Air Conditioning	3	0	0	3
7.	R21MEV807	Dynamics of Ground Vehicles	3	0	0	3

VERTICAL – 9: DIVERSIFIED COURSES GROUP 2

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV901	Maintenance Engineering	3	0	0	3
2.	R21MEV902	Non-traditional Machining Processes	3	0	0	3
3.	R21MEV903	Industrial safety	3	0	0	3
4.	R21MEV904	Computer Application in Design	3	0	0	3
5.	R21MEV905	Entrepreneurship Development	3	0	0	3
6.	R21MEV906	Design for Manufacturing	3	0	0	3
7.	R21MEV907	Power Generation Equipment Design	3	0	0	3

VERTICAL – 10: DIVERSIFIED COURSES GROUP 3

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV1001	Advanced Vehicle Engineering	3	0	0	3
2.	R21MEV1002	Advanced Internal Combustion Engineering	3	0	0	3
3.	R21MEV1003	Casting and Welding Processes	3	0	0	3
4.	R21MEV1004	Process Planning and Cost Estimation	3	0	0	3
5.	R21MEV1005	Surface Engineering	3	0	0	3
6.	R21MEV1006	Gas Dynamics and Jet Propulsion	3	0	0	3
7.	R21MEV1007	Statistical Quality Control	3	0	0	3

VERTICAL FOR MINOR DEGREE**VERTICAL: ENTREPRENEURSHIP**

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEVG21	Foundations of Entrepreneurship	3	0	0	3
2.	R21MEVG22	Team Building and Leadership Management for Business	3	0	0	3
3.	R21MEVG23	Creativity and Innovation in Entrepreneurship	3	0	0	3
4.	R21MEVG24	Principles of Marketing Management for Business	3	0	0	3
5.	R21MEVG25	Human Resource Management for Entrepreneurs	3	0	0	3
6.	R21MEVG26	Financing New Business Ventures	3	0	0	3

LIST OF OPEN ELECTIVES – ODD AND EVEN SEMESTER

S. No.	Course Code	Course Name	Semester
1.	R21UME971	Introduction to Industry 4.0	ODD
2.	R21UME972	Product Life Cycle Management	ODD
3.	R21UME973	Introduction to Additive Manufacturing	ODD
4.	R21UME974	Basics of Industrial Layout Design and Safety	ODD
5.	R21UME975	Introduction to Energy Conservation in Industries	ODD
6.	R21UME976	Renewable Energy Technologies	EVEN
7.	R21UME977	Green Supply Chain Management	EVEN
8.	R21UME978	Introduction to Process Planning and Cost Estimation	EVEN
9.	R21UME979	Robotics	EVEN
10.	R21UME980	Basics of Industrial Design & Rapid Prototyping Techniques	EVEN

LIST OF INDUSTRY DESIGNED COURSES

S. No.	Course Code	Course Name	L	T	P	C
1.	R21UME861	Jigs and Fixtures	1	0	0	1
2.	R21UME862	Smart Materials	1	0	0	1
3.	R21UME863	Solar energy	1	0	0	1
4.	R21UME864	Work Study	1	0	0	1
5.	R21UME865	CNC programming	1	0	0	1
6.	R21UME866	Limits, Fits and Tolerances	1	0	0	1
7.	R21UME867	Solid Works	1	0	0	1
8.	R21UME868	Gear Design	1	0	0	1
9.	R21UME869	Revit MEP	1	0	0	1

COURSE OFFERED TO OTHER DEPARTMENT

SEMESTER - I

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
1.	ES	R21UME110	Engineering Drawing and Design (Only for CSD)	3	0	0	3	45
2.	ES	R21UME226	Basic Civil and Mechanical Engineering (Only for EEE)	3	0	0	3	45

SEMESTER – I

[illegible]

R21UEN101

ENGLISH FOR TECHNICAL COMMUNICATION
(Common to ALL Branches – Except CSBS)

L	T	P	C
2	0	0	2

OBJECTIVES:

- To enhance the vocabulary of students.
- To strengthen the application of functional grammar and basic skills.
- To improve the language proficiency of students.

UNIT I

8

Listening–Formal and informal conversations and comprehension. **Speaking**- introducing oneself – exchanging personal and social information - Reading – Skimming and Scanning. **Writing** – Sentence Formation, Formal Letters (Permission/Requisition) - **Grammar** - Parts of Speech – Tense - **Vocabulary Development** – Technical Word Formation- Prefix- suffix - Synonyms and Antonyms - Phrases and Clauses.

UNIT II

8

Listening– Telephonic Conversations. **Speaking** – Pronunciation rules with Stress pattern. **Reading** – comprehension-pre-reading, post-reading- comprehension questions **Writing** – Punctuation rules, paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions, Precise writing, Developing Hints - Report Writing (Industrial, Accident) - **Grammar** – Voice **Vocabulary Development**- Words from other languages in English.

UNIT III

7

Listening – Motivational speech by Great Speakers **Speaking** –Narrating daily events -retelling short stories. **Reading** – Newspaper reading. **Writing** – Job application letter - Transformation of Information (Transcoding) –**Grammar** Subject-Verb Agreement (Concord),— **Vocabulary Development** –Same word in different parts of speech.

UNIT IV

7

Listening – Understating the instruction. **Speaking** -Intonation and preparing dialogue on various formal and informal situation. **Reading** –Note Making from given text - **Writing** –Creating coherence, Essay writing with proper introduction and conclusion, Giving Instruction (Guidance/Procedure) - **Grammar** – Spot the Errors in English, **Vocabulary Development** – One-word substitution.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply grammar effectively in writing meaningful sentences and paragraphs.
2. Exhibit reading skills and comprehension to express the ideas in the given text.
3. Develop writing skills to present the ideas in various formal situations.
4. Develop oral fluency to express the ideas in various formal situations.
5. Prepare reports for various purpose

TEXT BOOK:

1. KN Shoba, Lourdes Joavani Rayen, Communicative English, New Delhi, Cambridge University Press, 2017.

REFERENCE BOOKS:

1. Raman, Meenakshi, Sangeetha Sharma, Business Communication, New Delhi, Oxford University Press, 2014.
2. Lakshminarayanan. K.R, English for Technical Communication, Chennai, Scitech Publications (India) Pvt. Ltd, 2004.
3. Rizvi. Asraf M, Effective Technical Communication, New Delhi, Tata McGraw-Hill Publishing Company Limited, 2007.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1									2	3		2			
CO 2									2	3		2			
CO 3									2	3		2			
CO 4									2	3		2			
CO 5									2	3		2			
R21UEN101									2	3		2			

Ref:

3-Strong

2-Medium

1 –Weak

L	T	P	C
3	1	0	4

- To make the students capable of identifying linear equations-based problems (Eigen value) from practical areas and obtain the Eigen value-oriented solutions in certain cases.
- To widen the student's knowledge base on linear algebra, growth rate computation and application of integrals.
- Able to integrating various types of functions using various integration methods.
- To familiarize the students with the basic rules of differentiation and use them to find derivatives of products and quotients of functions.
- To apply these mathematical concepts (matrix theory, differentiation and integration) in engineering field.

Eigen value and eigenvector of a real matrix – Characteristic equation – Properties – Cayley- Hamilton theorem (excluding Proof) – Orthogonal reduction – (transformation of a symmetric matrix to diagonal form) – Quadratic form – Reduction of quadratic form to canonical form by orthogonal transformation

Introduction – Definition of derivatives – Limits and Continuity – Differentiation techniques (Product rule, Quotient rule, Chain rule) – Successive differentiation (n^{th} derivatives) – Leibnitz theorem (without proof) – Maclaurin's series – Physical Applications (Newton's law of cooling – Heat flow problems, Rate of decay of radioactive materials - Chemical reactions and solutions, Ohm's law, Kirchoff's law – Simple electric circuit problems)

Partial derivatives – Euler’s theorem for homogenous functions – Total derivatives – Differentiation of implicit functions – Jacobian – Taylor’s expansion – Maxima and Minima – Method of Lagrangian Multipliers.

Definitions and concepts of integrals – Methods of integration (Decomposition method, Substitution method, Integration by parts) – Definite integrals – Properties and problems – Reduction formulae – Beta and Gamma functions.

Double integration – Cartesian and Polar coordinates – Change of order of integration – Area as a double integral - Change of variables between Cartesian and Polar coordinates – Triple integration in Cartesian coordinates – Volume as triple integral.

Evocation /Application of Mathematics, Quick Mathematics – Speed Multiplication and Division Applications of Matrices.

Total = 45 (L) + 15 (T) = 60 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply the Characteristic Equation, Characteristic roots and use the applicability of Cayley – Hamilton theorem to find the Inverse of matrix
2. Analyze functions using limits, continuity, derivatives and to solve Physical application problems
3. Apply differentiation techniques and Lagrange multiplier method to predict the extreme values of the functions with constrain
4. Apply the concept of some special function like Gamma, Beta function and their relation to evaluate some definite integral
5. Apply integration to compute Multiple integrals, Area and Volume in addition to change of order and change of variables
6. Understand the basic concept in Matrix, Differentiation and Integration.

TEXT BOOK:

1. Bali N.P and Manish Goyal, “A Textbook of Engineering Mathematics”, Laxmi Publications (P) Ltd, New Delhi, 8th Edition, (2011).
2. Veerarajan T, “Engineering Mathematics” Tata McGraw Hill Publishing Company, New Delhi, 2008.
3. Grewal. B.S, “Higher Engineering Mathematics”, Khanna Publications, New Delhi, 42nd Edition, (2012).

REFERENCE BOOKS:

1. Ramana B.V, “Higher Engineering Mathematics”, Tata McGraw Hill Publishing Company, New Delhi, 11th Reprint,(2010).
2. Glyn James, “Advanced Engineering Mathematics”, Pearson Education, New Delhi, 7th Edition,(2007).
3. Jain R.K and Iyengar S.R.K,” Advanced Engineering Mathematics”, Narosa Publishing House, New Delhi, 3rd Edition,(2007).
4. Bharati Krishna Tirthaji, “Vedic Mathematics - Mental Calculation”, Motilal Banarsi Dass Publications, New Delhi, 1st Edition,(1965).
5. Kreyszig. E, “Advanced Engineering Mathematics”, John Wiley & Sons, New York, 10th Edition,(2011).
6. P. Sivaramakrishna Das, E. Rukmangadachari “Engineering mathematics”, volume1,Pearson Edison New Delhi, 2nd Edition, (2013).

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3														
CO 2	3	3		1											
CO 3	3														
CO 4	3														
CO 5	3														
CO 6	2														
R21UMA102	3	3		1											

Ref:

3-Strong

2-Medium

1 –Weak

L	T	P	C
3	0	0	3

- To impart the knowledge on Chemical bonding and types.
- To describe the basic chemical reactions.
- To Impart the knowledge on chemical kinetics
- To explain the boiler feed water requirements related problems and water treatment techniques.
- To explain the principles and control methods of corrosion.

UNIT I CHEMICAL BONDING 9

Chemical Bonding: Electronic Configuration– Ionic Bond - Covalent Bond – Metallic bond – Aufbau principle, Pauli Exclusion principle, Valence bond theory applications and its limitations, Various types of hybridization (sp , sp^2 , sp^3) (C_2H_2 , C_2H_4 , CH_4) -bond strength and bond energy - Hydrogen bonding, Vander Waals forces.

UNIT II BASIC CHEMICAL REACTION 9

Chemical reaction- Balanced chemical equation, Implication of a balanced chemical equation - Basic types of reaction- Combination, Decomposition, Displacement, Precipitation, Neutralization and Redox Reactions - General properties, examples and uses of Acids, Bases and Salt. Concept of pH scale - Importance of pH in everyday life.

UNIT III PHOTONICS 9

Basic definitions, Differential equation view of rate - Rate constant, Rate law - Reaction order 1st and 2nd order kinetics - Determination of kinetics from rate laws, Half-life - Activation energy - Michaelis menten kinetics of enzyme catalyzed reaction.

UNIT IV WATER AND ITS TREATMENT TECHNOLOGIES 9

Introduction- Definition- Types – Chemical corrosion (Dry corrosion, mechanism and its Example)- Electrochemical corrosion (Wet corrosion, mechanism and its Types – Galvanic & Differential aeration Corrosion- Pitting, crevice & Wire fence corrosion). Corrosion prevention - Cathodic protection and Protective coatings – Paint, Electro plating – Gold plating.

UNIT V PREVENTION OF CORROSION 9

Introduction- Definition- Types - Chemical corrosion (Dry corrosion, mechanism and its Example) - Electrochemical corrosion (Wet corrosion, mechanism and its Types - Galvanic & Differential aeration Corrosion- Pitting, crevice & Wire fence corrosion). Corrosion prevention - Cathodic protection and Protective coatings - Paint, Electro plating - Gold plating.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the basic concept of chemistry involving chemical bonding, chemical kinetics, water treatment methods and corrosion.
2. Explain the bonding properties of molecules and order of reaction.
3. Apply the knowledge of chemical bonding to identify the types of bond in molecules
4. Analyze the impurities of water to find its hardness and remove the hardness of water for industrial application
5. Analyze the causes of corrosion, its consequences and methods to minimize corrosion to improve industrial designs
6. Write a report on chemical applications for Industries.

TEXT BOOK:

1. Jain P.C. and Monica Jain, "Engineering Chemistry", Dhanpat Rai Publishing Company (P)Ltd., New Delhi, 2010
2. Dr. Sunita Rattan, "A Textbook of Engineering Chemistry" S. K .Kataria & Sons, New Delhi, 2013.
3. Pradeep. T "A textbook of Nano science and Nanotechnology", Tata McGraw - Hill Education Private ltd, 2012.

REFERENCE BOOKS:

1. Physical chemistry – Samuel Glasstone, Macmillan II edition, 1969.
2. Physical Chemistry – P. L. Sony, Sulthan Chand & Sons, Delhi -6.
3. A. K. Kaw, Mechanics of Composite Materials, CRC Press, New Delhi 2005.
4. S. C. Sharma, Composite materials, Narosa Publications, New Delhi, 2000.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	2														
CO 3	3														
CO 4	3	3													
CO 5	3	3													
CO 6	3														
R21UCY104	3	3													

Ref:**3-Strong****2-Medium****1 –Weak**

R21UME204	ENGINEERING MATERIALS AND METALLURGY (Only for Mechanical)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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.
- To explain the various tests and experiments available to improve the quality characteristics.

INTRODUCTION TO MATERIAL PHYSICS (NOT FOR EXAM) 2

Crystal structure - BCC, FCC and HCP structure - unit cell - crystallographic planes and directions, miller indices - crystal imperfections, point, line, planar and volume defects - Grain size, ASTM grain size number.

UNIT I CONSTITUTION OF ALLOYS & SELECTION OF MATERIALS 7

Constitution of alloys - Solid solutions, substitution and interstitial - phase diagrams, Isomorphous, eutectoid, eutectic, peritectic, and peritectoid reactions, Iron - Iron carbide equilibrium diagram- Selection of Materials.

UNIT II MATERIAL PROCESSING 9

Heat treatment-Full annealing, stress relief, recrystallization and spheroidizing-normalizing, hardening and tempering of steel – Isothermal transformation diagrams - cooling curves superimposed on I.T. diagram, CCR- Hardenability - Austempering, martempering – case hardening, carburising, nitriding, cyaniding, carbonitriding-flame and induction hardening.

UNIT III MATERIAL TESTING 9

Mechanism of plastic deformation, slip and twinning - Types of fracture - Testing of materials under tension, compression and shear loads - Hardness tests (Brinell, Vickers, Rockwell & Barcol), Impact test - Izod and Charpy, S-N curves Fatigue and creep tests, fracture toughness tests.

UNIT IV FERROUS AND NON FERROUS METALS 9

FERROUS MATERIAL: Effect of alloying elements on steel (Mn, Si, Cr, Mo, V, Ti &W) – stainless and tool steels - HSLA - maraging steels. Classification of steel and cast Iron, microstructure, properties and applications.

NON FERROUS MATERIALS: Copper and Copper alloys - Nickel, Magnesium, Titanium, Lead, Tin. Important alloys - their composition properties and applications of Brass, Bronze and Cupronickel - Aluminum and Al-Cu alloy. Properties and Applications

UNIT V NON-METALLIC MATERIALS 9

Polymers - types of polymer, commodity and engineering polymers - Properties and applications of PE, PP, PS, PVC, PMMA, PET, PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE Polymers - Urea and Phenol Formaldehydes – Introduction to Fiber reinforced Composite.– Processing, fabrication & its Applications.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the concepts of basic material science, material processing and mechanical properties testing procedures. (Understand)
2. Apply the mechanical engineering concepts for selecting the suitable engineering materials for various applications. (Apply)
3. Apply the characteristics and properties of non-metallic materials for various engineering applications. (Apply)
4. Select suitable heat treatment techniques for the given ferrous materials. (Apply)
5. Analyse the material deformations and fracture behaviours for different materials. (Analyze)
6. Evaluate the suitable mechanical properties of metallic materials for different engineering applications. (Analyze)

REFERENCE BOOKS:

1. Kenneth G Budinski, Michael K. Budinski, "Engineering Materials", Prentice-Hall of India Private Limited, 4th Indian Reprint, 2002
2. William D Callister, "Material Science and Engineering", John Wiley and Sons, 2007
3. Srinivasan. R, "Engineering Materials and Metallurgy", Tata McGraw-Hill Publishing Limited, 2013.
4. Raghavan. V, "Materials Science and Engineering," Prentice Hall of India Pvt., Ltd, 2007.
5. Sydney H. Avner, "Introduction to Physical Metallurgy", McGraw Hill Book Company, 2007.
6. O.P. Khanna, "A text book of Materials Science and Metallurgy", Khanna Publishers, 2003.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	3														
CO 3	3														
CO 4	3														
CO 5	3	3													
CO 6	3	3													
R21UME204	3	3													

Ref:

3-Strong

2-Medium

1 –Weak

R21UME109	ENGINEERING GRAPHICS (Common to All Branches Except CSBS, AI & DS and CSD)	L	T	P	C
		1	3	0	4

OBJECTIVES:

- To develop student's graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.
- To impart knowledge in development of surfaces and isometric projections.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION) 4

Importance of Graphics in Engineering Applications – Use of Drafting Instruments – BIS Conventions and Specifications – Size, Layout and Folding of Drawing Sheets – Lettering and Dimensioning - Introduction to Plane Curves, Projection of Points, Lines and Plane Surfaces.

UNIT I PROJECTION OF SOLIDS 12

Projection of simple solids like prisms, pyramids, cylinder and cone with axis is parallel, perpendicular and inclined to one of the plane.

UNIT II SECTION OF SOLIDS 10

Section of solids - simple position with cutting plane parallel, perpendicular and inclined to one of the plane.

UNIT III DEVELOPMENT OF SURFACES 10

Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones - Development of lateral surfaces of sectioned solids.

UNIT IV ISOMETRIC PROJECTIONS 12

Principles of isometric projection – isometric scale – isometric view - isometric projections of simple solids and cut solids.

UNIT V ORTHOGRAPHIC PROJECTION 12

Representation of Three Dimensional objects – General principles of orthographic projection- Need for importance of multiple views and their placement – First angle projection – layout views. Developing visualization skills of multiple views (Front, top and side views) from pictorial views of objects.

Total = 45 (L) + 15 (T) = 60 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Draw orthographic projections of basic geometrical entities in various positions and translate the Geometric information of engineering objects into engineering drawings. (Understand)
2. Apply the principles of orthographic projections to draw projections of solids and sections of solids. (Apply)
3. Develop lateral surfaces of regular and sectioned solids. (Apply)
4. Prepare isometric drawings of simple solids from orthographic views. (Apply)
5. Construct orthographic projection from the given pictorial view. (Apply)
6. Analyze the projections of various solid models using different resting conditions. (Analyze)

TEXT BOOK:

1. Natarajan K.V., “A Text book of Engineering Graphics”, Dhanalakshmi Publishers,(2006).
2. Bhatt N.D., “Engineering Drawing”, Charotar Publishing House,(2012).

REFERENCE BOOKS:

1. Venugopal K., and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, (2008).
3. Gopalakrishnan K.R., “Engineering Drawing” (Vol. I & II), 23rd edition, Subhas Publications, (2014).
4. Dhananjay A. Jolhe, “Engineering Drawing with an introduction to Auto CAD”, Tata McGraw Hill Publishing Company Limited,(2012).
5. Saravanan M, Bensan Raj J, Ganesh Kumar S, “Engineering Graphics”, JBR Trisea Publishers, Nagarcoil, 2020.

COURSE ARTICULATION MATRIX: CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2									3					
CO 2	3												2		
CO 3	3												2		
CO 4	3									3			2		2
CO 5	3				3					3		3	2		2
CO 6	3	2			3					3		3	3		2
R21UME109	3	2			3					3		3	3		2

Ref:

3-Strong

2-Medium

1 –Weak

R21UME211	COMPUTER AIDED DRAFTING AND MODELING			
	LABORATORY			
	(Only for Mechanical)			
	L	T	P	C
	0	0	3	1.5

OBJECTIVES:

- To demonstrate the capabilities of software for drafting and modeling.
- To train the students understand and draw simple solids, isometric projection of simple objects and residential building.

LIST OF EXPERIMENTS

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi- line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using B spline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V- block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.).
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc.
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

A minimum of nine experiments shall be offered

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Construct the parabola and involutes using B spline or cubic spline. (Mechanism)
2. Draw the 2D view of simple solids like V-block, base of a mixie and regular solid.(Mechanism)
3. Construct the 3D view of objects in Isometric projection using AutoCAD software. (Mechanism)
4. Draw the sectional view of solids like prism, pyramid, cylinder and cone. (Mechanism)
5. Sketch a plan of residential building using AutoCAD software. (Mechanism)
6. Sketch the simple steel truss using AutoCAD software. (Mechanism)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3				3					2			2		
CO 2	3				3					2			2		
CO 3	3				3					2			2		
CO 4	3				3					2			2		
CO 5	3	2			3				3	2		2	2		2
CO 6	3	2			3				3	2			2		2
R21UME211	3	2			3				3	2		2	2		2

Ref:

3-Strong

2-Medium

1 –Weak

R21UME111

ENGINEERING PRACTICES LABORATORY
(Common to Mech, EEE, Civil & Agri)

L	T	P	C
0	0	2	1

OBJECTIVES:

- To demonstrate the plumbing and carpentry works.
- To train the students to perform welding, fitting and drilling operations.
- To demonstrate residential house wiring, fluorescent lamp wiring, measurement of earth resistance, colour coding of resistors, logic gates and soldering.

LIST OF EXPERIMENTS

GROUP A (CIVIL & MECHANICAL)
CIVIL ENGINEERING PRACTICE

1. Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, and elbows in house hold fittings.
2. Preparation of plumbing line sketches for water supply and sewage works.
3. Hands-on-exercise: Basic pipe connections–Mixed pipe material connection Pipe connections with different joining components.
4. Demonstration of plumbing requirements of high-rise buildings.
5. Study of the joints in roofs, doors, windows and furniture.
6. Hands-on-exercise: Wood work, cutting, planning and joints by sawing –Half lap joint.

MECHANICAL ENGINEERING PRACTICE

1. Preparation of arc welding of butt joints, lap joints and tee joints.
2. Drilling Practice.
3. Sheet metal model making – Trays, funnels, etc.
4. Different type of fittings -‘V’ type, ‘L’ Type
5. Study of Lathe Machine tool.
6. Study of Plastic Injection Moulding.
7. Study of Moulding.

A minimum of five experiments shall be offered in GROUP A (CIVIL & MECHANICAL)

GROUP B (ELECTRICAL & ELECTRONICS)
ELECTRICAL ENGINEERING PRACTICE

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter and Stair case wiring.
2. Fluorescent lamp wiring.
3. Measurement of resistance to earth of electrical equipment.

ELECTRONICS ENGINEERING PRACTICE LIST OF EXPERIMENTS:

1. Study of Electronic components and equipment's – Resistor, colour coding Measurement of AC Signal parameter (peak-peak, rms, period, frequency) using CRO.
2. Study of logic gates AND, OR, EX-OR and NOT Gate.
3. Soldering practice – Components, Devices and Circuits – Using general purpose PCB.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Shows the centrifugal pump, air conditioner, lathe machine tool, molding, operations of foundry and fittings. (Set)
2. Assembles the carpentry work and plumbing work for a given diagram to complete the work. (Mechanism)
3. Imitates suitable tools for fabrication of sheet metals like cone, funnel and tray. (Guided Response)
4. Operates the welding and drilling operations for the various structures. (Mechanism)
5. Manipulate the components, Logic gates, soldering practices with help of printed circuit boards (PCB). (Mechanism)
6. Operate the various electronic components and using that for the industrial and housing application. (Guided Response)

EQUIPMENT REQUIREMENT

CIVIL ENGINEERING

S. No.	Name of the equipment	Quantity Required
1.	Assorted components for plumbing consisting of metallic Pipes, plastic pipes, flexible pipes, couplings, unions, Elbows, plugs and other fittings	5 Sets
2.	Carpentry vice (fitted to workbench)	15 Nos
3.	Standard working tools	15 Sets
4.	Models of industrial trusses, door joints, furniture joints	5 Each
5.	Power tool rotary hammer	2 Nos
6.	Demolition hammers	2 Nos
7.	Planer	2 Nos
8.	Hand drilling machine	2 Nos
9.	Jigsaw	2 Nos

MECHANICAL ENGINEERING

S. No.	Name of the equipment	Quantity Required
1.	Arc welding transformer with cables and holders	5 Nos
2.	Welding booth with exhaust facility	5 Nos
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit	2 Nos

S. No.	Name of the equipment	Quantity Required
5.	Vice	5 Nos
6.	Hacksaw frame and blade	5 Nos
7.	Files	5 Nos
8.	Study-purpose items: Centre Lathe, pattern, cope & drag box and moulding tools	Each 1 No.

ELECTRICAL ENGINEERING

S. No.	Name of the equipment	Quantity Required
1.	Assorted electrical components for house wiring	15 Sets
2.	Electrical measuring instruments	10 Sets
3.	Megger (250V/500V)	1 No
4.	Study purpose items: Iron box, fan and regulator, emergency lamp	One each
5.	Power Tools: (a) Range Finder	2 No 2 No

ELECTRICAL ENGINEERING

S. No.	Name of the equipment	Quantity Required
1.	Logic trainer kit	2 Nos
2.	CRO, AFO	2 Each
3.	Small multipurpose PCBs	10 Nos
4.	Soldering guns	10 Nos
5.	Multimeters	5 Nos
6.	Assorted electronic components for making circuits	Required quantity

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3														
CO 2	3							3	3			3	2		2
CO 3	3							3	3				2		
CO 4	3					2	2	3	3			3	2	3	2
CO 5	3							3	3						
CO 6	3							3	3			3			2
R21UME111	3					2	2	3	3			3	2	3	2

Ref:

3-Strong

2-Medium

1 –Weak

R21UCY113

CHEMISTRY LABORATORY

L T P C

**(Common to MECH, ECE,EEE, CIVIL, CHEMICAL, BT,
BME & AGRI)**

0 0 2 1

OBJECTIVES:

- To impart knowledge on basic concepts in applications of chemical analysis
- Train the students to handle various instruments.
- To acquire knowledge on the chemical analysis of various metal ions.

**LIST OF EXPERIMENTS
(Common to All Branches)**

1. Preparation of molar and normal solutions of the following substances – Oxalic acid , Sodium Carbonate , Sodium Hydroxide and Hydrochloric acid
2. Conductometric Titration of strong acid with strong base
3. Conductometric Titration of Mixture of Acids
4. Estimation of Iron by potentiometry
5. Determination of Strength of given acid using pHmetry
6. Determination of molecular weight of polymer by viscometry
7. Comparison of the electrical conductivity of two samples-conductometric method
8. Estimation of copper in brass by EDTA method

A minimum of FIVE experiments shall be offered

TOTAL: 30 Periods

Laboratory classes on alternate weeks for Physics and Chemistry

COURSE OUTCOMES:

After the successful completion of this course, the student shall be able to

1. Describe the basic concept of chemistry involved in chemical bonding, water treatment methods, smart materials, e-waste management and energy storage devices.
2. Explain the principles and application of organic light emitting diodes, liquid crystals and green chemistry.
3. Apply the knowledge of chemical bonding to identify the types of bonds in molecules.
4. Apply the knowledge of the basic electro chemical cell terminology to select suitable type of energy storage devices for engineering application.
5. Analyze the impurities of water to find its hardness and remove the hardness causing substances.
6. Write a report on chemical application for Industries

COURSE ARTICULATION MATRIX:

CO/PO/ PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	2														
CO.2	2														
CO.3	3								2						
CO.4	3					2	2		2						
CO.5	3	3	2			2	2		3				3		
CO. 6	3					2	2		3	3					2
R21UGS1	3	3	2			2	2		3	3			3		2

Ref: 3- Strong

2-Medium

1 – Weak

R21UGM131	INDUCTION PROGRAMME (Common to All Branches)	L	T	P	C
		0	3	0	P/F
OBJECTIVES: • To rejuvenate the Body and Mind • To strengthen Attitude and soft skills • To practice Moral values of life.					
UNIT I	PHYSICAL ACTIVITY				10
Zumba - Bokwa Fitness – Yoga – Mediation – Fine Arts					
UNIT II	CREATIVE ARTS				5
Painting – Class Painting – Wall Painting – Art from waste.					
UNIT III	UNIVERSAL HUMAN VALUES & EMINENT SPEAKERS				5
Ethical values – Ambition and Family Expectation, Gratitude, Competition and Excellence – Belief – Morality of life – Guest Lecture by Eminent personality.					
UNIT IV	LITERARY				5
Elocution - Essay writing Competition - Impromptu Session - Dance and singing competition.					
UNIT V	PROFICIENCY MODULES				10
Toastmaster club meet.					
UNIT VI	INDUSTRIAL & LOCAL VISIT				8
Vaigai Dam – Theni - VOC- Port-Tuticorin - Madurai Radio City-Madurai - Aavin Milk –Madurai-NSS Activities.					
UNIT VII	FAMILIARIZATION OF THE DEPT. AND INNOVATION				2
Department Introduction and Purpose of Course - Eminent speakers – Scope and Feature of the Course - Latest Innovation.					
Total = 45 Periods					

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Practice physical activities regularly.
2. Implement creativity in drawing and waste material.
3. Communicate their ideas effectively.
4. Identify inputs and outputs of different industry process.
5. Describe the scope and features of their programme of study.

REFERENCE BOOKS:

1. Student Induction Programme: A Detailed Guide by AICTE, New Delhi.

OBJECTIVES:

- To provide insights regarding the cultural heritage of the Tamil , Sangam Literature and the past History during ancient periods.

UNIT I	HERITAGE AND CIVILIZATION OF TAMIL THROUGH ARCHAEOLOGY	4

Introduction - Basics of archaeology – Historical Source - Archaeological Excavations in Keeladi - Findings based on Keeladi Excavation - Excavations near Mayiladumparai - Excavations near Sivagalai - Excavations at Adichanallur - An Analysis of the excavations in Tamilnadu

UNIT II	TAMIL HERITAGE IN SANGAM AGE	5

Introduction - Sangam Literature - Political History of Sangam Period - Sangam Polity and Administration – Sangam Society - Position of Women during Sangam Age - Economy of the Sangam Age

UNIT III	SOURCES OF ANCIENT TAMIL HERITAGE AND HISTORY	4

Evidences of Tamilakam in Greek and Roman Literature - Archaeological sources - Evidence for economic activities - Literary sources in Tamil - Literary Evidences about Tamil History in other languages - Epigraphical sources - Cave inscriptions - Pottery inscriptions - Numismatic(Coins) sources

UNIT IV	EVIDENCE FOR ANCIENTNESS OF TAMIL LITERATURE AND HERITAGE	4

Tamil Literature - India's Earliest Script: Tamil (Tamil Brahmi) - Literary work of Ancient Tamil - Tolkappiam - Thirukkural & Naladiyar - Tracing Ancient Tamil Literature by U.V. Aminaytha Iyer - Tamil, a Classical Language

Total = 15 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Describe the Heritage and Civilization of Tamil through Archaeology.(Understand)
2. Interpret the Tamil Literature and Civilization in historical manner. (Understand)
3. Demonstrate the ability to appreciate the ancientness Tamil heritage and literature.(Apply)
4. (Valuing – Affective Domain)
5. Analyze the sources of Tamil Civilization relating to Indus Valley Civilization. (Analyze).

TEXT CUM REFERENCE BOOKS:

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கக. கக. பிள்ளை(வவையீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முளவர இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – ளவளக நதிக்களரயில் சங்ககால நகர நாகரீகம்(வதால்லியல் துளை வவையீடு)
4. வபாருளந – ஆற்றைங்களர நாகரிகம். (வதால்லியல் துளை வவையீடு)
5. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (inprint)
6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu)

- (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by International Institute of Tamil Studies.)
 9. 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)
 10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
 11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu).
 12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book

தமிழர் மரபு

அலகு 1 தொல்லியல் வழியாக அறியப்படும் தமிழர்களின் மரபும் நாகரீகமும்

அறிமுகம் - தொல்லியலின் அடிப்படைக் கூறுகள் - வரலாற்று தரவுகள் - கீழடி தொல்லியல் அகழ்வராய்ச்சி - கீழடி அகழ்வராய்ச்சியின் கண்டுபிடிப்புகள் - மயிலாடும்பாறை அருகே நடந்த அகழ்வராய்ச்சி - சிவகங்கை அருகே நடந்த அகழ்வராய்ச்சி - தமிழ்நாட்டில் நடைபெற்ற அகழ்வராய்ச்சிகளின் பகுப்பாய்வு

அலகு 2 சங்க கால தமிழர் மரபு

அறிமுகம் - சங்க இலக்கியங்கள் - சங்க கால அரசியல் வரலாறு - சங்க கால அரசியலும் அரசு நிர்வாகமும் - சங்க கால சமூகம் - சங்க கால சமூகத்தில் மகளிரின் நிலை - சங்க கால பொருளாதாரம்

அலகு 3 பண்டைய தமிழர் மரபு மற்றும் வரலாற்றின் ஆதாரங்கள்

கிரேக்க மற்றும் ரோமானிய இலக்கியங்களில் தமிழ்நாடு பற்றிய சான்றுகள் - தொல்லியல் ஆதாரங்கள் - தமிழ் இலக்கிய ஆதாரங்கள் - தமிழர் வரலாறு பற்றி பிறமொழி இலக்கியங்களில் உள்ள சான்றுகள் - கல்வெட்டு ஆதாரங்கள் - குகை ஓவியங்கள், சிற்பங்களில் உள்ள ஆதாரங்கள் - பண்டைய மண்பாண்ட பொருட்களின் சான்றுகள் - நாணயவியல் ஆதாரங்கள்

அலகு 4 பண்டைய தமிழர் இலக்கியம் மற்றும் மரபின் தொன்மைக்கான ஆதாரங்கள்

தமிழ் இலக்கியங்கள் - இந்தியாவின் மிக ஆரம்பகால எழுத்து வடிவம் - (தமிழ் பிராமி எழுத்து வடிவம்) - பண்டைய தமிழகத்தின் இலக்கியப் பணிகள் - தொல்காப்பியம் - திருக்குறள் மற்றும் நாலடியார் - தொன்மை தமிழ் இலக்கியங்களை தடமறிந்து கண்டடைந்த உ.வே.சாமிநாத ஐயர் - தமிழ் - ஒரு உயர்தனிச் செம்மொழி

SEMESTER – II

[illegible]

R21UEN201	COMMUNICATION SKILLS FOR PROFESSIONALS			
	(INTEGRATED COURSE)			
	(Common to ALL Branches – Except CSBS)			
	L	T	P	C
	1	0	1	1.5

OBJECTIVES:

- Improve their oral expression and thought.
- Develop their confidence and ability to speak in public.
- Develop their capacity for leadership.

5 Oral Projects

Project 1

SELF INTRODUCTION & DELIVER A SPEECH BEFORE AUDIENCE (Time: 5 to 7 minutes)

- To Speak in front of an audience with courage.
- Make your message clear, with supporting material.
- Create a strong opening and conclusion.

Project2

SPEAK ON THE CHOSEN CONTENT (Time: 5 to 7minutes)

- Select a general topic and bring out specific purposes.
- Avoid using notes.
- Use symbolic ideas to develop your ideas.

Project3

USE EFFECTIVE BODY LANGUAGE & INTONATION (Time: 5 to 7minutes)

- Use appropriate posture, gestures, facial expressions and eye contact to express your ideas.
- Use proper intonation and adequate speech module.

Project4

PRESENT YOUR TOPIC WITH VISUAL AIDS (Time: 5 to 7minutes)

- Persuade your points with suitable illustration, specific facts, examples
- Use suitable visual aids to present your topic with confidence.

Project 5

GRASP THE ATTENTION OF THE AUDIENCE (Time: 5 to 7minutes)

- Influence your listeners by adopting holistic viewpoint.
- Use emotions, stories, and positive quotes in your speech.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Communicate orally with fluency and clarity in a given contextual situation.
2. Adapt them to work in a group as a member or leader for effectively executing the task.
3. Write language appropriately without error in any given circumstances.
4. Communicate information ideas and opinions in any given situations.
5. Present the ideas creatively with coherence for given topic.

REFERENCE BOOKS:

1. Competent Communication- A Practical Guide to becoming a better speaker, Toastmasters International, USA.
2. Norman Lewis – Word Power Made Easy, Pocket Book Publication, 2019.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1									2	3		2			2
CO 2									2	3		2			2
CO 3									2	3		2			2
CO 4									2	3		2			2
CO 5									2	3		2			2
R21UEN201									2	3		2			2

Ref:

3-Strong

2-Medium

1 –Weak

R21UMA202	CALCULUS, FOURIER SERIES AND NUMERICAL METHODS			
	(Only for MECH)			
	L	T	P	C
	3	1	0	4

OBJECTIVES:

- To acquaint the student with the roots of nonlinear (algebraic or transcendental) equations, solutions of large system of linear equations and eigenvalue problem of a matrix can be obtained numerically where analytical methods fail to give solution.
- To develop an understanding of the basics of vector calculus comprising of gradient, divergence and curl, and line, surface and volume integrals and the classical theorems involving them.
- To acquaint the student with Fourier transform techniques used in variety of situations.

UNIT I NUMERICAL SOLUTION OF SIMULTANEOUS EQUATIONS AND EIGEN VALUE PROBLEMS 9 + 3

Iteration method – Newton-Raphson method – Gauss Elimination method – Pivoting – Gauss Jordan methods – iterative methods : Gauss Jacobi method ,Gauss Seidel method - Eigen values of a matrix by Power method – Jacobi's method for a real symmetric matrix.

UNIT II SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS 9 + 3

Exact, linear and Bernoulli's Equations, Euler's Equation- Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Applications of ODE in Mechanical Engineering.

UNIT III VECTOR CALCULUS 9 + 3

Gradient Divergence and Curl – Directional derivative – Irrotational and Solenoidal vector fields –Vector integration–Green's theorem in a plane, Gauss divergence theorem and Stokes' Theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopiped. Applications of Vector calculus in Mechanical Engineering.

UNIT IV FOURIER SERIES 9 + 3

Dirichlet's conditions – General Fourier series–Odd and even functions–Half range sine series – Half range cosine series - Parseval's identity – Harmonic analysis - Application of Fourier series.

UNIT V FOURIER TRANSFORMS 9 + 3

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity - Application of Fourier Transform.

SUPPLEMENT TOPIC (for internal evaluation only-)

Evocation / Application of Mathematics.

Total = 45 (L) + 15 (T) = 60 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply various techniques to solve linear, nonlinear equations and Eigen value problems of a Matrix Numerically. (Apply) K3
2. Apply the knowledge of higher order ordinary differential equations in real life engineering problems. (Apply)
3. Apply the uses of vector identities in problem solving and evaluate the line, surface and volume integrals. (Apply)
4. Apply the knowledge of Fourier series for the given function or Discrete data and compute the Periodic function arising in the study of Engineering problems. (Apply)
5. Apply the acquired knowledge of Fourier transform and its properties which are used to transform signals between time and frequency domain. (Apply)
6. Understand the basic concept of periodic function, scalar potential and order of differential equation. (Apply)

TEXT BOOK:

1. Grewal B.S, “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 42nd Edition,(2012).
2. Bali N.P., Manish Goyal and Watains, “Advanced Engineering Mathematics”, Firewall Media (An imprint of Laxmi Publication Private limited) New Delhi, 7th Edition, (2009).
3. Iyengar S.R.K , Jain R.K. , Mahiden Kumar Jain “ Numerical Methods for Scientific and Engineering Computations” New Age International Publishers 7th Edition 2019.

REFERENCE BOOKS:

1. Kandasamy P, Thilagavathy K, and Gunavathy K, Engineering Mathematics III, S. Chand & Company Ltd., New Delhi, 3rd Edition, (1996).
2. Ramana.B.V, “Higher Engineering Mathematics” Tata McGraw Hill, New Delhi, 11th Reprint (2010).
3. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, New Delhi, 3rd Edition, (2007).
4. Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley India, 10th Edition, (2011).

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3														
CO 2	3			1											
CO 3	3														
CO 4	3														
CO 5	3														
CO 6	2														
21UMA202	3			1											

Ref:

3-Strong

2-Medium

1 –Weak

TOTAL = 45 PERIODS

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

1. Classify the types of crystals, lasers, elasticity and quantum behavior of solids. (Understand) K2
2. Apply the basic knowledge of crystal, quantum mechanics and mechanical behavior of solids to solve engineering problems. (Apply) K3
3. Apply the principle of laser to estimate the wavelength of emitted photons. (Apply) K3
4. Analyze the dual nature of matter using the concepts of quantum mechanics.(Analyze) K4
5. Analyze the structural and optical properties of crystals in industrial and medical applications.(Analyze) K4
6. Analyze the properties of materials for specific Engineering Applications. (Analyze) K4

TEXT BOOKS:

1. Dr. Mani.P, “Engineering Physics”, Dhanam Publications, Edition, 2018,Chennai.
2. Rajendran.V, “Engineering, Physics”, Tata Mc-Graw Hill Publishing Company limited, New Delhi, Revised Edition2018.
3. Palanisami P.K., “Physics for Engineers”, Scitech Publications (India), Pvt Ltd., Chennai, 2018.

REFERENCE BOOKS:

1. Raghuvenshi G.S., “Engineering Physics”, PHI Learning Private Limited, New Delhi, Revised Edition 2018.
2. Arul doss .G., “Engineering Physics”, PHI Learning Limited, New Delhi, Revised Edition 2018.
3. Marikani .A., “Engineering Physics”, PHI Learning Private Limited, New Delhi, Revised Edition2017.
4. Sankar B.N., and Pillai .S.O., “A Text book of Engineering Physics”, New Age International Publishers Private Limited, New Delhi, Revised Edition2017.
5. Avadhanulu M.N. and Kshirsagar P.G., “A Textbook: of Engineering Physics”, S.Chand & Company Ltd., New Delhi,2018.

COURSE ARTICULATION MATRIX:

CO/PO/ PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	2														
CO.2	3														
CO.3	3														
CO.4	3	3													
CO.5	3	3													
CO.6	3	3	2												3
R21UPH203	3	3	2												3

Ref: 3-Strong

2-Medium

1 –Weak

R21UM302

**FUNDAMENTALS OF MANUFACTURING
PROCESSES**

L	T	P	C
3	0	0	3

COURSE OBJECTIVE:

- To understand the concepts of different manufacturing processes and select the suitable one out of the available methods for a particular product.
- To develop the design skills based on the operating parameters for a given process

UNIT I METAL CASTING PROCESSES

9 hrs

Introduction to green sand casting - Moulding sand Properties - Pattern types, materials and allowances - Design of pattern – Design of riser and gating system – Cores - Chills and chaplets – Special casting processes – Shell moulding - Investment (Lost Wax process) casting – Pressure die casting – Centrifugal casting – Continuous casting - Inspection methods and remedies for casting defects

UNIT II ADVANCED WELDING PROCESSES

9 hrs

Introduction to Joining process - Submerged arc welding - TIG welding - MIG Welding - Electro slag welding - Thermit welding - Friction welding - Friction stir welding - Plasma arc welding - Electron beam welding - Ultra sonic welding -Thermo-chemical welding - Radiant energy welding – Under water welding - Inspection methods and Remedies for weld defects

UNIT III BULK DEFORMATION PROCESSES

9 hrs

Hot working and cold working of metals - Types of Forging Machines - Forging operations - Open and closed die forging - Rolling of metals - Types of Rolling mills - Flat strip rolling - Shape rolling operations - Principle of rod and wire drawing - Tube drawing - Principles of Extrusion - Hot and Cold extrusion – Direct and indirect extrusion - Plastic deformation and load estimation for forging, rolling, drawing and extrusion

UNIT IV SHEET METAL PROCESSES

9 hrs

Sheet metal processes - Shearing and non-shearing processes - Formability of sheet metal - Plastic deformation and yield strength estimation for deep drawing, shearing and bending - Operation and applications of stretch forming - Deep drawing - Metal spinning - Hydro forming - Rubber pad forming - Explosive forming - Electro hydraulic forming - Magnetic pulse forming - Electromagnetic forming.

UNIT V MANUFACTURING OF PLASTIC COMPONENTS

9 hrs

Types of plastics - Characteristics of the forming and shaping processes - Moulding of Thermoplastics - Working principles and typical applications of - Injection moulding - Plunger and screw machines - Compression moulding, Transfer moulding - Typical industrial applications - Introduction to Blow moulding - Rotational moulding - Film blowing - Extrusion - Thermoforming - Bonding of Thermoplastics - Powder metallurgy process - Composite mouldings.

Total: 45 Hrs

COURSE OUTCOMES:

After successful completion of this course the students will be:

- 1.Explain the concept of various manufacturing processes such as casting, welding, forming, deformation and additive processes (Understand)
- 2.Identify defects and interpret causes for defects in product of metal casting, welding, forming and deformation processes. (Apply)
- 3.Design the proper pattern with allowances, riser and gating system for casting process. (Create)
- 4.Identify real time applications of special casting process, Powder Metallurgy, welding and Rapid Prototyping in industries (Apply)
- 5.Select different processes of Rapid prototyping for given applications used in various industries (Apply)
- 6.Analyze the manufacturing processes used in mechanical working and welding operations.(Analyze)

REFERENCE BOOKS:

1. Pn. Rao “Manufacturing Technology Vol 1 Foundry Forming & Welding”, Tata Mcgraw HillPublishing Co Ltd, 4th Edition 2016.
2. Serope Kalpakjian, Steven Schmid. “Manufacturing Engineering & Technology”, Pearson Edu Asia, 7th Edition, 2014.
3. Ghosh A., Malik A.K. “Manufacturing Science”, Affiliated East-West Press Ltd, 2nd Edition,2010.
4. A Text-Book of Foundry Technology, O.P. Khanna, Dhanpat Rai Publications, 2011
5. Principles of metal casting, [Carl R Loper](#), [Philip C Rosenthal](#), [Richard W Heine](#), Tata McGraw-Hill, 2013.
6. A Text-Book of Welding Technology, O.P Khanna, Dhanpat Rai Publications, 2011.
7. [Manufacturing Process 1 :Casting & Welding Process](#), Radhakrishna K, Sapna Book House,2015.
8. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge International science publishing,2007.
9. HajraChoudhury, “Elements of Workshop Technology, Vol. I and II”, Media Promoters Pvt. Ltd,Mumbai, 2001.
10. Sharma. P.C, “A text book of production technology”, S. Chand and Company, I Edition,

E-Books / Website References

1. E-Foundry - IIT Bombay -<http://efoundry.iitb.ac.in/Academy/index.jsp>
2. NPTEL -<http://nptel.ac.in/courses/112107145>

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	3														
CO 3	3														
CO 4	3		2											3	
CO 5	3				3							3		3	
CO 6	3	3										3		3	
R21UME302	3	3	2		3							3		3	

Ref:**3-Strong****2-Medium****1 –Weak**

R21UEE226	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING (Common to Mech, Civil, Agri & Chem)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course facilitates the students to get a comprehensive exposure to electrical and electronics engineering.

UNIT I DC AND AC CIRCUITS 9

Direct currents and voltages, power, Kirchoffs Laws, Alternating current and voltage, Peak, RMS and average values, circuit elements R,L &C, Phasor Diagram, impedance, real and reactive power in single phase circuits.

UNIT II DC MACHINES AND TRANSFORMERS 9

DC machines Construction, principle of operation and applications, Single phase transformer – construction, principle of operation, Introduction to three phase systems.

UNIT III AC MACHINES 9

Synchronous and Induction machines -Construction, Principle of operation, and applications.

UNIT IV SPECIAL MACHINES 9

Brushless D.C Motor, Stepper Motor, Linear motor and Universal Motor – Construction, Principle of operation and applications.

UNIT V INTRODUCTION TO ELECTRONICS 9

Diode- PN Diode, Zener Diode, BJT Configurations, Rectifiers, Data acquisition system- ADC, DAC – principles of operation.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the principle of operation and construction of AC machines.
2. Apply the basic laws of electrical circuits to linear circuit problems.
3. Analyze the working principles and construction of special machines to evaluate their performance and identify their suitability for various applications.
4. Analyze the characteristics of basic semiconductor devices to assess their behavior and performance in different circuit applications.
5. Apply the working principles and construction knowledge of DC machines and transformers to solve practical problems and perform analysis in electrical systems.
6. Create and evaluate complex DC and AC circuits using Kirchhoffs Laws and phasor diagrams, incorporating resistive, inductive, and capacitive elements.

REFERENCE BOOKS:

1. V K Mehta and Rohit Mehta, “Principles of Electrical Engineering and Electronics”, S. Chand Publishing, New Delhi, 2019.
2. Arumugam M. and Premkumar N., “Electric circuits theory”, Khanna Publishers, 7th edition, New Delhi, 2007.
3. Kothari D.P. Nagrath I.J., “Electric Machines”, Tata McGraw Hill, 2009.
4. K. Venkataratnam, Special Electrical Machines, Universities Press, 2014.
5. R.J. Smith, R.C. Dorf, Circuits devices and systems, 5th edition, John Wiley and sons, 2001. Malvino, A.P, Leach D.P and Gowtham Sha, Digital Principles and Applications, 6th Edition, Tata McGraw hill, 2007.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	3														
CO 3	3	3											3		
CO 4	3	3													
CO 5	3				3										
CO 6	3														
R21UEE226	3	3			3								3		

Ref:

3-Strong

2-Medium

1 –Weak

R21UGS210

APPLIED PHYSICS LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

- To create scientific temper among the students.
- To know how to execute experiments properly, presentation of observations and arrival of conclusions.
- To view and realize the theoretical knowledge acquired by the students through experiments

LIST OF EXPERIMENTS

(Common to All Branches)

1. Laser – (a) Determination of particle size (b) wave length of Laser source.
2. Determination of numerical aperture and acceptance angle of an optical fiber using diode laser.
3. Poiseuille's method- Determination of coefficient of viscosity of liquid.
4. Spectrometer-Determination of wavelength of mercury spectrum using grating.
5. Determination of Energy band gap of a semiconductor.
6. Uniform bending method–Determination of Young's modulus of the given rectangular beam.
7. Lee's Disc – Determination of thermal conductivity of a bad conductor.
8. Air Wedge method-Determination of thickness of a thin wire.
9. Newton's rings – Determination of radius of curvature of a convex lens
10. Torsion pendulum-Determination of Moment of inertia of a metallic disc and rigidity modulus of a given metallic wire.
11. Determination of Solar cell characteristics using optical transducers kit.
12. Magnetic field along the axis of current carrying coil–Stewart and Gee

A minimum of FIVE experiments shall be offered

TOTAL: 30 Periods

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

1. Apply the principles of optics to determine the properties of light and material
2. Interpret the principle of optical fiber and demonstrate this principle with the help of Laser
3. Evaluate the mechanical, elastic and magnetic properties of the given material
4. Analyze the thermal conductivities of different bad conductors
5. Analyze the viscosity and compressibility of the given liquid
6. Analyze the characteristics of a semiconductor

COURSE ARTICULATION MATRIX:
CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	3								2						
CO.2	3								2		2				
CO.3	3				2				2				2		
CO.4	3	3							2					2	
CO.5	3	3							2				3		
CO.6	3	3							2				2		
R21UPH210	3	3			2				2		2		3	2	

Ref: 3-Strong

2-Medium

1-Weak

R21UME307	FUNDAMENTALS OF MANUFACTURING PROCESSES	L	T	P	C
	LABORATORY				
		0	0	2	1

OBJECTIVES :

- To train the knowledge about the lathe.
- To train the practical knowledge in welding processes.
- To demonstrate the sheet metal works.
- To demonstrate about moulding for metals and plastics.

