SYLLABUS

(With effect from 2023 -24)

ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕ ವರ್ಷ 2023-24)

Bachelor Degree
In

Mechanical Engineering

V & VI Semester

Out Come Based Education
With
Choice Based Credit System

[National Education Policy Scheme]

P.E.S. College of Engineering, Mandya - 571 401, Karnataka

[An Autonomous Institution affiliated to VTU, Belagavi,
Grant – in – Aid Institution (Government of Karnataka),
Accredited by NBA (All UG Programs), NAAC and Approved by AICTE, New Delhi]

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ
(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

Ph : 08232- 220043, Fax : 08232 – 222075,Web : www.pescemandya.org

VISION

"PESCE shall be a leading institution imparting quality Engineering and Management education developing creative and socially responsible professionals."

MISSION

- *Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching-learning practices.*
- *Impart engineering and managerial skills through competent and committed faculty using outcome based educational curriculum.*
- *Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs.*
- *Promote research, product development and industry-institution interaction.*

QUALITY POLICY

Highly committed in providing quality, concurrent technical education and continuously striving to meet expectations of stake holders.

CORE VALUES

***P**rofessionalism*
***E**mpathy*
***S**ynergy*
***C**ommitment*
***E**thics*

About Department of Mechanical Engineering

The Department of Mechanical Engineering was established in the year 1962 during the origination of the institute. The department was granted academic autonomy in the year 2009. The department presently offers B.E in Mechanical Engineering, M Tech in Machine Design, M.Sc., (Engg.) by research and research leading to Ph.D. The present intake capacity of the department is 120 for BE, 24 for M Tech Machine Design. The department has a faculty-student ratio of 1:20 for UG courses and 1:12 for PG courses. The department has well established laboratories to meet the academic requirements of UG and PG programmes and a skilled technical faculty to train the students. The department has its own library which has a collection of about 4600 reference books. The department is accredited with NBA for 3Years in 2019. The department regularly organizes industrial visits, technical talk by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current corporate developments. The students are encouraged to undergo industrial training as well as to take up industry oriented projects during their academic course. Mechanical Engineering Association (MEA), formed by the students and faculty of the department regularly organizes co-curricular and extracurricular activities for the students.

Department Vision

"Be a department well recognized for its ability to develop competent mechanical engineers capable of working in global environment"

Department Mission

The Mission of the Department of Mechanical Engineering is to:

- Provide quality education by competent faculty.
- Provide adequate infrastructure and learning ambience for the development of essential technical skills.
- Inculcate a sense of higher education and research orientation.
- Foster industry interaction.

Program Educational Objectives (PEOs)

The Department of Mechanical Engineering has formulated the following programme educational objectives for the under-graduate program in Mechanical Engineering:

The Mechanical Engineering graduates will be able to:

PEO1: Use the fundamentals of basic science, mathematics and mechanical engineering, to pursue their career as engineers as well as to lead and manage teams in global organizations.

PEO2: Pursue advanced education, research and development and engage in the process of life-long learning.

PEO3: Become entrepreneurs in a responsible, professional and ethical manner to serve the society.

Program Specific Outcomes (PSOs)

Engineering graduates should be able to:

PSO1: Apply conceptual knowledge with practical engagement that has real life problems by integrating different domains of mechanical engineering.

PSO2: Utilize the modern tools and emerging technologies with technical skills to design, develop and analyse mechanical systems through multidisciplinary approach.

Program Outcomes (POs)

Engineering Graduates will be able to:

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

	Bachelor of Engineering (V – Semester)										
Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week				Credits	Examination Marks		
				L	T*	P	PJ		CIE	SEE	Total
1	P21ME501	Management, Entrepreneurship and Professional Ethics	ME	3	-	-	-	3	50	50	100
2	P21ME502	Design of Machine Elements-I	ME	3	-	-	-	3	50	50	100
3	P21ME503X	Professional Elective Course - I	ME	3	-	-	-	3	50	50	100
4	P21ME504	Theory of Machine- I	ME	3	-	2	-	4	50	50	100
5	P21MEO505X	Open Elective – I	ME	3	-	-	-	3	50	50	100
6	P21MEL506	Energy Conversion Laboratory	ME	-	-	2	-	1	50	50	100
7	P21INT507	Internship - II	ME	-	-	-	-	2	-	100	100
8	P21HSMC508	Employability Enhancement Skills – V	HSMC	1	-	-	-	1	50	50	100
9	P21UHV509	Social Connect and Responsibility	ME	1	-	-	-	1	100	-	100
	Total							21			

Professional Elective Course–I (P21ME503X)		Open Elective–I (P21MEO505X)	
Course Code	Course Title	Course Code	Course Title
P21ME5031	Theory of Elasticity	P21MEO5051	Mechatronics and Microprocessor
P21ME5032	Non Traditional Machining	P21MEO5052	Robotics and Automation
P21ME5033	Aircraft and Rocket Propulsion	P21MEO5053	Experimental Stress Analysis
P21ME5034	Design of Experiments	P21MEO5054	Fundamentals of Thermal Sciences