List of Experiments

1. Facing, plain turning and step turning
2. Taper turning using compound rest
3. Single start V thread, cutting and knurling.
4. Boring.
5. Horizontal, Vertical, Arc welding.
6. Gas Cutting, Gas Welding - for demonstration purpose.
7. Brazing - for demonstration purpose.
8. Fabrication of sheet metal tray.
9. Fabrication of a funnel.
10. Mould with solid pattern
11. Mould with split pattern
12. Injection Moulding- for demonstration purpose.

A minimum of nine experiments shall be offered

TOTAL : 30 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Apply the knowledge of machining to make a part by using lathe. (Apply)
2. Apply the knowledge of welding to make different types of joints. (Apply)
3. Apply the knowledge of development of surfaces to prepare sheet metal models. (Apply)
4. Build sand moulds for various parts by selecting the proper casting tools and resources. (Apply)
5. Make use of knowledge of injection moulding machine and process to make different parts. (Apply)

EQUIPMENT REQUIREMENTS:

Sl. No.	Name of the equipment	Quantity required
1.	Centre Lathe with accessories	15
2.	Arc welding machine	04
3.	Gas welding machine	01
4.	Brazing machine	01
5.	Hand Shear 300mm	01
6.	Bench vice	05
7.	Standard tools and calipers for sheet metal work	05
8.	Moulding Table	05
9.	Moulding boxes, tools and patterns	05
10.	Injection Moulding Machine	01

CO/PO/PEO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	3					2			3	2		2	2		2
CO.2	3					2	2	2	3	2		2	2		2
CO.3	3								3	2			2		2
CO.4	3					2	2		3	2		2	2	3	2
CO.5	3	2				2	2	2	3	2		2	3	3	2
R21UME307	3	2				2	2	2	3	2		2	3	3	2

Ref: S- Strong M- Medium W- Weak

(Common to All Branches)

1 0 0 1

UNIT I WEAVING AND CERAMIC TECHNOLOGY**3**

Industries in Sangam Period - Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)

– Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY**3**

Designing and construction of Buildings & Construction materials during Sangam Age- Hero stones of Sangam age – Kallanai Dam – Construction on rocks Pallava period – Chozha Architecture – Thirumalai Naicker Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY**3**

Art of Ship Building – Catamaran – Navy Ships- Metallurgical studies – Coins of Sangam Era – Beads making-industries Stone beads -Glass beads - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND ANIMAL HUSBANDRY**3**

Agriculture in Sangam period – Land Classification – Land ownership – Agriculture Technology – irrigation - Animal Husbandry – Cowherds and Shepherds - Cattle rearing – Cattle raiding – Eru Thazhuvuthal – Mattu Pongal – Ponneru Pootuthal – Cattle Shed

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING**3**

Development of Scientific Tamil - Tamil computing – Tamil Computing and Tamil on Internet - Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS**TEXT-CUM-REFERENCE BOOKS**

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை
(வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரீகம்
(தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)

6. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies).
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D.Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
9. 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)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

R21UGT241

தமிழரும் தொழில்நுட்பமும்

அலகு I நெசவு மற்றும் பாணைத் தொழில்நுட்பம்:

3

சங்க காலத்தில் நெசவுத் தொழில் – பாணைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்:

3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் ஒரு கட்டுமான பொருட்கள், நடுகல்; – கல்லணை அணை – பாறைகள் மீது பல்லவர் கால கட்டிடம்; – சோழர் காலத்துப் கட்டிடக்கலை; – திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – ஆங்கிலேயருடைய காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம்:

3

கப்பல் கட்டும் கலை – கட்டுமரம் – உலோகவியல் – சங்க கால நாணயங்கள் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள்; – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு IV வேளாண்மை மற்றும் கால்நடை வளர்ப்பு; :

3

சங்க காலத்தில் விவசாயம் – நில வகைப்பாடு – நில உரிமை – விவசாய தொழில்நுட்பம் – நீர்ப்பாசனம் – கால்நடை வளர்ப்பு – மாடு மேய்ப்பவர்கள் மற்றும் மேய்ப்பர்கள் – கால்நடை வளர்ப்பு – கால்நடைத் தாக்குதல் – ஒரு தழுவுதல் – மாட்டு பொங்கல் – பொன்னேரு பூட்டுதல் – தொழுவம்.

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ்:

3

அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் கணினி மற்றும் இணையத்தில் தமிழ்-தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

R21UAC231

BIOLOGY FOR ENGINEERS

L	T	P	C
2	0	0	P/F

(Common to All excepts BME & BT)

OBJECTIVES:

- To explain the essentials of basic biological principles.
- To familiarize the different clinical and industrial applications of biology for solving societal problems with engineering tools.

UNIT I INTRODUCTION AND CLASSIFICATION 5

Characteristics of living organisms – Basic classification – Cell theory – Structure of prokaryotic and eukaryotic cell – Introduction to Bio-molecules: Definition – General classification and important functions of Carbohydrates – Lipids – Proteins – Nucleic acids, Vitamins and Enzymes – Genes and Chromosome.

UNIT II BIODIVERSITY 5

Plant System: Basic concepts of Plant growth – Nutrition – Photosynthesis and Nitrogen fixation – Animal System: Elementary study of Digestive, Respiratory, Circulatory, Excretory systems and their functions.

UNIT III BASICS OF CELL AND MOLECULAR BIOLOGY 6

Discovery of cell and Cell Theory – Comparison between plant and animal cells – Cell wall – Plasma membrane – Modification of plasma membrane and intracellular junctions – Stem cells and Tissue engineering.

UNIT IV HUMAN DISEASES 7

Infectious and Non-infectious diseases – Causative agents – Epidemiology – Pathogenicity, Control and prevention – Treatment of AIDS – Tuberculosis – Pathology of non-infectious and genetic diseases and disorders – Cancer, Diabetes mellitus, Cardiac diseases – Neurological disorders – Parkinson's disease.

UNIT V BIOLOGY AND ITS INDUSTRIAL AND CLINICAL APPLICATIONS 7

Transgenic plants and animals – Bioreactors – Bio-pharming – Recombinant vaccines – Cloning – Artificial memory and neural networks – Bioremediation – Biofertilizer – Biocontrol – Biofilters – Biosensors – Biopolymers – Bioenergy – Biochips.

TOTAL : 30 PERIODS

COURSE OUTCOMES:

At the end of the course the student will be able to:

1. Explain the fundamentals of living things, their classification, cell structure and biochemical constituents. (Understand)
2. Apply the concept of plant, animal and microbial systems and growth in real life situations. (Apply)
3. Analyze biological engineering principles, procedures needed to solve societal issues. (Analysis)

TEXT BOOKS:

1. Satyanarayana, U. "Biotechnology", 4th Edition, Books and Allied Pvt. Ltd. Kolkata, 2007.
2. Carol D. Tamparo and Marcia A. "Diseases of the Human Body", Lewis, F.A. Davis Company, 2011.
3. R.Khandpur, "Biomedical instrumentation-Technology and applications", McGraw Hill Professional, 2004.

REFERENCE BOOKS:

1. Lehninger A.L, Nelson D.L, Cox .M.M, Principles of Biochemistry", CBS Publications 2017.
2. Arthur T. Johnson, "Biology for Engineers", CRC Press, Taylor and Francis, 2nd Edition, 2019.
3. Cecie Starr, Ralph Taggart, Christine Evers and Lisa Starr, "Cell Biology and Genetics (Biology: The unity and diversity of life Volume I)", Cengage Learning, 12th Edition, 2008.
4. B.D. Singh, "Biotechnology: Expanding horizon", Kalyani Publishers, 2015.

SEMESTER – III

[illegible]

R21UMA321	PROBABILITY, STATISTICS AND PARTIAL DIFFERENTIAL EQUATIONS (Only for MECH)			
	L	T	P	C
	3	1	0	4

OBJECTIVES:

- To make the student acquire sound knowledge of fundamentals and applications of statistics which will greatly help at the data analysis stage of comparative experiments.
- To make the student acquire sound knowledge of standard distributions that can describe real life phenomena.
- To make the student knowledgeable in formulating certain practical problems in terms of partial differential equations, solve them and physically interpret the results.

UNIT I TESTING OF HYPOTHESIS 9 + 3

Sampling distributions - Normal, t, Chi-square and F distributions - Tests for single mean, Proportion, Difference of means (large and small samples) – Tests for single variance and equality of variances – Chi-square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 9 + 3

Completely randomized design – Randomized block design – Latin square design.

UNIT III PROBABILITY & RANDOM VARIABLES 9 + 3

Axioms of probability - Conditional probability - Total probability - Discrete and continuous random variables - Moments - Moment generating functions and their properties. Binomial, Poisson, Normal and Exponential-Joint probability distributions - Marginal and Conditional distributions – Covariance - Correlation and Regression

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations – Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT V APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Introduction of Partial differential equations - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

Total = 45 (L) + 15 (T) = 60 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Analyze the concept of testing of hypothesis for small and large samples in Real life Problems. (Analyze)
2. Analyze a process, to find its significance using design of experiments. (Analyze)
3. Apply the knowledge of concepts of probability to acquired knowledge of standard Distributions, Correlation and regression. (Apply)
4. Apply the knowledge of partial differential equation in solving linear and higher order partial differential equation. (Apply)
5. Apply the knowledge of PDE in solving linear, higher order and one dimensional Wave, Heat flow equation. (Apply)
6. Understand the knowledge of small sample and large sample, axioms of probability and Nature of PDE. (Understand)

TEXT BOOK:

1. Gupta S.C, Kapoor V.K. “Fundamental of Mathematical Statistics” 10th Edition Sultan Chand and Sons, New Delhi, 2002.
2. Grewal, B.S. “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 35th Edition, (2010).
3. Veerarajan T “Probability and Statistics” Tata McGraw Hill Publishing company Limited 2008.

REFERENCE BOOKS:

1. Walpole. R.E., Myers .R.H., Myers S.L., and YE. K, “Probability and Statistics for Engineers and Scientists”, Pearson Education, New Delhi, 8th edition, (2007).
2. Veerarajn.T “Probability and Statistics” Tata McGraw Hill Publishing company Limited, 2008.
3. Spiegel M.R., Schiller J. and Srinivasan R.A., “Schaum’s Outlines Probability and Statistics”, Tata McGraw Hill, New Delhi, (2004).
4. Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley India, 10th Edition, (2011).

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3		1								1	2	2	
CO 2	3	3		1								1	2	2	
CO 3	3			1								1	2	2	
CO 4	3			1								1	2	2	
CO 5	3			1								1	2	2	
CO 6	3			1								1	2	2	
R21UMA321	3	3		1								1	2	2	

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To understand the working of machine tools such as lathe, shaper, planner, slotter, milling, hobbing, and grinding and non-conventional machining process.`
- To impart knowledge on selection of suitable machine tools for the typical component.

UNIT I	METAL CUTTING THEORY	9

Introduction: material removal processes, mechanics of metal cutting and types of machine tools - theory of metal cutting: chip formation, orthogonal cutting and oblique cutting, cutting tool materials, tool wear, tool life, surface finish, Machinability, cutting fluids- environmental issues-merchant's equation - recent developments and applications (Dry machining and high speed machining).

UNIT II	LATHE, SEMI AUTOMATS AND AUTOMATS	9

Centre lathe, constructional features, various operations, taper turning methods, thread cutting methods, special attachments, machining time and power estimation. Capstan and turret lathes - automats - single spindle- Swiss type, automatics crew type, multi spindle - Turret Indexing mechanism, Bar feed mechanism.

UNIT III	RECIPROCATING MACHINES, DRILLING MACHINES	9

Shaper, Planer and Slotter - Introduction, types, specification and crank and slotted link quick return mechanism. Broaching - Introduction and types. Drilling - Introduction, types, specifications, construction of Radial drilling machine, types of drills and nomenclature of twist drill. Calculation of machining time for drilling. Introduction to fixtures and jigs.

UNIT IV	MILLING MACHINE, GEAR CUTTING AND CNC MACHINES	9

Milling - Introduction, types, specifications, up milling, down milling and operations-Plain milling, machining time calculation. Indexing -simple and differential indexing methods. Gear cutting - Eco-friendly Methods - gear milling, gear shaper and gear hobbing machine - CNC Machines – working of Lathe and Milling – CNC Lathe and Milling programming.

UNIT V	FINISHING PROCESSES AND NON-TRADITIONAL MACHINING PROCESSES	9

Finishing processes - Grinding -Introduction and Types. Grinding wheel- selection, glazing, loading, dressing and truing - Environmental Impact. Fine finishing processes - Honing, lapping, polishing, buffing and super finishing. Non-traditional machining processes: Principle, need, equipment, operation and LBM, plasma arc machining, Electro chemical machining, ultrasonic machining.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Summarize the working principles and operations of the machine tools such as lathe, shaping, milling, broaching, drilling, gear cutting process. (Understand)
2. Summarize CNC machining and finishing process and the working concepts of non-conventional machining process. (Understand)
3. Apply the concepts of metal cutting process like lathe, shaping to make different products. (Apply)
4. Apply metal cutting theory to calculate tool life, cutting forces, and the use of cutting tools and fluids, considering their impact on health, safety, and the environment. (Apply)
5. Apply the concepts of metal cutting process like milling, broaching, drilling and gear cutting process to produce different products. (Apply)
6. Examine the machining time for the traditional and Non-traditional machining operations.(Analyze)

REFERENCE BOOKS:

1. J. P. Kaushish, Manufacturing Processes, Prentice Hall India Learning Private Limited., New Delhi, 2013.
2. Serope kalpakjian, Steven R Schmid, 'Manufacturing Engineering and Technology', Pearson Education, 6th edition, 2015.
3. P. N. Rao, Manufacturing Technology- Metal Cutting and Machine Tools, Tata McGraw Hill Publishing Company Private Limited., New Delhi, 2013
4. S. K. Hajra Choudhury, Elements of Workshop Technology. Vol. II, Media Promoters & Publishers Private Limited., Mumbai, 2013.
5. P.CSharma, Manufacturing Technology-II, S. Chand & Company Limited. New Delhi, 2012.

E-Books / Web References:

1. Hanmin Shi, Metal Cutting Theory: New Perspectives and New Approaches, Springer international publishing, 2018.
https://www.google.co.in/books/edition/Metal_Cutting_Theory/q2BODwAAQBAJ?hl=en&gbpv=1&dq=metal+cutting+process&printsec=frontcover
2. <http://web.mit.edu/2.810/www/files/lectures/lec5-machining-2018.pdf>
3. <https://nptel.ac.in/courses/112/105/112105126/>

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2					2		2				2	2		
CO 2	2					2		2				2	2		
CO 3	3														3
CO 4	3					3	3					2	2		3
CO 5	3	3					3	3		3					2
CO 6	3						3	3		3					3
R21UME403	3	3				3	3	3		3		2	2		3

Ref:

3-Strong

2-Medium

1 –Weak

(Use of standard Steam table and Mollier diagram, Psychrometric Chart are permitted)

OBJECTIVES:

- Convey knowledge on the basics and application of laws of thermodynamics.
- Impart knowledge on the analyzing the performance of thermal devices.
- Demonstrate the various properties of steam through steam tables and Mollier chart.
- Impart knowledge on the properties of ideal and real gases and various thermodynamic relations.
- Analyzing the psychrometric properties and various Psychrometric processes.

UNIT I BASIC CONCEPTS AND FIRST LAW 9

Basic concepts - concept of continuum, macroscopic approach, Thermodynamic systems - closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics, concept of temperature and heat. First law of thermodynamics - application to closed and open systems, internal energy, specific heat capacities, enthalpy, steady flow process with reference to various thermal equipments.

UNIT II SECOND LAW AND ENTROPY 9

Second law of thermodynamics – Kelvin's and Clausius statements of second law, perpetual- motion machines, Heat Engines, Refrigerator and Heat Pump, Coefficient of Performance, Reversibility and irreversibility, Carnot cycle - reversed Carnot cycle, Carnot theorem, Thermodynamic temperature scale. Clausius theorem, Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy – absolute entropy

UNIT III PROPERTIES OF STEAM AND STEAM POWER CYCLES 9

Properties of pure substances - Formation of steam at constant pressure, Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule P-V, P-T, T-V, T-S, H-S diagrams, PVT surfaces, thermodynamic properties of steam., Calculations of work done and heat transfer in non- flow and flow processes., – steam tables and Mollier chart uses, standard Rankine cycle.

UNIT IV IDEAL AND REAL GASES AND THERMODYNAMIC RELATIONS 9

Gas mixtures, Properties ideal and real gases, equation state, Avogadro's Law, Vander Wall's equation of state, compressibility factor, compressibility chart- Dalton's law of partial pressure, exact differentials, T-D relations, Maxwell's relations, Clausius Clapeyron equations, Joule- Thomson coefficient.

UNIT V PSYCHROMETRY 9

Properties of Atmospheric air, Psychrometry, Psychrometry charts, Property calculation of air- vapour mixtures, Psychrometric processes, Sensible heat exchange processes, Latent heat exchange processes, Adiabatic mixing, Evaporation cooling, Adiabatic saturation-Steam injection

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the basic concepts of thermodynamics , steam properties and various psychometric processes.(Understand)
2. Apply the first and second law of thermodynamics to solve problems in various thermal equipments. (Apply)
3. Apply the concept of thermodynamics derive the energy equation and various thermodynamic relations. (Apply)
4. Apply the thermodynamic properties of steam and concepts to calculate work done and heat transfer in various thermal devices. (Apply)
5. Analyze the performance of energy conversion devices and steam power cycles.(Analyze)
6. Design the refrigeration system by estimating the cooling load in various environment Conditions. (Evaluate)

TEXT BOOKS:

1. Rajput.R.K , “Engineering Thermodynamics”, Laxmi Publication, Fourth edition, New Delhi,2010.
2. Yunus a. Cengel and michael a. Boles, Thermodynamics, 8th edition 2015.

REFERENCE BOOKS:

1. Holman J.P, “Thermodynamics”, Tata McGraw-Hill, Third Edition, 2006.
2. Cengel Y., “Thermodynamics An Engineering Approach”, Tata McGraw-Hill, New Delhi, 2008.
3. Venwylen, Sontag, “Classical Thermodynamics”, Wiley Eastern, 1987.
4. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2004.
5. Natarajan. E, “Engineering Thermodynamics”, Anuragam Publications, First Edition, 2012.
6. Nag P.K, “Engineering Thermodynamics”, Tata McGraw-Hill, Third reprint, New Delhi, 2017.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2													2	
CO 2	3	2						2						3	
CO 3	3	2												3	
CO 4	3	2				2		2						3	
CO 5	3	3							3			2		3	
CO 6	3	3	3		2	2	2	3	3			2	3	3	2
R21UME303	3	3	3		2	2	2	3	3			2	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To understand the structure and the properties of the fluid.
- To analyze the complexities involved in solving the fluid flow problems.
- To familiarize the flow measurement devices, roto dynamic machines and positive displacement machines.

UNIT I	INTRODUCTION	9

Units & Dimensions. Properties of fluids - Specific gravity, specific weight, viscosity, compressibility, vapour pressure and gas laws - capillarity and surface tension. Types of flow - laminar, turbulent, unsteady, steady, non-uniform and uniform flows. Stream line, streak line and path line. Application of control volume to continuity equation, energy equation, momentum equation and moment of momentum equation. Manometry.

UNIT II	FLOW THROUGH CIRCULAR CONDUITS	9

Pressure at a point. Hydrostatic law and aerostatic law Statement of Navier Stokes equation, derivation of Euler's equation and Bernoulli's energy equation, examples illustrating the use of energy equations. Laminar flow through circular conduits and circular annuli. Hydraulic and energy gradient. Darcy – Weisbach equation. Friction factor and Moody diagram. Commercial pipes. Minor losses. Flow through pipes in series and in parallel.

UNIT III	DIMENSIONAL ANALYSIS	9

Dimension and units: Rayleigh method, Buckingham's π theorem. Discussion on dimensionless parameters Reynolds, Froude, Euler, Weber and Mach number and their application in model testing. Models and similitude. Applications of dimensionless parameters.

UNIT IV	HYDRAULIC TURBINES	9

Impact of jets - Velocity triangles - Theory of roto-dynamic machines - Classification of turbines – Pelton wheel, Francis turbine (inward and outward) and Kaplan turbine- Working principles- Workdonebywaterontherunner-Efficiencies–Drafttube-Specificspeed- Performance curves for turbines – Governing of turbines.

UNIT V	HYDRAULIC PUMPS	9

Classification of pumps- Centrifugal pumps– working principle -Hydraulic accumulator- Heads and efficiencies– Velocity triangles- Work done by the impeller - performance curves - Reciprocating pump working principle – indicator diagram and it's variations – work saved by fitting air vessels.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Outline the fundamental concepts and working principle of various fluid flow systems. (Understand)
2. Apply the fundamental concept of fluid mechanics to calculate the various fluid properties for the given problem. (Apply)
3. Apply the velocity triangle concept to calculate the various parameters of hydraulic turbines and centrifugal pump. (Apply)
4. Apply the concept of conservation laws and Buckingham's π theorem to compute losses in circular pipes and solve the dimensional analysis of a given set of variables. (Apply)
5. Analyze the performance characteristics of hydraulic turbines (Analyze)
6. Analyze the performance characteristics of hydraulic pumps. (Analyze)

REFERENCE BOOKS:

1. Bansal R.K, "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd, Ninth Edition, New Delhi, 2010.
2. Ramamritham S, "Fluid Mechanics, Hydraulics and Fluid Machines", Dhanpat Rai & Sons, New Delhi, 2012.
3. Kumar. K.L, "Engineering Fluid Mechanics", Eurasia Publishing House (P) Ltd, Seventh Edition, New Delhi, 1995.
4. Streeter. V. L, Wylie, E.B "Fluid Mechanics", Tata McGraw-Hill, 1983.
5. Rathakrishnan. E, "Fluid Mechanics", Prentice Hall of India, Second Edition, 2007.
6. Frank White, "Fluid Mechanics", Tata McGraw Hill Education Pvt. Ltd, Seventh Edition, New Delhi, 2011.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	3			2	2									2	
CO 3	3														
CO 4	3			2											
CO 5	3	3					2								
CO 6	3	3					2								
R21UME304	3	3		2	2		2							2	

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To understand the vectorial and scalar representation of forces and moments.
- To apply static equilibrium of particles and rigid bodies both in two dimensions and also in three dimensions. To comprehend the effect of friction on equilibrium.
- To understand the principle of work and energy, the laws of motion, the kinematics of motion.
- To write the dynamic equilibrium equation.

UNIT I	BASICS & STATICS OF PARTICLES	9

Introduction - Units and Dimensions - Laws of Mechanics - Lame's theorem, Parallelogram and triangular Law of forces - Equivalent systems of forces - Principle of transmissibility - Single equivalent force - Resolution and Composition of forces - Equilibrium of a particle. Vectors - Vectorial representation of forces and moments - Coplanar Forces - Forces in space - Equilibrium of a particle in space.

UNIT II	EQUILIBRIUM OF RIGID BODIES	9

Moments and Couples - Moment of a force about a point and about an axis - Types of supports and their reactions - Varignon's theorem - Free body diagram - Equilibrium of Rigid bodies in two and three dimensions.

UNIT III	PROPERTIES OF SURFACES AND SOLIDS	9

First moment of area and the Centroid of sections T section, I section, Angle section, Hollow section, Parallel axis theorem and perpendicular axis theorem, Theorem of Pappus Theorem of Pappus and Guldinus Theorem - second and product moments of plane area of T section, I section. Polar moment of inertia, Principal axes of inertia of I section, L section- Mass moment of inertia simple sections.

UNIT IV	DYNAMICS OF PARTICLES	9

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

UNIT V	FRICTION	9

Frictional force - Laws of Coloumb friction - Angle of Repose- Cone of friction -Simple contact friction - Rolling resistance -Screw jack friction - Belt friction.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Illustrate the vectorial and scalar representation of forces and moments. (Understand)
2. Apply laws of mechanics, momentum, work energy and friction to calculate the resultant force, friction and motion of rigid bodies. (Apply)
3. Apply the concept of dynamics of particles and frictional force to solve the given problem. (Apply)
4. Apply the different mechanisms concept to build mathematical models and develop position, velocity and acceleration considering societal and environmental impacts using virtual lab. (Apply)
5. Solve planar and spatial systems to determine the forces in members of trusses, frames and problems related to friction. (Apply)
6. Compare the analytical result of centroid, moment of inertia of the given problem with software tool. (Analyze)

TEXT BOOKS:

1. Kottiswaran N, "Engineering Mechanics, Statics and Dynamics", Sri Balaji Publications, 2019
2. Hibbeler R.C, "Engineering Mechanics: Statics & Dynamics", Pearson Education Asia Pvt. Ltd, 2012.

REFERENCE BOOKS:

1. Ferdinand P. Beer, E. Russell Johnston Jr., David F. Mazurek, Phillip J. Cornwell and Elliot R. Eisenberg "Vector mechanics for Engineers: Static and Dynamic", McGraw-Hill International, Ninth Edition, 2010.
2. Palanichamy M.S, Nagan S, "Engineering Mechanics: Statics and Dynamics", Tata McGraw Hill, 2011.
3. Rajasekaran S, Sankarasubramanian G, "Fundamentals of Engineering Mechanics", Vikas Publishing House Pvt. Ltd, 2012.
4. Irving H. Shames, "Engineering Mechanics – Statics and Dynamics", Pearson Education Asia Pvt. Ltd, IV Edition, 2013.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2												2		
CO 2	3											3		3	
CO 3	3													3	
CO 4	3	2			3	3	3	3	3			3	3		
CO 5	3								3				3		
CO 6	3	3			3				3				3		
R21UME305	3	3			3	3	3	3	3			3	3	3	

Ref:**3-Strong****2-Medium****1 –Weak**

R21UME306	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the basic principles of measurements.
- To educate the fundamental concepts and characteristics of measurement and errors.
- To impart the knowledge on the functional aspects of measuring instruments.
- To educate the fundamental working of sensors and transducers and their applications.
- To summarize the overall measurement and instrumentation with the knowledge on digital instrumentation principles

UNIT I PRINCIPLES OF MEASUREMENT 9

General concept - Generalized measurement system-Units and standards-measuring instruments: sensitivity, stability, range, difference between precision and accuracy -static and dynamic response-repeatability- Errors in Measurements -correction, calibration

UNIT II LINEAR, ANGULAR AND FORM MEASUREMENTS 9

Linear measuring instruments and Angular measurements - Tool Makers Microscope- Interferometer, Principle of interferometry, autocollimator, Optical flats - Comparators -Measurement of screw thread and gear elements. Surface roughness tester.

UNIT III ADVANCES IN METROLOGY 9

Coordinate measuring machine (CMM) - Basic concept of CMM – Types of CMM – Constructional features – Applications. Machine Vision - Basic concepts of Machine Vision System, Advanced Computed Tomography (CT) Magnetic resonance imaging (MRI) - technological advancements and Vision Measuring Machine (VMM) (Content Beyond Syllabus)

UNIT IV MEASUREMENT OF MECHANICAL PARAMETERS 9

Measurement of Force, torque, mechanical, pneumatic, hydraulic and electrical type-Pressure measurement – manometers, bourdon tube pressure gauge – Temperature measurement -bimetallic strip, thermocouples, pyrometer, electrical resistance thermistor.

UNIT V SENSORS, TRANSDUCERS AND DATAACQUISITION SYSTEM 9

Sensors and Transducers - Selection of Sensors, Sensors for Displacement, Position - Classification of transducers – Selection of transducers – Resistive, capacitive & inductive Transducers – Piezoelectric, Hall effect, optical and digital transducers – Elements of data acquisition system - technological advancements

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the concepts of generalized measurement system and errors for various measuring instruments. (Understand)
2. Apply the concepts and applications of linear, angular and form measuring instruments in quality department. (Apply)
3. Apply the concepts of Coordinate measuring machine and Machine Vision System in mechanical industries (Apply)
4. Apply the concepts of Advanced Computed Tomography and Magnetic resonance imaging in production industries. (Apply)
5. Apply the knowledge of measuring instruments to study the operational features of sensors, transducers and Data Acquisition System (Apply)
6. Analyze mechanical parameters using measuring instruments for different applications, ensuring ethical accuracy, integrity and responsibility in reporting results. (Analyze)

TEXT BOOKS:

1. Jain R.K, “Engineering Metrology”, Khanna Publishers, 2009.
2. A.K. Sawhney, “Mechanical Measurement and Instrumentation”, 3rd Edition, Dhanpat Rai, 2004.

REFERENCE BOOKS:

1. Raghavendra N.V. and Krishnamurthy. L., Engineering Metrology and Measurements, Oxford University Press, 2013.
2. Venkateshan, S. P., “Mechanical Measurements”, Second edition, John Wiley & Sons, 2015
3. Alan S Morris, Measurement and Instrumentation Principles, 3rd/e, Butterworth Hienemann, 2001
4. D.V.S. Murthy, ‘Transducers and Instrumentation’, Prentice Hall of India Pvt. Ltd, 2015
5. Jayal A.K, - Instrumentation and Mechanical Measurements, Galgotia Publications 2000

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2												2		2
CO 2	3												3		3
CO 3	3											3	3		
CO 4	3											3	3		3
CO 5	3			3	3							3	3		
CO 6	3	3			3			3	3	3		3	3		3
R21UME306	3	3		3	3			3	3	3		3	3		3

Ref:**3-Strong****2-Medium****1 –Weak**

R21UME407	MANUFACTURING TECHNOLOGY LABORATORY	L	T	P	C
		0	0	2	1

OBJECTIVES:

- To train the various metal cutting operations using machine tools.
- To demonstrate the operation of shapers, lathes, grinding machine, and gear hobbing machine.

LIST OF EXPERIMENTS

1. One exercise in Metal Cutting Experiment (Example: Cutting Force.)
2. One or More Exercises in Shaper, Slotter, Drilling, Milling Machines (Example: V block, Internal keyway cutting in Slotter, Drilling and tapping in Drilling machine, Gear Milling in Milling machine.)
3. One or Two Exercises in Grinding / Abrasive machining (Example: Surface Grinding, Cylindrical Grinding.)
4. One Exercise in Assembly of Machined Components for different fits. (Example: Parts machined using Lathes)
5. One Exercises in Capstan or Turret Lathes.
6. Study of Gear Machining in gear Hobbing machine.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Measure the cutting force and thrust force with help of tool dynamometer.(Guided Response)
2. Construct different type of jobs for the required shape and size with the application of shaper, slotter, and drilling machine. (Guided Response)
3. Assemble different components using grinding Machine. (Guided Response)
4. Construct a spur gear with the help of horizontal milling machine. (Guided Response)
5. Operate capstan or turret lathes to manufacture precision components, considering societal, environmental, and ethical impacts. (Guided Response)
6. Analyze the gear machining process using a gear hobbing machine, considering societal impacts and environmental sustainability. (Guided Response)

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3								3						
CO 2	3								3						
CO 3	3							2	3						3
CO 4	3							3	3				3		3
CO 5	3					3	3	3	3	3					3
CO 6	3					3	3	3	3	3			3		3
R21UME407	3					3	3	3	3	3			3		3

Ref: 3-Strong 2-Medium 1 –Weak

EQUIPMENT REQUIREMENT

S. No.	Name of the Equipment	Quantity Required
1.	Centre Lathe	2
2.	Capstan & Turret Lathe	1
3.	Horizontal Milling Machine	1
4.	Surface Grinding Machine	1
5.	Cylindrical Grinding Machine	1
6.	Shaping Machine	2
7.	Slotting Machine	1
8.	Planer	1
9.	Radial Drilling Machine	1
10.	Tool Dynamometer	1
11.	Gear Hobbing Machine	1

R21UME308	FLUID MECHANICS AND MACHINERY	L	T	P	C
	LABORATORY	0	0	2	1

OBJECTIVES :

- The laboratory exercises aim at imparting practical knowledge on concepts of fluid mechanics by conducting experiments in flow through pipes / pumps and turbine.

LIST OF EXPERIMENTS:

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

TOTAL : 30 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Measure the coefficient of discharge for flow through pipes using Venturi meter **(Guided Response)**
2. Measure the rate of flow for pipes using Rota meter. **(Guided Response)**
3. Measure the coefficient of discharge for flow through pipes using Orifice meter. **(Guided Response)**
4. Sketch the performance characteristics of hydraulic pumps to determine the efficiency. **(Guided Response)**
5. Sketch the performance characteristics of hydraulic turbines to determine the efficiency. **(Guided Response)**
6. Proceed the major loss in flow through pipes to measure the friction factor. **(Set)**

COURSE ARTICULATION MATRIX:**CO/PO/PSO MAPPING**

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3							3							
CO 2	3							3							
CO 3	3							3							
CO 4	3							3		2					2
CO 5	3							3		2					2
CO 6	3							3					3		
R21UME308	3							3		2			3		2

Ref: 3 - Strong 2 - Medium 1 – Weak

R21UME309	MEASUREMENTS AND INSTRUMENTATION LABORATORY				L	T	P	C
					0	0	2	1

OBJECTIVES:

- To demonstrate the students with the use of measuring instruments and their characteristics.
- To calibrate various metrology instruments
- To demonstrate the students to the metrology instruments
- To demonstrate the students to the measurement mechanical parameters
- To communicate knowledge in the various measurements and instruments

LIST OF EXPERIMENTS

1. Calibration of Vernier caliper / Micrometer/ Dial gauge using Slip gauges.
2. Measurements of Gear Tooth Dimensions using gear tooth vernier
3. Measurement of Angle using bevel protector & sine bar.
4. Measurement of thread parameters using tool makers microscope & profile projector.
5. Inspection of the component using different probe in CMM.
6. Measurement of Force using force measuring setup
7. Measurement of Torque using torque measuring setup
8. Measurement of Displacement using LVDT
9. Digital measurement methods -Data acquisition systems
10. Measuring surface finish of components using surface roughness tester (Content Beyond the Syllabus)

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Shows the functions of Data acquisition systems (Set)
2. Measure the linear, angular and form measurements for the given components. (Mechanism)
3. Measure the thread parameters using tool makers microscope (Mechanism)
4. Measure the profile dimensions of various components using CMM. (Mechanism)
5. Measure the gear profile dimensions using gear tooth vernier. (Mechanism)
6. Operate force, torque, and displacement measuring instruments to assess mechanical parameters, while considering societal impact, sustainability and ethical practices (Guided response)

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3								3						
CO 2	3								3						3
CO 3	3								3				2		3
CO 4	3				3				3				2		3
CO 5	3								3				2		3
CO 6	3					3	3	3	3	3			3		3
R21UME309	3				3	3	3	3	3	3			3		3

Ref:

3-Strong

2-Medium

1 –Weak

EQUIPMENT REQUIREMENT

S. No.	Name of the Equipment	Quantity Required
1.	Micrometer	5
2.	Vernier Caliper	5
3.	Vernier Height Gauge	1
4.	Vernier Depth Gauge	1
5.	Slip Gauge Set	1
6.	Gear Tooth Vernier	1
7.	Sin Bar	1
8.	Bevel Protractor	1
9.	Force Measuring Setup	1
10.	Torque Measuring Setup	1
11.	Displacement Measuring Setup	1

OBJECTIVES

- To explain the concepts of Environment and ecosystem.
- To describe the knowledge about the impact of environmental pollution.
- To impart the environmental issues in the society.
- To explain the knowledge about the impact of environment related to human health.
- To describe the knowledge in alternative energies.

UNIT I ENVIRONMENT AND ECOSYSTEMS**6**

Definition, scope and importance of environment – Need for public awareness – Concept of ecosystem – Structure and function of ecosystem – Producers, consumers and decomposers- Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Aquatic ecosystems (c) Grassland ecosystem.

UNIT II ENVIRONMENTAL POLLUTION**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 - pollution case studies - Role of an individual in prevention of pollution –Disaster management: floods, earthquake, cyclone and landslides.

UNIT III SOCIAL ISSUES AND THE ENVIRONMENT**6**

Water conservation, rain water harvesting, watershed management – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. Environmental laws/Acts, (EPA).

UNIT IV HUMAN POPULATION AND THE ENVIRONMENT**6**

Population growth, variation among nations – Population explosion – Human rights – Family welfare programme – Environment and Human Health – Human Rights - Value education –HIV / AIDS – Women and child welfare – Role of information technology in environment and human health.

UNIT V FUTURE POLICY AND ALTERNATIVES**6**

Introduction to future policy and alternatives – fossil fuels-nuclear energy-solar energy-wind energy - hydro electric energy-geothermal energy - tidal energy – sustainability - green power-nanotechnology.

Total: 30 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Understand the basic concept of structure and function of ecosystem (Understand)
2. Apply the knowledge of various pollution types to prevent the ecosystem and Environment (Apply)
3. Analyze the environmental problem to report the social issues and the Environment (Analyze)
4. Device suitable methods for conservation and sustainable development of natural resources (Analyze)
5. Apply the principles of value education with respect to human population to preserve Environment (Apply)
6. Analyze the current energy crisis and suggest suitable sustainable alternatives that promotes social health and environmental prospects (Analyze)

TEXT BOOKS

1. Anubha Kaushik, kaushik C.P., “Environmental Science and Engineering”, Third Edition, New Age International, New Delhi, 2009.
2. Benny Joseph “Environmental Science and Engineering”, Tata Mc-Graw Hill, New Delhi, 2006.

REFERENCE BOOKS:

1. Gilbert M. Masters, ‘Introduction to Environmental Engineering and Science’, Pearson Education, Upper saddle River, New Jersey, 2008.
2. Miller T.G. Jr., Environmental Science”, Wadsworth Publishing Company, Belmont, California, 2005.
3. De A.K., “Environmental Chemistry”, Wiley Eastern Ltd., New Delhi, 2001.
4. Trivedi R.K., Goel P.K., “Introduction to Air Pollution”, Techno-Science Publication, Jaipur, 2005.

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	2	1				2	3					2			
CO.2	3	1				2	3					2		1	
CO.3	3	1				2	3					2		1	
CO.4	3	1				2	3					2			
CO.5	3	1				2	3					2			
CO.6	3	1				2	3					2		1	1
R21UGM331	3	1				2	3					2		1	1

Ref: 3-Strong 2-Medium 1-Weak

SEMESTER – IV

[illegible]

OBJECTIVES:

- To understand the principles basic motions and its possible inversions.
- To impart knowledge to analyze velocity and acceleration at any point in a link of a mechanism.
- To understand and design the cam mechanisms for a specified output motions.
- To understand the basic concepts, terminologies and kinematics of gears, gear trains.

UNIT I BASICS OF MECHANISMS

9

Definitions: Link, kinematic pairs, kinematic chain, mechanism, structure, degrees of freedom, Classification links, Classification of pairs based on type of relative motion, Grubler's criterion, mobility of mechanism, Groshoff's criteria, Inversions of Simple Mechanism, four bar chain, single slider crank chain, double slider crank chain, pantograph, Peaucellier's mechanism..

UNIT II KINEMATIC ANALYSIS (Graphical Method)

9

Angular velocity and angular acceleration of links, velocity of rubbing, Velocity, acceleration s and coriolis component analysis of four bar mechanism, slider crank mechanism and Toggle mechanism.

UNIT III KINEMATICS OF CAMS

9

Types of cams, types of followers, cam profiles: Radial cam with followers such as knife-edge, roller and flat-face followers, inline with uniform velocity, Simple Harmonic Motion, Uniform Acceleration Retardation.

UNIT IV GEAR

9

Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Form of teeth: cycloidal and involute profiles. Velocity of sliding – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact.

UNIT V GEAR TRAIN

9

Introduction to gear Trains, Simple gear train, compound gear trains tabular methods of finding velocity ratio of gear trains. selection of gear box-Differential gear for an automobile.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Illustrate the various concepts of simple mechanisms and its inversions, cam, Gear, Gear train and friction devices for various applications. (Understand)
2. Calculate the characteristic of various kinematic elements like simple mechanism, cam, gear, gear train for the given problem. (Apply)
3. Analyze the planar mechanisms for position, velocity and acceleration, profile of cam, gear, gear train for the specified kinematic conditions.(Analyze)
4. Analyze kinematic constrain of cam and gear train using software package for the given applications. (Analyze)
5. Estimate the suitable analytical constrains to make appropriate mechanism for the given conditions. (Evaluate)
6. Construct a working model of planner mechanism used in domestic appliances, vehicles, agricultural machines (Create)

REFERENCE BOOKS:

1. Khurmi R.S, Gupta J. K, "Theory of Machines", S.Chand Company Ltd., Prentice Hall of India, Fourteenth Revised Edition, New Delhi, 2012.
2. David H. Myszka, "Machines and Mechanisms applied Kinematic Analysis", Pearson publishing house, Fourth edition, 2012.
3. Uicker J.J, Pennock G.R, Shigley J.E, "Theory of Machines and Mechanisms", (Indian edition) Oxford University Press, 2017.
4. Ghosh A, Mallick.A.K, "Theory of Mechanisms and Machines", Affiliated East- West Pvt. Ltd, New Delhi, 2012.
5. Rao J.S, Duggipati R.V, "Mechanism and Machine Theory", Wiley-Eastern Ltd, New Delhi, 1992.

ONLINE RESOURCES:

1. <http://nptel.ac.in/courses/112104121/>
2. <https://freevidelectures.com/course/2359/kinematics-of-machines>.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2	2			2			2				2	2		
CO 2	3												3		2
CO 3	3	3											3		2
CO 4	3	3			3								3		2
CO 5	3	3	3	3									3		2
CO 6	3	3	3			3	3	3	3	2		2	3		3
R21UME401	3	3	3	3	3	3	3	2		2		2	3		3

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To familiarize the concepts, laws and different gas power cycles.
- To impart knowledge on the working principles of IC engines, Steam Turbines, Steam Nozzles, Compressors, Refrigeration and Air conditioning systems.
- To study the engine components and working principles of SI and CI engines.
- To study the performance characterization of diesel and petrol engines.
- To study the performance of steam generator and steam turbine

UNIT I GAS POWER CYCLES**9**

Air standard cycles-Otto, Diesel, Dual, Brayton cycles, Brayton with Reheat and Regenerative cycle, Comparison of Otto, Diesel and Dual cycles, Calculation of mean effective pressure and air standard efficiency.

UNIT II INTERNAL COMBUSTION ENGINES**9**

Classification - Components and their function, Carburetor system, Diesel pump and injector system, Ignition Systems, Lubrication system and Cooling system, Performance and Heat balance Analysis

UNIT III STEAM NOZZLES AND TURBINES**9**

Flow of steam through nozzles, shapes of nozzles, effect of friction, critical pressure ratio, supersaturated flow, Impulse and Reaction principles, compounding, velocity diagram for simple and multi-stage turbines, speed regulations - Governors.

UNIT IV AIR COMPRESSOR**9**

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 V REFRIGERATION AND AIR CONDITIONING**9**

Vapour compression refrigeration cycle, vapour absorption system, Alternate refrigerants – Air conditioning system, - Types, GSHF ESHF RSHF calculations, Introduction about Aircraft air conditioning, Application of Air conditioning in food preservation.

NOTE: Use of Steam Tables with Mollier Chart and Refrigeration and Air Conditioning tables with psychometric chart is permitted

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Explain the concepts of gas power cycles, vapour power cycles, I.C Engines, steam nozzles, turbines and air compressor. (Understand)
2. Apply the various gas power cycle principles to find the MEP and efficiency. (Apply)
3. Apply the properties of steam to measure the steam nozzle performance. (Apply)
4. Calculate the performance of steam turbine by applying properties of steam. (Apply)
5. Identify the suitable refrigeration and air conditioning system for a requirement considering the environmental issues. (Apply)
6. Analyze the performance of air compressors with help of compression processes. (Analyze)

TEXT BOOKS:

1. Rajput. R. K., “Thermal Engineering” Laxmi Publishers, 2018.
2. Kothandaraman C.P, Domkundwar S, Domkundwar A.V, “A course in thermal engineering”, Dhanpat Rai & sons, Fifth edition, 2016.

REFERENCE BOOKS:

1. Nag P.K. “ Power Plant Engineering “ Tata McGraw Hill , 4th Edition, 2019
2. Mahesh. M. Rathore, “Thermal Engineering”, 1st Edition, Tata Mc Graw Hill Publications, 2010.
3. Ganesan. V, “Internal Combustion Engines”, Tata McGraw Hill, Third Edition, 2017.
4. Arora .C.P., “Refrigeration and Air Conditioning”, Third edition, Tata McGraw hill, 2017.

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2													2	
CO 2	3													3	
CO 3	3													3	
CO 4	3						2	2						3	
CO 5	3						3	3	3			2		3	3
CO 6	3	3					3	3	3			2		3	3
R21UME402	3	3					3	3	3			2		3	3
Ref:		3-Strong				2-Medium				1 –Weak					

R21UME409	OPERATIONS RESEARCH FOR MECHANICAL ENGINEERS	L	T	P	C
		3	1	0	4

OBJECTIVES:

- To familiarize knowledge about optimization and utilization of resources.
- To impart knowledge on operations research techniques in industrial operations.

UNIT I	LINEAR MODEL	9+3

Introduction to OR–Meaning and scope –characteristics – modes in OR LPP– LPP Formulation–Graphical method–Simplex method– Big M method- Two Phase method.

UNIT II TRANSPORTATION AND ASSIGNMENT MODEL 9+3

Transportation model –Basic feasible solution– Balanced and Unbalanced TP –Formulation solving a TP–
Assignment models– Balanced and Unbalanced – Formulation solving.

UNIT III	SEQUENCING AND NETWORK MODEL	9+3

Sequencing Problems – Processing 'n' jobs through two machines and three machines - Network models – Basic Concepts – Construction of Networks–Shortest route – Minimal spanning tree – Maximum flow – Project Network – CPM and PERT.

UNIT IV	INVENTORY AND REPLACEMENT MODEL	9+3

Types of Inventory– EOQ – Deterministic inventory problems –Selective inventory control techniques – Replacement of items that deteriorate with time –Value of money changing with time – not changing with time –Optimum replacement policy – Individual and group replacement.

UNIT V	GAME THEORY AND SIMULATION	9+3

Game theory –Two person zero-sum games – Maximin - Minimax principle – Saddle point –Value of the game – Mixed and pure strategies –Dominance property– Arithmetic method–Graphical method – Simulation– Monte-Carlo technique – Uses of simulation. Queuing models- elements of queuing system – characteristics of queuing model.

TOTAL : 45(L)+15(T) = 60 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the various concepts of operations research techniques. (Understand)
2. Apply the knowledge of linear programming technique to find optimal solution for the given problem. (Apply)
3. Make use of decision making to solve replacement, inventory, game theory and queuing theory problems. (Apply)
4. Utilize excel solver for linear programming problems to determine the optimal solution. (Apply)
5. Analyze the optimum replacement policy to select the individual or group replacement for the given situation. (Analyze)
6. Compare the different operation research technique problems using TORA software. (Analyze)

TEXT BOOKS:

1. Sundaresan V, Ganapathy Subramanian K S, Ganesan K, “Resource Management Techniques Operations Research”, AR Publications, 10th edition, 2016.
2. Hamdy A. Taha, “Operation Research an Introduction”, Prentice-Hall, Eighth Edition, 2006.

REFERENCE BOOKS:

1. Srinivasan G, “Operations Research Principles and Applications”, PHI Learning Private Limited, Third Edition, 2017.
2. Wayne L. Winston, “Operations Research Applications and Algorithms”, Thomson Learning, Fourth Edition, 2007.
3. Panneerselvam R, “Operations Research”, PHI Learning Private Limited, Second Edition, 2009.
4. Hira and Gupta “Operations Research”, S. Chand and Company Pvt. Ltd, Seventh Edition, 2014.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2										2				
CO 2	3										2		2		
CO 3	3										2		2		
CO 4	3				3			2			2	2	2		
CO 5	3	3							3		3	3	2		3
CO 6	3	3			3			3	3		3	3	2		
R21UME409	3	3			3			3	3		3	3	2		3

Ref:**3-Strong****2-Medium****1 –Weak**

COURSE OBJECTIVES:

- To impart knowledge of simple stresses, strains and deformation in components due to external loads.
- To familiarize the student to calculate stresses, deflections and torsion for beams, twisting bars for various engineering applications
- Analyze the thin and thick shells and principal stresses in beam for various engineering applications.

UNIT I	STRESS, STRAIN AND DEFORMATION OF SOLIDS	9

Introduction - stress, strain and mechanical properties of materials - Stress and strain due to axial force - elastic limit - Hooke's law - factor of safety - stepped bars - uniformly varying sections - stresses in composite bar due to axial force and temperature - Strain Energy due to axial force - Lateral strain - Poisson's ratio - volumetric strain - changes in dimensions and volume - relationship between elastic constants- Plane stress - Stresses on inclined planes - Principal stresses and maximum shear stresses - graphical method -Mohr's circle for plane stress.

UNIT II	SHEAR FORCE, BENDING MOMENT, STRESSES AND DEFLECTION IN BEAMS	9

SHEAR FORCE AND BENDING MOMENT IN BEAMS

Shear force and bending moment - Relation between load, shear force and bending moment - Construction of Shear force diagrams and Bending moment diagrams for different types of static loading on cantilever, simply supported and overhanging beams. Theory of simple bending - assumptions in simple bending- Determination of bending stresses - Modulus of section - bending stress - Flitched beams - shear stress distribution across various beam sections.

DEFLECTION OF BEAMS

Introduction - differential equation for deflection - slope and moments - Double Integration method – Macaulay's method – Area moment method and Conjugate beam method for computation of slopes and deflections in beams.

UNIT III	TORSION OF CIRCULAR SHAFTS	9

Theory of torsion and assumptions-derivation of the equation - polar modulus - stresses in solid and hollow circular shafts - power transmitted by solid and hollow circular shafts- polar modulus-stepped shaft-Composite shaft - Shaft in series and parallel - Statically indeterminate torsion members- Alternative differential equation approach for torsion.

UNIT IV	ANALYSIS OF COLUMNS AND STRUTS	9

Introduction - Euler's theory on columns, Effective length, Slenderness ratio, Short and long columns, Radius of gyration, Buckling load, Assumptions, Derivation of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula. Numerical problems.

UNIT V	THIN AND THICK WALLED PRESSURE VESSELS	9

Stresses in a thin cylindrical shell due to internal pressure – Change in dimensions – Change in volume – Thin spherical shells – Lamé's theory – Stresses in a thick cylindrical shell – Introduction to Compound cylinders.

Total : 45 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Illustrate the behavior of materials under given loading conditions. (Understand)
2. Apply the knowledge of solid mechanics to calculate the stresses in various beams, solid and hollow shafts. (Apply)
3. Estimate the stresses involved in columns and thin cylinders for the given circumstance. (Apply)
4. Calculate shear force, bending moment and deflection of the given beam using software resources. (Apply)
5. Compute the modulus of the given material using suitable testing methods. (Apply)
6. Analyze structural designs, columns and pressure vessels subjected to various forces and loads (Analyze)

TEXT BOOKS

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., sixth edition, 2018.
2. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S. Chand & company Ltd., New Delhi, 7th edition, 2018.

REFERENCE BOOKS

1. Ramamrutham. S, Narayanan. R, "Strength of Materials", Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2020.
2. Beer. F.P. & Johnston. E.R. "Mechanics of Materials", Tata McGraw Hill, 8th Edition, New Delhi 2019.
3. Rattan S.S., "Strength of Materials", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2017.
4. Singh. D.K., "Strength of Materials", Ane Books Pvt. Ltd., New Delhi, 2021.
5. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013.
6. Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2015.

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2								2		
CO 2	3												2		
CO 3	3												2		
CO 4	3	2			3				3	3		2	3		3
CO 5	3	3	2		3			2	3	3		2	3		3
CO 6	3	3	2			2	2	2	3	3		2	3		3
R21UME404	3	3	2		3	2	2	2	3	3		2	3		3
Ref:	3-Strong				2-Medium				1 –Weak						

R21UGS431	REASONING AND QUANTITATIVE APTITUDE (Common to Mech, EEE, Agri and Chem Engineering)	L	T	P	C
		1	0	0	1

OBJECTIVES:

- To make the student acquire sound knowledge of the characteristic of quantitative and qualitative aptitude.
- To familiarize the student with various principles involved in solving mathematical problems.
- To develop an understanding of the basic concepts of reasoning skills.

UNIT I QUANTITATIVE APTITUDE 8

Ratio and Proportion - Averages – Percentages – Problems on ages – Profit and Loss – Simple and Compound Interest – Time – Speed –Distance - Time and Work – Permutation and Combination - Alligation or Mixture – Probability – Clocks – Calendars.

UNIT II	VERBAL AND NON VERBAL REASONING	7

Analytical Reasoning – Circular and Linear arrangement – Direction problems – Blood relations – Analogy – Odd Man Out – Venn Diagrams – Letter series & arrangement – Alpha Numeric Series – Syllogism - Coding – Decoding.

Total = 15 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Select an appropriate technique to solve the quantitative problems within the stipulated time. (Apply)
2. Apply Verbal and Non Verbal Reasoning skills to solve the problems based on the logical and analytical reasoning. (Apply)
3. Analyse the direction to solve equations involving one or more unknowns. (Analyze)

TEXT BOOKS:

1. Dr. R.S. Agarwal, “Quantitative Aptitude”, S. Chand Publications, New Delhi, 20th Edition, (2013).
2. Abijit Guha, “Quantitative Aptitude for Competitive Examinations”, Tata McGraw Hill Publication, New Delhi, 4th Edition, (2011).
3. R.V. Praveen, “Quantitative Aptitude and Reasoning”, PHI Learning Pvt. Ltd., Delhi, 2nd Edition, (2013).

REFERENCE BOOKS:

1. Ashish Aggarwal, “Quick Arithmetic”, S. Chand Publications, New Delhi, 6th Revised Edition,(2014).
2. Dr. V.A. Sathgurunath’s “A Guide for Campus Recruitment”, Sagarikka Publications, Thiruchirapalli, 3rd Edition, (2011).

WEBSITES:

www.m4maths.com, www.indiabix.com, www.fresherworld.com, www.campusgate.co.in,
www.indianstudyhub.in, www.tcyonline.com.

COURSE OBJECTIVES:

- To impart the concepts in basic organization of computers and problem solving techniques.
- To familiarize the programming constructs of C.
- To explain the concepts of arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION TO C PROGRAMMING**9**

Basic Organization of a Computer –Algorithm – Pseudo code – Flow Chart- Introduction to ‘ C’ programming – fundamentals – structure of a ‘C’ program – Compilation and Linking processes – Constants, Variables – Data Types – Expressions using operators in ‘C’ – Managing Input and Output operations.

UNIT II DECISION MAKING AND LOOPING STATEMENTS**9**

if - if-else - nested if-else – else-if ladder statement – switch – goto – for- while – do-while – break – continue statements .

UNIT III ARRAYS, STRINGS AND FUNCTIONS**9**

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays - String - String operations – string arrays. Function – Definition of function – Declaration of function – Parameter passing methods – Recursion.

UNIT IV POINTERS, STRUCTURES AND UNIONS**9**

Pointers - Dynamic Memory allocation – Structures – Unions.

UNIT V APPLICATIONS OF C PROGRAMMING**9**

C programming for problem solving of manufacturing ,fluid mechanics, thermal engineering and heat transfer problems.

TOTAL: 45 Periods**COURSE OUTCOMES:**

After the successful completion of this course, the student will be able to

1. Explain the basic problem-solving techniques and concepts of the C programming language. (Understand)
2. Apply problem-solving techniques and basic concepts of the C programming language to find solutions to real-world problems. (Apply)
3. Apply the concepts of looping, branching, and decision-making statements for a given problem.(Apply)
4. Apply the advanced concepts of C language like, pointers, structures, unions and arrays to solve real-world problems. (Apply)
5. Analyze the appropriateness of C language constructs to provide solutions to mechanical engineering problems. (Analyze)
6. Work individually or in teams and demonstrate the solutions to the given exercises (Affective Domain-Organize)

TEXT BOOKS :

1. Balagurusamy, E, "Programming in ANSI C", Eighth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2019.
2. Deitel and Deitel, "C How to Program", Pearson Education, New Delhi, 2011

REFERENCE BOOKS :

1. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
2. Kernighan.B.W, Ritchie.D.M, "The C Programming language", Pearson Education, Second Edition, 2006.
3. Stephen G.Kochan, "Programming in C", Pearson Education India, Third Edition, 2005.
4. Anita Goel, Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd, Pearson Education in South Asia, 2011.
5. Byron S Gottfried, "Programming with C", Schaum's Outlines, Tata McGraw-Hill, Second Edition, 2006.
6. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", Oxford University Press, First Edition, 2009.

CO-PO/PSO MAPPING
COURSE ARTICULATION MATRIX

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1													3		
CO 2	3				3								3		
CO 3	2				3								3		
CO 4	3				3								3		
CO 5		3			3								3		3
CO 6								3	3						
R21UME410	3	3			3			3	3				3		3

Ref: 1- Weak 2- Medium 3- Strong

OBJECTIVES:

- To impart practical knowledge on experimentally test the tension, shear, torsion, deflection, hardness and impact for different materials.
- To realize how certain measuring devices are used for dynamic testing.
- Students will be able to learn and practice preparation of mounted samples, identification of microstructure, vickers hardness and understand the mechanical engineering applications of various furnaces.

LIST OF EXPERIMENTS

1. Determine the modulus of rigidity and stiffness of the given rod using torsion testing machine.
2. Determine the impact resistance of the given specimen.
3. Determine the modulus of rigidity and stiffness of the given spring using spring testing machine.
4. Determine the Young's modulus of the given beam material.
5. Draw the stress strain curve of the given rod using Universal Testing Machine.
6. Determine the shear strength of the given specimen using Double shear test.
7. Determine the hardness number of the given specimen using Brinnell/Rockwell hardness test.
8. Preparation of specimen for metallographic observation and identify the material of the given specimen (steel, cast iron, copper and aluminium alloying element)
9. Determine the Vickers hardness number for the given specimen before and after of heat treatment by using muffle furnace.
10. Determine the Vickers hardness number for the given specimen by using Jominy end quench test.

A minimum of nine experiments shall be offered

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Determine the mechanical behavior of the given mild steel specimen by performing tensile test, shear test, impact test and deflection test. (Apply)
2. Calculate the modulus of rigidity and stiffness of the given spring using spring testing machine under tensile and compressive loads. (Apply)
3. Calculate the twisting moment and modulus of rigidity of the given specimen using torsion testing machine. (Apply)
4. Determine the impact strength of the given standard specimen using Izod and Charpy test. (Apply)
5. Identify the given specimen through the effective utilization of metallurgical microscope and evaluate the hardness of the given specimen subjected to heat-treatment and quenching under different mediums using Rockwell/Brinell hardness test. (Apply)
6. Analyze and compare the different mechanical properties of the given material using suitable testing method. (Analyze)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3				2			2	3				2		3
CO 2	3							2	3						
CO 3	3							2	3						
CO 4	3							2	3						
CO 5	3	3					3	3	3			3	3		3
CO 6	3	3			3	2		3	3			3	3		3
R21UME406	3	3			3	2	3	3	3			3	3		3

Ref: **3-Strong** **2-Medium** **1 –Weak**

EQUIPMENT REQUIREMENT

S. No.	Name of the Equipment	Quantity Required
1.	Universal Tensile Testing machine with double	1 No.
2.	Shear attachment – 40 Ton Capacity	1 No.
3.	Torsion Testing Machine (60 NM Capacity).	1 No.
4.	Impact Testing Machine (300 J Capacity).	1 No.
5.	Spring Testing Machine for tensile and compressive loads (2500 N)	1 No.
6.	Rockwell hardness testing machine	1 No.
7.	Brinell hardness testing machine	1 No.
8.	Muffle Furnace (800 °C)	1 No.
9.	High Temperature Tubular furnace-1600 o C	1 No.
10.	Speciman mounting press	1 No.
11.	Jominy End Quench apparatus	1 No.

R21UME408

I.C ENGINES & STEAM LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

- To study the engine components and working principles of SI and CI engines.
- To study the performance characterization of diesel and petrol engines.
- To study the performance of steam generator and steam turbine.

LIST OF EXPERIMENTS

1. Determination of Valve Timing Diagrams.
2. Determination of Port Timing Diagrams.
3. Determination of Flash and Fire point using cleave land apparatus.
4. Determination of viscosity using red wood viscometer.
5. Performance Test on 4-stroke Diesel Engine with mechanical loading.
6. Heat Balance Test on 4-stroke Diesel Engine.
7. Performance Test on Petrol Engine with electrical loading.
8. Performance test on 4 stroke diesel engine with eddy current dynamometer using Data Acquisition system.
9. Performance test on 4-stroke variable Compression ratio Diesel Engine using Data Acquisition system.
10. Determination of exhaust emissions from 4-stroke Diesel Engine using exhaust gas analyzer.
11. Determination of smoke opacity from 4-stroke Diesel Engine using smoke meter.
12. Performance and energy balance test on a steam generators.
13. Performance and energy balance test on steam turbine

Note: Use of Steam Table, HMT table is permitted.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Set up and arrange the necessary equipment and instruments for measuring fuel properties and engine performance. (Set)
2. Follow the procedures to draw valve timing and port timing diagrams for given IC engines (Guided Response)
3. Calibrate the measurements of fuel properties and engine performance, and interpret the results. (Mechanism)
4. Measure the performance parameters of steam generators and turbines based on gathered data and formulas. (Complex Overt Response)
5. Alter measurement techniques to achieve optimal performance and emission levels in diesel engines. (Adaptation)
6. Create innovative strategies for optimizing engine performance and reducing emissions based on test results. (Origination)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3								3					3	
CO 2	3							2	3					3	
CO 3	3								3	2				3	3
CO 4	3								3	2				3	3
CO 5	3	3		2			3	3	3	2		2		3	3
CO 6	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
R21UME408	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

R21UME411	C PROGRAMMING LABORATORY FOR MECHANICAL ENGINEERS				L	T	P	C
					0	0	2	1

COURSE OBJECTIVES :

- Familiarize with programming environment
- Familiarize the implementation of programs in C

LIST OF EXPERIMENTS

- **Familiarization with Integrated Development Environment (IDE)**(Compile, Debug)

Problems involve arithmetic computations and sequential logic

1. Write a C program to display the Bio data using printf statement.
2. Write a c program to find simple interest.
3. Writing a C program for a landscaping company. The company needs a tool to calculate the amount of material required to create circular garden beds and the length of edging required for each bed.

Problems involve decision making

- 1 Write a C program for an event management company that organizes seating arrangements for events such as concerts, conferences, or sports matches. The company needs a tool to efficiently assign seats to attendees based on whether their ticket numbers are even or odd.
- 2 Write a C program for developing software for a payroll management system used by a company with employees working on projects spanning multiple years. The system needs to calculate salaries and benefits, taking into account leap years for accurate time calculations. Your task is to write a program that determines whether a given year is a leap year or not.
- 3 Write a C program to find Biggest among Three Numbers given by user using Else-if Statement.
- 4 Write a C program to check to calculate factorial of given number using for loop

Problems involve iterations

- 1 You are developing a program for a financial institution that offers investment plans based on the Fibonacci sequence. The institution wants to provide a tool that visualizes the growth of investments over time using the Fibonacci series.
- 2 Developing a program for an online security system that requires checking whether a user's chosen PIN is a prime number. The security system wants to ensure that users have unique and secure PINs.
- 3 A supermarket manager wishes to keep some toys and puzzle games to enable the customers to manage their kids during the purchase time. He kept a machine called “Fortune Teller machine”, it replies the kid with some fortune message if he enters the palindrome number. It replies with “try again later” if the kid failed to input a valid palindrome number.
- 4 Write a C program to print Triangle Pattern Using Nested for Loop.

Problems involve arrays

- 1 You are developing a program for a gradebook application used by teachers to manage student scores. The application needs a tool that allows teachers to input the scores of five different assignments for each student and then display the scores entered. Your task is to write a C program that takes 5 values from the user representing the scores of five different assignments and stores them in an array. After storing the values, the program should print the elements stored in the array.
- 2 You are developing a program for a scientific research project where data from multiple experiments need to be analyzed. The research team wants a tool that can calculate the average of a set of data points collected from various experiments. Your task is to write a C program that finds the average of n numbers using arrays.
- 3 You are developing a program for a financial analysis tool used by an investment firm. The tool requires performing matrix addition to analyze the performance of various investment portfolios over multiple periods. Your task is to write a C program that prints the elements of two 2D arrays representing the returns of two investment portfolios over a specific time period and then performs matrix addition to calculate the combined returns.
- 4 Write a C program to print the elements of 2D-array Matrix addition using 2D-Array.

Problem involve strings

1. Developing a program for a language learning platform that helps students practice reading and understanding words and sentences in a foreign language. As part of the exercises, the platform needs a tool to display the reverse of the words or sentences entered by the students.

Problems involve in functions, recursion

1. Write a C program to swap two values using call by value and call by reference.
2. You are developing a program for a manufacturing company that produces various components. One of the critical processes involves calculating the number of possible combinations of components that can be assembled. Your task is to write a C program that calculates the factorial of a given number representing the number of components available, using recursion.

Problems involve structures, Unions

1. Create a C programming using Union called Employee which stores the name, id, basic pay, HRA and DA as members. Find the total pay of the employee.
2. Create a C programming using an Structure called Student with name, class, rollnum, total marks as members. Find and display the grade of each student.
 - >80 – Grade A
 - >60 – Grade B
 - > 50 – Grade C
 - <50 - Fail

COURSE OUTCOMES:

After the successful completion of this course, the student will be able to

1. Write programs to solve problems involving computations. (Apply)
2. Develop computer applications using suitable control structures. (Apply)
3. Apply different programming constructs to solve a variety of computational problems efficiently. (Apply)
4. Design solutions for computer applied complex Engineering Problems that meet specified needs. (Create)
5. Communicate effectively to justify the solutions to the given problems based on legal and ethical principles.
(Affective domain - Value)
6. Work effectively as an individual or in teams to develop solution for the given problem. (Affective domain - Value)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3												3		
CO 2	3												3		
CO 3	3												3		
CO 4		3	3			3							3		
CO 5									2						
CO 6								3		3					
R21UME411	3	3	3			3		3	2	3			3		

Ref:

3-Strong

2-Medium

1 –Weak

GENDER EQUALITY (Common to All Branches)

L	T	P	C
1	0	0	P / F

- To introduce basic concepts relating to gender and to provide logical understanding of gender roles.

Definition of gender, Perspectives-Gender sensitive approach- Gender and sex- Social construction of gender and gender roles- Socialisation- institutions of socialization- changing content and context of gender-need for re-socialization. Gender Stereo typing and Gender Discrimination.

Indian constitution related to equality - Fundamental rights - Directive principles of state policy - right to equality - rights against exploitation - cultural and educational rights - the right to constitutional remedy - University Declaration of Human Rights - Enforcement of Human Rights for Women and Children - Role of Cells and Counselling Centres- Internal Complaints Committee - Legal AID cells, Help line, State and National level Commission.

Gender & Morality – Structural and functionalist views of Gender- Gender in the Classroom- Beyond access for girls and boys-Gender equality in schools-Gender equality and adult basic education-Developing capacity to achieve gender equality in education-Individuality and removal of gender stereotypes- Respect for each other's-Promote equal Opportunity.

Total = 15 Periods

1. Sheila Aikman and Elaine Unterhalter, "Practicing Gender Equality in Education", Oxfam GB, 2007.
2. Pasadena and Hackensack, "Gender roles and Equality", Salem Press, 2011.

SEMESTER – V

[illegible]

OBJECTIVES:

- To learn the principal mechanism of heat transfer under steady state and transient conditions.
- To learn the fundamental concept and principles in convective heat transfer.
- To learn the theory of phase change heat transfer and design of heat exchangers.
- To study the fundamental concept and principles in radiation heat transfer.
- To develop the basic concept and diffusion, convective di mass transfer.

UNIT I CONDUCTION**9**

Basic Concepts - Mechanism of Heat Transfer - Conduction, Convection and Radiation -Fourier Law of Conduction - General Differential equation of Heat Conduction - Cartesian and Cylindrical Coordinates - One Dimensional Steady State Heat Conduction - Conduction through Plane Wall, Cylinders and Spherical systems - Composite Systems - Conduction with Internal Heat Generation - Extended Surfaces - Unsteady Heat Conduction - Lumped Analysis - Use of Heisler's Chart - Methods of enhanced thermal conduction.

UNIT II CONVECTION**9**

Basic Concepts - Boundary Layer Concept - Types of Convection - Forced Convection - Dimensional Analysis - External Flow - Flow over Plates, Cylinders and Spheres - Internal Flow - Laminar and Turbulent Flow - Combined Laminar and Turbulent flows - Flow over Bank of tubes - Free Convection - Dimensional Analysis - Flow over Vertical Plate, Horizontal Plate, Inclined Plate, Cylinders and Spheres - Mixed Convection.

UNIT III RADIATION**9**

Basic Concepts, Laws of Radiation - Stefan Boltzman Law, Kirchoff's Law Emissive power-Black Body Radiation - Grey body radiation, Radiation heat transfer between surfaces, Radiosity -Shape Factor Algebra - Electrical Analogy - Radiation Shields -Introduction to Gas Radiation.

UNIT IV PHASE CHANGE HEAT TRANSFER AND HEAT EXCHANGERS**9**

Nusselt's theory of condensation- Regimes of pool boiling and flow boiling and Flow boiling, correlations in boiling and condensation. Heat exchanger Types-tube arrangements, single and multi-tube types, parallel, counter and cross flow - Heat Exchanger Analysis - LMTD Method and NTU Methods - Overall Heat Transfer Coefficient - Fouling Factors - Fundamentals of Heat Pipes and its applications.

UNIT V MASS TRANSFER**9**

Basic Concepts - Diffusion Mass Transfer - Fick's Law of Diffusion – Steady state Molecular Diffusion - Convective Mass Transfer Rate equations- Convective Mass Transfer Correlations. Mass diffusion in binary mixtures, Momentum, Heat and Mass Transfer Analogy.

NOTE: Use of Steam Table, HMT table is permitted.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Illustrate the concepts of phase change heat transfer, conduction, convection, radiation, heat exchanger and mass transfer and its applications with the suitable examples. (Understand)
2. Apply the heat transfer concepts of conduction, convection and radiation to solve the given problem. (Apply)
3. Apply the heat exchanger, mass transfer and phase change heat transfer concepts to solve the given problem and (Apply)
4. Analyze the heat exchanger effectiveness for the given input conditions. (Analyze)
5. Analyze the conduction heat transfer for various systems using ANSYS software. (Analyze)
6. Evaluate heat transfer characteristics under steady state and transient conditions, considering societal impact, sustainability, ethical practices, and professional development. (Evaluate)

TEXT BOOKS:

1. R.C. Sachdeva, "Fundamentals of Engineering Heat & Mass transfer", New Age International Publishers, 2009
2. Yunus A. Cengel, "Heat Transfer A Practical Approach" – Tata McGraw Hill, 5th Edition – 2013.

REFERENCE BOOKS:

1. Frank P. Incropera and David P. Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley & Sons, 7th Edition, 2014.
2. Holman, J.P., "Heat and Mass Transfer", Tata McGraw Hill, 2010
3. Kothandaraman, C.P., "Fundamentals of Heat and Mass Transfer", New Age International, New Delhi, 2012
4. Ozisik, M.N., "Heat Transfer", McGraw Hill Book Co., 1994.
5. S.P. Venkateshan, "Heat Transfer", Ane Books, New Delhi, 2014

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2									2	
CO 2	3													3	2
CO 3	3													3	2
CO 4	3	3		2			2	2	3				2	3	3
CO 5	3	3	3	2	3			2	3	2		3	3	3	3
CO 6	3	3	3	3		3	3	3	3	2		3	2	3	3
R21UME501	3	3	3	3	3	3	3	3	3	2		3	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To explain the method of static force analysis and dynamic force analysis of mechanisms.
- To impart knowledge in the concept of vibratory systems and their analysis.

UNIT I	FORCE ANALYSIS AND FLYWHEELS	9

Static force analysis of mechanisms - D'Alembert's principle - Inertia force and Inertia torque - Dynamic force analysis - Dynamic Analysis in Reciprocating Engines - Bearing loads - Crank shaft Torque – Engine shaking Forces - Turning moment diagrams - Flywheels of engines and punch press

UNIT II	BALANCING	9

Static and dynamic balancing - Balancing of rotating masses - Balancing a single cylinder Engine - Primary and secondary unbalanced forces - Balancing Multi-cylinder Engines.

UNIT III	FREE VIBRATION	9

Basic features of vibratory systems - Degrees of freedom - Single degree of freedom - Free vibration - natural frequency - Types of Damping - Damped free vibration - Whirling of shafts and critical speed - Torsional systems; Natural frequency of two and three rotor systems

UNIT IV	FORCED VIBRATION	9

Response to periodic forcing - Harmonic Forcing - Forced vibration caused by unbalance - Support motion - Force transmissibility and amplitude transmissibility - Vibration isolation.

UNIT V	MECHANISMS FOR CONTROL	9

Governors - Types - Centrifugal governors - Gravity controlled and spring controlled governor Gyroscopes - Gyroscopic couple - Gyroscopic stabilization - Gyroscopic effects in ships

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Illustrate the concepts of static and dynamic forces of given simple mechanisms, frequency of free and forced vibrations, governors and gyroscopic couples. (Understand)
2. Apply the inertia force and balancing concepts to find the various forces, magnitude and position of rotating and reciprocating parts. (Apply)
3. Calculate the frequency of free, damped and forced vibration and the effect of undesirable simple forced vibrations. (Apply)
4. Estimate the gyroscopic effect in ships and aero planes and speed control using governors. (Apply)
5. Investigate the effect of forces of given simple mechanisms, turning moments in flywheel and balancing of masses. (Analyze)
6. Analyze vibration systems, isolation, and transmissibility, considering societal impact, sustainability, ethics and continuous learning. (Analyze)

TEXT BOOKS:

1. Rattan S.S, “Theory of Machines”, Tata McGraw Hill, Fourth Edition, New Delhi, 2014.
2. Khurmi R.S, Gupta J.K, “Theory of Machines”, Eurasia Publishing House, 14th edition, 2015.

REFERENCE BOOKS:

1. Shigley J.E, Uicker J.J, “Theory of Machines and Mechanisms”, Oxford press, Fourth edition, 2014.
2. Sadhu Singh, “Theory of Machines”, Pearson Education, 2002.
3. Ghosh A, Mallick A.K, “Theory of Mechanisms and Machines”, Affiliated East- West Press Pvt. Ltd, New Delhi, 1998.
4. Rao J S, Duggipati R.V, “Mechanism and Machine Theory”, Wiley-Eastern Limited, New Delhi, 1998.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														2
CO 2	3												2		2
CO 3	3												2		2
CO 4	3												2		3
CO 5	3	3	2	3	3				3	3			3		3
CO 6	3	3	2			3	3	3	3	3			3		3
R21UME502	3	3	2	3	3	3	3	3	3	3			3		3

Ref:**3-Strong****2-Medium****1 –Weak**

R21UME405	OBJECT ORIENTED PYTHON PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire programming skills in core python.
- To learn about the usage of python shell for running programs.
- To understand the different data types available in python.
- To acquire object oriented skills in python.
- To understand the creation and usage of various modules and packages.

UNIT I PYTHON FUNDAMENTALS AND DATA STRUCTURES 9

Introduction – Data types – Numbers – Variables – Strings – Lists – Dictionaries – Tuples – Sets – Boolean – Basic I/O operations – Python Operators

UNIT II PYTHON STATEMENTS, METHODS AND FUNCTIONS 9

Decision Making – Loops – If, Else, Elif – While Loops – For Loops – Nested Loop – Break – Continue
Methods – Functions – Built in Functions – Lambda Functions – Python Arrays

UNIT III MODULES, PACKAGES AND LIBRARIES 9

Modules and Packages – Standard Libraries – Python Maths – Queues – FIFO Queue – LIFO Queue – Priority Queue – Third Party Library – Numpy

UNIT IV OBJECT ORIENTED PROGRAMMING METHODOLOGIES 9

Object Oriented Programming – Creating Python Classes – Initializing Objects – Python Object Recognition – Objects and Classes – Inheritance and its Types – Basic Inheritance – Multiple Inheritance – Polymorphism

UNIT V STRINGS FORMATING, FILE AND EXCEPTION HANDLING 9

String Formatting – File Handling - Escaping Braces – Keyword Arguments – Exception Handling – Raising Exception – Effects of Exception – Handling the Exception – Exception Hierarchy – Creating our own Exceptions

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the various concepts of object oriented python programming language. (Understand)
2. Apply the knowledge of python programming fundamentals, statements and functions to give solution for engineering problems. (Apply)
3. Make use of python arrays, libraries, modules and packages to solve engineering problems for the required condition. (Apply)
4. Apply the knowledge of python class, inheritance, string formatting, file handling and exception handling to write programs for the given condition. (Apply)
5. Utilize the modern tool package for various object oriented python concepts. (Apply)
6. Formulate and analyze complex engineering problems using object oriented python programming methodologies. (Analyze)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO 1	2												2			
CO 2	3												2			
CO 3	3												2			
CO 4	3												2			
CO 5					3					3			3		2	
CO 6		3			3					3			3		2	
R21UME405	3	3			3					3			3		2	
Ref:		3-Strong				2-Medium				1 –Weak						

OBJECTIVES :

- To familiarize the students about various steps involved in the Design Process.
- To design shafts, couplings, temporary and permanent Joints for various applications.
- To design helical, leaf springs, flywheels, connecting rods and crank shafts for various applications
- To impart knowledge on the design aspects of belts, pulleys, clutches and brakes.
- To familiarize the usage of standard data and catalogues.

	FUNDAMENTALS OF DESIGN CONCEPTS AND STRESSES IN MACHINE	
UNIT I	MEMBERS	9

Introduction to the design process - factor influencing machine design, selection of materials based on mechanical properties - Preferred numbers, limits, fits and tolerances - Calculation of principle stresses for various load combinations, eccentric loading - Design of curved beams - crane hook and 'C' frame - Factor of safety - theories of failure – Stress concentration - Design for variable loading - Soderberg, Goodman and Gerber relations.

UNIT II	DESIGN OF SHAFTS, KEYS AND COUPLINGS	9

Design of solid and hollow shafts based on strength, rigidity and critical speed under static and fatigue loadings - Design of keys, key ways and splines - Design of Rigid couplings – Sleeve couplings, Clamp Couplings and Flange Coupling - Design of Flexible couplings – Bushed-Pin type flange couplings, Gear Coupling, Disc type flexible coupling.

UNIT III	DESIGN OF TEMPORARY AND PERMANENT JOINTS	9

Threaded fasteners - Design of bolt for static, dynamic and eccentric loads – Design of Knuckle joints - Design of Cotter joints - Design of welded joints - Butt, Fillet and parallel transverse fillet welds – welded joints subjected to bending, torsional and eccentric loads - riveted joints for structures - theory of bonded joints.

UNIT IV	DESIGN OF ENERGY STORING ELEMENTS AND BEARINGS	9

Types of springs, design of helical and concentric springs--surge in springs, Design of laminated springs - rubber springs - Flywheels considering stresses in rims and arms for engines and punching machines-- Solid and Rimmed flywheels-- connecting rods and crank shafts.

Sliding contact and rolling contact bearings - Hydrodynamic journal bearings, Somerfield Number, Raimondi & Boyd graphs, -- Selection of Rolling Contact bearings

UNIT V	DESIGN OF FLEXIBLE ELEMENTS, CLUTCHES AND BRAKES	9

Design of Flat belts and pulleys - Design of V belts and pulleys - Wire ropes and pulleys - Design of plate clutches –axial clutches-cone clutches-internal expanding rim clutches - Electromagnetic Clutches - Band and Block brakes

TOTAL : 45 PERIODS

NOTE: PSG Design data book is permitted for End Semester Examination.

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Illustrate the concepts of theories of failures, machine elements like shafts, couplings, joints, springs, bearings and transmission systems like belts, pulleys clutches and brakes.(Understand)
2. Apply the knowledge of suitable design process to design the given machine element.(Apply)
3. Calculate the various stresses and failure modes for the given machine element (Apply)
4. Select the shaft, coupling, springs, joints, bearings, flexible elements, clutches and brakes for various applications (Apply).
5. Analyze the stresses in the machine element using software tools under the given loading conditions (Analyze)
6. Design and analyze the flat belt, V-belt, clutches and brakes. (Analyze)

TEXT BOOKS:

1. Bhandari V.B., “Design of Machine Elements”, 4th Edition, Tata McGraw-Hill Book Co, 2016.
2. Joseph Shigley, Charles Mischke, Richard Budynas and Keith Nisbett “Mechanical Engineering Design”, 9th Edition, Tata McGraw-Hill, 2011.
3. Sundararajamoorthy.T.V, Shanmugam.N ,“Machine Design”,Anuradha Publications Chennai, 2015.

REFERENCE BOOKS:

1. Khurmi. R.S, Gupta.J.K, “Machine Design ”, Eurasia Publishing House , 2005.
2. Alfred Hall, Halowenko, A and Laughlin, H., “Machine Design”, Tata McGraw-Hill Book Co.(Schaum’s Outline), 2010.
3. P.C. Gope, “Machine Design – Fundamental and Application”, PHI learning private ltd, New Delhi, 2012.
4. R.B. Patel, “Design of Machine Elements”, MacMillan Publishers India P Ltd., Tech-Max Educational resources, 2011.
5. Prabhu. T.J, “Design of Transmission Elements”, Mani Offset, Chennai, 2000.
6. Maitra G.M, Prasad L.V, “Hand book of Mechanical Design”, Tata McGraw-Hill, New Delhi,2011.
7. Ugural A, C, “Mechanical Design Integrated Approach”, Tata McGraw-Hill, 2004.

COURSE ARTICULATION MATRIX

CO/PO/PSO MAPPING

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2				2										2
CO2	3												2		2
CO3	3												2		2
CO4	3												3		3
CO5	3	3	2		3			2	3	2		3	3		3
CO6	3	3	2					3	3	3		3	3		3
R21UME504	3	3	2		3			3	3	3		3	3		3

Ref: *1- Weak* *2- Medium* *3- Strong*

R21UGM535

UNIVERSAL HUMAN VALUES II

L	T	P	C
2	1	0	3

OBJECTIVES:

- To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

MODULE 1 INTRODUCTION TO VALUE EDUCATION 9

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Sharing about Oneself, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Exploring Human Consciousness, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations, Exploring Natural Acceptance

MODULE 1I HARMONY IN THE HUMAN BEING 9

Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, Exploring the difference of Needs of Self and body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Exploring Sources of Imagination in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health, Exploring Harmony of Self with the Body

MODULE 1II HARMONY IN THE FAMILY AND SOCIETY 9

Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Exploring the Feeling of Trust, 'Respect' – as the Right Evaluation, Exploring the Feeling of Respect, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order, Exploring Systems to fulfil Human Goal.

MODULE 1V HARMONY IN THE NATURE/EXISTENCE 9

Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Exploring the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence, Exploring Co-existence in Existence

MODULE V IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS 9

Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, Exploring Ethical Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Exploring Humanistic Models in Education, Holistic Technologies, Production Systems and Management Models Typical Case Studies, Strategies for Transition towards Value-based Life and Profession, Exploring Steps of Transition towards Universal Human Order

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the need, basic guidelines, content and process for value education and develop the right understanding of happiness and prosperity in life (Understand)
2. Apply the concepts of harmony in the human being to ensure self-regulation and holistic well-being. (Apply)
3. Apply the principles of trust, respect, and other feelings to foster harmony in family and society. (Apply)
4. Analyze the interconnectedness and mutual fulfillment among the four orders of nature to understand harmony in existence. (Apply).
5. Analyze the implications of a holistic understanding in professional and social contexts to identify ethical conduct (Analyze)
6. Evaluate different humanistic models and strategies to transition towards a value-based life and universal human order (Evaluate)

TEXT BOOKS:

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.
2. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022

REFERENCE BOOKS:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Susan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986.
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers.
8. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
9. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press.
10. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008

R21UGS533

INTERPERSONAL SKILLS LABORATORY
(Common to Mech, Civil, BME and BT)

L	T	P	C
0	0	3	1.5

LIST OF EXERCISES

Part - A : Communication and Leadership Projects

I) Speech Projects

1. The Open up Speech (Prepared Speech)
2. Speech Organizing to the Point (Prepared Speech)
3. Table Topics Speech

I) Speech Projects

1. Speech Evaluation
2. TAG (Timer, Ah Counter and Grammarian) Evaluation

I) Leadership Roles

1. Speech Master of the Day
2. General Evaluator
3. Table Topics Master

Part - B : Problem-Solving and Decision- Making Project

IV) Quality Circle Project

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Communicate orally with fluency and clarity in a given contextual situation (Responding - Affective Domain)
2. Evaluate a speech and offer constructive evaluation of the speech (Evaluating - Cognitive Domain)
3. Adapt themselves to work in a group as a member or a leader for efficiently executing the given task (Organization – Affective Domain)
4. Analyze a problem and find appropriate solution (Analyze - Cognitive Domain)
5. Take decision by organizing relevant information and defining alternatives (Create - Cognitive Domain)

OBJECTIVES:

- To realize how certain measuring devices are used for dynamic testing.
- To demonstrate the operation of measuring devices used for dynamic testing.

LIST OF EXPERIMENTS

1. Determination of mass moment of inertia using connecting rod and flywheel.
2. Determination of mass moment of inertia using bifilar suspension.
3. Determination of mass moment of inertia using turn table apparatus.
4. Determine the characterization of Watt governor.
5. Determine the characterization of porter governor.
6. Determine the characterization of Proell governor.
7. Determine the characterization of Hartnell governor.
8. Determine the natural frequency of single rotor system.
9. Determine the natural frequency of two rotor system.
10. Determine the natural frequency of helical spring.
11. Determination of gyroscopic couple.
12. Balancing of rotating and reciprocating masses.
13. Determination of transmissibility ratio using vibrating table.

A minimum of nine experiments shall be offered

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Demonstrate the experimental procedure to examine the unbalance forces in rotating and reciprocating masses. (Understand)
2. Apply the knowledge of dynamics principles to find the moment of inertia for given object using oscillation method. (Apply)
3. Conduct experiments to analyze the Sensitiveness of the governors.(Apply)
4. Apply the knowledge of vibration to calculate the natural frequency of longitudinal and torsional vibrating systems.(Apply)
5. Examine the effect of the Gyroscopic Couple.(Create)
6. Analyze the vibrations and gyroscopic effects, considering safety, societal impact, environmental sustainability, and ethical practices. (Analyze)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2								3	2					2
CO 2	3								3	3					
CO 3	3								3	3			3		
CO 4	3								3	3					
CO 5	3								3	3			3		3
CO 6	3	3				3	3	3	3	3			3		3
R21UME506	3	3				3	3	3	3	3			3		3

Ref:

3-Strong

2-Medium

1 –Weak

EQUIPMENT REQUIREMENT

S. No.	Name of the Equipment/Software	Quantity Required
1.	Motorized gyroscope	1
2.	Governor apparatus	1
3.	Dynamic balancing of Rotating system	1
4.	Dynamic balancing of reciprocating system	1
5.	Vibrating table	1
6.	Compound pendulum attachment with flywheel & connecting rod	1
7.	Vibration test facilities apparatus.	1

PREAMBLE:

Creativity is vital in nearly every industry and occupation. Creativity and innovation are key to generation of new ideas and methods of improving goods and services for customer satisfaction. This course enhances the creative thinking and innovation skills of the students. Being creative helps one to be a better problem solver in all areas of life and work.

OBJECTIVES:

- To develop next generation Entrepreneurs and Creative Leaders to resolve live challenges.
- To transform innovative ideas into successful businesses
- To use a range of creative thinking tools to develop Out of the Box Ideas

Course Content

Introduction to Creativity and Innovation- Creative Techniques - Problem Identification through Brain Storming - Solution Identification through Creative Techniques - Presentation on the Innovative Idea - Market Analysis - Revenue and Business Model - Preparation of promotional aids - Customer Feedback Analysis.

Total = 30 Periods

List of Activities:

Duration	What does the Faculty do?	What do the students do?
Week 1	Explains creativity and innovation	Team Formation (Team Size: 3)
Week 2	Explains the Creative Techniques (Through Video / Presentation)	Discovering Consumer Need through Need Analysis (Customer Segment)
Week 3	Facilitates the brain storming	Problem Identification through brain storming
Week 4	Facilitates problem solving	Identify the solution for the chosen problem through creative techniques
Week 5	Evaluates the presentation	Presentation on the Innovative Idea and Value Proposition
Week 6	Evaluates the presentation	Presentation on the Innovative Idea and Value Proposition
Week 7	Explains about the Market Research / Competitor Analysis, Revenue Model and Business Model	Market Analysis after the explanation
Week 8	Facilitates the students work	Preparation of Innovation Development Plan, Business Development Plan and Financial Plan
Week 9	Facilitates the students work	Preparing product promotional material
Week 10	Facilitates the students work	Improvement through Feedback

Assessment Pattern

1. Internal Assessment: Presentation on the Innovative Idea
2. End Semester Assessment:
 - Submission of Business Plan
 - Presentation on My Startup Idea (Evaluator : From Industry)

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Demonstrate the ability to assess societal, health and safety issues and the consequent responsibilities relevant to the professional engineering practice (Valuing – Affective Domain)
2. Examine impact on environment and society in the proposed innovative idea and provide solutions for sustainable development (Organization – Affective Domain)
3. Adapt themselves to work in a group as a member or a leader for efficiently executing the given task (Organization – Affective Domain)

R21UME508

HEAT AND MASS TRANSFER LABORATORY

L	T	P	C
0	0	2	1

OBJECTIVES:

- To demonstrate the concept of various modes in heat transfer.
- To understand the concept of refrigeration and air conditioning system.
- To calculate the performance of air compressor.

LIST OF EXPERIMENTS

HEAT TRANSFER

1. Thermal conductivity measurement by guarded plate method.
2. Thermal conductivity of pipe insulation using lagged pipe apparatus.
3. Natural convection heat transfer from a vertical cylinder.
4. Forced convection inside the tube.
5. Heat transfer from pin-fin apparatus by 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.

REFRIGERATION AND AIR CONDITIONING

1. Determination of COP of a refrigeration system.
2. Determination of COP on the air conditioning system.
3. Performance test on single/two stage reciprocating air compressor.

Note: Use of Steam Table, HMT table is permitted.

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Measures the thermal conductivity in guarded hot plate and lagged pipe apparatus. (Mechanism)
2. Measures the heat transfer co-efficient in natural and forced convection apparatus (Mechanism)
3. Calibrates the Stefan Boltzmann constant and compare with theoretical values and to determine the emissivity of a grey surface (Mechanism).
4. Calibrates the co – efficient of performance of refrigeration and air conditioning from the given apparatus. (Mechanism)
5. Measures the Effectiveness of the Parallel/Counter flow heat exchangers. (Mechanism)
6. Follows the instructions to perform the test on single/two stage reciprocating air compressor (Guided response).

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3								3	2				3	2
CO 2	3								3	2				3	2
CO 3	3	3							3	3		2	3	3	3
CO 4	3						3	3	3	3		2		3	3
CO 5	3						3		3					3	3
CO 6	3						3		3	3				3	3
R21UME508	3	3					3	3	3	3		2	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

R21UME409

**OBJECT ORIENTED PYTHON PROGRAMMING
LABORATORY**

L	T	P	C
0	0	2	1

OBJECTIVES:

- To acquire programming skills in core python
- To learn about the usage of python shell for running programs
- To understand the different data types available in python.
- To acquire object oriented skills in python
- To understand the creation and usage of various modules and packages.

LIST OF EXPERIMENTS

1. Demonstrate the basics concepts in python programming.
2. Develop a program to implement basic I/O operations in python.
3. Develop a program to demonstrate a list in python.
4. Develop a program to demonstrate a dictionary in python.
5. Develop a program to implement if, else and elif loops in python.
6. Develop a program to implement while loop in python.
7. Develop a program to implement for loop in python.
8. Develop a program to demonstrate functions in python.
9. Develop a program to demonstrate FIFO queue in python.
10. Develop a program to demonstrate LIFO queue in python.
11. Develop a program to demonstrate Priority queue in python.
12. Develop a program to create class in python.
13. Develop a python program to implement single and multiple inheritance.
14. Develop a python program to implement single and multiple polymorphism.
15. Develop a python program to implement string handling and string formatting.
16. Develop a python program to implement Exception handling.
17. Develop a python program to read and write files.

A minimum of nine experiments shall be offered

Total = 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Attempt to repeat the basics in python programming concepts. (Imitate)
2. Perform the skill in python programming fundamentals, statements and functions for engineering applications. (Manipulate)
3. Complete the concepts of packages and libraries in python programming. (Manipulate).
4. Perform various problems on python class, inheritance and polymorphism by using object oriented python programming concepts. (Manipulate)
5. Produce various outputs by applying the concept of string formatting, file handling and exception handling. (Manipulate)
6. Independently perform the skill with accuracy for object oriented python programming. (Precision)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2								2		
CO 2	3				3				2			2	3		
CO 3	3				3				2			2			
CO 4	3				3				2			2			
CO 5	3				3				2			2			
CO 6	3	3			3				3			2	2		3
R21UME409	3	3			3				3			2	3		3

Ref:

3-Strong

2-Medium

1 –Weak

Semester – VI

[illegible]

OBJECTIVES :

- To explain the principles involved in discretization and finite element approach.
- To impart knowledge to calculate the stiffness matrices and force vectors for simple elements.

UNIT I	FINITE ELEMENT FORMULATION OF BOUNDARY VALUE PROBLEMS	9

Introduction to FEA – Weighted residuals methods (Least square method, collocation, sub-domain collocation, Galerkin's method) –Variational approach – Rayleigh Ritz method.

UNIT II	ONE DIMENSIONAL FINITE ELEMENT ANALYSIS	9

General form of total potential for 1-D applications - generic form of finite element equations - nodal approximation - development of shape functions - element matrices and vectors -One Dimensional finite element analysis: bar element, beam element, spring element and truss element, quadratic element.

UNIT III	TWO DIMENSIONAL FINITE ELEMENT ANALYSIS	9

Two dimensional finite element analysis: types of elements, shape functions, natural coordinate systems - Iso-parametric elements -transformations to natural coordinates - Gaussian quadrature - plane stress, plane strain and axisymmetric applications.

UNIT IV	DYNAMIC ANALYSIS USING FINITE ELEMENT METHOD	9

Introduction - vibration problems - equations of motion based on weak form - longitudinal vibration of bars - transverse vibration of beams – consistent mass matrices- element equations - solution of Eigenvalue problems - vector iteration methods - normal modes - transient vibrations - modeling of damping - mode superposition technique - direct integration methods.

UNIT V	APPLICATIONS IN HEAT TRANSFER & FLUID MECHANICS	9

One dimensional heat transfer element - application to one-dimensional heat transfer problems - scalar variable problems in 2-Dimensions- Applications in heat transfer and fluid mechanics in 2D Problems. Introduction to FE software.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Illustrate the various finite element concepts for structural, non-structural, Vibrational, Heat Transfer and Fluid mechanics. (Understand)
2. Apply the finite element equations to solve 1D, 2D and 3 D problems. (Apply)
3. Apply the FEM concepts to derivate shape function, displacement function, Temperature function for various ID, 2D elements. (Apply)

- Analyze beams and shafts using finite element analysis. (Analyze)
- Compare 1D, 2D problems by analytical method and commercial FEA software packages. (Analyze)
- Evaluate the given heat transfer, solid mechanics and fluid mechanics problems. (Evaluate)

TEXT BOOKS:

- Seshu.P, “Text Book of Finite Element Analysis”, Prentice-Hall of India Pvt. Ltd, New Delhi, 2018.
- Reddy .J.N, “An Introduction to the Finite Element Method”, McGraw-Hill International 3rd Editions, 2017.

REFERENCE BOOKS:

- Chandrupatla, Belagundu, “Introduction to Finite Elements in Engineering”, Prentice-Hall of India Eastern Economy 4th Editions, 2015.
- Senthil.S.Dr, Panneerdhass.R, “Finite Element Analysis”, Lakshmi Publications, Chennai,2012.
- Cook.Robert. D, Plesha. Michael. E, Witt. Robert.J, “Concepts and Applications of Finite Element Analysis ”, Wiley Student 4th Edition,2004.
- David V., “Fundamentals of Finite Element Analysis”, Tata McGraw-Hill Edition, 2005.

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1															2
CO.2	3														3
CO.3	3	3												3	
CO.4		3	3												3
CO.5					3								3		
CO.6		3		3										3	3
R21UME601	3	3	3	3	3								3	3	3

Ref: 3 - Strong 2 - Medium 1 – Weak

OBJECTIVES :

- To explain the interdisciplinary applications of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.
- To impart knowledge on mechanical system with pneumatic, hydraulic components integrated with sensor and actuators.

UNIT I INTRODUCTION TO MECHATRONICS 9

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 – Strain gauges – Hall Effect sensor – Temperature sensors – Light sensors. Fiber optic transducers – Solid state sensors and transducers for magnetic measurements – piezoelectric sensor and accelerometers - Ultrasonic sensors for flow and distance.

UNIT II MICROPROCESSOR, MICROCONTROLLER AND PROGRAMMABLE PERIPHERAL INTERFACE 9

Introduction – Architecture of 8085 – Pin Configuration – Addressing Modes –Instruction set, Timing diagram of 8085 – Concepts of 8051 microcontroller – Block diagram. Introduction to Programmable peripheral interface –Temperature Control – Stepper Motor Control – Traffic Control interface.

UNIT III MECHATRONICS SYSTEM DESIGN USING ARDUINO 9

Introduction to Arduino board – Arduino Uno – Hardware description – digital I/O pins – power pins – accessories – breadboard – sensors – Arduino IDE – serial port – arduino programming – setup functions – loop function – pin mode – digital write and read – relay – if else – while loop – for loop – servomotor control using arduino.

UNIT IV ACTUATORS AND PROGRAMMABLE LOGIC CONTROLLER 9

Introduction – Pneumatic and Hydraulic Actuation Systems - Rotary Actuators - Mechanical Switches. Programmable Logic Controller - Basic structure – Input and output processing – Programming – Mnemonics –Timers, counters and internal relays – Selection of PLC -Programming the PLC using Ladder diagram for simple applications.

UNIT V CASE STUDIES OF MECHATRONICS SYSTEM 9

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 = 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Explain the concepts of sensors, transducers, actuators, Microprocessor, controllers, PLC, and Arduino for various applications (Understand)
2. Apply the function of sensors, transducers, actuators, architecture & timing diagram of microprocessor, controllers, PLC and Arduino for given scenario. (Apply)
3. Apply suitable interface circuits to link I/O devices with the microprocessor and Arduino. (Apply)
4. Analyze the function of Programmable Logic Controllers, Microprocessor, Microcontroller and Arduino in mechatronics system (Analyze)
5. Analyze the various actuators in mechatronics system using software's for the given applications. (Analyze)
6. Design a model of a mechatronics system for various applications (Create)

TEXT BOOKS:

3. Bolton W., "Mechatronics", Pearson Education, 6th Edition, 2015.
4. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", Penram International Publishing Private Limited, 6th Edition, 2013.

REFERENCE BOOKS:

1. Bradley D.A., Dawson D., Buru N.C. and Loader A.J., "Mechatronics", Chapman and Hall, 1993.
2. Davis G.Alciatore and Michael B.Histand, "Introduction to Mechatronics and Measurement systems", McGraw Hill Education, 2011.
3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", Cengage Learning, 2010.
4. Nitaigour Premchand Mahalik, "Mechatronics Principles, Concepts and Applications", McGraw Hill Education, 2015.
5. Smaili.A and Mrad.F, "Mechatronics Integrated Technologies for Intelligent Machines", Oxford University Press, 2007.
6. Fu, K.S., Gonzalez, R.C. and Lee C.S.G. – 'Robotics: Control, Sensing, Vision, and Intelligence' – McGraw Hill, New York, NY – 1987

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1															
CO.2	3														
CO.3		2													
CO.4		3													
CO.5					2								3		
CO.6			2						3	3			3		3
R21UME602	3	3	2		2				3	3			3		3

Ref: 3 - Strong 2 - Medium 1 – Weak

R21UME603	DATA SCIENCE AND DATA ANALYTICS FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To understand the fundamentals of data science applicable to mechanical engineering problems.
- To apply descriptive analytics to mechanical datasets such as production, thermal, and machine performance data.
- To visualize engineering data for decision-making in design, manufacturing, and maintenance.
- To perform inferential statistical analyses relevant to mechanical experiments.
- To develop predictive models for condition monitoring, reliability, and process optimization.

UNIT I	INTRODUCTION TO DATA SCIENCE IN MECHANICAL ENGINEERING	9

Need for data science in mechanical engineering – role in design, manufacturing, thermal systems, and maintenance – benefits and industrial applications (Industry 4.0, predictive maintenance, quality improvement) – types and sources of mechanical engineering data (sensor data, machine logs, CFD/FEA outputs) – data science process – defining engineering research goals – retrieving and preprocessing engineering datasets – exploratory data analysis for mechanical systems – introduction to modelling and engineering applications.

UNIT II	DESCRIPTIVE ANALYTICS FOR ENGINEERING DATA	9

Frequency distributions and histograms for mechanical measurements – outliers in experimental/production data – interpreting distributions – graphical methods in engineering (control charts, scatter plots, performance curves) – averages and measures of variability – interquartile range – variability in qualitative and ranked engineering data – normal distribution and applications in quality control – z-scores – correlation analysis for mechanical parameters – linear regression – regression line and least squares – standard error and R^2 interpretation – multiple regression for mechanical systems.

UNIT III	INFERENTIAL STATISTICS FOR ENGINEERING EXPERIMENTATION	9

Population and samples in mechanical experiments – random sampling – sampling distribution – standard error – hypothesis testing in mechanical engineering research – z-test, t-test, decision rules and interpretations – one-tailed and two-tailed tests – estimation of mechanical parameters – confidence intervals – sample size considerations for engineering trials and experiments.

UNIT IV ANALYSIS OF VARIANCE FOR ENGINEERING APPLICATIONS 9

t-test for one and two samples – application in comparing machine/tool performance – p-value and statistical significance – paired sample tests for before/after maintenance analysis – F-test – ANOVA for comparing multiple process parameters (e.g., speeds, feeds, materials) – two-factor ANOVA with/without interactions – introduction to chi-square tests – applications in reliability, quality control, and material selection.

UNIT V PREDICTIVE ANALYTICS & ENGINEERING APPLICATIONS 9

Linear least squares – engineering implementation – goodness of fit – model evaluation – weighted resampling – multiple regression and nonlinear models for engineering processes – logistic regression for failure classification – introduction to time series analysis for mechanical systems (vibration signals, temperature, load variations) – moving averages – handling missing values – autocorrelation – introduction to survival analysis and reliability modelling (MTBF, hazard rate).

TOTAL = 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

CO1: Explain the data analytics pipeline with relevance to mechanical engineering applications.

CO2: Describe, analyze, and visualize mechanical datasets from experiments and processes.

CO3: Perform statistical inference for engineering problem-solving.

CO4: Apply ANOVA and hypothesis testing to evaluate mechanical system performance.

CO5: Build predictive models for quality control, condition monitoring, and process optimization.

TEXT BOOKS:

1. David Cielen, Arno D. B. Meysman, and Mohamed Ali, “Introducing Data Science”, Manning Publications, 2016.
2. Robert S. Witte and John S. Witte, “Statistics”, Eleventh Edition, Wiley Publications, 2017.
3. Jake VanderPlas, “Python Data Science Handbook”, O’Reilly, 2016.

REFERENCE BOOKS:

1. Allen B. Downey, "Think Stats: Exploratory Data Analysis in Python", Green Tea Press, 2014.
2. Sanjeev J. Wagh et al., "Fundamentals of Data Science", CRC Press, 2022.
3. Amit Kumar Tyagi, "Data Analytics for Engineering and Science Applications", Springer, 2020.
4. S. Suresh & R. Murugesan, "Industrial Data Analytics for Engineers", McGraw Hill, 2021.

R21UME604	DIGITAL ELECTRONICS FOR MECHANICAL ENGINEERS	L	T	P	C
		3	0	0	3

OBJECTIVES :

- To introduce the fundamentals of digital electronics required for automation, CNC, robotics, and mechatronic systems.
- To provide knowledge on essential electronic components and signal-conditioning circuits used in mechanical systems.
- To develop the ability to design and analyze simple digital circuits relevant to industrial applications.
- To familiarize students with modern industrial communication, IoT concepts, and embedded system blocks without programming depth.

UNIT I BASIC ELECTRONIC COMPONENTS & SIGNAL CONDITIONING 9

Overview of electronics used in mechanical systems (CNC, HVAC, automation) , Semiconductor basics: Diodes, rectifiers (block-level), voltage regulators (7805/7812), SMPS concept. Transistors (BJT/MOSFET): Working principle and switching applications.

Need for signal conditioning in sensors, Op-amp essentials (concept only): Inverting & Non-inverting amplifier, Comparator, Buffer, Applications of op-amps in mechanical instrumentation (temperature, vibration, and displacement), Introduction to ADC and DAC.

UNIT II DIGITAL ELECTRONICS FUNDAMENTALS 9

Analog vs Digital signals. Number systems and basic logic operations, Logic gates: AND, OR, NOT, NAND, NOR, XOR, Boolean algebra simplification, Karnaugh map (2 & 3 variables), Combinational circuits: Adders, subtractors, multiplexers, demultiplexers, Sequential circuits: Flip-flops (SR, JK, D), counters (concept and applications). Industrial relevance of digital circuits in automation and controllers

UNIT III TIMERS, OSCILLATORS & EMBEDDED SYSTEM BASICS 9

IC 555 Timer: Astable and monostable operation, pulse generation, PWM basics and applications in motor speed control, Oscillator fundamentals (RC, crystal—conceptual only). Introduction to embedded systems (block-level only): Processor, Memory, I/O ports, Sensors & actuators, • Comparison of microprocessor and microcontroller (no architecture). Applications of embedded systems in mechanical engineering: CNC control, Automatic lubrication systems, Simple industrial automation units

UNIT IV INDUSTRIAL ELECTRONICS & INTERFACING 9

Switching devices in mechanical systems: Relays, Solenoid valves, Solid-state switches, • Motor interfacing basics: DC motor, Stepper motor, Servo motor, Noise, grounding, and shielding in industrial environments. Introduction to control panel wiring, Interfacing principles between digital circuits and mechanical actuators.

UNIT V INDUSTRIAL COMMUNICATION & IoT IN MECHANICAL SYSTEMS

9

Wired communication: RS232, RS485, CAN concept & application, Wireless communication basics: Wi-Fi, Bluetooth Low Energy (BLE). IoT architecture for mechanical systems: sensor node, gateway, cloud, Cloud-enabled condition monitoring for machines (vibration, temperature), Smart manufacturing, Predictive maintenance, Digital twins, Basics of modulation (AM/FM) and GSM communication (concept only). Applications- Smart HVAC, Remote monitoring, Data logging systems

TOTAL = 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Explain the essential semiconductor devices and signal-conditioning techniques used in mechanical measurement systems.
2. Apply digital logic concepts to implement combinational and sequential circuits.
3. Describe the operation of timers, oscillators, and embedded system building blocks.
4. Analyze basic interfacing circuits used for actuators and control in mechanical automation.
5. Explain industrial communication protocols and IoT-based monitoring systems used in modern manufacturing.
6. Integrate digital and electronic modules into mechanical engineering systems like CNCs, robots, and smart manufacturing setups.

TEXT BOOKS:

1. D.P. Kothari & I.J. Nagrath, *Basic Electronics*, McGraw Hill.
2. Thomas L. Floyd, *Digital Fundamentals*, Pearson.

REFERENCE BOOKS:

1. Robert Boylestad & Nashelsky, *Electronic Devices and Circuit Theory*, Pearson.
2. Ronald J. Tocci, *Digital Systems: Principles and Applications*, Pearson.
3. D.P. Mandal, *Introduction to Mechatronics*, McGraw Hill.

OBJECTIVES :

- To demonstrate the knowledge on interpret drawings of machine components and assembly drawings using standard CAD packages.
- To train the students in the Indian standards on drawing practices and standard components.

LIST OF EXPERIMENTS :

CAD ASSEMBLY DRAWING (USING APPLICATION PACKAGES)

1. Practice various commands using Creo software
2. Develop the part modeling using Creo software
3. Develop the assembled views of Shaft coupling
4. Develop the assembled views of Flange coupling
5. Develop the assembled views of Plummer block
6. Develop the assembled views of Screw jack
7. Develop the assembled views of Universal Joint
8. Develop the assembled views of Sleeve and Cotter Joint
9. Develop the assembled views of Socket and Spigot Joint
10. Develop the assembled views of sports bicycle

CAM

1. Practice various CNC codes using CADEM software
2. Develop CNC Program For Step Turning and Generate the Tool Path Simulation
3. Develop CNC Program for Multiple Turning and Generate the Tool Path Simulation
4. Develop CNC Program for Thread Cutting, Grooving and Generate the Tool Path Simulation
5. Develop CNC Program for Drilling and Generate the Tool Path Simulation
6. Develop CNC Program for Rectangular Pocketing and Generate the Tool Path Simulation
7. Develop CNC Program for Rectangular and Circular Pocketing and Generate the Tool Path Simulation

A minimum of nine experiments shall be offered

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Illustrate the basics of modeling and simulation using Creo & CADEM Software. (Understand)
2. Apply the knowledge of modeling software to develop different mechanical components. (Apply)
3. Apply the concepts of assemble module to combine various mechanical components for the given engineering application. (Apply)
4. Develop CNC program for turning, grooving and thread cutting operations using CNC Lathe. (Apply)
5. Apply the knowledge of simulation software to build CNC program for drilling and pocketing operations using CNC Mill. (Apply)
6. Design and analyze the given mechanism using modeling (Analyze)

EQUIPMENT REQUIREMENT

Sl. No.	Name of the equipment/software	Quantity required
1.	Computer Server	1
2.	A3 size plotter	1
3.	Laser Printer	1
4.	Trainer CNC Lathe	1
5.	Trainer CNC milling	1
6.	Computer system	30
7.	SOLIDWORKS /Auto CAD/Pro-E	30
8.	CAD/CAM software (Pro-E or IDEAS or Unigraphics or CATIA	15
9.	CAM Software (CNC Programming and tool path simulation for FANUC /Sinumeric and Heiden controller)	15
10.	Licensed operating system	Adequate

COURSE ARTICULATION MATRIX:

CO/PO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1													2		
CO 2	3				3								3		
CO 3	3				3								3		
CO 4	3				3								3		
CO 5	3				3								3		
CO 6	3				3								3		
R21UME605	3				3								3		

Ref: 3 - Strong 2 - Medium 1 – Weak

OBJECTIVES:

- To impart the knowledge in servo controller, micro controller, PLC, hydraulics and pneumatics systems,
- To learn the concepts and application of industrial robots and Additive Manufacturing

LIST OF EXPERIMENTS:

1. Design and testing of fluid power circuits to control velocity, direction of double acting cylinder.
2. Servo Controller Interfacing for Open and Closed Loop System.
3. Stepper motor interfacing with 8051 micro controller Full step / Half step revolutions
4. Design and simulation of a hydraulic circuits:
 - Design and simulation of a hydraulic circuit by using single solenoid 4/2-way valve to actuate two double acting cylinders.
 - Design and simulation of a hydraulic circuit by using one hand operated 4/2-way valve to actuate one double acting cylinder.
5. Design and simulation of a pneumatic circuits:
 - Design and simulation of a pneumatic circuit by using one hand operated 5/2-way valve to actuate one double acting cylinder.
 - Design and simulation of a pneumatic circuit by using two 3/2-way valve operated 4/2-way valve to actuate one double acting cylinder.
6. Design a circuit using electro pneumatic trainer kit:
 - Design a circuit of extend/ retract of single acting cylinder using push button and 3/2 solenoid valve by using electro pneumatic trainer kit.
 - Design a circuit of extends and retraction of double acting cylinder using two push buttons and 5/2 double solenoid valve by using electro pneumatic trainer kit.
7. Design and control of a circuit using versa pro with PLC:
 - Design of a circuit to extend and retract the cylinder with the help of the two sensors to control with PLC.
 - Design of a circuit for synchronization of two cylinders to control with PLC.
8. Study of various types of sensors and transducers.
9. Study of image processing technique.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Explain the concepts of hydraulics, pneumatics systems, servo controller, micro controller, industrial robots and additive manufacturing for various applications **(Understand)**
2. Apply the knowledge of hydraulics and pneumatics to design and simulate the different circuits using software. **(Apply)**
3. Apply the knowledge of pneumatics system to design and operate different circuits using electro pneumatic trainer kit. **(Apply)**
4. Apply a suitable sensor and image processing technique for mechatronics systems. **(Apply)**
5. Analyze the performance of servo motor for open and closed loop system and stepper motor interfacing with 8051 Micro controller. **(Analyze)**
6. Analyze the functions of PLC in hydraulics and pneumatics systems. **(Analyze)**

EQUIPMENT REQUIREMENT

SI. No.	Name of the requirement	Quantity required
1.	SYSCO simulation of speed control in hydraulic system kit	1 No.
2.	Hydraulic and Pneumatic system simulation software – FLUID SIM and HYDRO SIM	5 users
3.	Basic Electro Pneumatic Trainer kit (VMT-05) with Electrical control Trainer (VMT – 07)	1 No.
4.	Servo controller using closed / Open loop system and drive circuit set (VPAT-22) using WINPRO LADDER software	1 No.
5.	8051 – Micro controller with Stepper motor and drive circuit sets	1 No.
6	Raspberry pi and Arduino boards with drive circuit sets	1 No.
7	Basic Electro Pneumatic Trainer kit (VMT-04) with PLC control Trainer (VPLCT-02) using VERSA PRO software	1 No.
8	Multi process station (VMPA – 620 with Data Acquisition card set using Process Control (Win 98)	1 No.

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1															
CO 2	3				2								3		
CO 3		2													
CO 4		3													
CO 5		3							3	3			3		3
CO 6		3			2										
R21UME606	3	3			2				3	3			3		3

*** 3 – Strong**

2 – Medium

1 – Weak

OBJECTIVES:

- To make the student in integrated activities of reading, research, discussion and presentation around a designated subject.
- To impart knowledge to implement their skills acquired in the previous semesters to practical problems.
- To familiarize the students to make fabrication work.

PROJECT DESCRIPTION:

The students in convenient groups of not more than 4 members have to take one small item for design and fabrication. Every project work shall have a guide who is the member of the faculty of the institution and if possible with an industry guide also.

The item chosen may be small machine elements (Example-screw jack, coupling, machine vice, cam and follower, governor etc), attachment to machine tools, tooling (jigs, fixtures etc), small gear box, automotive appliances, agricultural implements, simple heat exchangers, small pumps, hydraulic /pneumatic devices etc.

The students are required to design and fabricate the chosen item in the college and demonstrate its working apart from submitting the project report. The report should contain assembly drawing, parts drawings, process charts relating to fabrication.

TOTAL: 120 PERIODS

COURSEOUTCOMES:

After successful completion of this course the students will be able to:

1. Identify the systematic way of organizing various resources for completing the project in time.
2. Implement most appropriate manufacturing processes for a specific task.
3. Build the proto type model for engineering applications.
4. Demonstrate the working of fabrication project.
5. Prepare and present the project along with report.

COURSE ARTICULATION MATRIX:

CO/PO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3	3				3							3	3	3
CO 2		3	3										3	3	3
CO 3				3	3								3	3	3
CO 4									3		3		3	3	3
CO 5										3			3	3	3
R21UME607	3	3	3	3	3	3			3	3	3		3	3	3

Ref: 3 - Strong 2 - Medium 1 – Weak

R21UGS632	SOFT SKILL & COMMUNICATION LABORATORY	L	T	P	C
	(Common to Mech, ECE, Civil, BME and BT)	0	0	2	1

COURSE OBJECTIVE:

- To develop a requisite knowledge in Communication skills and Soft skills.
- To enhance the students' acumen in honing the skills to meet the Global changes and Industrial needs.

UNIT I SPEAKING SKILLS 6

Conversational Skills - Self Introduction - Group Discussion - Public Speaking - Presentation Skills.

UNIT II WRITING SKILLS 6

Letter Writing – Report Writing – Email Writing – Job Application – Resume Preparation.

UNIT III READING AND LISTENING SKILLS 6

Reading Comprehension – Enriching Vocabulary – Error Spotting – Listening and Note Taking.

UNIT IV SOFTSKILLS 6

Professional Ethics – Interpersonal Skills – Stress Management – Leadership Qualities – Time Management – Conflict Resolution.

UNIT V INTERVIEW SKILLS 6

Types of Interview – Body Language – Professional Grooming – Basic Etiquette.

Total: 30 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be:

1. Answer the queries precisely after carefully listening to the conversation or speech.(Affective domain - Responding)
2. Communicate orally with fluency and clarity in a given contextual situation (Affective domain - Responding)
3. Debate with clarity of thought and expression to convey their ideas politely to others (Affective domain - Valuing)
4. Apply correct usage of English grammar in writing, fluent speaking and comprehending. (Cognitive Domain - Apply)

REFERENCE BOOKS:

1. Skills for Success, Listening and Speaking – Level 4 by Brooks and Margret – Oxford University Press, Oxford 2011 Edition.
2. Professional Communication by Raman, Meenakshi and Sangeetha Sharma – Oxford University Press, 2014 Edition.
3. Developing Soft Skills by Sherfield, Robert M, R J Montgomery and Patricia G Moody – Pearson Education Publishers.

21UGM631

INDIAN CONSTITUTION

L	T	P	C
1	0	0	P/F

Pre-requisites: Nil

COURSE OBJECTIVE:

- The students will be exposed to fundamental rights & duties in Indian Constitution.
- The students will be given knowledge on the components of the parliamentary system to prepare for the process of their career development.
- The student will have knowledge on powers and functions of Local bodies and Indian polity to appear for various competitive exams such as UPSC, TNPSC and RRB...
- The student will know about the functions of judiciary and electoral process followed in the country.

UNIT I INTRODUCTION ON INDIAN CONSTITUTION 4

Preamble - Salient features of the Constitution of India. Fundamental Rights - its restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) - Fundamental Duties: its Scope and significance in Nation building - Constitution components: schedule, parts and articles of constitution- important Amendments of constitution.

UNIT II PARLIAMENTARY SYSTEM 4

Parliamentary System – parliamentary system of other countries - Indian parliamentary system-Federal System – LS and RS, Centre-State Relations-Election of member of parliaments- Union Executive - President, Prime Minister, Union Cabinet. State Legislature -State Executives –election of MLA- Governor, Chief Minister, State Cabinet.

UNIT III JUDICIARY AND ELECTION COMMISSION 4

Supreme Court of India: Structure, Power and Functions of Supreme Court-- Judicial Reviews - Judicial Activism. High Court and Subordinate Courts: Structure, Power and Functions. – Lokadhalats. Elections- Electoral Process - Election Commission of India - Election Laws – Emergency Provisions - types of Emergencies and its consequences.

UNIT IV LOCAL ADMINISTRATION 3

Local Administration: Powers and functions of Municipalities and Panchayats System-Panchayat Raj- Co-operative Societies and Constitutional and Non-constitutional Bodies.

Total: 15 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be:

1. Able to apply knowledge of the fundamental rights and duties prescribed by Indian Constitution to prepare for various competitive examinations.
2. Able to manage complex societal issues in society with the knowledge of judiciary and local administration.
3. Able to interpret the societal, health, safety, legal and cultural issues with understanding of parliamentary system and electoral process through self-learning skills.
4. Able to understand the ethical responsibilities of municipalities, panchayats and co-operative societies.
5. Able to understand and distinguish the functioning of the parliamentary system followed in various countries.

TEXT BOOKS:

1. Shubham Singles, Charles E. Haries, et al., “Constitution of India and Professional Ethics” by Cengage Learning India Private Limited, 2018.
2. Subhash C. Kashyap, “Our Constitution: An Introduction to India’s Constitution and constitutional Law”, NBT, 2018.
3. Brij Kishore Sharma, “Introduction to the Constitution of India”, PHI Learning Pvt. Ltd., New Delhi, 2011.
4. M.V.Pylee, “An Introduction to Constitution of India”, Vikas Publishing, 2002.
5. Durga Das Basu, “Introduction to the Constitution on India”, Prentice Hall, 2001.

SEMESTER – VII[illegible]

R21UME701	PROJECT MANAGEMENT AND FINANCE			
	(Common to All Branches Except CSBS & AGRI)			
	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To impart knowledge to find solutions and approaches for various projects.
- To familiarize the utilization of project within time, resource and financial constraints.

UNIT I PROJECT MANAGEMENT CONCEPTS 9

Concept and characteristics of a project, importance of project management, types of project, project organizational structure, project life cycle, Statement of Work, Work Breakdown Structure.

UNIT II PROJECT PLANNING 9

Project Planning and Scheduling techniques - developing the project network using CPM/PERT, Limitations of CPM/PERT, Precedence Diagramming Method, constructing diagram and computations using precedence diagramming method, PERT/CPM simulation, reducing project duration.

UNIT III RESOURCE SCHEDULING & CRITICAL CHAIN SCHEDULING 9

Resource Scheduling - Resource allocation method, splitting and multitasking, Multi project resources scheduling - Critical Chain Scheduling -Concept of critical chain scheduling - critical chain scheduling method, application of Critical chain scheduling and limitations.

UNIT IV PROJECT QUALITY MANAGEMENT 9

Concept of project quality, responsibility for quality in projects, quality management at different stages of project, tools and techniques, Quality Management Systems, TQM in projects - Project Performance Measurement and Control - Monitor and assess project performance, schedule, and cost. Earned Value Management, performance measurement methods to monitor, evaluate and control planned cost and schedule performance - Project Closure/ Termination - Meaning of closure/ termination, project audit process, termination steps, final closure.

UNIT V FINANCIAL ACCOUNTING 9

Balance sheet and related concepts - Profit & Loss Statement and related concepts - Financial Ratio Analysis - Cash flow analysis - Funds flow analysis – Comparative financial statements. Investments - Average rate of return - Payback Period - Net Present Value - Internal rate of return.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Describe the concept and characteristics of project management and application of resource scheduling and critical chain scheduling. (Understand)
2. Apply the concepts of CPM and PERT to develop the project network (Apply)
3. Estimate the suitable resources required for given project work (Apply)
4. Examine the various tools and techniques at different stages of Quality management. (Analysis)
5. Construct the balance sheet to identify the fund flow and cash flow statements (Apply)
6. Evaluate the decision related to forecasting, inventory, quality control problems etc. for the industries (Evaluate)

TEXT BOOKS:

1. Prasanna Chandra, "Fundamentals of Financial Management' ", Tata McGraw Hill Publishing Ltd, 2015.
2. Jack Meredith, Samuel J. Mantel, "Project Management- A Managerial Approach", John Wiley and Sons.

REFERENCE BOOKS:

1. Clifford F Gray, Erik W Larson, "Project Management-The Managerial Process", Tata McGraw Hill Publishing Co Ltd.
2. John M Nicholas, "Project Management for Business and Technology", Prentice Hall of India Pvt. Ltd.
3. Paresh Shah, "Basic Financial Accounting for Management", Oxford University Press, 2020.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2										2				
CO 2	3										3				
CO 3	3					2					3				
CO 4	3				3	2					3		2		
CO 5	3	3			3	2	3		3		3		2		2
CO 6	3	3	3	2	3	2			3		3		2		3
R21UME701	3	3	3	2	3	2	3		3		3		2		3

Ref:**3-Strong****2-Medium****1 –Weak**

OBJECTIVES:

- To train the student to interpret drawings of components and analyze using analyzing packages.

LIST OF EXPERIMENTS

1. Stress analysis of cantilever beam.
2. Stress analysis of simply supported beam.
3. Stress analysis of fixed ends beam.
4. Stress analysis of an axi-symmetric component.
5. Mode frequency analysis of a 2 D component.
6. Mode frequency analysis of cantilever beams.
7. Mode frequency analysis of simply supported beam.
8. Thermal stress analysis of a 2D component.
9. Conductive heat transfer analysis of a 2D component.
10. Convective heat transfer analysis of a 2D component.
11. Introduction to ANSYS Modeling and simulation software to aerodynamic problems Numerical simulation of Flow over an airfoil.
12. Numerical simulation of Supersonic flow over a wedge.
13. Numerical simulation of Flat plate boundary layer.
14. Numerical simulation of Laminar flow through pipe.
15. Numerical simulation of Flow past cylinder.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Outline the basic concepts of FEA and CFD using ANSYS software for different structures (Understand)
2. Apply the vibration concepts to calculate the mode frequency for different beams. (Apply)
3. Apply heat transfer concept to compute the conduction, convection and temperature distribution for the given structures. (Apply)
4. Analyze the given structural problem to determine the deflection and stresses in different types of beams. (Analyze)
5. Analyze the given 2D axisymmetric component and find stress and deflection for different load conditions. (Analyze)
6. Analyze the fluid flow properties of flat plate, pipe and aero foil using CFD. (Analyze)

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2								2		
CO 2	3				3				2				3		
CO 3	3				3				2				3	3	
CO 4	3	3	2		3			3	3			2	3		2
CO 5	3	3	2		3			3	3			2	3		2
CO 6	3	3	3	3	3			3	3			2	3	3	3
R21UME703	3	3	3	3	3			3	3			2	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

SEMESTER – VIII

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PE	E6	Professional Elective VI	3	0	0	3	45
2.	OE	OE4	Open Elective IV	3	0	0	3	45
PRACTICAL								
3.	PW	R21UME801 / R21UGE810	Project Work / MDP Phase – II	0	0	16	8	240
MANDATORY								
4.	MC	R21UGM831	Professional Ethics and Human values (Common to All Branches)	2	0	0	P/F	30
TOTAL				8	0	16	14	360
Total No of Credits – 14								

R21UME801

PROJECT WORK

L	T	P	C
0	0	16	8

OBJECTIVES:

- The objective of this course is to help the students to develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same, and to train the students in preparing project reports and to face reviews and viva voce examination.

LIST OF EXPERIMENTS

PROJECT DESCRIPTION:

1. The project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study.
2. Every project work shall have a guide who is the member of the faculty of the institution.
3. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project.
4. The aim of the project work is to deepen comprehension of principles by applying them to a new problem which may be the design and manufacture of a device, a research investigation, a computer or management project or a design problem.
5. The progress of the project is evaluated based on a minimum of three reviews.

Total = 240 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Design/Develop sustainable solutions for societal issues with environmental considerations applying the basic engineering knowledge.
2. Analyze and review research literature to synthesize research methods including design of experiments to provide valid conclusion.
3. Utilize the new tools, algorithms, techniques to provide valid conclusion following the norms of engineering practice.
4. Test and evaluate the performance of the developed solution using appropriate techniques and tools.
5. Apply management principles to function effectively in the project team for project execution.
6. Engage in learning for effective project implementation in the broadest context of technological change with consideration for public health, safety, cultural and societal needs.
7. Write effective reports and make clear presentation to the engineering community and society.

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	3		3				3						3	3	3
CO 2		3		3									3	3	3
CO 3					3			3					3	3	3
CO 4		3			3								3	3	3
CO 5									3		3		3	3	3
CO 6						3	3					3	3	3	3
CO 7										3			3	3	3
R21UME801	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

R21UGM831	PROFESSIONAL ETHICS & HUMAN VALUES			
	(Common to All Branches)			
	L	T	P	C
	2	0	0	P / F

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

UNIT I HUMAN VALUES 7

Morals- Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage - Valuing Time - Co-operation –Commitment – Empathy- self-Confidence –Character.

UNIT II ENGINEERING ETHICS 7

Senses of ‘Engineering Ethics’ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg’s theory – Gilligan’s theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues –Uses of Ethical Theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 4

Engineering Harmony in the family – Harmony in the society – Trust and Respect – Universal harmonious order

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 6

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 6

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development– Engineers as Managers – Consulting Engineers – Honesty – Moral Leadership – Sample Code of Conduct.

TOTAL : 30 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.

REFERENCE BOOKS:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
4. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” McGraw Hill education, India Pvt. Ltd., New Delhi, 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011.

OBJECTIVES:

- To familiarize the construction and working principle of various parts of an automobile.
- To impart knowledge for alternate fuels, emission control and smart vehicles.

UNIT I VEHICLE STRUCTURE**9**

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, resistances to vehicle motion, vehicle aerodynamic resistance, Sensors and actuators for various engine applications.

UNIT II TRANSMISSION AND AUXILIARY SYSTEMS**9**

Clutch and its construction, need for a gearbox, Automatic gear box- gear shift mechanisms, Over drive, transfer box, propeller shaft, Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive. Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system, Electronic ignition system.

UNIT III STEERING, BRAKES AND SUSPENSION SYSTEM**9**

Steering geometry and types of steering gear box, Power Steering-types, Suspension Systems - Types, Braking system - Pneumatic and Hydraulic Braking Systems, Antilock Braking System.

UNIT IV ALTERNATE FUELS AND EMISSION CONTROL**9**

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- safety precautions for handling hydrogen, Fuel Cell. Engine emission control by three way catalytic converter system, Particulate filters, Selective Catalytic Reduction, Exhaust gas recirculation. Emission norms and emission control techniques -Euro norms-Bharath stage norms.

UNIT V SMART VEHICLES**9**

Hybrid Vehicles, Electric vehicles, Artificial Intelligence –machine learning-deep learning-Autonomous vehicles, Introduction to Big data, blockchain, IoT for vehicles. Biometric vehicle access, Adaptive Cruise Control, Traction Control- comprehensive Vehicle Tracking, airbag, Automatic High-Beam control, Automatic Emergency Braking.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Explain the vehicle structure, transmission systems, auxiliary systems, steering, brakes and suspension, Alternate Fuels, Emission Control and smart vehicles system. (Understand)
2. Design and explain the working of basic elements in automobile transmission, auxiliary systems and brakes. (Apply)
3. Apply the automobile engineering concepts to design aerodynamic resistance model, injection system, ignition system and braking system for a vehicle using modeling software. (Apply)
4. Select possible alternate sources of energy for IC Engines and explain the Engine modifications required. (Apply)
5. Explain the emission norms and emission reduction techniques to choose and judge the suitable alternate fuel for various applications/vehicles. (Apply)
6. Examine and apply big data and IoT in smart vehicles with considering safety,

societal needs and environmental constraints. (Apply)

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering Vol. 1 &2", Standard Publishers, 13th Edition, New Delhi, 2014
2. Hand notes, "Emission norms, emission control techniques, smart vehicles, big data, IoT", Mechanical Engineering Department, SIT.

REFERENCE BOOKS:

1. K.K. Jain, R.B. Asthana, "Automobile Engineering", Tata McGraw Hill Publishers, New Delhi, 2002.
2. Heinz Heisler, "Advanced Engine Technology", Prentice Hall (India) Pvt. Ltd, 2006
3. R.K. Rajput, Automobile Engineering, Laxmi Publications (P) Ltd., New Delhi, 2007.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2							2	2	3	
CO 2	3				3									3	
CO 3	3				3									3	
CO 4	3													3	
CO 5	3						3	3						3	
CO 6	3						3	3						3	
R21MEV101	3				3		3	3				2	2	3	

Ref:

3-Strong

2-Medium

1 –Weak

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Get an exposure to the Aerospace Industry.
2. Understand the Basics of Aircraft Systems and Aircraft Structures.
3. Industry Practices on Design of Aircraft Structures.
4. Understand the applicability of Design aspects in Aircraft Design.
5. Relate the theoretical knowledge with the design of Aircraft Structures.

REFERENCE BOOKS:

1. Flight without Formulae by A.C Kermode, Pearson Education, 10th Edition
2. Mechanics of Flight by A.C Kermode, Pearson Education, 5th Edition
3. Fundamentals Of Flight, Shevell, Pearson Education, 2nd Edition
4. Introduction to Flight by Dave Anderson
5. Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration by Ian moir, Allan Seabridge
6. Aircraft Design-A Conceptual Approach by Daniel P. Raymer, AIAA education series, 6th Edition
7. Airframe Structural Design by Michael Niu, Conmilit Press, 1988, 2nd Edition
8. Airframe Stress Analysis and Sizing by Michael Niu, Conmilit Press, 1999, 3rd Edition
9. The Elements of Aircraft Preliminary Design – Roger D. Schaufele, Aries Publications, 2000
10. Aircraft Structural Maintenance by Dale Hurst, Avotek publishers, 2nd Edition, 2006
11. Aircraft Maintenance & Repair by Frank Delp, Michael J. Kroes & William A. Watkins, Glencoe & McGraw-Hill, 6th Edition, 1993
12. An Introduction to Aircraft Certification; A Guide to Understanding Jaa, Easa and FAA by Filippo De Florio, Butterworth-Heinemann.

OBJECTIVES:

- To introduce the fundamentals and components of electric vehicle systems.
- To learn various electric propulsion technologies and powertrain architectures.
- To understand energy storage systems and battery management.
- To understand energy storage systems and battery management.
- To explore the role of fuel cells and alternative propulsion technologies in EVs.
- To provide insight into EV control systems and challenges in the EV ecosystem.

UNIT I	ELECTRIC VEHICLE ARCHITECTURE AND CONFIGURATION	9

EV vs. ICE vehicles – Types of Electric Vehicles (BEV, HEV, PHEV, FCEV) – Vehicle architecture – EV power train components – Traction motor characteristics – Regenerative braking.

UNIT II	ELECTRIC DRIVES AND POWER ELECTRONICS FOR EVS	9

Electric motors for EVs – BLDC (Brushless DC Motor) and PMSM (Permanent Magnet Synchronous Motor) Induction Motors – Motor control techniques – Inverters and converters – Controllers and drive systems – Thermal management of electric motors and drives.

UNIT III	ENERGY STORAGE SYSTEMS AND BATTERY TECHNOLOGY	9

Battery types Lead-acid, NiMH, and Lithium-ion – Battery characteristics and selection – Battery pack design – Battery Management Systems (BMS) – Charging infrastructure: on-board and off-board chargers.

UNIT IV	HYBRID VEHICLES AND CONTROL STRATEGIES	9

Series, Parallel and Series-Parallel Hybrid configurations – Control strategies for hybrid vehicles – Engine-motor coordination – Role of low-carbon fuels in hybrid systems – Challenges and trends in hybrid integration.

UNIT V	FUEL CELL AND FUTURE EV TECHNOLOGIES	9

Fuel cell electric vehicles (FCEV) – Types of fuel cells -Proton Exchange Membrane Fuel Cell (PEMFC), Alkaline Fuel Cell (AFC), Solid Oxide Fuel Cell (SOFC) – Hydrogen storage and safety – Fuel cell system design and control ,Vehicle-to-Grid (V2G) – Autonomous EVs and AI integration.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the key differences between ICE and electric vehicle architectures and explain various types of electric vehicles. (Understand)
2. Select electric motor technologies, power electronics, and control systems used in EVs. (Apply)
3. Develop battery technologies and energy storage systems used in electric vehicles. (Apply)
4. Select hybrid vehicle configurations and their control strategies on the real-time EV technology. (Apply)
5. Analyze the integration of AI and autonomous systems into modern EVs and assess their future impact on mobility. (Analyze)
6. Solve the role of hybrid and electric powertrain configurations along with battery and fuel technologies to develop integrated energy solutions for modern sustainable vehicles. (Apply)

TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2018.
2. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 3rd Edition, 2021.
3. Sandeep Dhameja, Electric Vehicle Battery Systems Newnes, 2002

REFERENCE BOOKS:

1. James Larminie & John Lowry, Electric Vehicle Technology Explained Wiley, 2nd Edition, 2012
2. S. Ramakrishnan, Electric Vehicles and Control Vijay Nicole Imprints, 1st Edition, 2020
3. Erjavec, Jack & Jeffery Arias, Hybrid, Electric and Fuel-Cell Vehicles Cengage Learning, 2nd Edition, 2013
4. Chris Mi, M. Abul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, Wiley, 2011
5. John G. Hayes & G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles Wiley, 2018

R21MEV104	RENEWABLE POWERED OFF HIGHWAY VEHICLES AND EMISSION CONTROL TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the low and zero carbon fuels suitability and methods of use in off-road vehicles.
- To learn and understand the green energy production methodologies and its use in off-road vehicle categories.
- To learn various fuel cell types and its suitability in off-highway vehicles applications
- To illustrate the impact of in-cylinder technologies on engine out emissions control.
- To study the existing after-treatment technologies used in off-highway vehicle applications.

UNIT I LOW AND ZERO CARBON FUELS POWERED OFF-HIGHWAY VEHICLES 9

Ethanol, Methanol, Butanol, Biodiesel, CNG, LNG, DME, Polyoxymethylene Dimethyl Ether (PODE), Ammonia and Hydrogen Fuels suitability, methods, and technologies for powering off-road vehicles.

UNIT II GREEN ENERGY POWERED OFF-HIGHWAY VEHICLES 9

Solar Technology for Green Electricity, Green Electricity for Hydrogen Production, Hydrogen Smart Grid Technologies, Hydrogen to ICE powered vehicles, Hydrogen to Fuel Cell Powered Vehicles.

UNIT III FUEL CELL POWERED OFF-HIGHWAY VEHICLES 9

Fuel Cell, Types, Applications, Fuel Cell Requirement, Sizing and Design for Off-Highway applications, Merits and Demerits, Pathway to overcome the limitations. Scope of the fuel cell research on Off-road vehicle applications.

UNIT IV IN-CYLINDER TREATMENT TECHNOLOGIES 9

Low temperature Combustion Modes - Homogeneous Charge Compression Ignition, Premixed-Charge Compression Ignition, Reactivity Controlled Compression Ignition, Gasoline Direct Injection Compression Ignition, Water Injection Technologies.

UNIT V AFTER TREATMENT TECHNOLOGIES 9

Diesel Oxidation Catalyst, Diesel Particulate Filter, Selective Catalytic Reduction, Ammonia slip / clean up catalyst. CO₂ absorption techniques, Waste Heat Recovery and Organic Rankine Cycle.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Evaluate the availability, suitability, and its role in off-road vehicle categories in reducing the carbon footprint on the environment.
2. Gain the knowledge on various green energy production methods and its impact on meeting energy demand of off-road vehicle applications.
3. Develop the working of fuel cell, various fuel cell types, and its design for off-road vehicle applications.
4. Gain the knowledge on various in-cylinder low temperature combustion technologies and its key role in controlling the engine-out emissions.
5. Develop the working of various existing after treatment systems in controlling the engine out emissions.

TEXT BOOKS:

1. John Twidell, and Tony Weir. Renewable Energy Sources – 3rd Edition 2015,
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature Combustion Engines.

REFERENCE BOOKS:

1. Daniel J Holt. Fuel Cell Powered Vehicles: Automotive Technology of the Future. Society of Automotive Engineers, 2001 - Technology & Engineering,
2. W. Addy Majewski, Magdi K. Khair. Diesel Emissions and Their Control.
3. Toward Zero Carbon: The Chicago Central Area DeCarbonization Plan by Adrian Smith and Gordon Gill | 1 June 2011
4. Transportation in a Net Zero World: Transitioning Towards Low Carbon Public Transport (Green Energy and Technology) by Kathryn G. Logan, Astley Hastings, et al. | 7 April 2022
5. The Political Economy of Low Carbon Transformation: Breaking the habits of capitalism (Routledge Studies in Low Carbon Development) by Harold Wilhite | 21 December 2017

R21MEV105	VEHICLE HEALTH MONITORING, MAINTENANCE AND SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enable the student to understand the principles, functions and practices adapted in maintenance activities of vehicles.
- To study the powertrain maintenance, fault diagnosis, maintenance of Batteries.
- To develop vehicle system maintenance and service of clutch, brake.
- To study the concepts of vehicle safety and regulations.
- To study and understand the simulation of safety concepts.

UNIT I INTRODUCTION 9

Need for Maintenance – importance, classification of maintenance work-basic problem diagnosis. Maintenance of vehicle systems – power pack, tyres, safety systems. Scheduled maintenance services – service intervals – On-board diagnostics, Computerized engine analyzer study and practice- OBD and scan tools;

UNIT II POWER TRAIN MAINTENANCE 9

Exhaust emission test of petrol and diesel engine; - Electronic fuel injection and engine management service - fault diagnosis- OBD-III and scan tool, identifying DTC and servicing emission controls, Maintenance of Batteries, Starting System, Charging System and Body Electrical -Fault Diagnosis Using Scan Tools.

UNIT III VEHICLE SYSTEM MAINTENANCE 9

Clutch- adjustment and service, Maintenance and Service of Hydraulic brake, Bleeding of brakes, Checking ABS and components. Maintenance and Service of McPherson strut, coil spring. tyre wear, measurement of read depth and tyre rotation, Computerized wheel balancing & wheel alignment, Maintenance and Service of steering linkage, steering column, Rack and pinion steering

UNIT IV VEHICLE SAFETY 9

Concepts of vehicle safety -Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, air bags, electronic system for activating air bags, bumper design for safety, Active Safety - ABS, EBD, CSC, Traction control system, Modern electronic features in vehicles like tyre pressure monitoring, Automatic headlamp ON, Rain sensing wipers.

UNIT V SIMULATION OF SAFETY CONCEPTS 9

Active safety: driving safety, conditional safety, perceptibility safety, operating safety passive safety: exterior safety, interior safety, deformation behavior of vehicle body, speed and acceleration characteristics of passenger compartment on impact. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system Interactions.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. The students have the knowledge of vehicle health monitoring, maintenance and safety.
2. The students able to maintenance of powertrain.
3. The students can ability to maintenance of Vehicle system.
4. Explain and awareness of vehicle safety.
5. Explain the simulation of safety concepts.

TEXT BOOKS:

1. 5th Edition, "Advanced Automotive Fault Diagnosis Automotive Technology: Vehicle Maintenance and Repair" By Tom Denton
2. Safety Management System and Documentation Training Programme Handbook by S. V. Paul ISBN: 9788123923444

REFERENCE BOOKS:

1. Ed May, "Automotive Mechanics Volume One" and Two, Mc Graw Hill Publications, Tenth edition, 2018
2. Bosch Automotive Handbook, Tenth Edition, 2018
3. Jack Erjavek, "A systems approach to Automotive Technology", Cengage Learning, 5th Edition, 2012
4. William H. Crouse and Donald L. Anglin, "Automotive Mechanics", Tata McGraw Hill, 10th Edition, 2004.
5. Vehicle Service Manuals of Reputed Indian Manufacturers.

OBJECTIVES:

- To study the use of computer in mobility software or mobility.
- To study the concepts computer aided design and rapid prototyping
- To introduce the basic concepts of the finite elements methods.
- To introduce basics and fundamental of the computational fluid dynamics
- To introduce Turbulence Modelling and various simulation techniques.

UNIT I INTRODUCTION TO CAE /CFD**9**

Introduction to use of computer in Mobility Product Life Cycle, Software for mobility. Introduction to design process and role of computers in the design process, use of modern computational tools used for design and analysis, Concept of modelling and simulation. CFD as a design and research tool, Applications of CFD in mobility engineering

UNIT II CAD AND RAPID PROTOTYPING**9**

Curves and Surfaces: Geometric modelling curves and surfaces, Wire frame models, Parametric representations, Parametric curves and surfaces, Solid modelling: Fundamentals of solid modelling, Different solid representation schemes, Boundary representation (B-rep), Constructive solid geometry (CSG). Mechanism design and assembly. CAD/CAM Data Exchange Formats: Types of file formats & their exchange, Graphics standards. CAD Data and Programming Techniques for RP: Transformations, Solid modelling for RP, Surface modelling, STL file generation, Defects in STL files and repairing algorithms, Interface formats

UNIT III INTRODUCTION TO FEA**9**

Basic Concept of Finite Element Method, Ritz and Rayleigh Ritz methods, Method of weighed residuals, Galerkin method. Governing differential equations of one- and two dimensional problems, One Dimensional Second Order Equations – Discretization – Linear and Higher order Elements – Interpolation and shape functions, Derivation of Shape functions and Stiffness matrices and force vectors-Assembly of Matrices - Solution of static problems and case studies in stress analysis of mechanical components using 2D and 3D elements

UNIT IV INTRODUCTION TO CFD**9**

CFD vs. experimentation; continuity, navier-stokes and energy equations; modelling and discretization techniques; basic steps in CFD computation Various simplifications, Dimensionless equations and parameters, Incompressible inviscid flows, Source panel method, and Vortex panel method. Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. 3-D structured and unstructured grid generation, mesh smoothing and sensitivity checks.

UNIT V PROBLEM SOLVING USING CFD**9**

Turbulence Modelling, different turbulent modelling scheme. Incompressible Viscous Flows:, Applications to internal flows and boundary layer flows. Eddy viscosity and non-eddy viscosity models; Vehicle Aerodynamic Simulation Wind tunnel and on-road simulation of vehicles; Simulation of Ahmed and Windsor bodies; Vorticity based grid-free simulation technique; simulation in climatic and acoustic wind tunnels; velocity vector and pressure contour simulation

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the basic concept of the CAE /CFD
2. Develop the computer aided design and rapid prototyping.
3. Discuss the basic concept of Finite Element methods.
4. discuss the concepts of computational fluid dynamics
5. Solving the problem and simulation using computational fluid dynamics.

TEXT BOOKS:

1. Computational Fluid Dynamics: A Practical Approach by Jiyuan Tu, Guan Heng Yeoh, Chaoqun Liu
2. Applied Computational Fluid Dynamics by S. C. Gupta

REFERENCE BOOKS:

1. Ibrahim Zeid, "Mastering CAD CAM" Tata McGraw-Hill Publishing Co. 2007
2. Groover, M. P., CAD/CAM: Computer-Aided Design and Manufacturing, Pearson Education, 2008
3. Tirupathi R. Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
4. Dhanaraj R and Prabhakaran Nair K, "Finite Element Analysis", Oxford Publications, 2015.
5. Versteeg H.K., and Malalasekera W., "An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014
6. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill, 1998.

R21MEV107	HYBRID AND ELECTRIC VEHICLE TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concept of hybrid and electric drive trains.
- To elaborate on the types and utilisation of hybrid and electric drive trains.
- To expose on different types of AC and DC drives for electric vehicles.
- To learn and utilise different types of energy storage systems
- To introduce concept of energy management strategies and drive sizing.

UNIT I INTRODUCTION 9

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.

UNIT II HYBRID ELECTRIC DRIVE TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

UNIT III CONTROL OF AC & DC DRIVES 9

Introduction to electric components used in hybrid and electric vehicles, Configuration, and control - DC Motor drives, Induction Motor drives, Permanent Magnet Motor drive, and Switch Reluctance Motor drives, drive system efficiency.

UNIT IV ENERGY STORAGE 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Energy storage and its analysis - Battery based, Fuel Cell based, and Super Capacitor based, Hybridization of different energy storage devices.

UNIT V DRIVE SIZING AND ENERGY MANAGEMENT STRATEGIES 9

Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selection of appropriate energy storage technology, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification, and comparison of energy management strategies, Implementation issues.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss Characterise and configure hybrid drivetrains requirement for a vehicle
2. Design and apply appropriate hybrid and electric drive trains in a vehicle
3. Design and install suitable AC and DC drives for electric vehicles.
4. Discuss arrive at a suitable energy storage system for a hybrid / electric vehicle
5. Apply energy management strategies to ensure better economy and efficiency.

TEXT BOOKS:

1. Iqbal Husain, — Electric and Hybrid Vehicles: Design FundamentalsII, Third Edition, 2021
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

REFERENCE BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
3. Hybrid, Electric and Fuel-Cell Vehicles, International Edition by Jack Erjavec | 6 June 2012
4. Energy Management in Hybrid Electric Vehicles using Co-Simulation by Christian Paar | 11 February 2011
5. Hybrid Electric Vehicle Design and Control: Intelligent Omnidirectional Hybrids (MECHANICAL ENGINEERING) by Yangsheng Xu , Jingyu Yan, et al. | 16 December 2013.

TEXT BOOKS:

1. Ibrahim Dincer, Halil S. Hamut, and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", Wiley, 2017.
2. Jiuchun Jiang and Caiping Zhang, "Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles", Wiley, 2015.
3. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles-Fundamentals, Theory, and Design", CRC Press, 2005.
4. John G. Hayes and G. Abbas Goodarzi, "Electric Powertrain", Wiley, 2018
5. Davide Andrea, "Battery Management Systems for Large Lithium-Ion Battery Packs" ARTECH House, 2010.

REFERENCE BOOKS:

1. Nag.P.K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill Education, New Delhi, 2013.
2. "Vehicle thermal Management Systems Conference Proceedings", 1st Edition; 2013, Coventry Techno centre, UK
3. Younes Shabany, "Heat Transfer: Thermal Management of Electronics Hardcover" 2010, CRC Press.
4. T. Yomi Obidi, "Thermal Management in Automotive applications", 2015, SAE International.
5. Jerry Sergeant, Al Krum, "Thermal Management Handbook: For Electronic Assemblies Hardcover", 1998, McGraw Hill.

VERTICAL – 2: PRODUCT AND PROCESS DEVELOPMENT

S. No.	Course Code	Course Name	L	T	P	C	H
1.	R21MEV201	Value Engineering	3	0	0	3	45
2.	R21MEV202	Additive Manufacturing	3	0	0	3	45
3.	R21MEV203	CAD/CAM	3	0	0	3	45
4.	R21MEV204	Design For X	3	0	0	3	45
5.	R21MEV205	Ergonomics in Design	3	0	0	3	45
6.	R21MEV206	New Product Development	3	0	0	3	45
7.	R21MEV207	Precision Manufacturing	3	0	0	3	45
8.	R21MEV208	Production Planning and Control	3	0	0	3	45

OBJECTIVES:

- To study the value engineering process and able to identify its functions within the process.
- To determine the appropriate value engineering methodology for a given project and propose appropriate training to centralized and decentralized modes.
- To learn various decision-making processes and cost evaluation models and apply them in appropriately in the product development life-cycle.
- To explore in-depth understanding of various value engineering applications in human resources, manufacturing and marketing.
- To demonstrate to implement value engineering solutions and propose to perfect them.

UNIT I	VALUE ENGINEERING BASICS	9

Origin of value engineering - Meaning of value engineering - Definition of value engineering and Value analysis- Value Management - Value Analysis Versus Value Engineering - Value Analysis versus Traditional cost reduction techniques - Types of Value function – Basic and Secondary functions - concept of cost and worth - creativity In Value Engineering - uses, applications, advantages and limitations of Value analysis.

UNIT II	VALUE ENGINEERING JOB PLAN AND PROCESS	9

Seven phases of job plan - FAST Diagramming as Value Engineering Tool - Behavioral and organizational aspects of Value Engineering - Ten principles of Value analysis - Benefits of Value Engineering.

UNIT III	VALUE ENGINEERING TECHNIQUES	9

Creativity - Brain storming - Gordon technique - Morphological Analysis - ABC Analysis- Probabilistic approach - Make or Buy decisions – Function cost worth analysis (FCWA) - Function Analysis System technique (FAST) - Break Even Analysis - Life cycle cost(LCC)

UNIT IV	WORKSHEETS AND GUIDELINES	9

Preparation of worksheets - general and information phase - Function Classification, relationship and summary - Meaningful costs - Cost analysis - idea listing and comparison - Feasibility ranking - Investigator phase, study summary - guidelines for writing value engineering proposal - Financial aspects - List cycle cost analysis - Oral presentation - Audit - Case studies and Discussion.

UNIT V	VERSATILITY OF VALUE ENGINEERING	9

Value engineering operation in maintenance and repair activities - value engineering in non hardware projects - Initiating a value engineering programme Introduction - training plan - career development for value engineering specialties.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Estimate a product cost based on value engineering principles in terms of its values, functions and worthiness.
2. Discuss the product and articulate it in various phases of value engineering
3. Discuss and select appropriate methods, standards and apply them on value engineering project and propose appropriate training
4. Apply querying theory and FAST to perfect a value engineering project implementation.
5. Develop various case studies related to value engineering project implementation.

TEXT BOOKS:

1. Iyer. S.S., “Value Engineering”, New Age International (P) Limited, 9th Edition, 2009.
2. Anil Kumar. and Mukhopadhyaya., “Value Engineering: Concepts Techniques and applications”, SAGE Publications, 1st Edition, 2003.

REFERENCE BOOKS:

1. Del L. Younker., “Value Engineering: analysis and methodology”, CRC Press, 2003.
2. Richard Park., “Value Engineering A Plan for Invention”, CRC Press, 1998.
3. Arthur E. Mudge., “Value Engineering: A systematic approach", McGraw Hill, 1989.
4. Alphonse Dell'Isola., “Value Engineering: Practical Applications...for Design, Construction, Maintenance and Operations”, R.S. Means Company, 1997.
5. Lawrence D. Miles., “Techniques of Value Analysis and Engineering”, Lawrence D. Miles Value Foundation, 3rd Edition, 2015.

OBJECTIVES:

- To introduce the development of Additive Manufacturing (AM), various business opportunities and applications
- To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
- To be acquainted with vat polymerization and direct energy deposition processes
- To be familiar with powder bed fusion and material extrusion processes.
- To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes.

UNIT I INTRODUCTION**9**

Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping- Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing- Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING (DfAM)**9**

Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization- Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.

UNIT III VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSITION**9**

Photo polymerization: Stereolithography Apparatus (SLA)- Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS)- Process - Material Delivery - Materials -Benefits - Applications.

UNIT IV POWDER BED FUSION AND MATERIAL EXTRUSION**9**

Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials -Applications and Limitations.

UNIT V OTHER ADDITIVE MANUFACTURING PROCESSES**9**

Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the evolution, process, classifications, applications, and benefits of Additive Manufacturing in industries like automobile, aerospace, and healthcare.
2. Apply Additive Manufacturing technologies to identify suitable applications considering safety and societal impact.
3. Apply design principles like topology optimization and lattice structures for optimized additive manufacturing models, ensuring quality, sustainability, and ethics.
4. Apply VAT polymerization techniques, SLA and DLP to develop prototypes, ensuring efficient resource management with advancements in technology.
5. Analyze the selection of powder bed fusion or material extrusion techniques based on material properties and application needs.
6. Analyze the use of Binder Jetting, Material Jetting, and Sheet Lamination for part fabrication, considering material, benefits, and limitations.

TEXT BOOKS:

1. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani “Additive manufacturing technologies”. 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0
2. Andreas Gebhardt and Jan-Steffen Hötter “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.

REFERENCE BOOKS:

1. Andreas Gebhardt, “Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing”, Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN: 9783446425521.
2. Milan Brandt, “Laser Additive Manufacturing: Materials, Design, Technologies and Applications”, Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3. Amit Bandyopadhyay and Susmita Bose, “Additive Manufacturing”, 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4. Kamrani A.K. and Nasr E.A., “Rapid Prototyping: Theory and practice”, Springer., United States ,2006, ISBN: 978-1-4614-9842-1.
5. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press., United States, 2011, ISBN: 9780849334092.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2					2	2	2							2
CO 2	3					3						2			3
CO 3	3	2					3	3				2			3
CO 4	3	2			3						3	3			3
CO 5	3	3										3	3		3
CO 6	3	3										3	3		3
R21MEV202	3	3			3	3	3	3			3	3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To Introduce and understand the Basic of Design.
- To study the two dimensional drafting and bill of material creation.
- To learn three dimensional modelling and its advantages.
- To study the basic and purpose of assembling modeling.
- To study the basics of computer aided machining and part programming.

UNIT I BASICS OF DESIGNS**9**

Understanding of Projections, Scales, units, GD & T; its 14 symbols, Special characteristics & Title Block readings. Revision / ECN status of drawings – Customer Specific requirements – Drawing Grid reading

UNIT II 2D DRAFTING**9**

Projection views – Orthographic view, Axillary view, Full & Half Section views, Broken Section view, Offset Section view – Title Block creation – BOM Creation – Notes creation – Ballooning of 2D drawing and its features for Inspection reporting

UNIT III 3D MODELING**9**

Conversion of Views – 2D to 3D, 3D to 2D – Parametric and Non-Parametric Modeling – Tree features of 3D Modeling and its advantages – Surface Modeling – BIW (Body In White) – Solid Modeling, Boolean operations like Unites, Subtraction, Intersect, etc.

UNIT IV ASSEMBLY MODELING**9**

Basics of Assembly modeling, Purpose of Assembly modeling & its advantages – Top to Down and Bottom Up modeling approaches – Analysis of Clearances – Undercuts – Interferences – Stack up analysis – Cumulative effect of Tolerances in after assembly conditions.- motion analysis

UNIT V CAM**9**

Basics of CNC Machining – 3, 4 & 5 Axis machines - CNC and Part Programing, CAM programing 2D & 3D. Elements of CAM Orientation, Boundary Creation, Cutter Path Selection, Cutter Compensation – Machining Stocks, Roughing, Re-roughing, Semi Finishing & Finishing - Tool Path Generation, Isl and Milling Programing. Machining program simulation, integration of program with machine; Estimation of CNC Cycle time. – Post Process NC Code conversion and Setup Sheet Preparation.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Discuss the basics of the design and concepts.
2. Develop the two dimensional drafting and projection views.
3. Discuss the three dimensional modeling, parametric and Non-parametric modeling
4. Discuss the assembly modeling and top down, bottom up approaches.
5. Develop the computer aided machining and writing part programming.

TEXT BOOKS:

1. Computer Aided Design Manufacturing - Jacob Moses & Ruchi Agarwal
2. CAD / CAM Principles Application - J. Srinivas

REFERENCE BOOKS:

1. CAD / CAM - Ibrahim Zaid (Text & Reference Book)
2. CAD / CAM – Chandandeep Grewal
3. CAD CAM Automation - FarazdakHaideri (Text & Reference Book)
4. Computer Aided Design Manufacturing – Anup Goel
5. CAD / CAM – PN Rao

OBJECTIVES:

- To introduce the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- To learn the design consideration principles of forming in the design of extruded, stamped, and forged products
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.
- To learn design consideration principles in additive manufacturing.

UNIT I	INTRODUCTION	9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric Tolerances - Assembly limits -Datum features - Tolerance stacks. Design to minimize material usage – Design for disassembly – Design for recyclability – Design for manufacture – Design for energy efficiency – Design to regulations and standards.

UNIT II	FACTORS INFLUENCING FORM DESIGN	9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice –Influence of materials on form design - form design of welded members, forgings and castings.

UNIT III	COMPONENT DESIGN - MACHINING CONSIDERATION	9

Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability – Design for accessibility - Design for assembly – Product design for manual assembly - Product design for automatic assembly – Robotic assembly.

UNIT IV	COMPONENT DESIGN – CASTING CONSIDERATION	9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V	DESIGN FOR ADDITIVE MANUFACTURING	9

Introduction to AM, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Elaborate the design principles for manufacturability
2. discuss the factors influencing in form design
3. Apply the component design features of various machine.
4. Discuss the design consideration principles of welding in the design of welded products.
5. Discuss the design consideration principles of additive manufacturing.

TEXT BOOKS:

1. James G. Bralla, "Design for Manufacturability Handbook", McGraw Hill Professional, 1998.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

REFERENCE BOOKS:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5. Boothroyd, G, Hartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994

OBJECTIVES:

- To introduce to industrial design based on ergonomics.
- To consider ergonomics concept in manufacturing
- To apply ergonomics in design of controls and display.
- To apply environmental factors in ergonomics design.
- To develop aesthetics applicable to manufacturing and product.

UNIT I INTRODUCTION**9**

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT II ERGONOMICS AND PRODUCTION**9**

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS**9**

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT IV ENVIRONMENTAL FACTORS**9**

Colour: Colour and light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsell colour notation, reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT V AESTHETIC CONCEPTS**9**

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout software's, total layout design.

Total = 45 Periods**COURSE OUTCOMES****After successful completion of this course the students will be able to:**

1. Appreciate ergonomics need in the industrial design.
2. Apply ergonomics in creation of manufacturing system
3. Discuss on design of controls and display.
4. Consider environmental factors in ergonomics design.
5. Report on importance of aesthetics to manufacturing system and product.

TEXT BOOKS:

1. Ergonomics in Design: Methods and Techniques (Human Factors and Ergonomics) by Marcelo M. Soares , Francisco Rebelo
2. Ergonomics in Product Design by Sendpoints Publishing Co. Ltd.

REFERENCE BOOKS:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7th Edition, 2002
2. Brain Shakel,“Applied Ergonomics Hand Book”, Butterworth Scientific London 1988.
3. Bridger, R.C., Introduction to Ergonomics, 2nd Edition, 2003, McGraw Hill Publications.
4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
5. Mayall W.H. “Industrial design for Engineers”, London Hiffee books Ltd., 1988.

OBJECTIVES:

- To introduce the fundamental concepts of the new product development
- To develop material specifications, analysis and process.
- To Learn the Feasibility Studies & reporting of new product development.
- To study the New product qualification and Market Survey on similar products of new product development
- To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model.

UNIT I FUNDAMENTALS OF NPD**9**

Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics.

UNIT II MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS**9**

Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis,), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Metal and Material Flow, Fill and Solidification analysis.

UNIT III ESSENTIALS OF NPD**9**

RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, , Machining –Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials.

UNIT IV CRITERIONS OF NPD**9**

New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson Learned & Horizontal deployment in NPD

UNIT V REPORTING & FORWARD-THINKING OF NPD**9**

Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost).

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss fundamental concepts and customer specific requirements of the New Product development (Understand)
2. Discuss the Material specification standards, analysis and fabrication, manufacturing process. (Understand)
3. Apply feasibility studies and report on new product development, considering safety, societal impact, and regulatory compliance (Apply)
4. Apply the role of multiple functions in creating a new product, focusing on resource management and financial planning. (Apply)
5. Analyze new product qualification and market surveys on similar products, focusing on resource management and finances (Analyze)
6. Analyze reverse engineering, cloud point generation, and converting data to 3D models, focusing on efficiency and sustainability (Analyze).

TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger.

REFERENCE BOOKS:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Change by Design
3. Toyota Product Development System – James Morgan & Jeffrey K. Liker
4. Winning at New Products – Robert Brands 3rd Edition
5. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2							2			2	2			2
CO 2	2							2			2	2			2
CO 3	3					3		2				2			3
CO 4	3	2			2						3	2			3
CO 5	3	3					3	3	3	3	3	3	3		3
CO 6	3	3			2		3	3	3	3		3	3		3
R21MEV206	3	3			2	3	3	3	3	3	3	3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

OBJECTIVES:

- To study the need, significance and progress of precision manufacturing and the different levels of manufacturing.
- To study the principle and working of different methods of precision machining.
- To study the special construction requirements of precision machine tools.
- To study the errors involved in precision machine tools and calculate the error budgets for a given situation.
- To study the Selecting a suitable measurement solution to measure and characterize precision machined features.

UNIT I	PRECISION ENGINEERING	9

Introduction to Precision Engineering, Need for precision manufacturing, Taniguchi diagram, Four Classes of Achievable Machining Accuracy – Normal, Precision, High-precision, Ultra-precision Processes and Nanotechnology.

UNIT II	PRECISION MACHINING	9

Overview of Micro- and Nano-machining, Conventional micro machining techniques - micro-turning, micro-milling, micro-grinding, Ultra-precision diamond turning, Non-conventional micromachining techniques – abrasive jet and water jet micromachining, Ultrasonic micromachining, micro electrical discharge machining, photochemical machining, electro chemical micromachining, laser beam micromachining, Electron beam micromachining, Focused Ion Beam micromachining, etc.

UNIT III	MACHINE DESIGN FOR PRECISION MANUFACTURING	9

Philosophy of precision machine design, Ultra-Precision Machine Elements: Guide- ways, Drive Systems, Friction Drive, Linear Motor Drive, Spindle Drive. Bearings: Principle, construction and application of Rolling, Hydrodynamic and Hydrostatic Bearings, Aerostatic Bearings, Magnetic bearings.

UNIT IV	MECHANICAL AND THERMAL ERRORS	9

Sources of error, Principles of measurement, Errors due to machine elements, bearings, spindles, Kinematic design, Structural compliance. Vibration, Thermal errors – background, thermal effects, Environmental control of precision machinery. Error mapping and error budgets.

UNIT V	MEASUREMENT AND CHARACTERISATION	9

Optical dimensional metrology of precision features – Machine vision, Multi-sensor coordinate metrology, Laser Tracking Systems, Laser scanners, White-Light Interference 3D Microscopes, Focus-Based Optical Metrology- Fringe projection method, Measurement of Typical Nano features. Surface metrology - 3D surface topography - Need, Measurement – Chromatic confocal Microscopy, Interferometry, Non-optical Scanning Microscopy – Scanning electron Microscopes, Scanning probe microscopes, Parameters for characterizing 3D surface topography.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the need, significance and progress of precision manufacturing and the different levels of manufacturing.
2. Explain the principle and working of different methods of precision machining.
3. Explain the special construction requirements of precision machine tools.
4. Explain the errors involved in precision machine tools and calculate the error budgets for a given situation.
5. Select a suitable measurement solution to measure and characterize precision machined features.

TEXT BOOKS:

1. Jain, V.K., Introduction to micromachining, Narosa publishers, 2018
2. Venkatesh V.C., SudinIzman, Precision Engineering, Tata Mc.Graw Hill Publishing Company, New Delhi 2007.

REFERENCE BOOKS:

1. David Dornfeld, Dae-Eun Lee, Precision Manufacturing, Springer, 2008.
2. Jain, V.K., Micro manufacturing Processes, CRC Press, 2012.
3. Joseph McGeough, Micromachining of Engineered Materials, Marcel Dekker Inc., 2002.
4. Kevin Harding, "Handbook of Optical Dimensional Metrology, Series: Series in Optics and optoelectronics", Taylor & Francis, 2013.
5. Murty, R.L., Precision Engineering in Manufacturing, New Age publishers, 2005.

R21MEV208	PRODUCTION PLANNING AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explain the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory control.
- To impart knowledge on the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP).

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 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.

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-Production Forecasting and anticipated production-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. Integrated production planning and control: A multi-objective optimization model.

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 - Project management in inventory and production planning.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, and Inventory control in an engineering Industry.(Understand)
2. Apply the concepts of production planning and control in complex problems. (Apply)
3. Apply the Manufacturing knowledge and utilization of computers to control the production in shop floor. (Apply)
4. Choose the recent trends like Manufacturing Requirement Planning (MRP II) and Enterprise Resource Planning (ERP), Profit consideration, Economics of a new design to enhance productivity. (Apply)
5. Utilize the knowledge of Production Engineering to the contemporary topics relevant to business of all functional disciplines and inventory control. (Apply)
6. Examine various problems with production planning control to identify the optimal work schedule. (Analyze)

TEXT BOOKS:

1. Mart and Telsang, “Industrial Engineering and Production Management”, S. Chand and Company, 1st edition, 2000.
2. James B. Dilworth, “Operations management – Design, Planning and Control for manufacturing and services”, McGraw Hill International edition, 1992.

REFERENCE BOOKS:

1. Samson Eilon, “Elements of production planning and control”, Universal Book Corpn, 1984.
2. Elwood S. Buffa, Rakesh K. Sarin, “Modern Production / Operations Management”, Ed. John Wiley and Sons 8th Edition, 2000.
3. KanishkaBedi, “Production and Operations management”, Oxford university press, 2nd Edition, 2007.
4. Melynk, Denzler, “Operations management – A value driven approach”, Irwin Mcgrawhill.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2											2			2
CO 2	3	2										3	3		3
CO 3	3				2								3		3
CO 4	3	2			3						3		3		3
CO 5	3	3							3	3			3		3
CO 6	3	3	2		3				3	3	3		3		3
R21MEV208	3	3	2		3				3	3	3	3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

VERTICAL – 3: ROBOTICS AND AUTOMATION

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV301	Sensors and Instrumentation	3	0	0	3
2.	R21MEV302	Electrical Drives and Actuators	3	0	0	3
3.	R21MEV303	Augmented based application and programming methods for robotics	3	0	0	3
4.	R21MEV304	Smart Mobility and Intelligent Vehicles	3	0	0	3
5.	R21MEV305	AI & Expert systems	3	0	0	3
6.	R21MEV306	AI& Drone Technologies	3	0	0	3
7.	R21MEV307	Industry 4.0	3	0	0	3

OBJECTIVES:

- To understand the concepts of measurement technology.
- To learn the various sensors used to measure various physical parameters.
- To learn the fundamentals of signal conditioning, data acquisition and communication systems used in mechatronics system development
- To learn about the optical, pressure and temperature sensor
- To understand the signal conditioning and DAQ systems.

UNIT I INTRODUCTION**9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS**9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS**9**

Strain Gage, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS**9**

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS**9**

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi-channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Recognize with various calibration techniques and signal types for sensors.
2. Describe the working principle and characteristics of force, magnetic, heading, pressure and temperature, smart and other sensors and transducers.
3. Apply the various sensors and transducers in various applications
4. Select the appropriate sensor for different applications.
5. Acquire the signals from different sensors using Data acquisition systems.

TEXT BOOKS:

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009.
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", Dhanpat Rai & Co, 12th edition New Delhi, 2013.

REFERENCE BOOKS:

1. C Sujatha Dyer, S.A., Survey of Instrumentation and Measurement, John Wiley & Sons, Canada, 2001.
2. Hans Kurt Tönshoff (Editor), Ichiro, "Sensors in Manufacturing" Volume 1, Wiley-VCH April 2001.
3. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
4. Patranabis D, "Sensors and Transducers", 2nd Edition, PHI, New Delhi, 2011.
5. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

OBJECTIVES:

- To familiarize a relay and power semiconductor devices
- To get a knowledge on drive characteristics
- To obtain the knowledge on DC motors and drives.
- To obtain the knowledge on AC motors and drives.
- To obtain the knowledge on Stepper and Servo motor.

UNIT I	RELAY AND POWER SEMI-CONDUCTOR DEVICES	9

Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

UNIT II	DRIVE CHARACTERISTICS	9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor.

UNIT III	DC MOTORS AND DRIVES	9

DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications

UNIT IV	AC MOTORS AND DRIVES	9

Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

UNIT V	STEPPER AND SERVO MOTOR	9

Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation- Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Recognize the principles and working of relays, drives and motors.
2. Explain the working and characteristics of various drives and motors.
3. Apply the solid state switching circuits to operate various types of Motors and Drivers.
4. Interpret the performance of Motors and Drives.
5. Suggest the Motors and Drivers for given applications.

TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S Chand & Co. Ltd., New Delhi, 2016.

REFERENCE BOOKS:

1. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosal Publishing House, New Delhi, 2001.
2. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S Chand & Co. Ltd., New Delhi, 2012.

R21MEV303	AUGMENTED BASED APPLICATION AND PROGRAMMING METHODS FOR ROBOTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To familiarize the architecture and fundamental units of microcontroller.
- To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
- To design the interface circuit and programming of I/O devices, sensors and actuators.
- To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
- To acquaint the knowledge of real time embedded operating system for advanced system developments.

UNIT I INTRODUCTION TO MICROCONTROLLER 9

Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

UNIT II PROGRAMMING AND COMMUNICATION 9

Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

UNIT III PERIPHERAL INTERFACING 9

I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

UNIT IV ARM PROCESSOR 9

Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

UNIT V SINGLE BOARD COMPUTERS AND PROGRAMMING 9

System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages – Python for Embedded Systems- GPIO Programming – Interfacing.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.
2. Recognize the role of each functional units in microcontroller, processors and system- on-chip based on the features and specifications.
3. Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing
4. Design the circuit and write the programming microcontroller, processors and system on chip
5. Develop the applications using Embedded system.

TEXT BOOKS:

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

REFERENCE BOOKS:

1. Muhammad Ali Mazidi and Janice Gillispie Mazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition, 2015
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005

R21MEV304	SMART MOBILITY AND INTELLIGENT VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce students to the various technologies and systems used to implement smart mobility and intelligent vehicles.
- To learn Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, LIDAR Sensor Technology and Systems and other sensors for automobile vision system.
- To learn Basic Control System Theory applied to Autonomous Automobiles.
- To produce overall impact of automating like various driving functions, connecting the automobile to sources of information that assist with a task
- To allow the automobile to make autonomous intelligent decisions concerning future actions of the vehicle that potentially impact the safety of the occupants through connected car & autonomous vehicle technology.

UNIT I INTRODUCTION TO AUTOMATED, CONNECTED, AND INTELLIGENT VEHICLES 9

Concept of Automotive Electronics, Electronics Overview, History & Evolution, Infotainment, Body, Chassis, and Powertrain Electronics, Introduction to Automated, Connected, and Intelligent Vehicles. Case studies: Automated, Connected, and Intelligent Vehicles.

UNIT II SENSOR TECHNOLOGY FOR SMART MOBILITY 9

Basics of Radar Technology and Systems, Ultrasonic Sonar Systems, Lidar Sensor Technology and Systems, Camera Technology, Night Vision Technology, Other Sensors, Use of Sensor Data Fusion, Integration of Sensor Data to On-Board Control Systems

UNIT III CONNECTED AUTONOMOUS VEHICLE 9

Basic Control System Theory applied to Automobiles, Overview of the Operation of ECUs, Basic Cyber-Physical System Theory and Autonomous Vehicles, Role of Surroundings Sensing Systems and Autonomy, Role of Wireless Data Networks and Autonomy

UNIT IV VEHICLE WIRELESS TECHNOLOGY & NETWORKING 9

Wireless System Block Diagram and Overview of Components, Transmission Systems – Modulation/Encoding, Receiver System Concepts– Demodulation/Decoding, Wireless Networking and Applications to Vehicle Autonomy, Basics of Computer Networking – the Internet of Things, Wireless Networking Fundamentals, Integration of Wireless Networking and On-Board Vehicle

UNIT V CONNECTED CAR & AUTONOMOUS VEHICLE TECHNOLOGY 9

Connectivity Fundamentals, Navigation and Other Applications, Vehicle-to-Vehicle Technology and Applications, Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications, Autonomous Vehicles - Driverless Car Technology, Moral, Legal, Roadblock Issues, Technical Issues, Security Issues.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Recognize the concept of cyber-physical control systems and their application to collision avoidance and autonomous vehicles
2. Select the concept of remote sensing and the types of sensor technology needed to implement remote sensing
3. Familiar with the concept of fully autonomous vehicles
4. Apply the basic concepts of wireless communications and wireless data networks
5. Analyze the concept of the connected vehicle and its role in automated vehicles.

TEXT BOOKS:

1. "Intelligent Transportation Systems and Connected and Automated Vehicles", 2016, Transportation Research Board.
2. Radovan Miucic, "Connected Vehicles: Intelligent Transportation Systems", 2019, Springer.

REFERENCE BOOKS:

1. Tom Denton, "Automobile Electrical and Electronic systems, Routledge", Taylor & Francis Group, 5th Edition, 2018.

OBJECTIVES:

- To understand Basic Concepts of Artificial Intelligence and Expert Systems.
- To provide knowledge on Various Techniques and Tools involved in Artificial Intelligence.

UNIT I	INTRODUCTION	9

Introduction: History, Definition of AI, Emulation of human cognitive process, knowledge search trade off, stored knowledge, semantic nets. An abstract view of modelling, elementary knowledge. Computational logic, analysis of compound statements using simple logic connectives, predicate logic, knowledge organization and manipulation, knowledge acquisition

UNIT II	PROGRAMMING AND LOGICS IN ARTIFICIAL INTELLIGENCE	9

LISP and other programming languages- introduction to LISP, syntax and numerical function, LISP and PROLOG distinction, input output and local variables, Interaction and recursion, property list and arrays alternative languages, formalized symbolic logics- properties of WFRS, non-deductive inference methods.

UNIT III	SEARCH METHODS	9

Structure knowledge: Graph, frames and related structures, Object oriented representation- object classes, message and methods, simulation examples using OOPS programs, OOP languages. Search and control strategies - Concepts, search problems, uniformed or Blined search, searching AND – OR graphs

UNIT IV	KNOWLEDGE ORGANISATION AND COMMUNICATION IN EXPERT SYSTEMS	9

Knowledge organization- Indexing and retrieval techniques, integration of knowledge in Smemory organization systems, Perception, communication and Expert systems. Overview of Linguistics, Basic passim techniques, semantic analysis and representation structures, natural language generation and system

UNIT V	PATTERN RECOGNITION AND LEARNING TECHNIQUES	9

Pattern recognition system- understanding speech recognition, Image transformation, low level processing, medium and high level processing, vision system architecture, Rule based system architecture, knowledge acquisition and validation, knowledge system building tools, use of AI and ES in manufacturing and design, types of learning- general learning model, performance measures, learning automate genetic algorithm, learning by induction - LEX, ID3, INDUCE systems

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the Basics about Artificial Intelligence and Expert Systems. (Understand)
2. Apply AI programming logic to build intelligent systems that can simulate human decision-making processes. (Apply)
3. Choose appropriate search algorithms to efficiently solve structured and unstructured AI problems. (Apply)
4. Develop simple expert systems using knowledge representation techniques and inference mechanisms. (Apply)
5. Identify suitable image processing techniques for tasks such as object detection, segmentation, and pattern recognition. (Apply)
6. Select relevant AI tools and knowledge systems to design practical solutions for real-world applications in domains such as healthcare, robotics, or business analytics. (Apply)

TEXT / REFERENCE BOOKS:

1. Russel (Stuart), 'Artificial Intelligence- Modern approach, Pearson Education series in AI', 3rd Edition, 2009.
2. Dan W Patterson, 'Introduction to Artificial intelligence and Expert systems', Prentice Hall of India Pvt. Ltd, 2001
3. Eugene Charniak, Drew Mc Dermot, 'Introduction to Artificial intelligence', Addison Wesley Longman Inc., 2009
4. George. F, William. A. Stubblefield, 'Artificial intelligence and the design of expert systems', The Benjamin Cummins Publishing Co., Inc 2nd Edition, 1992.
5. Robert J Schalkoff, 'Artificial intelligence An Engineering Approach', McGraw Hill International Edition, 1990.

OBJECTIVES:

- To understand the basics of drone concepts
- To learn and understand the fundamentals of design, fabrication and programming of drone
- To impart the knowledge of an flying and operation of drone
- To know about the various applications of drone
- To understand the safety risks and guidelines of fly safely.

UNIT I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability.

UNIT II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy- Drones configurations -The methods of programming drone- Download program - Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection.

UNIT III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment- Drone controls Flight operations –management tool –Sensors-Onboard storage capacity - Removable storage devices- Linked mobile devices and applications

UNIT IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT V FUTURE DRONES AND SAFETY 9

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Know about a various type of drone technology, drone fabrication and programming.
2. Execute the suitable operating procedures for functioning a drone
3. Select appropriate sensors and actuators for Drones
4. Develop a drone mechanism for specific applications
5. Create the programs for various drones.

TEXT BOOKS:

1. Daniel Tal and John Altschuld, "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation", 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, "Make:Getting Started with Drones ",Maker Media, Inc, 2016.

REFERENCE BOOKS:

1. John Baichtal, "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs", Que Publishing, 2016.
2. Završnik, "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance", Springer, 2018.

OBJECTIVES:

- To introduce and familiarize the industry 4.0 and its physical structure and inter-connectivity.
- To understand the lean production systems
- To outline the industrial internet of things
- To familiar the concepts of Additive manufacturing.
- To learn the Robotics concepts.

UNIT I INTRODUCTION TO INDUSTRY 4.0**9**

The Various Industrial Revolutions - Main Concepts and Components of Industry 4.0- Drivers, Enablers of industry 4.0 - Supportive Technologies- Comparison of Industry 4.0 Factory and Today's Factory - Internet of Things and Industrial Internet of Things - Machine-to-Machine (M2M) communications and its requirements- Benefits and Challenges of Industry 4.0.

UNIT II PRECISION MACHINING**9**

Lean Production Systems-Levels of Lean Automation-Lean tools and Industry 4.0 technologies ladder-Automation Based Lean Production Applications

OPPORTUNITIES AND CHALLENGES

Future of Works and Skills for Workers in the Industry 4.0 Era - Strategies for competing in an Industry 4.0 world

UNIT III INTRODUCTION TO THE INDUSTRIAL INTERNET**9**

Industrial Internet - The Power of 1% - Key IIoT Technologies - Need of industrial internet-Catalysts and Precursors of the IIoT- Key Opportunities and Benefits Industrial Internet Use – Cases, Healthcare, Oil and Gas Industry, Logistics and the Industrial Internet and Retail.

UNIT IV ADDITIVE MANUFACTURING**9**

Introduction to Additive Manufacturing (AM) systems- Classification of AM process – Generic AM process - Stereo-lithography Apparatus (SLA)- Introduction to Selective Laser Sintering (SLS)- Fused deposition modeling- Laminated object manufacturing- Advantages, Disadvantages. Three dimensional Printing (3DP) - Solid Liquid based and powder based 3DP systems - Applications and case studies- Ballistic Particle Manufacturing (BPM)-Introduction to 4D printing technology.

UNIT V ADVANCES IN ROBOTICS**9**

Recent Technological Components of Robots-Advanced Sensor Technologies-Artificial Intelligence- Internet of Robotic Things-Cloud Robotics-Cognitive Architecture for Cyber-Physical Robotics- Industrial Robotic Applications-Manufacturing, Human-Robot Collaborative Manufacturing, Cooperating Robots in Manufacturing, Maintenance and assembly.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Outline the need of industry 4.0, IOT, IIOT and its inter-connectivity. (Understand)
2. Illustrate the concepts of Lean Production Systems, additive manufacturing and robotics (Understand)
3. Apply the concepts of additive manufacturing and robotics in various manufacturing sectors. (Apply)
4. Analyze the Opportunities and Challenges in industry 4.0. (Analyze)
5. Plan the uses of IOT, IIOT and Industry 4.0 technologies (Apply)
6. Design of smart vehicle, smart industries and smart home using IOT and analyze its performance (Analyze).

REFERENCES:

1. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things, A Press, 2016.
2. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
3. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
4. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
5. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
6. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018
7. Kiran Kumar Pabbathi, "Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0", Createspace Independent Publishing Platform, 2018.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2											3			3
CO 2	2											3			3
CO 3	3				3							3			3
CO 4	3	3			3					3		3	3		3
CO 5	3				3					3					3
CO 6	3	3	3						3	3		3	3		3
R21MEV307	3	3	3		3				3	3		3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

VERTICAL – 4: DIGITAL AND GREEN MANUFACTURING

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV401	Digital Manufacturing and IoT	3	0	0	3
2.	R21MEV402	Industrial Design & Rapid Prototyping Techniques	3	0	0	3
3.	R21MEV403	Industrial Robotics	3	0	0	3
4.	R21MEV404	Green Manufacturing Design and Practices	3	0	0	3
5.	R21MEV405	Environment Sustainability and Impact Assessment	3	0	0	3
6.	R21MEV406	Energy Management	3	0	0	3
7.	R21MEV407	Supply Chain Management	3	0	0	3

R21MEV401	DIGITAL MANUFACTURING AND IoT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the various aspects of digital manufacturing.
- To inculcate the importance of DM in Product Lifecycle Management and Supply chain Management.
- To formulate of smart manufacturing systems in the digital work environment.
- To interpret IoT to support the digital manufacturing.
- To elaborate the significance of digital twin.

UNIT I INTRODUCTION 9

Introduction – Need – Overview of Digital Manufacturing and the Past – Aspects of Digital Manufacturing: Product life cycle, Smart factory, and value chain management – Practical Benefits of Digital Manufacturing – The Future of Digital Manufacturing.

UNIT II DIGITAL LIFE CYCLE & SUPPLY CHAIN MANAGEMENT 9

Collaborative Product Development, Mapping Requirements to specifications – Part Numbering, Engineering Vaulting, and Product reuse – Engineering Change Management, Bill of Material and Process Consistency – Digital Mock up and Prototype development – Virtual testing and collateral. Overview of Digital Supply Chain - Scope& Challenges in Digital SC - Effective Digital Transformation - Future Practices in SCM

UNIT III SMART FACTORY 9

Smart Factory – Levels of Smart Factories – Benefits – Technologies used in Smart Factory – Smart Factory in IoT- Key Principles of a Smart Factory – Creating a Smart Factory – Smart Factories and Cybersecurity

UNIT IV INDUSTRY 4.0 9

Introduction – Industry 4.0 –Internet of Things – Industrial Internet of Things – Framework: Connectivity devices and services – Intelligent networks of manufacturing – Cloud computing – Data analytics –Cyber physical systems –Machine to Machine communication – Case Studies.

UNIT V STUDY OF DIGITAL TWIN 9

Basic Concepts – Features and Implementation – Digital Twin: Digital Thread and Digital Shadow-Building Blocks – Types – Characteristics of a Good Digital Twin Platform – Benefits, Impact & Challenges – Future of Digital Twins.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Impart knowledge to use various elements in the digital manufacturing.
2. Differentiate the concepts involved in digital product development life cycle process and supply chain management in digital environment.
3. Select the proper procedure of validating practical work through digital validation in Factories.
4. Implementation the concepts of IoT and its role in digital manufacturing.
5. Analyze and optimize various practical manufacturing process through digital twin.

TEXT BOOKS:

1. Zude Zhou, Shane (Shengquan) Xie and Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", A Press, 2016.

REFERENCE BOOKS:

1. Lihui Wang and Andrew YehChing Nee, Collaborative Design and Planning for Digital Manufacturing, Springer-Verlag London Limited, 2009.
2. Andrew Yeh Chris Nee, Fei Tao, and Meng Zhang, "Digital Twin Driven Smart Manufacturing", Elsevier Science., United States, 2019.
3. Alp Ustundag and Emre Cevikcan, "Industry 4.0: Managing The Digital Transformation", Springer Series in Advanced Manufacturing., Switzerland, 2017
4. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.
5. Ronald R. Yager and Jordan Pascual Espada, "New Advances in the Internet of Things", Springer., Switzerland, 2018.

1. <https://www.adobe.com/products/xd/learn/get-started.html>.
2. <https://developer.android.com/guide>.
3. <https://help.autodesk.com/view/fusion360/ENU/courses/>.
4. <https://help.prusa3d.com/en/category/prusaslicer> 204.

OBJECTIVES:

- To introduce definition, history of robotics and robot anatomy.
- To learn the simulation of robot kinematics
- To study the grasping and manipulation of robots.
- To study about mobile robot and manipulation.
- To study the applications of industrial, service, domestic robots.

UNIT I INTRODUCTION**9**

Robot: Definition, History of Robotics, Robot Anatomy, Co-ordinate systems, types and classification, Configuration space and degrees of freedom ; task space and workspace, Homogeneous transformation matrices. ,Need for Robots . Robot drive systems:, D.C. Servo Motors, Stepper Motor, A.C. Servo Motors, Design Considerations, Automation, Types & Levels of Automations, Need of automation.

UNIT II SIMULATION OF ROBOT KINEMATICS AND ROBOT SENSORS**9**

Robot kinematics, Forward and inverse kinematics (two three four degrees of freedom, Denavit and Hartenberg (D-H) transformation, , feedback control system- Point to point control, Continuous path control, open and closed loop control Sensors - Tactile sensor – Proximity and range sensors – Sensing joint forces Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing -Image segmentation – Pattern recognition – Training of vision system.

UNIT III GRASPING AND MANIPULATION OF ROBOTS AND DRIVE SYSTEMS**9**

Kinematics of contact, contact types (rolling, sliding, and breaking), graphical methods for representing kinematic constraints in the plane, and form-closure grasping, End effectors, grippers, types of gripper, Guidelines for design for robotic gripper, gripper force analysis, and examples of manipulation and grasping. Drive systems - Pneumatic Drives , Hydraulic Drives Mechanical Drives, Electrical Drives, Linear and rotary actuators and control valves.

UNIT IV MOBILE ROBOTS**9**

Mobile robot, Wheeled Mobile Robots: Kinematic models of omnidirectional and non-holonomic wheeled mobile robots, Controllability, motion planning, feedback control of non-holonomic wheeled mobile robots; odometry for wheeled mobile robots; and mobile manipulation. Reference Trajectory generation, feed forward control.

UNIT V APPLICATIONS OF ROBOTS**9**

Application of robotic: industrial robots, Service robots, domestic and house hold robots, Medical robots, military robots, agricultural robots, space robots, Aerial robotics Role of robots in inspection, assembly, material handling, underwater, space and healthcare continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning. Safety, Various Steps; Safety Considerations for Robot Operations.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the definition, history of robotics, robot anatomy, grasping and manipulation of robots.
2. Explain about mobile robot, manipulation and applications of industrial, service, domestic robots.
3. Apply the various concepts of drive systems, motors, and sensors to control industrial robotics, ensuring safety, regulatory compliance, and societal impact.
4. Apply robotics concepts for various robots such as industrial, service, domestic, medical, military, etc., focusing on sustainability and ethical considerations..
5. Analyze the different types of grippers and robot drive systems, evaluating their performance and suitability for specific applications with advancements in technology.
6. Analyze the simulation of robot kinematics and mobile robots, evaluating their design and functionality for specific tasks

TEXT BOOKS:

1. Modern Robotics: Mechanics, Planning, and Control, by Kevin M. Lynch , Frank C. Park , Cambridge University Press; 1st edition (25 May 2017), ISBN-10 : 110715.
2. Modern Robotics: Mechanics, Systems and Control, by Julian Evans, Larsen and Keller Education (27 June 2019), ISBN-10 : 1641720751.

REFERENCE BOOKS:

1. Modern Robotics: Designs, Systems and Control, by Jared Kroff, Willford Press (18 June 2019) ISBN-10 : 1682856763
2. Advanced Technologies in Modern Robotic Applications, by ChenguangYang , Hongbin Ma, Mengyin Fu, Springer; Softcover reprint of the original 1st ed. 2016 edition (30 May 2018), ISBN- 10 : 981109263X
3. Modern Robotics: Building Versatile Machines, by Harry Henderson, Facts On File Inc; Illustrated edition (1 August 2006), ISBN-10 : 0816057451
4. Artificial Intelligence for Robotics, by Francis X. Govers, Packt Publishing Limited; Standard Edition (30 August 2018), ISBN-10 : 1788835441
5. Modern Robotics Hardcover by Lauren Barrett (Editor), Murphy & Moore Publishing (1 March 2022), ISBN-10: 1639873732.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														2
CO 2	2											2			2
CO 3	3					3						2			2
CO 4	3						3	3				2	3		2
CO 5	3	3							3	3		3	3		3
CO 6	3	3	3						3	3		3	3		3
R21MEV403	3	3	3			3	3	3	3	3		3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

R21MEV404	GREEN MANUFACTURING DESIGN AND PRACTICES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concept of environmental design and industrial ecology.
- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.
- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To introduce the concept of green co-rating and its need.

UNIT I DESIGN FOR ENVIRONMENT AND LIFE CYCLE ASSESSMENT 9

Environmental effects of design -selection of natural friendly material - Eco design - Environmental damage Material flow and cycles – Material recycling – Emission less manufacturing- Industrial Ecology – Pollution prevention – Reduction of toxic emission – design for recycle.

UNIT II AIR POLLUTION SAMPLING AND MEASUREMENT 9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behavior dispersion of air Pollutants-solution to the atmosphere dispersion equation- the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants-collection of particulate pollutants-stock sampling, analysis of air pollutants-sulfur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone.

UNIT III NOISE POLLUTION AND CONTROL 9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise- Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT IV WATER DEMAND AND WATER QUALITY 9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non-portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

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

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the environmental design and selection of eco-friendly materials.
2. Analyze manufacturing processes towards minimization or prevention of air pollution.
3. Analyze manufacturing processes towards minimization or prevention of noise pollution.
4. Analyze manufacturing processes towards minimization or prevention of water pollution.
5. Evaluate green co-rating and its benefits.

TEXT BOOKS:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010.
2. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006.

REFERENCE BOOKS:

1. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
2. Frances Cairncross– Costing the Earth: The Challenge for Governments, the Opportunities for Business – Harvard Business School Press – 1993.
3. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
4. Rao M.N. and Dutta A.K. “Wastewater treatment”, Oxford & IBH publishing Co. Pvt. Ltd., New Delhi, Second Edition, 2006
5. Rao CS Environmental Pollution Control Engineering-, Wiley Eastern Ltd., New Delhi, 2006.
6. Lewis H Bell and Douglas H Bell, Industrial noise control, Fundamentals and applications, Marcel Decker, 1994.

R21MEV405

**ENVIRONMENT SUSTAINABILITY AND IMPACT
ASSESSMENT**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To make the students to understand the concepts of Environmental Sustainability & Impact Assessment
- To familiarize the students in environmental decision making procedure.
- Make the students to identify, predict and evaluate the economic, environmental, and social impact of development activities
- To provide information on the environmental consequences for decision making
- To promote environmentally sound and sustainable development through the identification of appropriate alternatives and mitigation measures.

UNIT I ENVIRONMENTAL IMPACT ASSESMENT 9

Environmental impact assessment objectives – rationale and historical development of EIA - Conceptual frameworks for EIA Legislative development – European community directive – Hungarian directive.

UNIT II ENVIRONMENTAL DECISION MAKING 9

Strategic environmental assessment and sustainability appraisal – Mitigation, monitoring and management of environmental impacts- Socio economic impact assessment.

UNIT III ENVIRONMENTAL POLICY, PLANNING AND LEGISLATION 9

Regional spatial planning and policy – Cumulative effects assessment – Planning for climate change, uncertainty and risk.

UNIT IV LIFE CYCLE ASSESSMENT 9

Life cycle assessment; Triple bottom line approach; Industrial Ecology. Ecological foot printing, Design for Environment, Future role of LCA, Product stewardship, design, durability and justifiability, measurement techniques and reporting

UNIT V SUSTAINABLE URBAN ECONOMIC DEVELOPMENT 9

Spatial economics – Knowledge economy and urban regions.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the concepts of Environment Sustainability and trained to make decision related to Environment.
2. Make decision that has an effect on our environment
3. Evaluate the basics of environmental policy, planning and various legislation Get valuable information for exploring decisions in each life stage of materials, buildings, services and infrastructure.
4. Explain the Life cycle assessment of Environmental sustainability.
5. Explain sustainable urban economic development.

TEXT BOOKS:

1. The Application of Science in Environmental Impact Assessment, by Aaron J. MacKinnon, Peter Duinker , Tony R. Walker , Routledge; 1st edition (14 May 2019), ISBN-10 : 0367340194.
2. Routledge Handbook of Environmental Impact Assessment, by Kevin Hanna, Routledge; 1st edition (11 April 2022), ISBN-10 : 0367244470.

REFERENCE BOOKS:

1. Clive George, C. Collin, H. Kirkpolarice – Impact Assessment and sustainable development – Edward Elgar Publishing, 2007
2. Robert B Gibsan, Sustainability Assessment, Earth Scan publishers, 2005
3. Simon Dresner, The principle of sustainability – Earth Scan publishers, 2008
4. Canter, R.L., “Environmental Impact Assessment”, McGraw Hill Inc., New Delhi, 1996.
5. Shukla, S.K. And Srivastava, P.R., “Concepts In Environmental Impact Analysis”, Common Wealth Publishers, New Delhi, 1992.
6. John G. Rau And David C Hooten “Environmental Impact Analysis Handbook”, McGraw Hill Book Company, 1990.

OBJECTIVES:

- To introduce the various energy saving machineries and components to the students for the purpose of conserving energy.
- To study the basics and principles of transforms, Pumps and motors.
- To impart the knowledge about the methods of energy conservation.
- To introduce the energy efficiency devices and concepts of ENCON.
- To impart the knowledge about CO₂ mitigation.

UNIT I	BASICS OF ELECTRICAL ENERGY USAGE	9

Fuel to Power : Cascade Efficiency – Electricity Billing : Components and Costs – kVA – Need and Control – Determination of kVA demand and Consumption – Time of Day Tariff – Power Factor Basics – Penalty Concept for PF – PF Correction – Demand Side Management (a brief) - energy monitoring, measurement and analysis.

UNIT II	TRANSFORMERS AND MOTORS	9

Transformer – Basics and Types – AVR and OLTC Concepts – Selection of Transformers – Performance Prediction - Energy Efficient Transformers - Motors : Specification and Selection – Efficiency / Load Curve – Load Estimation – Assessment of Motor Efficiency under operating conditions – Factors affecting performance – ill effects of Rewinding and Over sizing - Energy Efficient Motors – ENCON Scope. Transmission Line Parameters – Transmission Line Losses- Kelvin's Law Performance Calculation and Analysis

UNIT III	FANS, PUMPS AND COMPRESSORS	9

Basics – Selection – Performance Evaluation – Cause for inefficient operation – scope for energy conservation – methods adopted for effecting ENCON – Economics of ENCON adoption.

UNIT IV	STUDY OF ILLUMINATION AND ENERGY EFFICIENT DEVICES	9

Specification of luminaries - Types - Efficacy - Selection and Application - ENCON Avenues and Economic Proposition - New Generation Luminaries (LED - Induction Lighting) - Soft Starters- Auto Star - Delta - Star Starters- APFC - Variable Speed and Frequency Drives - Time Sensors - Occupancy Sensors.

UNIT V	CO₂ MITIGATION AND CASE STUDIES	9

Evaluation for 3 / 4 Typical Sectors – PAT Scheme (an introduction) – CO₂ Mitigation - Energy Conservation - Cost Factor. Case Studies on Industrial Energy Audit.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the various energy saving machinery and components.
2. Evaluate the various methods of conservation of energy.
3. Evaluate the performance and energy conservation of fans, pumps and compressors.
4. Discuss the various energy efficiency devices.
5. Explain the CO₂ mitigation and cost factor.

TEXT BOOKS:

1. Energy-Efficient Shutdown of Circuit Components and Computing Systems, by Ehsan Pakbazni Proquest, Umi Dissertation Publishing (1 September 2011) ,ISBN-10 : 1243819898.
2. Handbook on Energy Efficiency, TERI, New Delhi, 2001.

REFERENCE BOOKS:

1. Hamies, Energy Auditing and Conservation ; Methods Measurements, management and Case Study, Hemisphere, Washington, 1980
2. Trivedi, PR and Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997
3. Handbook on Energy Efficiency, TERI, New Delhi, 2001
4. Peters, Kraushaar and Ristenen, Sustainable Energy, beta – test – draft, Energy and Problems of a Technical Society, 1993
5. Guide book for National Certification Examination for Energy Managers and Energy Auditors (www.energymanagertraining.com)
6. Nagrath IJ and Kothari DP, Power system engineering, TMH, 2007.

OBJECTIVES:

- To familiar the various standards and legislation of modern electronic manufacturing.
- To know the conventional electronic processing and lead-free electronic manufacturing techniques. To recognize the steps involved in assembly process and understand the need of recycle the electronics
- To implement reliability and product life cycle estimation tools in green electronic manufacturing.
- To demonstrate the green electronic manufacturing procedure in applications.

UNIT I INTRODUCTION TO GREEN ELECTRONICS**9**

Environmental concerns of the modern society- Overview of electronics industry and their relevant regulations in China, European Union and other key countries- global and regional strategy and policy on green electronics industry. Restriction of Hazardous substances (RoHS) - Waste Electrical and electronic equipment (WEEE - Energy using Product (EuP) and Registration - Evaluation, Authorization and Restriction of Chemical substances (REACH).

UNIT II GREEN ELECTRONICS MATERIALS AND PRODUCTS**9**

Basics of IC manufacturing and its process – Electronics with Lead (Pb) -free solder pastes, conductive adhesives, Introduction to green electronic materials and products - halogen-free substrates and components. Substitution of non-recyclable thermosetting polymer based composites with recyclable materials X-Ray Fluorescence (XRF) for identifying hazardous substances in electronic products

UNIT III GREEN ELECTRONICS ASSEMBLY AND RECYCLING**9**

Various processes in assembling electronics components - the life-cycle environmental impacts of the materials used in the processes - substrate interconnects. Components and process equipments - Technology and management on e-waste recycle system construction, global collaboration, and product disassembles technology.

UNIT IV PRODUCT DESIGN AND SUSTAINABLE ECO-DESIGN**9**

Stages of product development process in green design: Materials- Manufacturing - Packaging and use - End of Life and disposal - Design for recycling - Life Cycle Assessment (LCA), and Eco-design tools - Environmental management systems, and International standards - Eco-design in electronics industry.

UNIT V CASE STUDIES**9**

Reliability of green electronics systems , Reuse and recycle of End-of-Life(EOL) electrical and electronic equipment for effective waste management – Introduction of Green Supply Chain, and Modeling green products from Supply Chain point of view - A life-cycle assessment for eco-design of Cathode Ray Tube Recycling.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Get concise awareness of standards and legislation of modern electronic manufacturing for green environment.
2. Explain the conventional electronic processing and lead free electronic manufacturing techniques.
3. Realize the assembly process and the need of recycle of electronics
4. Use reliability and product life cycle estimation tools for electronic manufacturing.
5. Validate the green electronic manufacturing procedures in applications.

TEXT BOOKS:

1. Green Supply Chain Management, by Charisios Achillas , Dionysis D. Bochtis, Dimitrios Aidonis, Routledge; 1st edition (16 November 2018), ISBN-10 : 1138644617
2. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

REFERENCE BOOKS:

1. David Austen, Green Electronic Morning, Ingleby Gallery, 2006.
2. John Hu. Mohammed Ismail, CMOS High Efficiency on – Chip Power Management, Springer Publications 4th edition, 2011.
3. Yuhang yang and Maode Ma, Green Communications and Networks, Springer Publication, 2014.
4. Sanka Ganesan, Michael Pecht, Lead free Electronics, John Wiley & Sons, 2006.
5. Charles A. Harper, Electronic Materials and Processes Hand book, McGraw-Hill, 2010.
6. Sammy G. Shina, Green Electronics Design and Manufacturing, McGraw Hill., 2008.

VERTICAL – 5: PROCESS EQUIPMENT AND PIPING DESIGN

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV501	Design of Pressure Vessels	3	0	0	3
2.	R21MEV502	Failure Analysis and NDT Techniques	3	0	0	3
3.	R21MEV503	Material Handling and solid Processing Equipment	3	0	0	3
4.	R21MEV504	Rotating Machinery Design	3	0	0	3
5.	R21MEV505	Thermal and Fired Equipment design	3	0	0	3
6.	R21MEV506	Industrial Layout Design and Safety	3	0	0	3
7.	R21MEV507	Design Codes and Standards	3	0	0	3

R21MEV501	DESIGN OF PRESSURE VESSELS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the Mathematical knowledge to design pressure vessels and piping
- To learn the ability to carry of stress analysis in pressure vessels and piping
- To study the design of vessels and theory of reinforcement.
- To study buckling and fracture analysis in vessels.
- To learn piping layout and flow diagram..

UNIT I INTRODUCTION 9

Methods for determining stresses – Terminology and Ligament Efficiency – Applications

UNIT II STRESSES IN PRESSURE VESSELS 9

Introduction – Stresses in a circular ring, cylinder –Dilation of pressure vessels, Membrane stress Analysis of Vessel – Cylindrical, spherical and, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT III DESIGN OF VESSELS 9

Design of Tall cylindrical self-supporting process columns – Supports for short vertical vessels – Stress concentration at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – Pressure Vessel Design.

UNIT IV BUCKLING AND FRACTURE ANALYSIS IN VESSELS 9

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT V PIPING 9

Introduction – Flow diagram – piping layout and piping stress Analysis.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

Explain Methods for determining stresses Terminology and Ligament Efficiency, Applications

Analyze stress in pressure vessels

Design and analysis of pressure vessels.

Analysis of buckling and fracture analysis in vessels

Design and analysis piping layout and piping.

TEXT BOOKS:

1. John F. Harvey, "Theory and Design of Pressure Vessels", CBS Publishers and Distributors, 1987.
2. Theory and Design Of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001.

REFERENCE BOOKS:

1. Henry H. Bedner, "Pressure Vessels, Design Hand Book", CBS publishers and Distributors, 1987.
2. Stanley, M. Wales, "Chemical process equipment, selection and Design". Buterworths series in Chemical Engineering, 1988.
3. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997.
4. Sam Kannapan, "Introduction to Pipe Stress Analysis". John Wiley and Sons, 1985.
5. Theory and design of Pressure Vessels (Pb 2001) by HARVEY J.F. | 1 January 2001.

R21MEV502	FAILURE ANALYSIS AND NDT TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce need and scope of failure analysis and fundamental sources of failures.
- To learn about non-destructive testing and basic principles of visual inspection.
- To study about magnetic testing and principles, techniques.
- To learn the principle of radiography testing and its inspection techniques and methods.
- To study the acoustical testing principle and technique and instrumentation.

UNIT I INTRODUCTION 9

Introduction and need and scope of failure analysis. Engineering Disasters and understanding failure analysis. Fundamental sources of failures. Deficient design. Improper Manufacturing & Assembly. Tree diagram and FMEA.

UNIT II VISUAL INSPECTION 9

Introduction to Non-Destructive Testing: An Introduction, Visual examination, Basic Principle, The Eye, Optical aids used for visual inspection, Applications. Liquid Penetrant Testing: Physical principles, Procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods, Sensitivity, Applications, Limitations and Standards

UNIT III MAGNETIC TESTING 9

Magnetic Particle Testing, Eddy Current Testing: Magnetism-basic definitions and principle of magnetic particle testing, Magnetizing techniques, induced current flow, Procedure used for testing a component, Equipment Used for magnetic particle testing, Sensitivity, Limitations. Eddy Current Testing: Principles, Instrumentation for eddy current testing Techniques. Sensitivity Advanced Eddy Current Test Methods, Applications, Limitations.

UNIT IV RADIOGRAPHY TESTING 9

Radiography, Ultrasonic Testing: Basic principle, Electromagnetic radiation, Sources, Radiation attenuation in the specimen. Effect of radiation in film, Radiographic imaging, Inspection techniques, Applications of radiographic inspection, Limitations, Safety in Industrial Radiography, Standards, Neutron radiography. Ultrasonic Testing: Basic properties of sound beam, Ultrasonic transducers, Inspection methods, Techniques for Normal Beam Inspection, Techniques for Angle Beam Inspection, Flaw characterization techniques, Ultrasonic flaw detection equipment, Modes of Display, Immersion Testing, Applications of Ultrasonic Testing, Advantages, Limitations

UNIT V ACOUSTIC TESTING 9

Acoustic Emission Testing: Principle of Acoustic Emission Testing, Technique, Instrumentation, Sensitivity, Applications, Standards. Thermograph: Basic Principles, Detectors and Equipment, Techniques, Applications, Codes and Standards. In Situ Metallographic Examination: Approach to the Selection of Site for Metallographic examination, Replication process, Significance of Microstructure observation, Decision making, Applications, Codes and Standards.(digital signal process)

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the need and scope of failure analysis and fundamental sources of failures.
2. Describe about non-destructive testing and basic principles of visual inspection.
3. Explain about magnetic testing and principles, techniques.
4. Explain the principle of radiography testing and its inspection techniques and methods.
5. Describe the acoustic testing principle and technique and instrumentation.

TEXT BOOKS:

1. Baldev Raj, T Jayakumar, M Thavasimuthu Practical Non-Destructive Testing, Narosa Publishing House, 2014.
2. Ravi Prakash, Non-Destructive Testing Techniques, 1st revised edition, New Age International Publishers, 2010.

REFERENCE BOOKS:

1. ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook, Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing
3. Charles, J. Hellier, Handbook of Non destructive evaluation, McGraw Hill, New York 2001.
4. Paul E Mix, Introduction to Non-destructive testing: a training guide, Wiley, 2nd Edition New Jersey, 2005
5. J Prasad and C.G.K. Nair, Non-Destructive Test and Evaluation of Materials, Tata McGraw-Hill Education, 2nd edition (2011).

R21MEV503	MATERIAL HANDLING AND SOLID PROCESSING EQUIPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge on materials handling equipment.
- To provide knowledge on Industrial Vehicles
- To provide knowledge on conveyor equipment.
- To provide knowledge on Auxiliary Equipment and Hoisting Equipment.
- To provide knowledge on Bulk Handling Equipment and Systems.

UNIT I INTRODUCTION TO MATERIALS HANDLING 9

Basic principles & objectives in material handling and its benefits - Classification of material handling equipment - selection of material handling equipments - guidelines for effective utilisation of material handling equipments - unit load concept.

UNIT II INDUSTRIAL VEHICLES 9

Introduction and types - Hand trucks - Two wheel Hand Trucks - Multiple wheel Hand Trucks - Hand Lift Trucks - Power Trucks - Fixed Platform Truck - Platform Lift Truck - Pallet Lift Truck - Walkie Truck - Straddle Carrier - Fork Lift Trucks - Specifications of FLT - FLT Attachments - Tractors - Industrial Tractor-Trailer-Self-propelled trucks and fork trucks - Automated guided vehicles Theory

UNIT III CONVEYORS 9

Classification of conveyors- Definition - Description - General Characteristics - types and uses of belt Conveyors - Roller conveyors - Haulage Conveyors - Screw Conveyors - Bucket Conveyors - Chain Conveyors - Cable Conveyors - Pneumatic and Hydraulic conveyors - Computer controlled conveyor system.

UNIT IV AUXILIARY EQUIPMENT AND HOISTING EQUIPMENT 9

Hoppers - Gates- Feeders- Chutes-positioners- Ball Table- Weighing and Control Equipment- Pallet loaders and unloaders - applications and advancements. - Hoisting Equipment - parts of hoisting equipment - Description and uses of hoists - Description and uses of ropes - description and purpose of crane hooks - Elevators - Cranes - Derricks - and its types

UNIT V BULK HANDLING EQUIPMENT AND SYSTEMS 9

Storage of bulk solids - bulk handling equipment - Robotic handling - Materials handling at the workplace - Robots and their classification - Major components of a robot - classification of Robotic manipulators - Robotic handling applications.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the basic concepts of material handling equipment.
2. Explain the basic working principles of various industrial Vehicles.
3. Develop the basic working principles of various conveyors.
4. Elaborate the basic working principles of various Auxiliary Equipment and Hoisting Equipment.
5. Explain the basic working principles of various Bulk Handling Equipment and Systems.

TEXT BOOKS:

1. Allegri (Sr.), T.H., Material Handling – Principles and Practices, CBS Publishers and Distributors, Delhi, 1987.
2. Siddharta Ray, Introduction to Materials Handling, New Age International Publishers.

REFERENCE BOOKS:

1. Bolz, H. A and Hagemann, G. E (ed.), "Materials Handling Handbook", Ronald Press
2. 8005:1976, Classification of Unit Loads, Bureau of Indian Standards.
3. Apple, J.A., "Material Handling System Design", John Wiley & Sons
4. Theodore H., Allegre Sr., Material Handling Principles and Practice, CBS Publishers and Distributors
5. Immer J. R., Material Handling, Tata McGraw Hill Publication.

OBJECTIVES:

- To familiarize the course member with various operations of gas turbines and other driven rotating machines.
- To familiarize students with the common problems associated with the mechanical design and the lifting of the major rotating components of the gas turbine engine.
- To study the failure criteria of rotating machinery.
- To learn the design of discs, blades for rotating machinery.
- To study about blade vibrations Damage Mechanisms.

UNIT I INTRODUCTION**9**

Overview of the different operational regimes for gas turbine applications: base load, peak load, standby and backup operations, alongside their individual operational requirements. Fundamentals of Creep and Fatigue damage mechanisms. Material, design and operational parameters that affect creep and fatigue. Experimental and test procedures to characterize creep and fatigue damage.

UNIT II DESIGNING FORCES**9**

Loads/forces/stresses in gas turbine engines: loads - rotational inertia, flight, precession of shafts, pressure gradient, torsion, seizure, blade release, engine mountings and bearings-Discussion of major loadings-rotating components and pressure casing components.

UNIT III FAILURE CRITERIA**9**

Monotonic failure criteria: proof, ultimate strength. Theories of failure - bi-axial loads. Other failure mechanisms - gas turbine engines including creep and fatigue. Fatigue properties - SN and RM diagrams. Stress concentration, mean stress, Cumulative fatigue, Goodman diagram and safety factor for gas turbine components. Larson-Miller time-temperature parameter.

UNIT IV BLADE DESIGN**9**

Design of discs, blades. Illustration of magnitude stresses in conventional axial flow blades- simple desk-top method -effects of leaning the blade. Design of flanges and bolted structures. Leakages through a flanged joint and failure from fatigue.

UNIT V BLADE VIBRATIONS AND DAMAGE MECHANISMS**9**

Natural frequencies turbo machine blades. Blade twist, centrifugal stiffening, Sources of blade excitation, Stationary flow disturbance, rotating stall and flutter. Campbell diagram and troublesome resonances. Allowances for temperature, pre-twist and centrifugal stiffening. Methods for dealing with resonances.

TOTAL : 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Differentiate the operational regimes and requirements related to different gas turbine applications.
2. Describe and distinguish the design requirements and loads encountered by gas turbine components during normal operation;
3. Analyze, evaluate and assess the loads, stresses, failure criteria and factors of safety used in gas turbine engines
4. Evaluate impact of vibrations on design and operation of gas turbine;
5. Assess the creep and fatigue damage of gas turbine components based on design and operational parameters.

TEXT BOOKS:

1. A S Rangawala, Turbo Machinery Dynamics-Design and operations, McGraw-Hill, 2005, ISBN-13: 978-0071453691.
2. Design, Modeling and Reliability in Rotating Machinery, Robert X. Perez (Editor) ISBN: 978-1-119-63169-9.
- 3.

REFERENCE BOOKS:

1. P.P Walsh and P. Peletcher, Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.
2. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
3. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
4. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005
5. Shaft Alignment Handbook (Mechanical Engineering) by John Piotrowski | 2 November 2006.

R21MEV505	THERMAL AND FIRED EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the concepts of thermal and fired equipment.
- To study the basis, design and construction of boilers.
- To study of typical fuel firing systems in the boiler.
- To study of materials requirements for pressure parts.
- To study of various boiler auxiliaries system.

UNIT I INTRODUCTION 9

Principal equipment in Thermal Power Plant, Historical developments of Boiler, Utility, Industrial boilers, Modern trends in boiler design, Basic knowledge of different types of Thermal Fired Equipment, sub critical and super critical boilers - Coal, Oil, Gas, Pulverized fuel cyclone, FBC, CFBC, MSW, and Stoker firing, Boiler efficiency, auxiliary power consumption, Performance data, Performance Correction Curves.

UNIT II BASIS OF BOILERS AND DESIGN 9

Codes- Design and Construction, IBR, ISO, ASME, BS, Heat balance diagram, Boiler parameters, Fuel analysis and variations, Site conditions, Furnace heat loadings, FOT, Plan area loading, Volumetric loading, Balanced Draft and Pressurised Furnace, Natural / Controlled Circulation, Constant and Sliding Pressure, Boiler heat transfer surfaces, Flue gas velocities, boiler auxiliaries, Boiler schemes, Boiler Layouts

UNIT III FIRING SYSTEM- FUEL AND MILLING 9

Coal / Oil / Natural Gas in any combination, Lignite, Blast Furnace Gas / Coke Oven Gas / Corex Gas Carbon Monoxide / Tail gas, Asphalt, Black Liquor, Bagasse, Rice Husk, Washery Rejects, Wheat / Rice straw MSW, wind box, Burner, Type of Stokers, Pulverizers - Bowl mill, Tube mill, Direct firing, Indirect firing, Wall firing (Turbulent / Vortex Burners), Tangential firing (Jet Burners), Fire Ball.

UNIT IV PRESSURE PARTS AND DESIGN AND MATERIALS 9

Economiser, Drums, Water Walls, Headers, Links, Super Heater, Super Heaters, Reheaters, Tubes, Spiral Tubes, Surface area, Free Gas Area, Metal temperature, LMTD, Acid Dew Point Temperature, Carbon steel, Low alloy steel, Titanium alloy steel.

UNIT V BOILER AUXILIARIES 9

Air preheaters (APH) – bi sector APH, Tri sector APH, Cold PA System, Hot PA System, Tubular APH, Steam coil Air preheater, FANS – Axial, Radial, Performance curves, MILLS- Tube, Vertical mills, Air quality Control systems, Dust Collection System - Mechanical Precipitator, Electrostatic Precipitator, FGD, SCR, SNCR.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the concepts of thermal and fired equipment.
2. Discuss the basis, design and construction of boilers.
3. Describe of typical fuel firing systems in the boiler.
4. Discuss the materials requirements for pressure parts.
5. Discuss of various boiler auxiliaries system.

TEXT BOOKS:

1. A Course in Power Plant Engineering; Dhanapat Rai and Sons – Domkundwar.
2. Power Plant Engineering by B. Vijaya Ramnath C. Elanchezhian, L. Saravanakumar.

REFERENCE BOOKS:

1. Elwakil M, Power Plant Technology, McGraw Hill, New York, 1964.
2. Steam Generators and Waste Heat Boilers: For Process and Plant Engineers (Mechanical Engineering) by V. Ganapathy.
3. Steam Generators: Description and Design by Donatello Annaratone.
4. An Introduction to Coal and Wood Firing Steam Generators (Power Plants Engineering) by J Paul Guyer.
5. Advances in Power Boilers (JSME Series in Thermal and Nuclear Power Generation) by Mamoru Ozawa and Hitoshi Asano | 28 January 2021.

R21MEV506

INDUSTRIAL LAYOUT DESIGN AND SAFETY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To introduce the industrial facility layout design principles, process and material flow analysis and product and equipment analysis.
- To learn the facilities layout design algorithms and selecting appropriate software.
- To study the facilities layout problem modelling tools and algorithms for production, warehouse, and material handling.
- To learn the safety planning and management principles in industries.
- To learn the various safety management approaches in industries.

UNIT I INTRODUCTION

9

Industrial Facility Layout: Definition, Types of Layout Problems, Engineering Design Problem Approach – Product Analysis, Equipment Selection, Personnel Requirement Analysis, Space Requirement and Availability – Process and Material Flow Analysis, Data Requirement for Layout Decisions, Tools for Presenting Layout Designs.

UNIT II FACILITIES LAYOUT DESIGN & ALGORITHMS

9

Traditional Approaches to Facility Layout, Systematic Layout Planning, Special Considerations in Office Layout, Engineering Design Problem Approach, Code Compliance, OSHA, ADA Regulations, and Other Considerations in Facility Design – Algorithms for the Layout Problem, Construction Algorithms, Improvement Algorithms, Hybrid Algorithms, Layout Software (CRAFT, BLOCPLAN, PFAST, Layout-iQ, VIP-PLANOPT, Factory CAD, Factory FLOW, Plant Simulation)

UNIT III FACILITIES LAYOUT PROBLEM MODELS & ALGORITHMS

9

Models for the Layout Problem, Generic Modeling Tools, Models for the Single-Row Layout Problem, Models for the Multi row Layout Problem with Departments of Equal and Unequal Area – Material Handling, Principles, Types, Models for Material-Handling System Design – Storage and Warehousing, Warehouse Functions, Warehouse Design and Operation.

UNIT IV SAFETY PLANNING & MANAGEMENT

9

Introduction: Elements of Safety Programming, Safety Management. Upgrading Safety Developmental Programs: Safety Procedures, Arrangements and Performance Measures, Education, Training and Development in Safety. Safety Performance: An Overview of an Accident, Occupational Health and Industrial Hygiene. Indian Factories Act 1948 for Health and Safety.

UNIT V APPROACHES IN SAFETY MANAGEMENT

9

Safeguarding against Common Potential Hazards: Trips, Slips and Falls, Preventing Electrocution, Static Electricity, Hazardous Energy Control. Specific Hazard Control Measures: Forklift Hazard Control, Tractor Hazard Control. Safe Handling and Storage: Material Handling, Compressed Gas Cylinders, Corrosive Substances, Hydrocarbons.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the types of facility layout problems and the importance of engineering design approaches in industrial layout planning. (Understand)
2. Explain the elements of safety programming and safety performance measures as per the Indian Factories Act 1948. (Understand)
3. Apply systematic layout planning and layout software tools like CRAFT, BLOCPLAN, and Plant Simulation for designing efficient facility layouts. (Apply)
4. Implement safety management practices and control measures to prevent common industrial hazards such as trips, electrocution, and hazardous energy. (Apply)

5. Analyze various models and algorithms used for single-row and multi-row layout problems with different department sizes and requirements. (Analyze)
6. Evaluate the material handling systems, warehouse functions, and storage design models for efficient industrial facility operation. (Analyze)

TEXT BOOKS:

1. Sunderesh S. Heragu, "Facilities Design", 3rd Edition, CRC Press Taylor & Francis Group, 2008.
2. L. M. Deshmukh, "Industrial Safety Management: Hazard Identification and Risk Control", Tata McGraw-Hill Publishing Co. Ltd., 2005.

REFERENCE BOOKS:

1. Eric Teicholz, "Facility Design and Management Handbook", Tata McGraw-Hill Publishing Co. Ltd., 2001.
2. James A. Tompkins, John A. White, Yavuz A. Bozer, and J. M. A. Tanchoco, "Facilities Planning", 4th Edition, John Wiley & Sons, 2010.
3. Matthew P. Stevens and Fred E. Meyers, "Manufacturing Facilities Design and Material Handling", 5th Edition, Purdue University Press, 2013.
4. Charles D Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.
5. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
6. Industrial Hazard and Safety Handbook: (Revised impression by Ralph W King and John Magid | 24 September 2013.

COURSE ARTICULATION MATRIX:

CO/PO MAPPING

CO	PO's												PSO's		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1															
CO 2	3			2	2									2	
CO 3	3														
CO 4	3			2											
CO 5	3	3					2								
CO 6	3	3					2								
R21MEV5 06	3	3		2	2		2							2	

Ref: 3 - Strong 2 - Medium 1 - Weak

R21MEV507

DESIGN CODES AND STANDARDS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study the Codes and Standards and Need for them in the Industry
- To know the different sources and the bodies that publish Codes and Standards
- To familiarize the Government Regulations and its applicability
- To familiarize with different codes used in Different Industry
- To familiarize the Codes and Standards used in Process Industry.

UNIT I INTRODUCTION

9

Introduction to Codes and Standards. What is code? What is Standard? Need for codes and standards. Objective of Codes and Standards. Codes, Standards and Good Engineering Practices.

UNIT II CODES

9

Codes and Standards used in Different Industry. Material, Design, Inspection and Construction Codes. Process Industry Codes. Machinery Design codes. Codes used in Oil and Gas Industry. Welding Codes. Machine Design. Automotive. HVAC. Performance Test Codes. Other Discipline codes

UNIT III STANDARDS

9

Sources of Codes and Standards. Who publishes Codes and Standards? International Societies and Professional Bodies. Process of Standardization and Code publishing in Professional Bodies and Companies. Interdisciplinary Codes.

UNIT IV REGULATIONS

9

Government and Federal Regulations. Need for them. Indian and International Regulations. Standards organisations. Weather and Climatic codes. IS, ISO, IBR, OISD. Certification Bodies. Authorities and Engineers to certify. PE, Chartered Engineers

UNIT V DESIGN CODES

9

Codes and Standards applicable in Process Industry Equipment Design. Pressure Vessel Design Codes. Heat Exchanger Design Codes. Wind and Seismic Codes. Machinery Codes. Package Equipment Design Codes. Performance Test Codes. ASTM, ASME, API, AWS, ANSI, ISO, ASHRAE.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the need for codes and Standards in Industry.
2. Discuss the different codes and standards used in different industry.
3. Discuss the sources of different codes and standards and the societies that publish them and how these are evolved
4. Explain need for Government regulations and Certification authorities and familiar with common regulations in India and International
5. Discuss knowledge of codes and standards used in Process equipment design for Oil and Gas Industry.

TEXT BOOKS:

1. Mechanical Engg. Handbook. ASME. ASTM.API.
2. Perrys Chemical Engg Handbook.

REFERENCE BOOKS:

1. ASME
2. API
3. ISO, IBR, OISD
4. AWS

VERTICAL – 6: CLEAN AND GREEN ENERGY TECHNOLOGIES

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV601	Bioenergy Conversion Technologies	3	0	0	3
2.	R21MEV602	Carbon Footprint estimation and education techniques	3	0	0	3
3.	R21MEV603	Energy Conservation in Industries	3	0	0	3
4.	R21MEV604	Energy Efficient Buildings	3	0	0	3
5.	R21MEV605	Energy Storage Device	3	0	0	3
6.	R21MEV606	Non Conventional Energy Sources	3	0	0	3
7.	R21MEV607	Equipment for pollution Control	3	0	0	3

R21MEV601	BIOENERGY CONVERSION TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To elucidate on biomass, types, availability, and characteristics
- To study the bio-methanation process.
- To impart knowledge on combustion of biofuels
- To describe on the significance of equivalence ratio on thermochemical conversion of biomass
- To provide insight to the possibilities of producing liquid fuels from biomass.

UNIT I INTRODUCTION 9

Biomass: types – advantages and drawbacks – typical characteristics – proximate & ultimate analysis – comparison with coal - Indian scenario - carbon neutrality – biomass assessment studies – typical conversion mechanisms - densification technologies.

UNIT II BIOMETHANATION 9

Biomethanation process – influencing parameters – typical feed stocks – Biogas plants: types and design, Biogas appliances – burner, luminaries and power generation systems – Industrial effluent based biogas plants.

UNIT III COMBUSTION 9

Perfect, complete and incomplete combustion – stoichiometric air requirement for biofuels - equivalence ratio – fixed Bed and fluid Bed combustion.

UNIT IV GASIFICATION, PYROLYSIS AND CARBONISATION 9

Chemistry of gasification - types – comparison – typical application – performance evaluation – economics. Pyrolysis - Classification - process governing parameters – Typical yield rates. Carbonization – merits of carbonized fuels – techniques adopted for carbonization.

UNIT V LIQUIFIED BIOFUELS 9

Straight Vegetable Oil (SVO) as fuel - Biodiesel production from oil seeds, waste oils and algae - Process and chemistry - Biodiesel Vs. Diesel – comparison on emission and performance fronts. Production of alcoholic fuels (methanol and ethanol) from biomass – engine modifications.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Estimate the surplus biomass availability of any given area.
2. Design a biogas plant for a variety of biofuels.
3. Determine and compare the cost of steam generation from biofuels with that of coal and petroleum fuels.
4. Analyze the influence of process governing parameters in thermochemical conversion of biomass.
5. Synthesize liquid biofuels for power generation from biomass.

TEXT BOOKS:

1. Biomass for Bioenergy and Biomaterials, by Nidhi Adlakha, Rakesh Bhatnagar , Syed Shams Yazdani, CRC Press; 1st edition (22 October 2021), ISBN-10 : 0367745550.
2. Bioenergy and Biochemical Processing Technologies, by Augustine O. Ayeni, Samuel Eshorame Sanni , Solomon U Oranusi, Springer (30 June 2022).

REFERENCE BOOKS:

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood Chichester, 1984.
2. Iyer PVR et al, Thermochemical Characterization of Biomass, M N E S
3. Khandelwal KC, Mahdi SS, Biogas Technology – A Practical Handbook, Tata McGraw Hill, 1986
4. Mahaeswari R.C. Bio Energy for Rural Energisation, Concepts Publication,1997
5. Tom B Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981.

R21MEV602	CARBON FOOTPRINT ESTIMATION AND REDUCTION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce climate change and carbon footprint
- To study the principle of product life cycle and Green House Gas emissions accounting
- To study the Methodology for Carbon Footprint Calculation
- To learn emission mitigation and carbon sink
- To study the case study of carbon footprint.

UNIT I CLIMATE CHANGE AND CARBON FOOTPRINT 9

Green House Effect and Climate Change - Causes and Impacts of Climate Change – Economic implications of Climate Change -IPCC Reports and Projected Climate Change Scenarios – Green House Gas (GHG) Emission – Carbon footprint of Activities, Processes, Products and Services of Organisations – GHG Emission factors and Calculations.

UNIT II PRODUCT LIFE CYCLE AND GHG EMISSIONS 9

Life-cycle GHG Accounting - Principles of Product Life Cycle GHG Accounting and Reporting - Fundamentals of Product Life Cycle GHG Accounting - Establishing the Scope of a Product Inventory- GHG Emission Inventories and Accounting - Collecting Data and Assessing Data Quality- Allocation and Assessing Uncertainty.

UNIT III METHODOLOGICAL ASPECTS OF CARBON FOOTPRINT 9

Methodology for Carbon Footprint Calculation in Crop and Livestock Production, End of Life Scenarios and Carbon Footprint of Wood Cladding, Carbon Footprints and Greenhouse Gas Emission Savings of Alternative Synthetic Biofuels, Making Food Production GHG Efficient, Carbon Footprint of Wood-Based Products and Buildings, Challenges and Merits of Choosing Alternative Functional Units, modeling aspects of carbon footprint, Quantifying Spatial–Temporal Variability of Carbon Stocks and Fluxes.

UNIT IV EMISSION MITIGATION AND CARBON SINK 9

Setting GHG Reduction Targets and Tracking Inventory Changes – Non-Fossil Fuel based Energy Systems - Carbon Dioxide capture and Storage Technologies –Mitigation potentials of different Sectors and systems – Innovation, Technology Development and Transfer, - Social aspects of mitigation –Policies, Institutions and international corporations – Carbon Pricing and Finance –GHG Offsetting and Green marketing.

UNIT V CASE STUDIES 9

Carbon Footprint Estimation from Building Sector - Urban Carbon Footprint Evaluation - Applications of carbon footprint in urban planning – Mechanical Equipment and Electronic Product Carbon Footprint - Carbon Footprint of Aqua and Agriculture products- GHG Emissions from Municipal Wastewater Treatment and Solid waste management.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the climate change and carbon footprint
2. Discuss the principle of product life cycle and Green House Gas emissions accounting
3. Explain the Methodology for Carbon Footprint Calculation
4. Discuss emission mitigation and carbon sink
5. Explain the case study of carbon footprint.

TEXT BOOKS:

1. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1, by Subramanian Senthilkannan Muthu, Springer; Softcover reprint of the original 1st ed. 2014 edition (23 August 2016), ISBN-10 : 9811011737.
2. Assessment of Carbon Footprint in Different Industrial Sectors, Volume 2, by Subramanian Senthilkannan Muthu, Springer Nature; 2014th edition (30 April 2014), ISBN-10 : 9814585742.

REFERENCE BOOKS:

1. Subramanian, Senthil Kannan, Muthu (2016), Carbon Foot Print Handbook, CRC Press
2. Subramanian, Senthil Kannan, Muthu (2016), Environmental Carbon Foot Print Industrial case Studies, Butterworth Heinemann Publishers
3. World Resources Institute, Green House Gas Protocol - Product Life Cycle Accounting and Reporting Standard
4. ISO 14067 -2018, Green House gases and carbon footprint, Requirements and Guidelines for Quantification, International Organization for Standardization.
5. IPCC (2022) –Sixth Assessment Reports – Intergovernmental Panel on Climate Change, United Framework convention on Climate Change.

R21MEV603	ENERGY CONSERVATION IN INDUSTRIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign
- To analyzing factors behind energy billing and applying the concept of demand side management for lowering energy costs
- To learn computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
- To diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
- To applying CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project.

UNIT I INTRODUCTION 9

Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

UNIT II ELECTRICAL SUPPLY SYSTEMS 9

Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics.

UNIT III ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES 9

Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.

UNIT IV ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES 9

Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems.

UNIT V ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS 9

Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss Quantify the energy demand and energy supply scenario of nation and appreciate the need for energy auditing for becoming environmentally benign
2. Analyse factors behind energy billing and apply the concept of demand side management for lowering energy costs
3. Compute the stoichiometric air requirement for any given fuel and quantify the energy losses associated with thermal utilities of industries
4. Diagnose the causes for under performance of various electrical utilities and suggest remedies for improving their efficiency
5. Apply CUSUM and other financial evaluation techniques to estimate the accruable energy savings/monetary benefits for any energy efficiency project

TEXT BOOKS:

1. Guide book for National Certification Examination for “Energy Managers and Energy Auditors” (4 Volumes). Available at <http://www.em-ea.org/gbook1.asp>. This website is administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.
2. K Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers &Dist, 2007.

REFERENCE BOOKS:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, “Handbook of Energy Engineering”, 7thEdition, The Fairmont Press, 2013.
3. Murphy W.R. and McKay G, “Energy Management”, Butterworth, London 1982.
4. Paul W. O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009.

OBJECTIVES:

- To learn the climate and buildings, building efficiency rating and standards.
- Developing energy efficiency in building envelopes through alternate methods.
- To study the thermal comfort, passive heating and cooling techniques.
- To apply various energy saving concepts in buildings.
- To incorporate Renewable energy systems in buildings.

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

Climate and Building, Historical perspective, Aspects of Net Zero building design – Sustainable Site, Water, Energy, Materials and IGBC, LEED, GRIHA, IEQ and ECBC Standards.

UNIT II**LANDSCAPE AND BUILDING ENVELOPES****9**

Energy efficient landscape design – Micro climates – various methods – Shading, water bodies – Building envelope: Building materials, Envelope heat loss and heat gain and its evaluation, paints, insulation, Design methods and tools.

UNIT III**THERMAL COMFORT, PASSIVE HEATING AND COOLING****9**

Thermal comfort, Psychrometry, Comfort indices – ASHRAE / ISHRAE Standards on thermal Comfort – Passive heating and cooling systems - HVAC Systems for build environment – Heat Pumps, Evaporative Cooling and Radiant Cooling.

UNIT IV**ENERGY CONSERVATION IN BUILDING UTILITIES****9**

Energy conservation in Hot water generator – Boiler, Heat Pumps, DG Sets, Motors , Pumps, Illumination Systems, Electrical distribution systems, Cooling Towers, Refrigeration and Air Conditioning Systems, Water and Waste Management systems.

UNIT V**RENEWABLE ENERGY IN BUILDINGS****9**

Introduction of Renewable sources in buildings, , Stand-alone PV systems, BIPV, Solar water heating, Solar Air Conditioning in Buildings, Small wind turbines, Poly-generation systems in Buildings.

TOTAL : 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Familiar with climate responsive building design and basic concepts
2. Explain the basic terminologies related to buildings
3. Discuss the energy efficient air conditioning techniques
4. Evaluate the performance of buildings
5. Gets acquainted with Renewable energy systems in buildings

TEXT BOOKS:

1. Advanced Decision Making for HVAC Engineers, by Javad Khazaii, Springer; Softcover reprint of the original 1st ed. 2016 edition (23 June 2018), ISBN-10 : 3319814869
2. Thermal Comfort and Energy-Efficient Cooling of Nonresidential Buildings, by Doreen E. Kalz, Jens Pfafferott, Springer; 2014th edition (8 April 2014), ISBN-10 : 9783319045818.

REFERENCE BOOKS:

1. ASHRAE Handbook – Fundamentals / Equipment's/ Applications – ASHRAE 2021,2020, 2019 Editions
2. Baruch Givoni: Climate considerations in building and Urban Design, John Wiley & Sons, 1998
3. Baruch Givoni: Passive Low Energy Cooling of Buildings by, John Wiley & Sons, 15-Jul-1994
4. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition, John Wiley & Sons, 2006.
5. Jan F. Kreider, Peter S. Curtiss, Ari Rabl, Heating and Cooling of buildings: Design for Efficiency, Revised Second Edition, CRC Press, 28-Dec-2009.

OBJECTIVES:

- To study the various types of energy storage devices and technologies and their comparison.
- To learn the techniques of various energy storage devices and their performances.
- To learn the basics of batteries and hybrid systems for EVs and other mobile applications.
- To learn about the renewable energy storage systems and management systems.
- To have an insight into other energy storage devices, hydrogen, and fuel cells.

UNIT I	INTRODUCTION TO ENERGY STORAGE	9

Need for Energy Storage – Types of Energy Storage – Various forms of Energy Storage – Mechanical – Thermal - Chemical – Electrochemical – Electrical - Other alternative energy storage technologies – Efficiency and Comparison.

UNIT II	ENERGY STORAGE SYSTEMS	9

Pumped Air Energy Storage – Compressed Air Energy Storage – Flywheel – Sensible and Latent Heat Storage – Storage Materials – Performance Evaluation - Thermochemical systems – Batteries – Types- Charging and Discharging – Battery testing and performance.

UNIT III	MOBILE AND HYBRID ENERGY STORAGE SYSTEMS	9

Batteries for electric vehicles - Battery specifications for cars, heart pacemakers, computer standby supplies – V2G and G2V technologies – HESS.

UNIT IV	RENEWABLE ENERGY STORAGE AND ENERGY MANAGEMENT	9

Storage of Renewable Energy Systems – Solar Energy – Wind Energy – Energy Storage in Micro grid – Smart Grid – Energy Conversion Efficiency - Battery Management Systems – EVBMS – Energy Audit and Management.

UNIT V	OTHER ENERGY DEVICES	9

Superconducting Magnetic Energy Storage (SMES), Supercapacitors – MHD Power generation – Hydrogen Storage - Fuel Cells – Basic principle and classifications – PEMFC, AMFC, DMFC, SOFC, MCFC and Biofuel Cells – Biogas Storage.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the need and identify the suitable energy storage devices for applications.
2. Explain the working of various energy storage devices and their importance.
3. Explain the basic characteristics of batteries for mobile and hybrid systems.
4. Discuss the storage of renewable energies and management systems.
5. Explain the need for other energy devices and their scope for applications.

TEXT BOOKS:

1. Rober Huggins, "Energy Storage: Fundamentals, Materials and Applications", 2nd Edition, Springer, 2015.
2. Dell, Ronald M Rand, David A J, "Understanding Batteries", Royal Society of Chemistry, 2001.

REFERENCE BOOKS:

1. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt," Energy Storage in Power Systems" Wiley Publication, 2016.
2. Ibrahim Dincer and Mark A Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons, 2002.
3. Lindon David, "Handbook of Batteries", McGraw Hill, 2002.
4. Aulice Scibioh M. and Viswanathan B, "Fuel Cells – principles and applications', University Press(India), 2006
5. Ru-Shiliu, Leizhang, Sueliang Sun, "Electrochemical Technologies for Energy Storage and Conversion", Wiley Publications, 2012.

R21MEV606	NON-CONVENTIONAL ENERGY SOURCES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the Indian and global energy scenario
- To learn the various solar energy technologies and its applications.
- To educate the various wind energy technologies.
- To explore the various bio-energy technologies.
- To study the ocean and geothermal technologies.

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 - Future energy plans

UNIT II SOLAR ENERGY 9

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

UNIT III WIND ENERGY 9

Wind data and energy estimation – Betz limit - Site selection for windfarms – characteristics - Wind resource assessment - 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 AND GEOTHERMAL 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.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the Indian and global energy scenario.
2. Describe the various solar energy technologies and its applications.
3. Explain the various wind energy technologies.
4. Explore the various bio-energy technologies.
5. Discuss the ocean and geothermal technologies.

TEXT BOOKS:

1. Fundamentals and Applications of Renewable Energy | Indian Edition, by Mehmet Kanoglu, Yunus A. Cengel, John M. Cimbala, cGraw Hill; First edition (10 December 2020), ISBN-10 : 9390385636.
2. Renewable Energy Sources and Emerging Technologies, by Kothari, Prentice Hall India Learning Private Limited; 2nd edition (1 January 2011), ISBN-10 : 8120344707.

REFERENCE BOOKS:

1. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 2012.
2. Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2014.
3. Sukhatme S.P., "Solar Energy: Principles of Thermal Collection and Storage", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. Tiwari G.N., "Solar Energy – Fundamentals Design, Modelling and applications", Alpha Science Intl Ltd, 2015.
5. Twidell, J.W. & Weir A., "Renewable Energy Resources", EFNSpon Ltd., UK, 2015.

R21MEV607	EQUIPMENT FOR POLLUTION CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the pollution control regulation and standards, water and wastewater.
- To study the equipment for various water pollution.
- To study the equipment for air pollution control.
- To study the equipment for solid waste processing
- To study the pollution monitoring equipment.

UNIT I	POLLUTION CONTROL REGULATIONS AND STANDARDS	9

Pollutants in water and wastewater – sources and impacts- Characteristics and impacts of solid and hazardous wastes - Indian Constitution and Environmental Protection Legislations - Environmental Standards under different Environmental legislations - Water Act (1974), Air Act (1981), Environmental Protection Act (1986) and major Notifications, Municipal solid Wastes (Management and Handling) Rules -Bio Medical Wastes (Management and Handling) Rules - Hazardous Wastes (Management and Handling Rules),Environment Impact Assessment Notifications - Unit operations and unit processes in Pollution Control- - Selection criteria for Pollution Control Equipment.

UNIT II	EQUIPMENT FOR WATER POLLUTION CONTROL	9

Operational principles and Design criteria of Flash mixers, Flocculators, Clarifiers, Sand Filters, Adsorption Columns, Aerators, Air blowers, Distillation units, Centrifugal and Reciprocating Pumps, Chemical dosing systems, Motors, Pipes, valves and Fittings.- Field visit to a wastewater treatment plant.

UNIT III	EQUIPMENT FOR AIR POLLUTION CONTROL	9

Operational principles and Design criteria of Cyclone separators, gravity settlers, Wet Scrubbers, Air strippers, Bag Filters, Electrostatic precipitators, Biofilters - Field visit to an industry with air pollution control systems.

UNIT IV	EQUIPMENT FOR SOLID WASTE PROCESSING	9

Operational principles and Design criteria of Dewatering equipment – centrifuge, Vacuum Filter, Filter Press- Size Reduction equipment – shredders, grinders – Trommel and Disc Screens – Air Classifiers - bailing and briquetting – incinerators –Pyrolysis – field visit to a solid waste processing facility.

UNIT V	POLLUTION MONITORING EQUIPMENT	9

Equipment's for sampling of water, solids and air- Sample preservation Equipment – incubators – Cold Storage systems- equipment for analysis of water and air samples- Ambient air and flue gas sampling and monitoring equipment.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the different types of pollution, their sources and effects.
2. Discuss the pollution control regulations and standards
3. Design equipment for pollution control
4. Discuss different methods of pollution control from various sources in air, water and soil
5. Discuss the Conduct performance assessment of pollution control equipment.

TEXT BOOKS:

1. George Tchobanoglous, Hilary Theisen and Samuel A, Vigil, "Integrated Solid Waste Management, Mc-Graw Hill India, First edition, 2015.
2. Rao. C.S (2006)., "Environmental Pollution and Control Engineering", 2nd Edition, Revised, Wiley Eastern Limited, India.

REFERENCE BOOKS:

1. Shyam Diwan and Armin Rosencranz, Environmental Law and Policy in India, Oxford, 2001.
2. Metcalf & Eddy, INC, „Wastewater Engineering – Treatment and Reuse, Fourth Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2014.
3. Noel de Nevers, "Air Pollution Control Engg", McGraw Hill, New York, 2016.
4. CPCB (2021), "Pollution Control Acts, Rules and Notifications issued thereunder, PCL Series- Central Pollution Control Board, Delhi.
5. CPHEEO, "Manual on Municipal Solid waste management, Vol. I, II and III, Central Public Health and Environmental Engineering Organization , Government of India, New Delhi, 2016.

VERTICAL – 7: COMPUTATIONAL ENGINEERING

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV701	Computational Solid Mechanics	3	0	0	3
2.	R21MEV702	Computational Fluid Dynamics	3	0	0	3
3.	R21MEV703	Theory on Computation and Visualization	3	0	0	3
4.	R21MEV704	Computational Bio Mechanics	3	0	0	3
5.	R21MEV705	Advanced Statistics and Data Analytics	3	0	0	3
6.	R21MEV706	CAD and CAE	3	0	0	3
7.	R21MEV707	Machine Learning for Intelligent Systems	3	0	0	3

OBJECTIVES:

- To study the definition and basics on theory of elasticity
- To learn finite element method and procedure for static linear elasticity
- To study the Non Linear and History depend problems
- To study time dependent and dynamic problems of Small and large strain visco- plasticity
- To study Structural Elements & Interfaces and contact using penalty method.

UNIT I	BASIC ON THEORY OF ELASTICITY	9

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Strain – displacement relations, Stress – strain relations, Lamé's constant –cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

UNIT II	FINITE ELEMENT METHOD FOR STATIC LINEAR ELASTICITY	9

Derivation and implementation of a basic 2D FE code with triangular constant strain elements. Generalization of finite element procedures for linear elasticity: interpolation and numerical integration in 1D, 2D and 3D. Deriving finite element equations - constructing variational forms; mixed methods. Accuracy and convergence; the Patch test.

UNIT III	NON LINEAR AND HISTORY DEPEND PROBLEMS	9

Small strain hypo-elastic materials - Small strain visco-plasticity - Large strain elasticity -Large strain visco-plasticity.

UNIT IV	TIME DEPENDENT AND DYNAMIC PROBLEMS	9

First-order systems - the diffusion equation - Explicit time integration – the Newmark method - Implicit time integration - Modal analysis and modal time integration.

UNIT V	STRUCTURAL ELEMENTS & INTERFACES AND CONTACT	9

Continuum Beams – Shells – Cohesive Zones - Enforcing constraints using penalty methods and Lagrange Multipliers - Contact elements (in two dimensions).

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the definition and basics on theory of elasticity
2. Derive the finite element method for static linear elasticity, solve problems.
3. Discuss the Non Linear and History depend problems, Solve problems.
4. Discuss time dependent and dynamic problems, solve problems.
5. Discuss Structural Elements & Interfaces and contact, solve problems.

TEXT BOOKS:

1. L S Srinath, Advanced Mechanics of Solids, 3rd Edition 2008. (0070139881 9780070139886).
2. J N Reddy, Introduction to Finite Element Method, 4th Edition 2020. (939038527X9789390385270).
3. R D Cook, Concepts and Applications of Finite Element Analysis, 4th Edition 2001 (978-0- 471-35605-9).
4. S Timoshenko, Theory of Elasticity, McGraw-Hill Education (India) Pvt Limited, 2010. (9780070701229-0070701229)
5. G Ramamurty, Applied Finite Element Analysis, I.K. International Publishing House Pvt. Limited, 2013 (9789380578453- 9380578458).

REFERENCES:

1. The Mechanics of Solids and Structures - Hierarchical Modeling and the Finite Element Solution (Computational Fluid and Solid Mechanics)by Miguel Luiz Buclelem and Klaus- Jurgen Bathe | 25 February 2013
2. The Finite Element Analysis of Shells - Fundamentals (Computational Fluid and Solid Mechanics)by Dominique Chapelle and Klaus-Jurgen Bathe | 27 January 2013
3. Inelastic Analysis of Solids and Structures (Computational Fluid and Solid Mechanics)by M. Kojic and Klaus-Jurgen Bathe | 22 October 2010
4. High-Resolution Methods for Incompressible and Low-Speed Flows (Computational Fluid and Solid Mechanics)by D Drikakis and W. Rider | 22 October 2010
5. Discontinuous Finite Elements in Fluid Dynamics and Heat Transfer (Computational Fluid and Solid Mechanics) by Ben Q. Li | 22 October 2010.

OBJECTIVES:

- To study the fluid flow simulation techniques and its mathematical behaviour.
- To learn the Discretize 1D and 2D systems using finite difference and finite volume techniques.
- To Formulate diffusion –convection problems using finite volume method.
- To study the flow field for different types of grids.
- To learn the need for turbulence models and its types.

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

Basics of Computational Fluid Dynamics – Governing equations– Continuity, Momentum and Energy equations – Boundary conditions & Types– Time-averaged equations for Turbulent Flow – Classification and Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations, comparison between Analytical, Experimental and Numerical techniques, Techniques of Discretization and Numerical errors.

UNIT II**FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION****9**

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion 1D and 2D problems – Use of Finite Difference and Finite Volume methods, Accuracy of solution, optimum step-size, Euler, Crank-Nicolson, and pure implicit methods, stability of schemes.

UNIT III**FINITE VOLUME METHOD FOR CONVECTION DIFFUSION****9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Computation of Boundary layer flow, von Neumann stability analysis.

UNIT IV**FLOW FIELD ANALYSIS****9**

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms, Computation of internal and external thermal boundary layer.

UNIT V**TURBULENCE MODELLING****9**

Turbulence model requirement and types, mixing length model, Two equation (k- ϵ) models – High and low Reynolds number models, LES, DNS, Mesh Generation and refinement Techniques- software tools, Stability of solver, Courant Fredrick Levy number, relaxation factor, and grid independence test.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Apply the fundamentals of CFD, and develop case specific governing equations.
2. Discuss finite difference and finite volume based analysis for steady and transient diffusion problems.
3. Implement various mathematical schemes under finite volume method for convection diffusion.
4. Solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.
5. Apply the various discretization methods, solution procedure and the concept of turbulence modelling.

TEXT BOOKS:

1. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics": The finite volume Method, Pearson Education, 2014 .
2. Ghoshdastidar, P.S., "Computational Fluid Dynamics and Heat Transfer", Cengage Learning, 2017.

REFERENCE BOOKS:

1. John. F. Wendt, "Computational Fluid Dynamics – An Introduction", Springer, 2013.
2. K Muralidhar & T.Sundararajan, Computational Fluid Flow and Heat Transfer, Narora Publishing House, 1994.
3. Suhas V, Patankar, "Numerical Heat transfer and Fluid flow", Taylor & Francis, 2009.
4. Uriel Frisch, Turbulence, Cambridge University Press, 1999.
5. Yogesh Jaluria & Kenneth E. Torrance, "Computational Heat Transfer", CRC press, 2002.

R21MEV703	THEORY ON COMPUTATION AND VISUALIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the concepts and techniques of discrete mathematics for theoretical computer science.
- To learn different formal languages and their relationship.
- To classify and construct grammars for different languages and vice-versa.
- To study Visualization, Graphical and Quantitative Information.
- To learn Visualization design and data Ink.

UNIT I REVIEW OF MATHEMATICAL THEORY 9

Sets, Functions, Logical statements, Proofs, Relations, Languages, Principal of Mathematical Induction, Strong Principle, Recursive Definitions, Structural Induction.

UNIT II REGULAR LANGUAGES AND FINITE AUTOMATA 9

Regular Expressions, Regular Languages, Application of Finite Automata, Automata with output – Moore machine & Mealy machine, Finite Automata, Memory requirement in a recognizer, Definitions, union- intersection and complement of regular languages, Non Deterministic Finite Automata, Conversion from NFA to FA - Non Deterministic Finite Automata, Conversion of NFA to NFA, Kleene's Theorem, Minimization of Finite automata, Regular And Non Regular Languages – pumping lemma.

UNIT III CONTEXT FREE GRAMMAR (CFG) AND PUSHDOWN AUTOMATA 9

Definitions and Examples, Unions Concatenations And Kleene's of Context free language, Regular Grammar for Regular Language, Derivations and Ambiguity , Unambiguous CFG and Algebraic Expressions, BacosNaur Form (BNF), Normal Form – CNF. Definitions, Deterministic PDA, Equivalence of CFG and PDA & Conversion, Pumping lemma for CFL, Intersections and Complements of CFL, Non-CFL.

UNIT IV VALUE OF VISUALIZATION 9

Information Visualization, In Readings in Information Visualization, Graphical Excellence, Graphical Integrity, Sources of Graphical Integrity In The Visual Display of Quantitative Information.

UNIT V VISUALIZATION DESIGN 9

The Power of Representation, Data-Ink and Graphical Redesign, Data-Ink Maximization and Graphical Design, Data Density and Small Multiples.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discussing the concepts and techniques of discrete mathematics for theoretical computer science.
2. Explain the different formal languages and their relationship.
3. Discussing to classify and construct grammars for different languages and vice-versa.
4. Explaining the Visualization, Graphical and Quantitative Information.
5. Applying the Visualization design and data Ink.

TEXT BOOKS:

1. Introduction to the Theory of Computation by Michael Sipser.
2. Automata Theory, Languages, and Computation By John Hopcroft, Rajeev Motowani, and Jeffrey Ullman.

REFERENCE BOOKS:

1. Introduction to Languages and the Theory of Computation, 4th by John Martin, Tata McGraw Hill
2. An introduction to automata theory and formal languages By Adesh K. Pandey, Publisher: S.K. Kataria and Sons
3. Introduction to computer theory By Deniel I. Cohen , Joh Wiley & Sons, Inc
4. Computation: Finite and Infinite By Marvin L. Minsky Prentice-Hall.

R21MEV704	COMPUTATIONAL BIO-MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Introduction of principles and concepts of bio-mechanics.
- Focuses on the studies of tissues and structure of musculoskeletal system.
- To study the mechanics of joints and human motion.
- To explain the computational approaches in biomechanics.
- To learn the quantification of forces and motion.

UNIT I INTRODUCTION TO BIOMECHANICS 9

Perspective of biomechanics, Terminologies, Kinematic and kinetic concepts for analyzing human motion, Kinetic concepts for analyzing human motion, Linear kinetics of human movement, Equilibrium, Angular kinetics of human Movement, Mechanical properties of soft tissues, bones, and muscles.

UNIT II BIOMECHANICS OF TISSUES AND STRUCTURES OF THE MUSCULOSKELETAL SYSTEM 9

Biomechanics of Bone, Biomechanics of Articular Cartilage, Tendons and Ligaments, Peripheral Nerves and Spinal Nerve Roots, Skeletal Muscle.

UNIT III BIOMECHANICS OF JOINTS AND HUMAN MOTION 9

Knee, Hip, Foot and Ankle, Lumbar Spine, Cervical Spine, Shoulder, Elbow Wrist, and Hand, Linear kinematic and kinetic aspects of human movement, angular kinematic and kinetic aspects of human movement, equilibrium and human moment.

UNIT IV COMPUTATIONAL APPROACHES IN BIOMECHANICS 9

Finite Element Analysis in Biomechanics, Computational modelling of Vancouver Periprosthetic Fracture in Femur, Scaffolds, artificial hip and knee joints, Aortic Valve.

UNIT V GAIT ANALYSIS 9

Exoskeleton design, Ergonomics, Sports mechanics, Performance Analysis, Biomechanical analysis, 3D printing.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the principles of mechanics.
2. Elaborate the tissues and structures of the musculoskeletal system
3. Discuss of joint mechanics and human motion.
4. Create Examples of computational mathematical modelling applied in biomechanics.
5. Describe the analysis of human motion.

TEXT BOOKS:

1. Susan J Hall, —Basic Biomechanics, 6th Edition, The McGraw-Hill Companies Inc., 2011
2. Jay D Humphrey and Sherry L Delange, —An Introduction to Biomechanics: Solids and Fluids, Analysis and Design, 1st edition, Springer-Verlag, 2010.

REFERENCE BOOKS:

1. Margareta Nordin and Victor H Frankel, —Basic Biomechanics of the Musculoskeletal System, 3rd Edition, Lippincott Williams and Wilkins, 2001.
2. Ozkaya, Nihat, Nordin, and Margareta, —Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation, 2nd Edition, Springer, 2009.
3. Pritam Pain, Sreerup Banerjee, Goutam Kumar Bose, Advances in Computational Approaches in Biomechanics, 2022
4. Kinetics and Dynamics: From Nano- to Bio-Scale: 12 (Challenges and Advances in Computational Chemistry and Physics)by Piotr Paneth and Agnieszka Dybala-Defratyka | 12 August 2010
5. Computational Approaches to Biochemical Reactivity: 19 (Understanding Chemical Reactivity) by Gábor Náray-Szabó and Arieh Warshel | 31 March 2002.

R21MEV705	ADVANCED STATISTICS AND DATA ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of linear regression and multiple regression
- To introduce exploratory data analysis
- To study logistic regression models for classification
- To develop the forecasting techniques for the predictions
- To introduce the time series analysis for the prediction of future behavior.

UNIT I REGRESSION 9

Introduction – Linear regression - Correlation analysis -Limitations, errors, and caveats of using regression and correlation analyses - Multiple regression and correlation analysis - Inferences about population parameters – Modeling techniques. - Coefficient of determination, Interpretation of regression coefficients, Categorical variables, heteroscedasticity, Multi-co linearity outliers, Ridge regression.

UNIT II EXPLORATORY DATA ANALYSIS 9

Rise of statistics, Data Wrangling, Data Quality. Visual encoding – Mapping Data to Visual Variables, Encoding Effectiveness, Scales & Axes, Aspect Ratio, Regression Lines, Multidimensional Data, Parallel Coordinates, Dimensionality Reduction.

UNIT III LOGISTIC AND MULTINOMIAL REGRESSION 9

Logistic function, Estimation of probability using Logistic regression, Variance, Wald Test, Hosmer Lemshow Test, Classification Table, Gini Co-efficient.

UNIT IV FORECASTING AND CAUSAL MODELS 9

Moving average, Exponential Smoothing, Casual Models.

UNIT V TIME SERIES ANALYSIS 9

Auto regression (AR), Moving Average(MA) Models, ARMA, ARIMA models , Multivariate Models.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Develop how to do regression fit for the given data.
2. Visualize the data through explanatory data analysis.
3. Classify the given data through logistic regression.
4. Analyzing forecasting techniques and causal inferences.
5. Utilize the effective time series analysis to predict/forecast the future behavior of data.

TEXT BOOKS:

1. Douglas C Montgomery and George C Runger, "Applied Statistics and Probability for Engineers", John Wiley & Sons, 2014.
2. Douglas C. Montgomery, Cheryl L. Jennings, Murat Kulachi, "Introduction to Time Series Analysis and Forecasting", Wiley, 2015.

REFERENCE BOOKS:

1. David Forsyth, 'Probability and Statistics for Computer Science', Springer; 2018.
2. Michael J. Evans, Jeffrey S. Rosenthal, 'Probability and Statistics - The Science of Uncertainty'. W H Freeman & Co, 2010.
3. Max Kuhn, Kjell Johnson, "Applied Predictive Modeling", Springer, 2014.
4. Ronald E. Walpole, Raymond H. Meyers, Sharon L. Meyers, "Probability and Statistics for Engineers and Scientists", Pearson Education, 2014.
5. Daniel T. Larose, Chantal D. Larose "Data Mining and Predictive Analytics", Wiley, 2015
6. Thomas W Miller, "Modeling Techniques in Predictive Analytics with Python and R: A guide to Data Science", Pearson Education, 2014.

OBJECTIVES:

- Applying the fundamental concepts of computer graphics and its tools in a generic framework.
- Creating and manipulating geometric models using curves, surfaces, and solids.
- Applying concept of 3D modeling, visual realism, and CAD standard practices in engineering design
- Developing mathematical models for Boundary Value Problems and their numerical solution.
- Formulating solution techniques to solve non-linear problems.

UNIT I	FUNDAMENTALS OF COMPUTER GRAPHICS	9

Design process - Computer Aided Design – Computer graphics – co-ordinate systems- 2D and 3D transformations - Graphic primitives (point, line, circle drawing algorithms) - Clipping- viewing transformation. Standards for computer graphics.

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 (B-Rep), Sweeps Representation, Constructive Solid Geometry (CSG).

UNIT III	VISUAL REALISM and CAD STANDARDS	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. Standards for computer graphics- Graphical Kernel System (GKS) - standards for exchange images- Open Graphics Library (OpenGL) - Data exchange standards - IGES, STEP, CALS etc.

UNIT IV	FINITE ELEMENT ANALYSIS	9

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of Boundary Value Problems – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

UNIT V	NON-LINEAR ANALYSIS	9

Introduction to Non-linear problems - some solution techniques- computational procedure- material non-linearity-Plasticity and visco-plasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate- Introduction to Analysis Software.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the fundamental concepts of computer graphics and its tools in a generic framework.
2. Create and manipulate geometric models using curves, surfaces and solids.
3. Discuss concept of 3D modeling , visual realism and standard CAD practices in engineering design.
4. Develop the mathematical models for one dimensional finite element problems and their numerical solutions.
5. Formulate solution techniques to solve non-linear problems.

TEXT BOOKS:

1. Ibrahim Zeid "Mastering CAD CAM" Tata McGraw-Hill Publishing Co.2007.
2. Seshu P, "Textbook of Finite Element Analysis", PHI Learning Pvt. Ltd., NewDelhi, 2012.

REFERENCE BOOKS:

1. William M Neumann and Robert F Sproul "Principles of Computer Graphics", McGraw Hill Book Co. Singapore, 1989.
2. Donald Hearn and M. Pauline Baker "Computer Graphics". Prentice Hall, Inc, 1992.
3. Foley, Wan Dam, Feiner and Hughes – "Computer graphics principles & practice", Pearson Education - 2003
4. Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth-Heinemann, 2018.
5. Reddy J.N. "Introduction to the Finite Element Method", 4thEdition, Tata McGraw Hill, 2018.

R21MEV707	MACHINE LEARNING FOR INTELLIGENT SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on Mathematical foundations necessary for Machine Learning.
- To provide knowledge on Machine Learning Algorithms.
- To develop programming skills required for Machine Learning Applications.

UNIT I INTRODUCTION TO MACHINE LEARNING 9

Real life Examples of machine Learning – Data & Machine Learning – Learning Function – Hypothesis - Parametric Machine Learning Algorithm – Non-Parametric Machine Learning Algorithm – Supervised Machine Learning – Unsupervised Machine Learning – Semi Supervised Machine Learning – Classification – Regression – Errors – Bias- Variance – Overfitting – Under fitting.

UNIT II LINEAR ALGORITHMS 9

Basics of Linear Regression – Gradient Descent Algorithm – Stochastic Gradient Descent Algorithm – Logistic Regression – Linear Discriminant analysis – Regularization - Basic of Python Programming – Exercises for linear Algorithms using Python Programming

UNIT III NON-LINEAR ALGORITHMS 9

Classification and Regression Trees (CART) – Naïve Bayes Algorithm – K Nearest Neighbors (KNN) – Learning Vector Quantization – Support Vector Machine - Exercises for Non-linear Algorithms using Python Programming

UNIT IV ENSEMBLE ALGORITHMS 9

Bagging – Bootstrap method – Bagging Aggregation – Bagged Decision Trees – Rain Forest Algorithm – Boosting ensemble method – Ada Boost Model - Exercises for ensemble Algorithms using Python Programming

UNIT V ARTIFICIAL NEURAL NETWORK (ANN) 9

Basics of Neural Network– Brain and ANN –Machine learning and ANN - Neurons -Hidden layer – Output layer – Activation function – Forward Propagation – Backward Propagation - Convolutional Neural Networks - Recurrent Neural Networks - Natural Language Processing - Exercises in Artificial Neural Network using Python Programming

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Understand the concepts of machine learning for solving various complex problems of engineering. (U)
2. Apply the knowledge machine learning to solve complex engineering problems based on regression and classification. (Ap)
3. Identify the suitable Machine learning algorithm for complex engineering problems for reaching sustained conclusions using the principles of mathematics and programming. (Ap)
4. Select and apply appropriate IT tools for modelling and prediction of the results of the complex engineering problems, understanding the limitations of the model. (Ap)
5. Design solutions for complex engineering problems to predict or forecast the results for engineering, business, health care and environmental applications (An)
6. Investigate data with Machine Learning and statistical methods to identify failure mechanisms and derive conclusions, focusing on resources. (An).

TEXT BOOKS:

1. Jason Brownlee “Master Machine Learning Algorithms”, Machine Learning Mastery Pty. Ltd., Australia, 2020
2. Aurélien Géron “Hands-On Machine Learning with Scikit-Learn and Tensor Flow” (2nd Edition), O'Reilly Media Inc., USA, 2017.

REFERENCE BOOKS:

1. Patrick Hall & Navdeep Gill, “An Introduction to Machine Learning Interpretability” (2nd Edition) by, O'Reilly Media, Inc., USA, 2018.
2. Giuseppe Bonaccorso “Machine Learning Algorithms”, PACKT PUBLISHING LIMITED, UK, 2018.
3. Vinod Chandra S.S., Artificial Intelligence & Machine Learning, PHI, 2014.
4. Simon O. Haykin, “Neural Networks and Learning Machines”, 3rd Edition, Pearson, 2009.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2							2			2
CO 2	3	2										2			2
CO 3	3	2										2			2
CO 4	3	2			3							2			3
CO 5	3	3			3	2	3		3	3		3	3		3
CO 6	3	3		3	3				3	3	3	3	3		3
R21MEV707	3	3		3	3	2	3		3	3	3	3	3		3

Ref:

3-Strong

2-Medium

1 –Weak

VERTICAL – 8: DIVERSIFIED COURSES GROUP 1

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV801	Automobile Engineering	3	0	0	3
2.	R21MEV802	Measurements and Controls	3	0	0	3
3.	R21MEV803	Design Concepts in Engineering	3	0	0	3
4.	R21MEV804	Composite Materials and Mechanics	3	0	0	3
5.	R21MEV805	Power Plant Engineering	3	0	0	3
6.	R21MEV806	Refrigeration and Air Conditioning	3	0	0	3
7.	R21MEV807	Dynamics of Ground Vehicles	3	0	0	3

OBJECTIVES:

- To familiarize the construction and working principle of various parts of an automobile.
- To impart knowledge for alternate fuels, emission control and smart vehicles.

UNIT I VEHICLE STRUCTURE**9**

Types of automobiles, vehicle construction and different layouts, chassis, frame and body, resistances to vehicle motion, vehicle aerodynamic resistance, Sensors and actuators for various engine applications.

UNIT II TRANSMISSION AND AUXILIARY SYSTEMS**9**

Clutch and its construction, need for a gearbox, Automatic gear box- gear shift mechanisms, Over drive, transfer box, propeller shaft, Differential, and rear axle, Hotchkiss Drive and Torque Tube Drive. Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system, Electronic ignition system.

UNIT III STEERING, BRAKES AND SUSPENSION SYSTEM**9**

Steering geometry and types of steering gear box, Power Steering-types, Suspension Systems - Types, Braking system - Pneumatic and Hydraulic Braking Systems, Antilock Braking System.

UNIT IV ALTERNATE FUELS AND EMISSION CONTROL**9**

Use of Natural Gas, Liquefied Petroleum Gas, Bio-diesel, Bio-ethanol, Gasohol and Hydrogen in Automobiles- safety precautions for handling hydrogen, Fuel Cell. Engine emission control by three way catalytic converter system, Particulate filters, Selective Catalytic Reduction, Exhaust gas recirculation. Emission norms and emission control techniques -Euro norms-Bharath stage norms.

UNIT V SMART VEHICLES**9**

Hybrid Vehicles, Electric vehicles, Artificial Intelligence –machine learning-deep learning-Autonomous vehicles, Introduction to Big data, blockchain, IoT for vehicles. Biometric vehicle access, Adaptive Cruise Control, Traction Control- comprehensive Vehicle Tracking, airbag, Automatic High-Beam control, Automatic Emergency Braking.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Explain the vehicle structure, transmission systems, auxiliary systems, steering, brakes and suspension, Alternate Fuels, Emission Control and smart vehicles system. (Understand)
2. Design and explain the working of basic elements in automobile transmission, auxiliary systems and brakes. (Apply)
3. Apply the automobile engineering concepts to design aerodynamic resistance model, injection system, ignition system and braking system for a vehicle using modeling software. (Apply)
4. Select possible alternate sources of energy for IC Engines and explain the Engine modifications required. (Apply)
5. Explain the emission norms and emission reduction techniques to choose and judge the suitable alternate fuel for various applications/vehicles. (Apply)
6. Examine and apply big data and IoT in smart vehicles with considering safety, societal needs and environmental constraints. (Apply)

TEXT BOOKS:

1. Kirpal Singh, "Automobile Engineering Vol. 1 &2", Standard Publishers, 13th Edition, New Delhi, 2014
2. Hand notes, "Emission norms, emission control techniques, smart vehicles, big data, IoT", Mechanical Engineering Department, SIT.

REFERENCE BOOKS:

1. K.K. Jain, R.B. Asthana, "Automobile Engineering", Tata McGraw Hill Publishers, New Delhi, 2002.
2. Heinz Heisler, "Advanced Engine Technology", Prentice Hall (India) Pvt. Ltd, 2006
3. R.K. Rajput, Automobile Engineering, Laxmi Publications (P) Ltd., New Delhi, 2007.

COURSE ARTICULATION MATRIX:
CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2				2							2	2	3	
CO 2	3				3									3	
CO 3	3				3									3	
CO 4	3													3	
CO 5	3						3	3						3	
CO 6	3						3	3						3	
R21MEV801	3				3		3	3				2	2	3	
Ref: 3-Strong 2-Medium 1 –Weak															

OBJECTIVES:

- To Identify measurement parameters and analyze errors of measurements.
- To Select and apply suitable transducer for a particular measurement.
- To identify measurement parameters and select the appropriate sensor for it.
- To Explain the working of various types of control systems of apply for specific applications.
- To apply the principle of automatic control systems to control various parameter(s).

UNIT I MEASUREMENTS AND ERROR ANALYSIS**9**

General concepts – Units and standards – Measuring instruments –sensitivity, readability, range, accuracy, precision – static and dynamic response – repeatability hysteresis – systematic and random errors –Statistical analysis of experimental data – Regression analysis – Curve fitting - calibration and Uncertainty.

UNIT II INSTRUMENTS**9**

Transducer, modifying (intermediate) and Terminal stages – Mechanical and electrical transducers, preamplifiers – charge amplifiers – filters – attenuators – D' Arsonval – CRO – Oscillographs – recorders – microprocessor- based data logging, processing and output.

UNIT III PARAMETERS FOR MEASUREMENT**9**

Dimension, displacement, velocity, acceleration, Impact – Force, torque, power- Pressure, Temperature, Heat Flux, Heat Transfer Coefficients, Humidity – Flow – Velocity - Time, frequency and phase angle – noise and sound level.

UNIT IV CONTROL SYSTEMS**9**

Basic elements – feedback principle, implication of measurements – Error detectors – final actuating elements – Two position, multi-position, floating, proportional controls – relays – servo amplifiers – servo motors – Electrical, magnetic, electronic control systems.

UNIT V APPLICATION OF CONTROL SYSTEMS**9**

Governing of speed, kinetic and process control – pressure, temperature, fluid level, flow-thrust and flight control – photo electric controls – designing of measurement and control systems for different applications.

TOTAL : 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Identify measurement parameters and analyze errors of measurements.
2. Select and apply suitable transducer for a particular measurement.
3. Identify measurement parameters and select the appropriate sensor for it.
4. Explain the working of various types of control systems of apply for specific applications.
5. Apply the principle of automatic control systems to control various parameter(s).

TEXT BOOKS:

1. Venkateshan S P, Mechanical Measurements, 2ndEdition, John Wiley & Sons, Ltd, 2015.
2. William Bolton, Instrumentation and Control Systems, 2ndEdition, Newnes, 2015.

REFERENCE BOOKS:

1. Beckwith, Marangoni and Lienhard, Mechanical Measurements, Pearson, 2013.
2. Ernest Doebelin and Dhanesh Manik, Measurement Systems, McGraw Hill InternationalEdition, 2017.
3. Holman J P, "Experimental Methods for Engineers", McGraw Hill Int. Edition, 7th Ed., 2017.
4. Nagrath I J, "Control Systems Engineering", New Age International Publishers, 2018

OBJECTIVES:

- To study the various design requirements and get acquainted with the processes involved in product development.
- To study the design processes to develop a successful product.
- To learn scientific approaches to provide design solutions.
- Designing solution through relate the human needs and provide a solution.
- To study the principles of material selection, costing and manufacturing in design.

UNIT I DESIGN TERMINOLOGY**9**

Definition-various methods and forms of design-importance of product design-static and dynamic products-various design projects-morphology of design-requirements of a good design-concurrent engineering-computer aided engineering-codes and standards-product and process cycles-bench marking.

UNIT II INTRODUCTION TO DESIGN PROCESSES**9**

Basic modules in design process-scientific method and design method-Need identification, importance of problem definition-structured problem, real life problem- information gathering - customer requirements- Quality Function Deployment (QFD)- product design specifications- generation of alternative solutions- Analysis and selection-Detail design and drawings-Prototype, modeling, simulation, testing and evaluation.

UNIT III CREATIVITY IN DESIGN**9**

Creativity and problem solving-vertical and lateral thinking-invention-psychological view, mental blocks- Creativity methods-brainstorming, synectics, force fitting methods, mind map, concept map- Theory of innovative problem solving (TRIZ) - conceptual decomposition creating design concepts.

UNIT IV HUMAN AND SOCIETAL ASPECTS IN PRODUCT DEVELOPMENT**9**

Human factors in design, ergonomics, user friendly design-Aesthetics and visual aspects environmental aspects-marketing aspects-team aspects-legal aspects-presentation aspects.

UNIT V MATERIAL AND PROCESSES IN DESIGN**9**

Material selection for performance characteristics of materials-selection for new design substitution for existing design-economics of materials-selection methods-recycling and material selection-types of manufacturing process, process systems- Design for Manufacturability (DFM) - Design for Assembly (DFA).

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Analyze the various design requirements and get acquainted with the processes involved in product development.
2. Apply the design processes to develop a successful product.
3. Apply scientific approaches to provide design solutions.
4. Design solution through relate the human needs and provide a solution.
5. Apply the principles of material selection, costing and manufacturing in design.

TEXT BOOKS:

1. Dieter. G. N., Linda C. Schmidt, "Engineering Design", McGraw Hill, 2013..
2. Horenstein, M. N., Design Concepts for Engineers, Prentice Hall, 2010.

REFERENCE BOOKS:

1. Dhillon, B. S., Advanced Design Concepts for Engineers, Technomic Publishing Co., 1998.
2. Edward B. Magrab, Satyandra K. Gupta, F. Patrick McCluskey and Peter A. Sandborn, "Integrated Product and Process Design and Development", CRC Press, 2009.
3. James Garratt, "Design and Technology", Cambridge University Press, 1996.
4. Joseph E. Shigley, Charles R. Mische, and Richard G. Budynas, "Mechanical Engineering Design", McGraw Hill Professional, 2003.
5. Sumesh Krishnan and MukulSukla, Concepts in Engineering Design, Notion Press, 2016.

R21MEV804

COMPOSITE MATERIALS AND MECHANICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To study the fundamentals of composite material strength and its mechanical behavior
- To study the analysis of fiber reinforced Laminate design for different combinations of plies with different orientations of the fiber.
- To study Thermo-mechanical behavior and study of residual stresses in Laminates during processing.
- To Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.
- To study the fundamentals of composite material strength and its mechanical.

UNIT I	INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING	9

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Q_{ij}), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

UNIT II	FLAT PLATE LAMINATE CONSTITUTE EQUATIONS	9

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

UNIT III	LAMINA STRENGTH ANALYSIS	9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure

UNIT IV	THERMAL ANALYSIS	9

Assumption of Constant C.T. E's. Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T. E's. C.T. E's for special Laminate Configurations – Unidirectional, Off- axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi-Isotropic Laminates.

UNIT V	ANALYSIS OF LAMINATED FLAT PLATES	9

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Summarize the various types of Fibers, Equations and manufacturing methods for
2. Derive Flat plate Laminate equations
3. Analyze Lamina strength
4. Analyze the thermal behavior of Composite laminates
5. Analyze Laminate flat plates.

TEXT BOOKS:

1. Gibson, R.F., "Principles of Composite Material Mechanics", Second Edition, McGraw Hill, CRC press in progress, 1994.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw Hill, 1998.

REFERENCE BOOKS:

1. Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 1990.
2. Halpin, J.C., "Primer on Composite Materials, Analysis", Technomic Publishing Co., 1984.
3. Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition – 2007.
4. Mallick, P.K., Fiber," Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.
5. Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.

OBJECTIVES:

- Providing an overview of Power Plants and detailing the role of Mechanical Engineers in their operation and maintenance.

UNIT I	BASICS OF THERMAL POWER PLANTS	9

Layout of Hydel power plant, - steam power plant -Fuel and ash handling, coal handling, choice of handling equipment, coal storage, Ash handling systems., MHD power plant - open and closed cycle.

UNIT II	STEAM POWER PLANT	9

Components of steam power plant, Combustion Equipment for burning coal - Mechanical Stokers. Pulveriser, Electrostatic Precipitator, Draught- Different Types. FBC boiler, Steam turbines, types, Surface condenser types, Cooling Towers.

UNIT III	NUCLEAR POWER PLANTS	9

Basics of Nuclear Engineering and Indian Nuclear Program me, Nuclear fission and Fusion Reaction, Layout of Nuclear Power Plants, Types of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Fast Breeder reactors (FBR) - Biological effects of Radiation, Safety & Security measures for Nuclear Power plants. Nuclear waste management.

UNIT IV	DIESEL AND GAS TURBINE POWER PLANT	9

Types of diesel plants, components, Selection of Engine type, applications-Gas turbine power plant-Fuels- Gas turbine material – open and closed cycles, Combined Power plant cycles.

UNIT V	RENEWABLE ENERGY AND ECONOMICS OF POWER PLANT	9

Geo thermal, OTEC, Biomass, Tidal, Pumped storage, Solar Photovoltaic - Solar central receiver system - Wind Power plants - Environmental hazards of all power plants, Power tariff types, Load distribution parameter, Load curve, Capital and operating cost different power plant.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the layout, construction and working of the components of various power plant. (Understand)
2. Apply the power plant engineering concepts to Identify various equipment required for power generation in different power plants. (Apply)
3. Apply the power plant engineering concepts to select the nuclear reactors and waste disposal methods to improve Nuclear power plant performance. (Apply)
4. Apply the power plant engineering concepts to identify the ways to extract power from renewable/non-conventional energy sources. (Apply)
5. Analyze the economic feasibility of power generation from renewable/nonrenewable energy systems, considering resource management and financial planning. (Analyze)
6. Apply principles of preventive engineering to analyze the environmental aspects and Safety measures of various power plant. (Analyze)

TEXT BOOKS:

1. Nag. P.K., "Power Plant Engineering", Fourth Edition, Tata McGraw – Hill Publishing Company Ltd., 2017.
2. Arora S.C, Domkundwar S, "A Course in Power Plant Engineering", DhanpatRai, 2001.

REFERENCE BOOKS:

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, 2004.
3. Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, "Power Plant Engineering", Second Edition, Standard Handbook of McGraw – Hill, 1998.
4. Ramalingam K.K, "Power Plant Engineering", SciTech Publications, 2015.
5. Nagpal G.R, "Power Plant Engineering", Khanna Publishers, 1998.
6. Rai G.D, "Introduction to Power Plant technology", Khanna Publishers, 1995.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2					2	2					2		2	2
CO 2	3					2	2					2		2	2
CO 3	3					2	2					2		2	2
CO 4	3					3	3					2		2	2
CO 5	3	3				3	3	3			3	3	3	3	3
CO 6	3	3				3	3	3					3	3	3
R21MEV805	3	3				3	3	3			3	3	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

R21MEV806	REFRIGERATION AND AIR CONDITIONING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on various refrigeration cycles, system components and refrigerants.
- To impart knowledge on Psychrometry and Air conditioning Systems.

UNIT I REFRIGERATION CYCLE 9

Thermodynamic principles of refrigeration – Vapour compression systems – Types of Vapour Compression Cycles, Use of ph charts, Cascade system, Basic air Refrigeration cycles.

UNIT II REFRIGERANTS AND SYSTEM COMPONENTS 9

Compressors – reciprocating and rotary (elementary treatment), Types of condensers, evaporators, cooling towers – Functional aspects. Refrigerants – properties – selection of refrigerants, Alternate Refrigerants, Cycling controls.

UNIT III PSYCHROMETRY 9

Psychrometric processes use of psychrometric charts – Grand and Room Sensible Heat Factors – bypass factor, requirements of comfort air conditioning, summer and Winter Air conditioning.

UNIT IV AIR CONDITIONING SYSTEMS 9

Air Conditioning Systems – Summer Air Conditioning System, Winter Air Conditioning System – Factors affecting Air Conditioning Systems – Working principles of Comfort Air Conditioning System, Centralized Air conditioning systems, Split Air conditioning systems. Indoor Air quality concepts.

UNIT V UNCONVENTIONAL REFRIGERATION CYCLES 9

Vapour Absorption system – Ejector jet, Steam jet refrigeration, Thermo electric refrigeration. Applications – ice plant – food storage plants – milk – chilling plants.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the working principle of refrigeration systems and cycle.
2. Summarize the system components and properties of refrigerants.
3. Apply the Psychrometric principles to solve problems.
4. Explain the working principles of Air conditioning systems.
5. Summarize the applications of Unconventional refrigeration cycles.

TEXT BOOKS:

1. Arora C.P, "Refrigeration and Air Conditioning", Tata McGraw Hill, New Delhi, 2013.
2. Er. R.K. Rajput, "Refrigeration and Air Conditioning", S.K. Kataria & Sons, 2012.

REFERENCE BOOKS:

1. Roy. J. Dossat, "Principles of Refrigeration", Pearson Education, 2013.
2. Khurmi RS, "Refrigeration and Air Conditioning", McGraw Hill Higher Education, 2010.
3. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd, 2005.
4. Stoecker N.F, Jones, "Refrigeration and Air Conditioning", TMH, New Delhi, 2001.

OBJECTIVES:

- To make the students to Develop physical and mathematical models to predict the dynamic response of vehicles.

UNIT I CONCEPT OF VIBRATION**9**

Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Undamped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility ratio, Base excitation. Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed.

UNIT II TYRES**9**

Tyre axis system, tyre forces and moments, tyre marking, tyre structure, hydroplaning, wheel and rim. Rolling resistance, factors affecting rolling resistance, Longitudinal and Lateral force at various slip angles, Tractive and cornering property of tire. Performance of tire on wet surface. Ride property of tyres. Various test carried on a tyre.

UNIT III VERTICAL DYNAMICS**9**

Human response to vibration, Sources of Vibration. Suspension requirements – types. State Space Representation. Design and analysis of Passive, Semi active and Active suspension using Quarter car, Bicycle Model, half car and full car vibrating model. Influence of suspension stiffness, suspension damping, and tire stiffness. Control law. Suspension optimization techniques. Air suspension system and their properties.

UNIT IV LONGITUDINAL DYNAMICS AND CONTROL**9**

Aerodynamic forces and moments. Equation of motion. Load distribution for three-wheeler and four-wheeler. Calculation of maximum acceleration, tractive effort and reaction forces for different drive vehicles. Power limited acceleration and traction limited acceleration. Estimation of CG location. Stability of vehicles resting on slope. Driveline dynamics. Braking and Driving torque. Prediction of Vehicle performance. ABS, stability control, Traction control.

UNIT V LATERAL DYNAMICS**9**

Steady state handling characteristics. Steady state response to steering input – Yaw velocity gain, Lateral acceleration gain, curvature response gain. Testing of handling characteristics. Transient response characteristics. Steering dynamics. Direction control of vehicles. Roll center, Roll axis. Stability of vehicle on banked road, during turn. Effect of suspension on cornering. Minuro Plot for Lateral Transient Response.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Develop physical and mathematical models to predict the dynamic response of vehicles
2. Apply vehicle design performance criteria and how to use the criteria to evaluate vehicle dynamic response
3. Use dynamic analyses in the design of vehicles.
4. Understand the principle behind the lateral dynamics.
5. Evaluate the longitudinal dynamics and control in an automobile.

TEXT BOOKS:

1. J. Y. Wong, "Theory of Ground Vehicles", Fourth Edition, Wiley-Interscience, 2008
2. Singiresu S. Rao, "Mechanical Vibrations," Fifth Edition, Prentice Hall, 2010
3. Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics," Society of Automotive Engineers Inc, 2014.

REFERENCE BOOKS:

1. Dean Karnopp, "Vehicle Dynamics, Stability, and Control", Second Edition, CRC Press, 2013.
2. Hans B Pacejka, "Tyre and Vehicle Dynamics," Second edition, SAE International, 2005.
3. John C. Dixon, "Tyres, Suspension, and Handling," Second Edition, Society of Automotive Engineers Inc, 1996.
4. Michael Blundell & Damian Harty, "The Multibody Systems Approach to Vehicle Dynamics", Elsevier Limited, 2004.
5. R. Nakhai Jazar, "Vehicle Dynamics: Theory and Application", Second edition, Springer, 2013.

VERTICAL – 9: DIVERSIFIED COURSES GROUP 2

S. No.	Course Code	Course Name	L	T	P	C	H
1.	R21MEV901	Maintenance Engineering	3	0	0	3	45
2.	R21MEV902	Non-traditional Machining Processes	3	0	0	3	45
3.	R21MEV903	Industrial safety	3	0	0	3	45
4.	R21MEV904	Computer Application in Design	3	0	0	3	45
5.	R21MEV905	Entrepreneurship Development	3	0	0	3	45
6.	R21MEV906	Design for Manufacturing	3	0	0	3	45
7.	R21MEV907	Power Generation Equipment Design	3	0	0	3	45

R21MEV901	MAINTENANCE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart knowledge on 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.

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 off- load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.

UNIT IV	REPAIR METHODS FOR BASIC MACHINE ELEMENTS	10

Repair methods for beds, sideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

UNIT V	REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT	8

Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Illustrate the knowledge on the principles, functions and practices for the successful management of maintenance activities in industry. (Understand)
2. Apply the concept of maintenance planning in industrial maintenance system (Apply)
3. Analyze the preventive maintenance concept by applying the knowledge of maintenance categories and understanding their societal impact (Analyze)
4. Analyze the temperature, vibration and wear debris of machine tool condition monitoring for safety maintenance. (Analyze)
5. Analyze the various failures in machine elements and identify the suitable safety precautions and repair methods, ensuring ethical responsibility (Analyze)
6. Analyze the various failures in material handling system and identify the suitable safety precautions and repair methods (Analyze)

TEXT BOOKS:

1. Srivastava S.K, “Industrial Maintenance Management”, S. Chand and Co, 1981.
2. Bhattacharya S.N, “Installation, Servicing and Maintenance”, S. Chand and Co, 1995.

REFERENCE BOOKS:

1. White E.N, “Maintenance Planning”, Gower Press, 1979.
2. Garg M.R, “Industrial Maintenance”, S. Chand & Co, 1986.
3. Higgins L.R, “Maintenance Engineering Hand book”, McGraw Hill, 5th Edition, 1988.
4. Davies, “Handbook of Condition Monitoring”, Chapman &Hall, 1996.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2										2				2
CO 2	3										2	2			3
CO 3	3	3				3	3	2			2	2			3
CO 4	3	3				3	3		3	3	2	2			3
CO 5	3	3					3	3	3	3	3	2			3
CO 6	3	3					3	3	3	3	3	2			3
R21MEV901	3	3				3	3	3	3	3	3	2			3

Ref:

3-Strong

2-Medium

1 –Weak

R21MEV902	NON-TRADITIONAL MACHINING PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To classify non-traditional machining processes and describe mechanical energy based non- traditional machining processes.
- To differentiate chemical and electro chemical energy-based processes.
- To describe thermo-electric energy-based processes
- To explain nano finishing processes.
- To introduce hybrid non-traditional machining processes and differentiate hybrid non-traditional machining processes.

UNIT I INTRODUCTION AND MECHANICAL ENERGY BASED PROCESSES 9

Introduction - Need for non-traditional machining processes - Classification of non-traditional machining processes - Applications, advantages and limitations of non-traditional machining processes - Abrasive jet machining, Abrasive water jet machining, Ultrasonic machining their principles, equipment, effect of process parameters, applications, advantages and limitations.

UNIT II CHEMICAL AND ELECTRO CHEMICAL ENERGY BASED PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Chemical machining, Electro-chemical machining, Electro-chemical honing, Electro-chemical grinding, Electro chemical deburring.

UNIT III THERMO-ELECTRIC ENERGY BASED PROCESSES 9

Principles, equipments, effect of process parameters, applications, advantages and limitations of Electric discharge machining, Wire electric discharge machining, Laser beam machining, Plasma arc machining, Electron beam machining, Ion beam machining.

UNIT IV NANO FINISHING PROCESSES 10

Principles, equipments, effect of process parameters, applications, advantages and limitations of Abrasive flow machining – Chemo mechanical polishing, Magnetic abrasive finishing, Magnetorheological finishing, Magneto rheological abrasive flow finishing.

UNIT V HYBRID NON-TRADITIONAL MACHINING PROCESSES 8

Introduction - Various hybrid non-traditional machining processes, their working principles, equipments, effect of process parameters, applications, advantages and limitations. Selection and comparison of different non-traditional machining processes.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Formulate different types of non-traditional machining processes and evaluate mechanical energy based non-traditional machining processes.
2. Illustrate chemical and electro chemical energy based processes.
3. Evaluate thermo-electric energy based processes.
4. Interpret nano finishing processes.
5. Analyze hybrid non-traditional machining processes and differentiate non- traditional machining processes.

TEXT BOOKS:

1. Adithan. M., “Unconventional Machining Processes”, Atlantic, New Delhi, India, 2009. ISBN 13: 9788126910458.
2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, India, 2019.

REFERENCE BOOKS:

1. Benedict, G.F., “Non-traditional Manufacturing Processes”, Marcel Dekker Inc., New York 1987. ISBN-13: 978-0824773526.
2. Carl Sommer, “Non-Traditional Machining Handbook”, Advance Publishing., United States, 2000, ISBN-13: 978-1575373256.
3. Golam Kibria, Bhattacharyya B. and Paulo Davim J., “Non-traditional Micromachining Processes: Fundamentals and Applications”, Springer International Publishing., Switzerland, 2017, ISBN:978-3- 319-52008-7.
4. Jagadeesha T., “Non-Traditional Machining Processes”, I.K. International Publishing House Pvt.Ltd., New Delhi, India, 2017, ISBN-13: 978-9385909122.
5. Kapil Gupta, Neelesh K. Jain and Laubscher R.F., “Hybrid Machining Processes: Perspectives on Machining and Finishing”, 1st edition, Springer International Publishing., Switzerland, 2016, ISBN- 13: 978-3319259208.

OBJECTIVES:

- To study the fundamental concept and principles of industrial safety
- To study the principles of maintenance engineering.
- To Analyzing the wear and its reduction.
- To study the faults in various tools, equipments and machines.
- To study the periodic maintenance procedures in preventive maintenance.

UNIT I INDUSTRIAL SAFETY**9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods. Concepts of Safety Management and Accident Prevention

UNIT II MAINTENANCE ENGINEERING**9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment. Hazard Identification, Risk Assessment and Control.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION**9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods. Safety in Engineering Industry.

UNIT IV FAULT TRACING**10**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes. Safety Performance Monitoring.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE**8**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, Advantages of preventive maintenance. Repair cycle concept and importance. Safety and Health Regulations

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the fundamental concept and principles of industrial safety (Understand)
2. Apply periodic maintenance procedures in preventive maintenance. (Apply)
3. Apply the principles of fire prevention in industrial settings.(Apply)
4. Apply the principles of maintenance engineering. (Apply)
5. Analyze wear and reduce it through systematic investigations and sustainable maintenance. (Analyze)
6. Evaluate faults in various tools, equipment, and machines while considering cost-effective maintenance and resource management. (Evaluate).

TEXT BOOKS:

1. L M Deshmukh, Industrial Safety Management, Tata McGraw-Hill Education, 2005.
2. Charles D. Reese, Occupational Health and Safety Management: A Practical Approach, CRC Press, 2003.

REFERENCE BOOKS:

1. Edward Ghali, V. S. Sastri, M. Elboudjaini, Corrosion Prevention and Protection: Practical Solutions, John Wiley & Sons, 2007.
2. Garg, HP, Maintenance Engineering, S. Chand Publishing.
3. J Maiti, Pradip Kumar Ray, Industrial Safety Management: 21st Century Perspectives of Asia, Springer, 2017.
4. R. Keith Mobley, Maintenance Fundamentals, Elsevier, 2011.
5. W. E. Vesely, F. F. Goldberg, Fault Tree Handbook, Create space Independent Pub, 2014.

COURSE ARTICULATION MATRIX:

CO / PO / PSO MAPPING

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														2
CO 2	3				2							2			3
CO 3	3				2	3		3				2	2		3
CO 4	3				2	3	3	3				2	2		3
CO 5	3	3		3	2		3	3	3	3		2	3		3
CO 6	3	3				3			3	3	3	2	3		3
R21MEV903	3	3		3	2	3	3	3	3	3	3	2	3	3	3

Ref:

3-Strong

2-Medium

1 –Weak

R21MEV904	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on computer applications in design.
- To understand fundamental concepts of computer graphics and its tools in a generic framework.
- To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
- To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
- To provide clear understanding of CAD systems for 3D modeling and viewing.
- To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT I	INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS	9

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software. Output primitives (points, lines, curves etc.), 2-D & 3-D transformation (Translation, scaling, rotation).

UNIT II	CURVES AND SURFACES MODELING	9

Introduction to curves - Analytical curves: line, circle and conics –curve manipulations. Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder.

UNIT III	NURBS AND SOLID MODELING	9

NURBS-Basics-curves, lines, arcs, circle and bilinear surface. Regularized Boolean set operations-primitive instancing - sweep representations - boundary representations – constructive solid Geometry.

UNIT IV	VISUAL REALISM	10

Hidden–Line–Surface–solid removal algorithms shading coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted parts using these packages.

UNIT V	ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE	8

Assembly modeling-interferences of positions and orientation-tolerances analysis–mass property calculations–mechanism simulation. Graphic sand computing standards – Open GL Data Exchange standards–IGES, STEP etc– Communication standards.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Analyze the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Design geometric models through animation and transform them into real world systems.
5. Apply appropriate Computer-Aided Design software to simulate the assembly of complex engineering parts.
6. Investigate and development work to solve real world problems by using computer applications in design finite element methods.

REFERENCES:

1. Boothroyd, G, "Assembly Automation and Product Design" Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C "Product design and manufacturing" PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams "Mathematical Elements for Computer Graphics" 2nd Edition, Tata McGraw Hill edition, 2003.
4. Donald D Hearn and M. Pauline Baker "Computer Graphics C Version", Prentice Hall, Inc., 2nd Edition, 2002.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2007.
6. William M Newman and Robert F.Sproull "Principles of Interactive Computer Graphics", McGraw Hill Book Co. 1stEdition, 2001.
7. https://onlinecourses.nptel.ac.in/noc22_cs38/preview.
8. Operating Systems: Three Easy Pieces",<https://pages.cs.wisc.edu/~remzi/OSTEP/>.
9. <https://www.cse.iitb.ac.in/~mythili/os/>.

R21MEV905	ENTREPRENEURSHIP DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To expose the students to an entrepreneur.
- To familiarize the students in financing and accounting.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrepreneur – Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

UNIT II MOTIVATION 9

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self-Rating, Business Game, Thematic Apperception Test – Stress management, Entrepreneurship Development Programs – Need, Objectives.

UNIT III BUSINESS 9

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

UNIT IV FINANCING AND ACCOUNTING 9

Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT/CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

UNIT V SUPPORT TO ENTREPRENEURS 9

Sickness in small Business – Concept, Magnitude, causes and consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Interpret the concept of entrepreneurship in economic growth. (Understand)
2. Understand the profile of the entrepreneur, classify their types and describe the role of entrepreneurship in economic growth. (Understand)
3. Identify various national and state level institutes offering entrepreneurship development program and to assess participants for the possibility of becoming successful entrepreneur. (Apply)
4. Apply suitable business opportunities for their enterprise and to prepare a project report for obtaining financial aid for their venture. (Apply)
5. Identify various sources of finance for their proposed company and to carryout break even analysis. (Apply).
6. Illustrate the reasons for sickness in small business establishments, its consequences and corrective measures and to explain suitable growth strategies for any small scale industry. (Analyze)

TEXT BOOKS:

1. S.S.Khanka “Entrepreneurial Development”, S.Chand& Company. Ltd. Ram Nagar New Delhi, 4th edition, 2012.

REFERENCE BOOKS:

1. Hisrich.R.D, Peters M P and Dean A.Shepherd, “Entrepreneurship”, 10th Edition, Tata McGraw-Hill, 2018.
2. C.B.Gupta&N.P.Srinivasan, “Entrepreneurial Development”, Sultan Chand & Sons New Delhi, Revised edition, 2015.
3. Mathew J Manimala, “Entrepreneurship Theory at the Crossroads: Paradigms and Praxis”, Dreamtech Press, 2nd edition, 2005.
4. Rabindra N. Kanungo, “Entrepreneurship and innovation”, Sage Publications, New Delhi, 1998.
5. P.C Jain,EDII, “Hand Book for New Entrepreneurs”, Oxford University Press, 2003.
6. Donald F Kuratko, “Entrepreneurship – Theory, Process and Practice”, Cengage Learning, Custom Publications, 10th edition, 2016.

OBJECTIVES:

- To introduce economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
- To learn design consideration principles of forming in the design of extruded, stamped, and forged products.
- To learn design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
- To learn design consideration principles of welding in the design of welded products.
- To learn design consideration principles of assembly in the design of assembled products.

UNIT I	INTRODUCTION AND CASTING	9

Introduction - Economics of process selection - General design principles for manufacturability; Design considerations for: Sand cast – Die cast – Permanent mold cast parts.

UNIT II	FORMING	9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts

UNIT III	MACHINING	9

Design considerations for: Turned parts – Drilled parts – Milled, planed, shaped and slotted parts– Ground parts.

UNIT IV	WELDING	9

Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment & heat treatment. Resistance welding – Design considerations for: Spot – Seam – Projection – Flash & Upset weldment.

UNIT V	ASSEMBLY	9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the economic process selection principles and general design principles for manufacturability in the development and design of products for various engineering applications. Also, apply design consideration principles of casting in the design of cast products.
2. Explain design consideration principles of forming in the design of extruded, stamped, and forged products.
3. Explain design consideration principles of machining in the design of turned, drilled, milled, planed, shaped, slotted, and ground products.
4. Explain design consideration principles of welding in the design of welded products.
5. Explain design consideration principles of assembly in the design of assembled products.

TEXT BOOKS:

1. James G. Bralla, "Handbook of Product Design for Manufacture", McGraw Hill, 1986.
2. O. Molloy, E.A. Warman, S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Springer, 1998.

REFERENCE BOOKS:

1. CorradoPoli, Design for Manufacturing: A Structured Approach, Elsevier, 2001.
2. David M. Anderson, Design for Manufacturability & Concurrent Engineering: How to Design for Low Cost, Design in High Quality, Design for Lean Manufacture, and Design Quickly for Fast Production, CIM Press, 2004.
3. Erik Tempelman, Hugh Shercliff, Bruno Ninaber van Eyben, Manufacturing and Design: Understanding the Principles of How Things Are Made, Elsevier, 2014.
4. Henry Peck, "Designing for Manufacture", Sir Isaac Pitman & Sons Ltd., 1973.
5. Matousek, "Engineering Design", Blackie & Sons, 1956.

R21MEV907	POWER GENERATION EQUIPMENT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the power generation equipments types layouts working cycles.
- To learn the fuels, combustion and burning methods of combustion system.
- To study the various boilers and its boilers parts of steam power plant.
- To study the basics of nuclear fuels and reactor classification.
- To study of techno economics and operating cost and safety of power plant.

UNIT I INTRODUCTION 9

Introduction to types, layouts and working cycles - Layouts of diesel-electric, hydro-electric, nuclear, gas turbine, steam, cogeneration, MHD and other power plants - Site selection - Reheat and regenerative steam cycles - Binary vapour cycle - Combined cycle - Topping cycle - Power plant instrumentation and control - air flow, furnace pressure, steam temperature control system - Governing system - Steam turbine.

UNIT II COMBUSTION SYSTEM 9

Fuels, combustion and burning methods - Fuel classification - Solid, liquid and gaseous - Compositions and heating values - Classification of coal - Combustion process, atmosphere and control - ESP Furnace construction - Stokers - suspension firing - pulverised fuel firing - oil and gas burners and systems - Fuel control - Burner management system - FSSS - Ash handling system.

UNIT III STEAM POWER PLANT 9

Steam generators - fire tube, water tube, forced circulation, once through, super charged, super critical, Lamont, Loeffler, Schmide, Hortmen and Velox boilers, Fluidised Bed & Circulated Fluidised Bed boilers - Natural, artificial, balanced and steam jet drafts - Simple problems - Functions of super heaters, economisers, air-heaters, deaerators, feed heaters, air ejectors - Feed pumps - Injectors - Feed water control- Condensers – Jet and surface type - Simple problems - Cooling towers.

UNIT IV NUCLEAR POWER PLANT 9

Nuclear power plant - Basics of nuclear fuels - Fission and chain reaction - Reactor classification - Boiling water, pressurised water, homogeneous, gas cooled breeding and metal cooled.

UNIT V TECHNO ECONOMICS OF POWER PLANT 9

Economics and safety - Actual load curves - Fixed and operating costs - Tariff methods for electrical energy - Peak load and variable load operations - Selection of generation type and general equipment. Introduction to safety aspects in power plants - Environmental impacts - assessment for thermal power plant.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss the power generation equipments types layouts working cycles.
2. Explain the fuels, combustion and burning methods of combustion system.
3. Discuss the various boilers and its boilers parts of steam power plant.
4. Explain the basics of nuclear fuels and reactor classification.
5. Discuss of techno economics and operating cost and safety of power plant.

TEXT BOOKS:

1. Power Plant Engineering - PK Nag
2. A Textbook of Power Plant Engineering - Rajput.

REFERENCE BOOKS:

1. Basics of Boiler and HRSG Design - Brad Buecker
2. Steam Plant Operation-Everett B. Woodruff,Herbert B. Lammers,Thomas F. Lammers
3. Nuclear Power Plant Design and Analysis Codes Development Validation and Application
2020 Edition by Jun Wang, Xin Li, Chris Allison, Judy Hohorst , Elsevier
4. A Techno-Economic Analysis of Solar Thermal Power Plant by Malik Monu and Saini R P |
8 November 2012
5. Power Plant Engineering by Dilip Vairagkar | 1 January 2019.

VERTICAL – 10: DIVERSIFIED COURSES GROUP 3

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEV1001	Advanced Vehicle Engineering	3	0	0	3
2.	R21MEV1002	Advanced Internal Combustion Engineering	3	0	0	3
3.	R21MEV1003	Casting and Welding Processes	3	0	0	3
4.	R21MEV1004	Process Planning and Cost Estimation	3	0	0	3
5.	R21MEV1005	Surface Engineering	3	0	0	3
6.	R21MEV1006	Gas Dynamics and Jet Propulsion	3	0	0	3
7.	R21MEV1007	Statistical Quality Control	3	0	0	3

OBJECTIVES:

- To introduce the basic concepts of electric vehicle and their characteristics
- To introduce different types of motors and the selection of motor for vehicle applications.
- To acquaint the student with different sensors and systems used in autonomous and connected vehicles.
- To give an overview of networking with sensors and systems.
- To introduce the modern methods of diagnosing on-board the vehicle troubles.

UNIT I ELECTRIC VEHICLES**9**

EV architectures, advantages and disadvantages, Electrical and mechanical energy storage technologies, battery management. Performance of Electric Vehicles, Tractive effort and Transmission requirement, Vehicle performance, Tractive effort in normal driving.

UNIT II ELECTRIC VEHICLE MOTORS**9**

Electric Propulsion basics, motor capacity determination, Induction motor, DC motor, Permanent Magnet Motor, Switch Reluctance Motor, Configuration, Characteristics, Performance and control of Drives.

UNIT III AUTONOMOUS AND CONNECTED VEHICLES**9**

Vehicle-to-Vehicle Technology, Vehicle to Road and Vehicle to Vehicle Infrastructure, Basic Control System, Surroundings Sensing Systems, Role of Wireless Data Networks, Advanced Driver Assistance Systems, Basics of Radar System, Ultrasonic Sonar Systems, Lidar System, Camera Technology, Basics of Wireless Technology, Receiver System.

UNIT IV AUTOMOTIVE NETWORKING**10**

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

UNIT V ON-BOARD TESTING**8**

Integration of Sensor Data to On-Board Control Systems (OBD), OBD requirements, certification, enforcement, systems, testing, Catalytic converter and Exhaust Gas Recirculation system monitoring, Introduction to Cyber-physical system.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Acquire an overview of electric vehicles and their importance in automotive.
2. Discuss the characteristics and the selection of traction motor.
3. Comprehend the vehicle-to-vehicle and autonomous technology.
4. Explain the networking of various modules in automotive systems, communication protocols and diagnostics of the sub systems.
5. Be familiar with on-board diagnostics systems.

TEXT BOOKS:

1. John G Hayes and G AbaasGoodarzi, Electric Powertrain -, 1st Edition, John Wiley & Sons Ltd., 2018.
2. Hussain T Mouftah, Melike Erol-kantarci and Samesh Sorour, Connected and Autonomous Vehicles in Smart Cities,CRC Press, 1st Edition, 2020.

REFERENCE BOOKS:

1. Dominique Paret, Multiplexed Networks for Embedded Systems, John Wiley & Sons Ltd., 2007.
2. Hong Cheng, —Autonomous Intelligent Vehicles: Theory, Algorithms Implementationll, Springer, 2011.
3. Advanced Technology Vehicles Manufacturing (ATVM) Loan Program (Energy Science, Engineering and Technology: Congressional Policies, Practices and Procedures)by Andrew M Wright and Harrison R Scott | 5 September 2012.
4. Advanced Vehicle Technology by Heinz Heisler MSc BSc FIMI MIRTE MCIT | 17 July 2002.
5. Advanced Motorsport Engineering: Units for Study at Level 3by Andrew Livesey | 1 September 2011.

R21MEV1002	ADVANCED INTERNAL COMBUSTION ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the working of Gasoline fuel injection systems and SI combustion.
- To study the working of Diesel fuel injection systems and CI combustion.
- To Identifying the source and measure it; explain the mechanism of emission formation and control methods.
- To study the Selecting alternative fuel resources and its utilization techniques in IC engines.
- To study the advanced combustion modes and future power train systems..

UNIT I SPARK IGNITION ENGINES 9

Mixture requirements – Fuel injection systems – Mono-point, Multipoint & Direct injection -Stages of combustion – Normal and Abnormal combustion, Spark Knock, Factors affecting knock, Combustion chambers.

UNIT II COMPRESSION IGNITION ENGINES 9

Diesel Fuel Injection Systems – Mechanical and Common Rail Direct Injection Systems - Stages of combustion – Knocking – Factors affecting knock –Direct and Indirect injection systems –Fuel Spray behaviour – Spray structure and spray penetration – Air motion - Combustion chambers – Turbo charging – Waste Gate, Variable Geometry turbochargers.

UNIT III EMISSION FORMATION AND CONTROL 9

Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling emissions – In-cylinder treatments – After treatment systems – Three Way Catalytic converter, Selective Catalytic Reduction, De-NO_x Catalyst, Diesel Oxidation Catalyst and Particulate Traps – Methods of emission measurement – Emission norms and Driving cycles.

UNIT IV ALTERNATIVE FUELS 10

Alcohol Fuels, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits – Utilization Methods - Engine Modifications.

UNIT V ALTERNATE COMBUSTION AND POWER TRAIN SYSTEM 8

Low Temperature Combustion - Homogeneous charge compression ignition (HCCI) – Reactivity Controlled Compression Ignition (RCCI) – Gasoline Compression Ignition – Spark Assisted HCCI - Hybrid Electric and Electric Vehicles – Fuel Cells.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the working of Gasoline fuel injection systems and SI combustion.
2. Explain the working of Diesel fuel injection systems and CI combustion.
3. Identify the source and measure it; explain the mechanism of emission formation and control methods.
4. Select alternative fuel resources and its utilization techniques in IC engines.
5. Explain advanced combustion modes and future power train systems..

TEXT BOOKS:

1. V. Ganesan, "Internal Combustion Engines", V Edition, Tata McGraw Hill, 2012.
2. John B. Heywood, "Internal Combustion Engines Fundamentals", McGraw-Hill, 1988.

REFERENCE BOOKS:

1. B.P. Pundir, "IC Engines Combustion & Emission", Narosa Publishing House, 2014.
2. Duffy Smith, "Auto Fuel Systems", The Good Heart Wilcox Company, Inc., 2003.
3. EranSher, Handbook of Air Pollution from Internal Combustion Engines: Pollutant Formation and Control, Academic Press, 1998.
4. K.K. Ramalingam, "Internal Combustion Engine Fundamentals", SciTech Publications, 2011.
5. R.B. Mathur and R.P. Sharma, "Internal Combustion Engines", Dhanpat Rai& Sons, 2007.

OBJECTIVES:

- To study the ferrous casting metallurgy and its applications.
- To study the nonferrous casting metallurgy and its applications.
- To study the ferrous welding metallurgy and its applications.
- To study the welding metallurgy of alloy steels and nonferrous metals and its applications
- To Identifying the causes and remedies of various welding defects; applying welding standards and codes.

UNIT I FERROUS CAST ALLOYS**9**

Solidification of pure metals and alloys and eutectics -Nucleation - Growth Process, Critical nucleus size- Super cooling- Niyama Criterion -G/R ratio- Cell- Dendritic - Random dendritic structure- Segregation and Coring- Eutectics-Compositions and alloys in Cast Irons, FG-CGI- SG structures, Metallic Glass- Mold dilation, Mold metal reactions- Structure and Section sensitivity Cast irons-family & microstructures-Alloying effects- Malleable Iron, ADI, Charge calculations- Effect of normal elements and alloying elements in steels- Compositional aspects and properties of alloy steels-melting procedure and composition control for carbon steels- low alloy steels - stainless steels-composition control- slag-metal reactions-desulphurization- dephosphorization, specifications for carbon steels- low alloy steels and stainless steels.

UNIT II NON-FERROUS CAST ALLOYS**9**

Copper- Aluminium- Magnesium- zinc - Nickel base alloys- melting practices - Al alloys, Mg alloys, Nickel alloys, Zinc alloys and copper alloys-modification and grain refinement of Al alloys- problems in composition control- degassing techniques -Heat Treatment of Aluminium alloys – Basics of Solution and Precipitation process. - Applications of Aluminium Alloy castings in various fields. Residual Stresses- defects in castings

UNIT III PHYSICAL METALLURGY OF WELDING**9**

Welding of ferrous materials: Iron- Iron carbide diagram, TTT and CCT diagrams, effects of steel composition, formation of different microstructural zones in welded plain-carbon steels. Welding of C-Mn and low-alloy steels, phase transformations in weld and heat - affected zones, cold cracking, role of hydrogen and carbon equivalent, formation of acicular ferrite and effect on weld metal toughness.

UNIT IV WELDING OF ALLOY STEELS AND NON-FERROUS METALS**10**

Welding of stainless steels, types of stainless steels, overview of joining ferritic and martensitic types, welding of austenitic stainless steels, Sensitization, hot cracking, sigma phase and chromium carbide formation, ways of overcoming these difficulties, welding of cast iron. Welding of non-ferrous materials: Joining of aluminium, copper, nickel and titanium alloys, problems encountered and solutions

UNIT V DEFECTS, WELDABILITY AND STANDARDS**8**

Defects in welded joints: Defects such as arc strike, porosity, undercut, slag entrapment and hot cracking, causes and remedies in each case. Joining of dissimilar materials, weldability and testing of weldments.

Introduction to International Standards and Codes.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the ferrous casting metallurgy and its applications.
2. Explain the non ferrous casting metallurgy and its applications.
3. Explain the ferrous welding metallurgy and its applications.
4. Explain the welding metallurgy of alloy steels and non ferrous metals and its applications.
5. Identify the causes and remedies of various welding defects; apply welding standards and codes.

TEXT BOOKS:

1. Heine R W, Loper C R and Rosenthal P C, "Principles of Metal Castings", Tata McGraw Hill, 2017.
2. A.K.Chakrabarthy, 'Casting Technology and Cast Alloys, Prentice Hall, 2005.

REFERENCES:

1. ASM International. Handbook Committee, ASM Handbook: Casting. Volume 15, ASM International, 2008.
2. Baldev Raj, Shankar V, Bhaduri A K, "Welding Technology for Engineers", Narosa Publications, 2009.
3. Beeley P, "Foundry Technology" Butterworth-Heinemann, 2001.
4. R.S.Parmar, 'Welding Engineering and Technology', Khanna Publishers, 2010
5. John Campbell, "Casting", Butterworth-Heinemann, 2003.

R21MEV1004	PROCESS PLANNING AND COST ESTIMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the process planning concepts to make cost estimation for various products after process planning
- To Learn the various Process Planning Activities
- To provide the knowledge of importance of costing and estimation.
- To provide the knowledge of estimation of production costing.
- To learn the knowledge of various Machining time calculations.

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 fixture selection 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 PRODUCTION COST ESTIMATION 9

Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.

UNIT V MACHINING TIME CALCULATION 9

Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planing -Machining Time Calculation for Grinding.

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Discuss and select the process, equipment and tools for various industrial products.
2. Explain the prepare process planning activity chart.
3. Explain the concept of cost estimation.
4. Compute the job order cost for different type of shop floor.
5. Calculate the machining time for various machining operations.

TEXT BOOKS:

1. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002.
2. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995..

REFERENCE BOOKS:

1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley,1998.
3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.
4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
5. K.C. Jain & L.N. Aggarwal, "Production Planning Control and Industrial Management", Khanna Publishers 1990.

OBJECTIVES:

- To study the fundamentals of surface features and different types of friction associated with metals and non-metals
- To study the different types of wear mechanism and its standard measurement.
- To study the different types of corrosion and its preventive measures
- To study the different types of surface properties and surface modification techniques
- To study the various types of materials used in the friction and wear applications.

UNIT I	SURFACES AND FRICTION	9

Basics of surfaces features – Roughness parameters – surface measurement - Cause of friction- Laws of friction – Static friction – Rolling Friction – Stick-slip Phenomenon - Friction properties of metal and nonmetals – Friction in extreme conditions – Thermal considerations in sliding contact.

UNIT II	WEAR	9

Laws of Wear - Types of Wear mechanism – wear debris analysis - Theoretical wear models - Wear of metals and nonmetals – International standards in friction and wear measurements.

UNIT III	CORROSION	9

Introduction – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.

UNIT IV	SURFACE TREATMENTS	9

Surface properties – Hydrophobic – Super hydrophobic – Hydrophilic - surface metallurgy –Surface coating Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying - New trends in coating technology – DLC – CNC – Thick coatings – Nano- engineered coatings – Other coatings, Corrosion resistant coatings.

UNIT V	ENGINEERING MATERIALS	9

Introduction – High and low friction materials - Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Bio Tribology - Nano Tribology.

Total = 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Describe the fundamentals of surface features and different types of friction associated with metals and non-metals
2. Analyze the different types of wear mechanism and its standard measurement.
3. Analyze the different types of corrosion and its preventive measures
4. Analyze the different types of surface properties and surface modification techniques
5. Analyze the various types of materials used in the friction and wear applications.

TEXT BOOKS:

1. G.W.Stachowiak and A.W.Batchelor, "Engineering Tribology", Butterworth-Heinemann, 2005.
2. S.K.Basu, S.N.Sengupta and B.B.Ahuja, "Fundamentals of Tribology", Prentice Hall of India, 2005.

REFERENCE BOOKS:

1. Fontana G., "Corrosion Engineering", McGraw Hill, 1985.
2. Halling, J. (Editor), "Principles of Tribology", MacMillan, 1984.
3. Rabinowicz.E., "Friction and Wear of materials", John Willey & Sons, 1995.
4. Williams J.A., "Engineering Tribology", Oxford University Press, 1994.
5. Joseph R. Davis, Corrosion: Understanding the Basics, ASM International, 2000..

OBJECTIVES:

- To explain the basic difference between incompressible and compressible flow.
- To impart knowledge in the phenomenon of shock waves and its effect on flow.

UNIT I	BASIC CONCEPTS AND ISENTROPIC FLOWS	9

Governing equations for compressible flows - static and stagnation properties - speed of sound and Mach number. Effect of Mach number on compressibility, isentropic flow through variable area passage ducts – Nozzle and Diffusers, Chocking of flow.

UNIT II	RAYLEIGH FLOW AND FANNO FLOW	9

Flows through constant area ducts with heat transfer (Rayleigh flow) and Friction (Fanno flow) – variation of flow properties – Use of tables and charts – Generalized gas dynamics.

UNIT III	NORMAL AND OBLIQUE SHOCKS	9

Governing equations – Variation of flow parameters across the normal and oblique shocks– Prandtl – Meyer relations – Use of table and charts – Applications.

UNIT IV	JET PROPULSION	9

Fundamentals of jet propulsion –Propulsion cycle - Power and efficiency calculations. Working of turbojet, turbofan and turbo prop engines.

UNIT V	ROCKET PROPULSION	9

Fundamentals of rocket propulsion, Types of rocket engines, Applications, Space flights.

Note: Use of Gas table is permitted in End Semester Examination

TOTAL : 45 Periods

COURSE OUTCOMES

After successful completion of this course the students will be able to:

1. Explain the various properties of compressible fluid flow, jet propulsion and rocket propulsion. (Understand)
2. Outline the environmental impact of jet and rocket propulsion engine. (Understand)
3. Apply isentropic flow concept to calculate the characteristics of flow in constant and variable area duct.(Apply)
4. Apply the concept of Isentropic flow to calculate the properties of variable area duct and shockwave.(Apply)
5. Compute the properties of a constant area duct and calculate the efficiency of jet engines using the principle of isentropic flow.(Apply)
6. Analyze the characteristics of shockwave in duct using ANSYS fluid flow software. (Analyze).

TEXT BOOKS:

1. Anderson, J.D, "Modern Compressible flow ", McGraw Hill, Third Edition, 2014.
2. S.M. Yahya, "Fundamentals of Compressible Flow", New Age International (P) Limited, New Delhi, 2018.

REFERENCE BOOKS:

1. Senthil, "Gas Dynamics and Jet Propulsion", A.R.S Publications, Chennai, 2021.
2. Zucrow N.J, "Principles of Jet Propulsion and Gas Turbines", John Wiley, New York, 2005.
3. Sutton G.P, "Rocket Propulsion Elements ", John wiley, New York,2014
4. Shapiro A.H, "Dynamics and Thermodynamics of Compressible fluid Flow", John wiley, New York, 2005.

OBJECTIVES:

- To know the fundamental and advanced knowledge of the Statistical Quality control.

UNIT I INTRODUCTION**9**

Definitions of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; The DMAIC Process, Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement).

UNIT II STATISTICAL PROCESS CONTROL**9**

Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, finding the Z score, Central limit theorem. SPC-The Magnificent Seven, Applications of SPC, Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL).

UNIT III CONTROL CHARTS FOR VARIABLES**9**

Control Charts for X-Bar and R- Charts, Statistical basis of the charts, Development and use of X bar and R charts, Interpretation of charts. Type I and Type II errors, the probability of Type II error, Numerical problems.

UNIT IV PROCESS CAPABILITY**9**

The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk} , p_p – process performance index, summary of process measures, Numerical problems. Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non-conformities per unit, Numerical problems.

UNIT V LOT-BY-LOT ACCEPTANCE SAMPLING FOR ATTRIBUTES**9**

The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans, Numerical problems, CUSUM Control Chart (basic principles of the chart for monitoring the process mean); EWMA control chart (EWMA control chart for monitoring process mean), design of an EWMA control chart.

Total = 45 Periods**COURSE OUTCOMES**

After successful completion of this course the students will be able to:

1. Acquire knowledge on the basics of Quality, Statistical Process Control, Control Charts for variables, Process capability and Acceptance Sampling. (Understand)
2. Apply the process control and acceptance sampling techniques for the given process. (Apply)
3. Apply the concept of control chart for variables and process capability to improve the quality process. (Apply)
4. Estimate the quality measures in general using relevant statistical tools. (Apply)
5. Interpret and analyze the results for statistical process control based on the charts. (Analyze)
6. Analyze the effectiveness of different acceptance sampling for attributes. (Analyze)

TEXT BOOKS:

1. Statistical Quality Control, E.L. Grant & R.S. Leavenworth, 7th Edition, McGraw- Hill.
2. Statistical Quality Control, R C Gupta, Khanna Publishers, New Delhi, 2005
3. Introduction to Statistical Quality Control, Douglas C Montgomery, Publisher: Wiley; 8th Edition.

REFERENCE BOOKS:

1. Statistical Process Control and Quality Improvement, Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. Statistical Quality Control for Manufacturing Managers, W S Messina, Wiley & Sons, Inc. New York, 1987.
3. Principles of Quality Control, Jerry Banks, Wiley & Sons, Inc. New York.

COURSE ARTICULATION MATRIX:**CO / PO / PSO MAPPING**

CO	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	2														
CO 2	3				2										2
CO 3	3				2										2
CO 4	3				3								2		3
CO 5	3	3	2		3			2	3	3		2	3		3
CO 6	3	3	2		3			2	3	3		2	3		3
R21MEV1007	3	3	2		3			2	3	3		2	3		3

Ref:

3-Strong

2-Medium

1 –Weak

LIST OF INDUSTRY DESIGNED COURSES:

S. No.	Course Code	Course Name	L	T	P	C
1.	R21UME861	Jigs and Fixtures	1	0	0	1
2.	R21UME862	Smart Materials	1	0	0	1
3.	R21UME863	Solar energy	1	0	0	1
4.	R21UME864	Work Study	1	0	0	1
5.	R21UME865	CNC programming	1	0	0	1
6.	R21UME866	Limits, Fits and Tolerances	1	0	0	1
7.	R21UME867	Solid Works	1	0	0	1
8.	R21UME868	Gear Design	1	0	0	1
9.	R21UME869	Revit MEP	1	0	0	1

OBJECTIVES :

- To understand the introduction of Jigs and fixtures
- To gain proficiency in the development of required views of the final knowledge.

UNIT I PRINCIPLES JIGS & FIXTURES**5**

Objectives of tool - Function and advantages of Jigs and fixtures – Basic elements – principles of location – Locating methods and devices – Mechanical actuation – pneumatic and hydraulic actuation Standard parts

UNIT II JIGS**5**

Introduction of jigs - Types of Jigs – Post, Turn over, Channel, latch, box, pot, angular post jigs – Indexing jigs Drill bushes and Jig buttons – Tolerances and materials used.

**UNIT
III FIXTURES****5**

Introduction of fixtures for given component General principles of milling, Lathe, boring, broaching and grinding fixtures – Assembly, Inspection and Welding fixtures – Modular fixturing systems- Quick change fixtures.

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Explain the jigs and fixtures.
2. Compare and development of jigs and fixtures.

REFERENCE BOOKS:

1. Joshi, P.H. “Jigs and Fixtures”, Second Edition, Tata McGraw Hill Publishing Co.,Ltd., New Delhi, 2010.
2. K. Venkataraman, “Design of Jigs Fixtures & Press Tools”, Tata McGraw Hill, NewDelhi, 2010.
3. Hoffman “Jigs and Fixture Design” – Thomson Delmar Learning, Singapore, 2011.

OBJECTIVES :

- The aim of this course is presents the latest on a variety of smart materials, smart structures, and propertiesand recent applications as well as the family grouping of materials.

UNIT I INTRODUCTION TO SMART MATERIALS**5**

Smart materials - Definition, Concept and classifications of smart materials - Advanced composite materials, Ceramics, Pure Glass, Gallium arsenide, Superconductors and Intelligent materials.

UNIT II SMART STRUCTURES AND PROPERTIES**7**

Components of a Smart Structure.Properties - Optical (optical bandgap engineering, nonlinear optical effects, electrochromic, photochromic and thermochromic effects). Electrical properties (piezoelectric effect). Thermo-mechanical properties (shape memory effect, self-healing).Magnetic properties (magnetoresistance). Active surface properties (photocatalytic effect, biocompatibility).

**UNIT
III****APPLICATIONS OF SMART MATERIALS****3**

Sensors (gas, vapors, temperature, strain, stress, adaptive structures). Energy (solar cells, solar absorbers, smart windows).Environment (self-cleaning surfaces).Biomedical (artificial lungs, DNA chips, smart hydrogels).Aerospace and outer space (self-healing protective surfaces, thermal radiators). Electronics and consumer products (displays, illumination, printed electronics).

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Explain the definition and types of smart materials.
2. Utilize the components of smart structures and unique properties of smart materials.
3. Categorize the applications of smart materials in various engineering field.

REFERENCE BOOKS:

1. Mel Schwartz, "Smart Materials", CRC Press, 2009.
2. A. V. Srinivasan, D. Michael McFarland, "Smart Structures, Analysis and Design", Cambridge University Press, 2001.
3. M.V. Gandhi, B.D. Thompson, "Smart Materials and Structures", Springer Science & Business Media, 1992.

OBJECTIVES :

- To gain knowledge on the various sources of renewable and non-renewable energy.
- To impart various conversion technique to tap the solar energy.

UNIT I INTRODUCTION TO SOLAR ENERGY

5

Energy – Renewable, Non – renewable, Man and Energy – Energy sources – Energy Alternatives – Devices for solar energy collection – Flat Plate Collector and Concentrated Collector.

UNIT II SOLAR ENERGY CONVERSION

5

Solar air heaters – Solar bond – Solar power plant – Solar air conditioning and refrigeration – solar cooker – solar still.

UNIT III DEVELOPMENT IN SOLAR ENERGY

5

Solar energy in agriculture – Advances in solar energy – Economic analysis of solar energy – Future of solar energy – solar Ice maker.

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Understand the different sources of availability of energy.
2. Apply the knowledge of thermal concepts for the extraction of solar energy.
3. Analysis the possibilities of getting improvement in the economy of solar energy.

REFERENCE BOOKS:

1. S P Sukhatme, J K Nayak, “Solar Energy: Principles of thermal Collection and Storage”, First Reprint, Tata McGraw – Hill, 2008.
2. Soteris A. Kalogirou, “Solar Energy Engineering: processes and Systems”, Second Edition, Academic Press, 2014.

OBJECTIVES :

- To impart knowledge about work study and dealing with work related issues in the work place.
- To familiarize the usage of standard time and allowances.

UNIT I WORK STUDY, MOTION STUDY & ERGONOMICS**7**

Work study definition; Role of work study in improving productivity; Work study procedure: Selection of jobs; Information collection and recording; Recording techniques-charts and diagrams. Motion study; Therbligs; Cycle graph and Chrono Cycle graph; Simo chart and Principles of Motion economy. Ergonomics; Work environment and Human factors.

UNIT II WORK MEASUREMENT & FACILITIES DESIGN**8**

Definition; Procedure; Performance rating; Concept of normal time; allowances. Work sampling technique. Introduction to pre - determined motion time system. Computing Standard Time. Site Selection: Factors influencing the selection of rural and urban locations of sites, Optimum decision on choice of site and analysis. Plant Layout: Types of production, Types of layouts, Advantages and Disadvantages of layout, Factors affecting layout. Design of work place layout.

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Produce a model using ergonomic principles that suitable for specified work environment.
2. Design of work place plant Layout.

REFERENCE BOOKS:

1. O.P.Khanna, "Industrial Engineering and Management" Dhanpat Rai & Sons, 2010.
2. Suresh Dalela and Saurabh Dalela "Text Book of Work Study and Ergonomics" Standard Publishers Distributors, New Delhi, 2013.

R21UME865

CNC PROGRAMMING

L	T	P	C
1	0	0	1

OBJECTIVES :

- The objective of this course is to programming of computerized numerical control equipment with hands-on practice on operations of a CNC milling and Turning.

UNIT I INTRODUCTION TO CNC

5

Functions of a machine tool - Concept of numerical control - Historical Development - Evolution of CNC - Limitations of CNC - Features of CNC.

UNIT II CNC MACHINING

10

Fundamentals of CNC milling& turning - Part programming techniques - examples -Linear interpolation- Circular interpolation- simulation.

TOTAL : 15 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Develop part programmes for given components.

REFERENCE BOOKS:

1. S K Sinha, "CNC Programming Using Fanuc", The McGraw-Hill Companies, Inc,2010.
2. Ashok Kumar Singh, "CNC Programming", Vayu Education of India; First edition (2015).
3. Hans B. Kief, Helmut A. Roschiwal, "CNC Handbook", McGraw-Hill Education: New York, 2012.

R21UME866

LIMITS, FITS AND TOLERANCES

L	T	P	C
1	0	0	1

OBJECTIVES :

- To familiarize the fundamentals of Types of fits used, limits and tolerances of dimensions methods which are to be used in industrial drawing.

UNIT I LIMITS AND FITS

7

Limits — Types of limits – Fits – Shaft and hole terminology – Clearance - Classifications of fits – System of Fits - Selection of fits – Methods of Indicating Fits on drawings - examples.

UNIT II TOLERANCES

8

Tolerances – Allowances – Unilateral and Bilateral tolerances – Methods of tolerances – Indication of tolerances on linear dimension of drawings – Indication of tolerances on angular dimension of drawings - Tolerance of form and position – Geometrical tolerances – Geometric characteristic symbols – Indication of Geometrical tolerances – Indication of Maximum material condition – Interpretation of Indication of Geometrical tolerances.

TOTAL : 15 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Apply the different types of limits and fits various types of machine parts
2. Apply the tolerance for various types of machine parts.

REFERENCE BOOKS:

1. Gopalakrishna K R, "Machine Drawing", Seventeenth Edition, Subhas Stores, Bangalore, 2003.
2. Sadhu singh, sah.P.L, "Fundamentals of machine drawing", PHI learning private limited, 2013.

OBJECTIVES :

- This course takes students through an introduction to SOLIDWORKS. Students will then move into the essentials of creating parts, assemblies and drawing. This course covers the basics of part design, editing and reusing geometry with patterns and symmetry

UNIT I INTRODUCTION TO SOLIDWORKS**3**

Starting SOLIDWORKS, Building Your First Part, Create a Part Drawing, Create an Assembly, Create an Assembly Drawing

UNIT II PART AND ASSEMBLY MODELLING**6**

Basic Part Modeling Creating Your Part with Design Intent, Remove Material, Fillets, and Holes, Creating Drawings

Assembly Modeling Getting Started, Adding More Components and Mates, Working with Assemblies,

UNIT III DETAILING & DESIGNING OF PARTS**6**

Basic Drawings Intro to Drawings, Types of Drawing Views, Dealing with Part Configurations, Dimensions, Annotations

Designing Molded & Casted Parts Introduction to Tapered and Drafted Geometries, Designing a Molded Production-ready Part, Designing a Part for Injection Molding,

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Explain the fundamental features of the SOLIDWORKS interface, including part modeling, assemblies, and drawing creation.
2. Use SOLIDWORKS tools to create basic part models, apply design features, and assemble components with appropriate mates and constraints.
3. Analyze design requirements and drawing standards to model and detail production-ready parts for casting and molding applications.

REFERENCE BOOKS:

1. Engineering Design with SOLIDWORKS 2021: A Step-by-Step Project Based Approach Utilizing 3D Solid Modeling by David C. Planchard
2. The Complete Guide to Mold Making with SOLIDWORKS 2021- Basic through Advanced Techniques.

OBJECTIVES :

- To explain the principles and procedure for the design of power Transmission components.
- To impart knowledge on the design aspects of gear boxes.
- To familiarize the usage of standard data and catalogues.

UNIT I DESIGN OF SPUR AND HELICAL GEARS**5**

Design of straight tooth spur helical gears based on strength and wear considerations – Pressure angle in the normal and transverse plane- Equivalent number of teeth-forces for helical gears - Estimating the size of the helical gears – Cross Helical Gear: Terminology-helix angles-Estimating the size of the pair of cross helical gears.

UNIT II DESIGN OF BEVEL AND WORM GEARS**5**

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.

**UNIT
III****DESIGN OF GEAR BOXES****5**

Geometric progression - Standard step ratio - Ray diagram, kinematics layout -Design of sliding mesh gear box - Constant mesh gear box – Design of multi speed gear box.

TOTAL : 15 PERIODS**COURSE OUTCOMES:**

After successful completion of this course the students will be able to:

1. Illustrate the various design of transmission system concepts for flexible elements, gears, gear boxes, brakes and clutches. (Understand)
2. Compute the various terminology of spur gear, helical gear, worm gear and bevel gears for the given problem. (Apply)
3. Design and analyze the gear boxes. (Analyze)

REFERENCE BOOKS:

1. Sundararamamoorthy.T.V, Shanmugam.N ,“Machine Design”,Anuradha Publications , Chennai, 2015.
2. Joseph Shigley,CharlesMischke,RichardBudynas and Keith Nisbett “Mechanical Engineering Design”, 10th Edition, Tata McGraw-Hill, 2015.

R21UME869

REVIT MEP

L	T	P	C
1	0	0	1

OBJECTIVES :

- This course is intended to introduce users to the software's user interface and the basic HVAC, electrical, and piping/plumbing components that make the Autodesk Revit software a powerful and flexible engineering modeling tool. The course will also familiarize users with the tools required to create, document, and print the parametric model. The examples and practices are designed to take the users through the basics of a full MEP project from linking in an architectural model to construction documents.

UNIT I Introduction to BIM and Autodesk Revit

5

BIM and Autodesk Revit - Overview of the Interface - Starting Projects - Viewing Commands - Basic Sketching and Modify Tools - Starting Systems Projects

UNIT II Working with Views

5

Modifying the View Display - Duplicating Views - Adding Callout Views - Creating Elevations and Sections - Setting up Spaces

**UNIT
III**

Heating and Cooling Loads Analysis

5

Creating Zones - Applying Color Schemes - Analyzing the Heating and Cooling Loads Basic System Tools HVAC Networks -Plumbing Networks - Advanced Systems for HVAC and Plumbing

TOTAL : 15 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Explain the fundamentals of Building Information Modeling (BIM) and the basic interface and tools of Autodesk Revit for MEP design.
2. Use Revit tools to create and document MEP systems, including HVAC and plumbing layouts, in coordination with architectural models.
3. Analyze heating and cooling loads using Revit's simulation tools to evaluate energy requirements and zone performance.

REFERENCE BOOKS:

1. Munir Hamad, Autodesk Revit 2023 for MEP: Mechanical, Electrical, and Plumbing, Publisher: Create Space Independent Publishing Platform, 2022
2. Daniel John Stine, Design Integration Using Autodesk Revit 2023, Publisher: SDC Publications, 2022

VERTICAL FOR MINOR DEGREE
VERTICAL: ENTREPRENEURSHIP

S. No.	Course Code	Course Title	L	T	P	C
1.	R21MEVG21	Foundations of Entrepreneurship	3	0	0	3
2.	R21MEVG22	Team Building and Leadership Management for Business	3	0	0	3
3.	R21MEVG23	Creativity and Innovation in Entrepreneurship	3	0	0	3
4.	R21MEVG24	Principles of Marketing Management for Business	3	0	0	3
5.	R21MEVG25	Human Resource Management for Entrepreneurs	3	0	0	3
6.	R21MEVG26	Financing New Business Ventures	3	0	0	3

COURSE OBJECTIVES:

- To develop and strengthen the entrepreneurial quality and motivation of learners.
- To impart the entrepreneurial skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of entrepreneurship and management in Technology oriented businesses.
- To empower the learners to run a Technology driven business efficiently and effectively

UNIT I INTRODUCTION TO ENTREPRENEURSHIP**9**

Entrepreneurship- Definition, Need, Scope - Entrepreneurial Skill & Traits - Entrepreneur vs. Intrapreneur; Classification of entrepreneurs, Types of entrepreneurs -Factors affecting entrepreneurial development — Achievement Motivation — Contributions of Entrepreneurship to Economic Development.

UNIT II BUSINESS OWNERSHIP & ENVIRONMENT**9**

Types of Business Ownership – Business Environmental Factors – Political-Economic-Sociological- Technological-Environmental-Legal aspects – Human Resources Mobilisation-Basics of Managing Finance- Essentials of Marketing Management - Production and Operations Planning – Systems Management and Administration

UNIT III FUNDAMENTALS OF TECHNOPRENEURSHIP**9**

Introduction to Technopreneurship - Definition, Need, Scope- Emerging Concepts- Principles - Characteristics of a technopreneur - Impacts of Technopreneurship on Society — Economy- Job Opportunities in Technopreneurship - Recent trends

UNIT IV APPLICATIONS OF TECHNOPRENEURSHIP**9**

Technology Entrepreneurship - Local, National and Global practices - Intrapreneurship and Technology interactions, Networking of entrepreneurial activities — Launching - Managing Technology based Product / Service entrepreneurship — Success Stories of Technopreneurs - Case Studies

UNIT V EMERGING TRENDS IN ENTREPRENEURSHIP**9**

Effective Business Management Strategies For Franchising - Sub-Contracting- Leasing- Technopreneurs – Agripreneurs - Netpreneurs- Portfolio entrepreneurship - NGO Entrepreneurship – Recent Entrepreneurial Developments - Local — National — Global perspectives.

TOTAL 45 : PERIODS

OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of Entrepreneurship

CO 2 Understand the business ownership patterns and environment

CO 3 Understand the Job opportunities in Industries relating to Technopreneurship
CO 4 Learn about applications of technopreneurship and successful technopreneurs
CO 5 Acquaint with the recent and emerging trends in entrepreneurship

TEXT BOOKS:

- 1) S.S.Khanka, "Entrepreneurial Development" S.Chand & Co. Ltd. Ram Nagar New Delhi, 2021.
- 2) Donal F Kuratko Entrepreneurship (11th Edition) Theory, Process, Practice by Published 2019 by Cengage Learning.

REFERENCES :

- 1) Daniel Mankani. 2003. Technopreneurship: The successful Entrepreneur in the new Economy. PrenticeHall
- 2) Edward Elgar. 2007. Entrepreneurship, Cooperation and the Firm: The Emergence and Survival of High-Technology Ventures in Europe. Eds: Jan Ulijn, Dominique Drillon, and Frank Lasch. Wiley Pub.
- 3) Lang, J. 2002, The High Tech Entrepreneur's Handbook, Ft.com.
- 4) David Sheff 2002, China Dawn: The Story of a Technology and Business Revolution,
- 5) HarperBusiness, <https://fanny.staff.uns.ac.id/files/2013/12/Technopreneur-BASED-EDUCATION-REVOLUTION.pdf>
- 6) JumpStart: A Technopreneurship Fable, Dennis Posadas, (Singapore: Pearson Prentice Hall, 2009
- 7) Basics of Technopreneurship: Module 1.1-1.2, Frederico Gonzales, President-PESO Inc; M. Barcelon, UP
- 8) Journal articles pertaining to Entrepreneurship

COURSE OBJECTIVES:

- To develop and strengthen the Leadership qualities and motivation of learners.
- To impart the Leadership skills and traits essential to become successful entrepreneurs.
- To apply the principles and theories of Team Building in managing Technology oriented businesses.
- To empower the learners to build robust teams for running and leading a business efficiently and effectively

NIT I INTRODUCTION TO MANAGING TEAMS 9

Introduction to Team - Team Dynamics - Team Formation — Stages of Team Development - Enhancing teamwork within a group - Team Coaching - Team Decision Making - Virtual Teams - Self Directed Work Teams (SDWTs) -Multicultural Teams.

UNIT II MANAGING AND DEVELOPING EFFECTIVE TEAMS 9

Team-based Organisations- Leadership roles in team-based organisations - Offsite training and team development - Experiential Learning - Coaching and Mentoring in team building - Building High-Performance Teams - Building Credibility and Trust - Skills for Developing Others - Team Building at the Top - Leadership in Teamwork Effectiveness.

UNIT III INTRODUCTION TO LEADERSHIP 9

Introduction to Leadership - Leadership Myths — Characteristics of Leader, Follower and Situation - Leadership Attributes - Personality Traits and Leadership- Intelligence Types and Leadership - Power and Leadership - Delegation and Empowerment .

UNIT IV LEADERSHIP IN ORGANISATIONS 9

Leadership Styles — LMX Theory- Leadership Theory and Normative Decision Model - Situational Leadership Model - Contingency Model and Path Goal Theory — Transactional and Transformational Leadership - Charismatic Leadership - Role of Ethics and Values in Organisational Leadership.

UNIT V LEADERSHIP EFFECTIVENESS 9

Leadership Behaviour - Assessment of Leadership Behaviors - Destructive Leadership - Motivation and Leadership - Managerial Incompetence and Derailment Conflict Management - Negotiation and Leadership- Culture and Leadership - Global Leadership – Recent Trends in Leadership.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, the student should be able to: CO 1 Learn the basics of managing teams for business.

CO 2 Understand developing effective teams for business management. CO 3 Understand the fundamentals of leadership for running a business. CO 4 Learn about the importance of leadership for business development.

CO 5 Acquaint with emerging trends in leadership effectiveness for entrepreneurs.”

REFERENCES :

1. Hughes, R.L., Ginnett, R.C., & Curphy, G.J., Leadership: Enhancing the lessons of experience, 9th Ed, McGraw Hill Education, Chennai, India. (2019).
2. Katzenback, J.R., Smith, D.K., The Wisdom of Teams: Creating the High Performance Organisations, Harvard Business Review Press, (2015).
3. Haldar, U.K., Leadership and Team Building, Oxford University Press, (2010).
4. Daft, R.L., The Leadership Experience, Cengage, (2015).
5. Daniel Levi, Group Dynamics for Teams ,4th Ed, (2014), Sage Publications.
6. Dyer, W. G., Dyer, W. G., Jr., & Dyer, J. H..Team building: Proven strategies for improving team performance, 5th ed, Jossey-Bass, (2013).

COURSE OBJECTIVES

- To develop the creativity skills among the learners
- To impart the knowledge of creative intelligence essential for entrepreneurs
- To know the applications of innovation in entrepreneurship.
- To develop innovative business models for business.

UNIT I CREATIVITY**9**

Creativity: Definition- Forms of Creativity-Essence, Elaborative and Expressive Creativities- Quality of Creativity-Existential, Entrepreneurial and Empowerment Creativities – Creative Environment- Creative Technology- - Creative Personality and Motivation.

UNIT II CREATIVE INTELLIGENCE**9**

Creative Intelligence: Convergent thinking ability – Traits Congenial to creativity – Creativity Training-- Criteria for evaluating Creativity-Credible Evaluation- Improving the quality of our creativity – Creative Tools and Techniques - Blocks to creativity- fears and Disabilities- Strategies for Unblocking- Designing Creativity Enabling Environment.

UNIT III INNOVATION**9**

Innovation: Definition- Levels of Innovation- Incremental Vs Radical Innovation-Product Innovation and Process- Technological, Organizational Innovation — Indicators- Characteristics of Innovation in Different Sectors. Theories in Innovation and Creativity- Design Thinking and Innovation- Innovation as Collective Change-Innovation as a system

UNIT IV INNOVATION AND ENTREPRENEURSHIP**9**

Innovation and Entrepreneurship: Entrepreneurial Mindset , Motivations and Behaviours- Opportunity Analysis and Decision Making- Industry Understanding - Entrepreneurial Opportunities- Entrepreneurial Strategies — Technology Pull/Market Push — Product -Market fit

UNIT V INNOVATIVE BUSINESS MODELS**9**

Innovative Business Models: Customer Discovery-Customer Segments-Prospect Theory and Developing Value Propositions- Developing Business Models: Elements of Business Models — Innovative Business Models: Elements, Designing Innovative Business Models- Responsible Innovation and Creativity.

TOTAL 45 : PERIODS

COURSE OUTCOMES:

Upon completion of this course, the student should be able to:

CO 1 Learn the basics of creativity for developing Entrepreneurship

CO 2 Understand the importance of creative intelligence for business growth

CO 3 Understand the advances through Innovation in Industries

CO 4 Learn about applications of innovation in building successful ventures

CO 5 Acquaint with developing innovative business models to run the business efficiently and effectively

SUGGESTED READINGS:

1 Creativity and Innovation in Entrepreneurship, Kankha, Sultan Chand

2 Pradip N Khandwalla, Lifelong Creativity, An Unending Quest, Tata Mc Graw Hill, 2004.

3 Paul Trott, Innovation Management and New Product Development, 4e, Pearson, 2018.

4 Vinnie Jauhari, Sudanshu Bhushan, Innovation Management, Oxford Higher Education, 2014.

5 Innovation Management, C.S.G. Krishnamacharyulu, R. Lalitha, Himalaya Publishing House, 2010.

6 Dale Timpe, Creativity, Jaico Publishing House, 2003.

7 Brian Clegg, Paul Birch, Creativity, Kogan Page, 2009.

8 Strategic Innovation: Building and Sustaining Innovative Organizations- Course Era, Raj Echambadi.

COURSE OBJECTIVES:

- To provide basic knowledge of concepts, principles, tools and techniques of marketing for entrepreneurs
- To provide an exposure to the students pertaining to the nature and Scope of marketing, which they are expected to possess when they enter the industry as practitioners.
- To give them an understanding of fundamental premise underlying market driven strategies and the basic philosophies and tools of marketing management for business owners.

UNIT I INTRODUCTION TO MARKETING MANAGEMENT**9**

Introduction - Market and Marketing — Concepts- Functions of Marketing - Importance of Marketing - Marketing Orientations - Marketing Mix-The Traditional 4Ps - The Modern Components of the Mix - The Additional 3Ps - Developing an Effective Marketing Mix.

UNIT II MARKETING ENVIRONMENT**9**

Introduction - Environmental Scanning - Analysing the Organisation's Micro Environment and Macro Environment - Differences between Micro and Macro Environment — Techniques of Environment Scanning - Marketing organization - Marketing Research and the Marketing Information System, Types and Components.

UNIT III PRODUCT AND PRICING MANAGEMENT**9**

Product- Meaning, Classification, Levels of Products — Product Life Cycle (PLC) - Product Strategies - Product Mix - Packaging and Labelling - New Product Development - Brand and Branding - Advantages and disadvantages of branding Pricing - Factors Affecting Price Decisions - Cost Based Pricing - Value Based and Competition Based Pricing - Pricing Strategies - National and Global Pricing.

UNIT IV PROMOTION AND DISTRIBUTION MANAGEMENT**9**

Introduction to Promotion — Marketing Channels- Integrated Marketing Communications (IMC) - Introduction to Advertising and Sales Promotion — Basics of Public Relations and Publicity - Personal Selling - Process - Direct Marketing - Segmentation, Targeting and Positioning (STP)-Logistics Management- Introduction to Retailing and Wholesaling.

UNIT V CONTEMPORARY ISSUES IN MARKETING MANAGEMENT**9**

Introduction - Relationship Marketing Vs. Relationship Management - Customer Relationship Management (CRM) - Forms of Relationship Management - CRM practices - Managing Customer Loyalty and Development — Buyer-Seller Relationships- Buying Situations in Industrial / Business Market - Buying Roles in Industrial Marketing - Factors that Influence Business - Services Marketing - E-Marketing or Online Marketing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of this course, the students will be able to:

CO1 Have the awareness of marketing management process

CO 2 Understand the marketing environment

CO 3 Acquaint about product and pricing strategies

CO 4 Knowledge of promotion and distribution in marketing management.

CO 5 Comprehend the contemporary marketing scenarios and offer solutions to marketing issues.

REFERENCES:

1. Marketing Management, Sherlekar S.A, Himalaya Publishing House, 2016.
2. Marketing Management, Philip Kotler and Kevin Lane Keller, PHI 15th Ed, 2015.
- 3 Marketing Management- An Indian perspective, Vijay Prakash Anand, Biztantra, Second edition, 2016.
4. Marketing Management Global Perspective, Indian Context, V.S.Ramaswamy &S.Namakumari, Macmillan Publishers India,5th edition, 2015.
5. Marketing Management, S.H.H. Kazmi, 2013, Excel Books India.
6. Marketing Management- text and Cases, Dr. C.B.Gupta & Dr. N.Rajan Nair, 17th edition, 2016.

R21MEVG25 HUMAN RESOURCE MANAGEMENT FOR ENTREPRENEURS

L	T	P	C
3	0	0	3

OBJECTIVES:

- 1) To introduce the basic concepts, structure and functions of human resource management for entrepreneurs.
- 2) To create an awareness of the roles, functions and functioning of human resource department.
- 3) To understand the methods and techniques followed by Human Resource Management practitioners.

UNIT I INTRODUCTION TO HRM**9**

Concept, Definition, Objectives- Nature and Scope of HRM - Evolution of HRM - HR Manager Roles- Skills - Personnel Management Vs. HRM - Human Resource Policies - HR Accounting - HR Audit - Challenges in HRM.

UNIT II HUMAN RESOURCE PLANNING**9**

HR Planning - Definition - Factors- Tools - Methods and Techniques - Job analysis- Job rotation- Job Description - Career Planning - Succession Planning - HRIS - Computer Applications in HR - Recent Trends

UNIT III RECRUITMENT AND SELECTION**9**

Sources of recruitment- Internal Vs. External - Domestic Vs. Global Sources -eRecruitment - Selection Process- Selection techniques -eSelection- Interview Types- Employee Engagement.

UNIT IV TRAINING AND EMPLOYEE DEVELOPMENT**9**

Types of Training - On-The-Job, Off-The-Job - Training Needs Analysis — Induction and Socialisation Process - Employee Compensation - Wages and Salary Administration — Health and Social Security Measures- Green HRM Practices

UNIT V CONTROLLING HUMAN RESOURCES**9**

Performance Appraisal — Types - Methods - Collective Bargaining - Grievances Redressal Methods — Employee Discipline — Promotion — Demotion - Transfer — Dismissal - Retrenchment - Union Management Relationship - Recent Trends

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course the learners will be able:

CO 1 To understand the Evolution of HRM and Challenges faced by HR Managers

CO 2 To learn about the HR Planning Methods and practices.

CO 3 To acquaint about the Recruitment and Selection Techniques followed in Industries.

CO 4 To know about the methods of Training and Employee Development.

CO 5 To comprehend the techniques of controlling human resources in organisations.

REFERENCES:

- 1) Gary Dessler and Biju Varkkey, Human Resource Management, 14e , Pearson, 2015.
- 2) Mathis and Jackson, Human Resource Management, Cengage Learning 15e, 2017.
- 3) David A. Decenzo, Stephen.P.Robbins, and Susan L. Verhulst, Human Resource Management, Wiley, International Student Edition, 11th Edition, 2014
- 4) R. Wayne Mondy, Human Resource Management, Pearson , 2015.
- 5) Luis R.Gomez-Mejia, David B.Balkin, Robert L Cardy. Managing Human Resource. PHI Learning. 2012
- 6) John M. Ivancevich, Human Resource Management,12e, McGraw Hill Irwin,2013.
- 7) K. Aswathappa, Sadhna Dash , Human Resource Management - Text and Cases , 9th Edition, McGraw Hill,2021.
- 8) Uday Kumar Haldar, Juthika Sarkar. Human Resource management. Oxford. 2012

COURSE OBJECTIVES:

- To develop the basics of business venture financing.
- To impart the knowledge essential for entrepreneurs for financing new ventures.
- To acquaint the learners with the sources of debt and equity financing.
- To empower the learners towards fund raising for new ventures effectively.

UNIT I ESSENTIALS OF NEW BUSINESS VENTURE 9

Setting up new Business Ventures — Need - Scope - Franchising - Location Strategy, Registration Process - State Directorate of Industries- Financing for New Ventures - Central and State Government Agencies - Types of loans — Financial Institutions - SFC, IDBI, NSIC and SIDCO.

UNIT II INTRODUCTION TO VENTURE FINANCING 9

Venture Finance – Definition – Historic Background - Funding New Ventures- Need – Scope – Types -Cost of Project - Means of Financing - Estimation of Working Capital - Requirement of funds – Mix of Debt and Equity - Challenges and Opportunities.

UNIT III SOURCES OF DEBT FINANCING 9

Fund for Capital Assets - Term Loans - Leasing and Hire-Purchase - Money Market instruments – Bonds, Corporate Papers – Preference Capital- Working Capital Management- Fund based Credit Facilities - Cash Credit - Over Draft.

UNIT IV SOURCES OF EQUITY FINANCING 9

Own Capital, Unsecured Loan - Government Subsidies , Margin Money- Equity Funding - Private Equity Fund- Schemes of Commercial banks - Angel Funding – Crowdfunding- Venture Capital.

UNIT V METHODS OF FUND RAISING FOR NEW VENTURES 9

Investor Decision Process - Identifying the appropriate investors- Targeting investors- Developing Relationships with investors - Investor Selection Criteria- Company Creation- Raising Funds - Seed Funding- VC Selection Criteria — Process- Methods- Recent Trends

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course, the students should be able to:

CO 1 Learn the basics of starting a new business venture.

CO 2 Understand the basics of venture financing.

CO 3 Understand the sources of debt financing.

CO 4 Understand the sources of equity financing.

CO 5 Acquaint with the methods of fund raising for new business ventures.

REFERENCES :

- 1) Principles of Corporate Finance by Brealey and Myers et al., 12TH ed, McGraw Hill Education (India) Private Limited, 2018
- 2) Prasanna Chandra, Projects : Planning ,Analysis,Selection ,Financing,Implementation and Review, McGraw Hill Education India Pvt Ltd ,New Delhi , 2019.
- 3) Introduction to Project Finance. Andrew Fight, Butterworth-Heinemann, 2006.
- 4) Metrick, Andrew; Yasuda, Ayako. Venture Capital And The Finance Of Innovation. Venture Capital And The Finance Of Innovation, 2nd Edition, Andrew Metrick And Ayako Yasuda, Eds., John Wiley And Sons, Inc, 2010.
- 5) Feld, Brad; Mendelson, Jason. Venture Deals. Wiley, 2011.
- 6) May, John; Simons, Cal. Every Business Needs An Angel: Getting The Money You Need To Make Your Business Grow. Crown Business, 2001.
- 7) Gompers, Paul Alan; Lerner, Joshua. The Money Of Invention: How Venture Capital Creates New Wealth. Harvard Business Press, 2001.
- 8) Camp, Justin J. Venture Capital Due Diligence: A Guide To Making Smart Investment Choices And Increasing Your Portfolio Returns. John Wiley & Sons, 2002.
- 9) Byers, Thomas. Technology Ventures: From Idea To Enterprise. McGraw-Hill Higher Education, 2014.
- 10) Lerner, Josh; Leamon, Ann; Hardyman, Felda. Venture Capital, Private Equity, And The Financing Of Entrepreneurship. 2012.

COURSE OFFERED TO OTHER DEPARTMENT

SEMESTER - I

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
1.	ES	R21UME110	Engineering Drawing and Design (Only for CSD)	3	0	0	3	45
2.	ES	R21UME226	Basic Civil and Mechanical Engineering (For EEE Only)	3	0	0	3	45

SEMESTER - II

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
1.	ES	R21UME209	ENGINEERING DRAWING	1	3	0	4	60

ENGINEERING DRAWING AND DESIGN	L	T	P	C
R21UME110	3	0	0	3
(Only for CSD)				

OBJECTIVES:

- To develop in students graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings
- To impart knowledge in development of surfaces, isometric and perspective projections

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 3D MODELING 8

Conics – Construction of ellipse, Parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of squard and circle.

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations, 3D modelling – types – solid, wireframe, and surface.

UNIT II PROJECTION OF SOLIDS 9

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to Horizontal plane (HP) only.

UNIT III DEVELOPMENT OF SURFACES 9

Development of lateral surfaces of simple and truncated solids inclined to Horizontal plane (HP) only – Prisms, pyramids, cylinders and cones

UNIT IV ISOMETRIC AND PERSPECTIVE VIEWS 9

Principles of isometric projection – isometric scale – isometric projections of simple solids, truncated prisms, pyramids, cylinders and cones when cutting plane inclined to Horizontal plane (HP) only.

Perspective projection of prisms, pyramids and cylinders by visual ray method.

UNIT V ORTHOGRAPHIC PROJECTION

9

Representation of three dimensional objects – General principles of orthographic projection

– Need for importance of multiple views and their placement – First angle projection – layout views

– Developing visualization skills of multiple views from pictorial views of objects.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Construct the conic curves, involutes and cycloid and 3D modeling solids. (Apply)
2. Illustrate simple solids like prisms, pyramids, cylinder and cone and draw the development of simple solids. (Apply)
3. Prepare isometric drawings of simple solids from orthographic views. (Apply)
4. Draw the perspective projections of simple solids. (Apply)
5. Prepare orthographic views from isometric drawings. (Apply)
6. Analyze the projections of various solid models using different resting conditions. (Analyze)

TEXT BOOKS:

1. Natrajan K.V., “A Text Book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2018.
2. Bhattacharya N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 53rd Edition, 2019.
3. Parthasarathy, N. S. and Vela Murali, “Engineering Drawing”, Oxford University Press, 2015

REFERENCE BOOKS:

1. Venugopal K., and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, (2008).
2. Gopalakrishnan K.R., “Engineering Drawing” (Vol .I&II), Subhas Publications,(1998).
3. DhananjayA. Jolhe, “Engineering Drawing with an introduction to Auto CAD”, Publishing Company Limited, (2008).
4. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, McGraw Hill, 2nd Edition, 2019.
5. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition,2017.
6. 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.
7. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson Education India,2nd Edition, 2009

R21UME226	BASIC CIVIL AND MECHANICAL ENGINEERING	L	T	P	C
	(Course offered to EEE Department)	3	0	0	3

OBJECTIVES :

- To understand the fundamentals of thermal systems
- To understand the basics of building construction and infrastructures

A – CIVIL ENGINEERING

UNIT I SURVEYING AND CIVIL ENGINEERING MATERIALS 9

Surveying:

Objects – types – classification – principles – measurements of distances – angles –leveling – determination of areas – illustrative examples.

Civil Engineering Materials:

Bricks – stones – sand – cement – concrete – steel sections

UNIT II BUILDING COMPONENTS AND STRUCTURES 9

Foundations:

Types, bearing capacity – Requirement of good foundations - Superstructure: Brick masonry – stone masonry – beams – columns – lintels – roofing – flooring – plastering – Mechanics – Internal and external forces – stress – strain – elasticity – Types of Bridges and Dams – Basics of Interior Design and Landscaping.

B – MECHANICAL ENGINEERING

UNIT III POWER PLANT ENGINEERING 9

Introduction, Classification of Power Plants – Working principle of steam, Gas, Diesel, Hydro-electric and Nuclear Power plants – Merits and Demerits – Pumps and turbines – working principle of Reciprocating pumps (single acting and double acting) – Centrifugal Pump.

UNIT IV IC ENGINES 9

Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Boiler as a power plant.

UNIT V REFRIGERATION AND AIR CONDITIONING SYSTEM 9

Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator – Window and Split type room Air conditioner

TOTAL : 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Summarize the measurement of landscape and different building materials with norms. (Apply)
2. Classify the different building structure and its applications relevant to civil engineering practice. (Apply)
3. Interpret the ideas of variety of energy sources considering the norms of engineering practice. (Understand)
4. Explain the working principle of I.C engines. (Understand)
5. Discuss the working principle of Refrigeration and Air conditioning systems. (Understand)
6. Explain the energy sources and operating principles of power plants in order to analyse the engineering problem. (Understand)

TEXT BOOKS:

1. Shanmugam G. and Palanichamy M.S., "Basic Civil and Mechanical Engineering", Tata Mc-Graw Hill Publishing Co., New Delhi, 2012.
2. Venugopal K., Prabhu Raja V., and Sreekanjana G., "Basic Civil and Mechanical Engineering", Anuradha Publications, Third Edition 2010.

REFERENCE BOOKS:

1. Ramamrutham S., "Basic Civil Engineering", Dhanpat Rai, Publishing Co. (P) Ltd, 2008.
2. Seetharaman S., "Basic Civil Engineering", Anuradha Agencies, 2005.
3. Shantha Kumar S.R.J., "Basic Mechanical Engineering", Hi-Tech Publications, Mayiladuthurai, 2000.

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1	2					3	2	3							2
CO.2	2					3	3	2							2
CO.3	2					2	2	3							2
CO.4	2														2
CO.5	2					2		2							2
CO.6	2					2		2							2
R21UME226	2					3	3	3							2

Ref: 3 - Strong 2 - Medium 1 – Weak

OBJECTIVES:

- To develop student's graphic skill for communication of concepts, ideas and design of engineering products and expose them to existing national standards related to technical drawings.
- To impart knowledge in development of surfaces and isometric projections.

CONCEPTS AND CONVENTIONS (NOT FOR EXAMINATION)**2**

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, PROJECTION OF POINTS AND LINES**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 and circle — Drawing of tangents and normal to the above curves.

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.

UNIT II PROJECTION OF SOLIDS**12**

Projection of simple solids like prisms, pyramids, cylinder and cone with axis is parallel, perpendicular and inclined to one of the plane.

UNIT III SECTION OF SOLIDS**10**

Section of solids - simple position with cutting plane parallel, perpendicular and inclined to one of the plane.

UNIT IV DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTIONS**12**

Development of lateral surfaces of simple and truncated solids - Prisms, pyramids, cylinders and cones - Development of lateral surfaces of sectioned solids.

Principles of isometric projection – isometric scale – isometric view - isometric projections of simple solids and cut solids.

Representation of Three Dimensional objects – General principles of orthographic projection- Need for importance of multiple views and their placement – First angle projection – layout views. Developing visualization skills of multiple views (Front, top and side views) from pictorial views of objects. Perspective projection of simple solids- Prisms, pyramids and cylinders by visual ray method.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Draw orthographic projections of basic geometrical entities in various positions and translate the Geometric information of engineering objects into engineering drawings. (Understand)
2. Apply the concepts of plane curves and principles of orthographic and perspective projections to draw conic curves, involutes, cycloid, projections of solids and sections of solids. (Apply)
3. Develop lateral surfaces of regular and sectioned solids. . (Apply)
4. Prepare isometric drawings of simple solids from orthographic views. (Apply)
5. Construct orthographic projection from the given pictorial view. (Apply)
6. Analyze the projections of various solid models using different resting conditions. (Analyze)

TEXT BOOKS:

1. Natarajan K.V., “A Text book of Engineering Graphics”, Dhanalakshmi Publishers,(2006).
2. Bhatt N.D., “Engineering Drawing”, Charotar Publishing House,(2012).

REFERENCE BOOKS:

1. Venugopal K., and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, (2008).
2. Gopalakrishnan K.R., “Engineering Drawing” (Vol.I&II), 23rd edition, Subhas Publications.(2014).
3. Dhananjay A. Jolhe, “Engineering Drawing with an introduction to Auto CAD”, Tata McGraw Hill Publishing Company Limited,(2012).
4. Saravanan M, Bensan Raj J, Ganesh Kumar S, “Engineering Graphics”, JBR Tri sea Publishers, Nagarcoil,2020.
5. Rameshbabu V, “Engineering Graphics”, VRB Publishers, 2023

COURSE ARTICULATION MATRIX:

CO/PO/PSO MAPPING

CO	POs												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO.1															2
CO.2	3									3					2
CO.3	3									3			3		2
CO.4	3									3			3		2
CO.5	3									3			3		2
CO. 6	3	2			3					3			3		2
R21UME209	3	2			3					3			3		2

Ref: 3 - Strong

2-Medium

1 –Weak