Bachelor of Engineering (VI –Semester)											
Sl. No.	Course Code	Course Title	Teaching Department	Hrs / Week				Credits	Examination Marks		
				L	T*	P	PJ		CIE	SEE	Total
1	P21ME601	Design of Machine Elements-II	ME	3	-	-	-	3	50	50	100
2	P21ME602X	Professional Elective Course–II	ME	3	-	-	-	3	50	50	100
3	P21ME603X	Professional Elective Course–III	ME	3	-	-	-	3	50	50	100
4	P21ME604	Heat and Mass Transfer	ME	3	-	2	-	4	50	50	100
5	P21MEO605X	Open Elective – II	ME	3	-	-	-	3	50	50	100
6	P21MEL606	Computer Aided Modeling and Analysis Lab	ME	-	-	2	-	1	50	50	100
7	P21MEMP607	Mini – Project	ME	-	-	2	2	2	50	50	100
8	P21HSMC608	Employability Enhancement Skills - VI	HSMC	1	-	-	-	1	50	50	100
9	P21UHV609	Universal Human Values and Professional Ethics	ME	1	-	-	-	1	50	50	100
	Total							21			

Professional Elective Course–II (P21ME602X)		Professional Elective Course–III (P21ME603X)		Open Elective – II (P21MEO605X)	
Course Code	Course Title	Course Code	Course Title	Course Code	Course Title
P21ME6021	Computer Integrated Manufacturing	P21ME6031	Advanced Engineering Materials	P21MEO6051	Alternate Fuels, Energy Conversion and Conservation
P21ME6022	Finite Element Methods	P21ME6032	Electric and Hybrid Vehicles	P21MEO6052	Introduction to Finite Element Methods
P21ME6023	Heating, Ventilation and Air Conditioning	P21ME6033	Control Engineering	P21MEO6053	Maintenance Engineering
P21ME6024	Materials Selection and Failure Analysis	P21ME6034	Production Management	P21MEO6054	Operations Research
		P21ME6035	Theory of Plasticity		

MANAGEMENT, ENTREPRENEURSHIP AND PROFESSIONAL ETHICS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21ME501		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

Enable the students to understand the basic concepts of Management, Entrepreneurship, and Organization.

Provide complete insight regarding the various organizational behavior, professional ethics, personality traits and stress management.

Course Content

UNIT-I

Introduction: Management -Introduction, Meaning, Evolution of Management Thought, Nature, Objectives, Importance, Difference between Administration and Management, Levels of Management, Functions of Management, **Planning-** Definition, Features, Importance of planning, **Organization structure**-Definitions, Importance, Principles, Organization Chart, Span of Control, Centralization and Decentralization of Authority. **Directing-**Definitions, Importance, Principles of Directing, **Controlling-**Definitions, Need of Controlling, Types of Control, Control Techniques**.**

8 Hrs

Self-Study Component: Steps in the Controlling Process.

UNIT-II

Entrepreneurship: Meaning of Entrepreneur, Evolution of Entrepreneur concept, Characteristics of Entrepreneur, Functions of Entrepreneur, Types of entrepreneur, Stages in entrepreneurial process, Role of entrepreneurs in economic development of country, barriers to entrepreneurship. **Business Organizations and Business Environment:** Introduction to various form of business organization, sole proprietorship, partnership, corporations, Limited Liability, company, Liberalization, Privatization and Globalization in India. Intellectual Property Rights (IPR), Types of IPRs.

8 Hrs

Self-Study Component: Development of Entrepreneurship in India. Support for MSME, Women empowerment by state and central financial intuitions.

UNIT-III

Organizational Behavior: Introduction, Definitions, Nature, Goals, Importance, Approaches to Organizational, **Attitude-** Meaning, Definition, Types, Components, Attitudes and Behaviour, Changing Attitudes in the Workplace; **Perception-**Perception, Perceptual Process, Factors Influencing Perception; **Personality-**Definitions, Factors Influencing Personality, Personality Traits, Personality Tools and Tests; **Motivation-**Definitions, Process of Motivation (Cycle of Motivation), Nature, Importance, Types, X and Y theories of Motivation.

8 Hrs

Self-Study Component: Decision-making, steps in Decision-making.

UNIT-IV

Organizational Culture- Definitions of Organizational Culture, Strong v/s Weak Culture, Characteristics, Types, Levels, Dimensions, Creating Organizational Culture, Changing Organizational Culture. **Group Dynamics-** Meaning of Group, Group Characteristics, Classification of Groups, **Group Behavior**, Impact of Group on Individual’s Behaviour, Impact of External Factors on Group Behaviour. **Teamwork-** Nature of Teams, Team Characteristics, Teams Versus Groups, Teamwork, Processes of Teamwork, Creating Effective Teams.

8 Hrs

Self-Study Component: Types of Teams and Reasons for Team Failure, Concepts of Leadership.

UNIT-V

Change and Stress Management: Change- Nature, Characteristics, Process, Forces Responsible for Change in Organizations, Resistance to Change, **Stress Management-**Definitions, Understanding Stress, Relation between Stress and Performance, Level, Signs and Symptoms of Stress, Types of Stress, Causes of Stress, Managing Stress.

8 Hrs

Self-Study Component: Managing Resistance to Change, Institutional support and government schemes.

Text Books:

P C Tripathi and P N Reddy, "**Principles of management**", Tata McGraw Hill, 5th edition, 2015. ISBN: 978-0-07-133333-9.

Chandrani Singh and Aditi Khatri, "**Principles and Practices of Management and Organisational Behaviour**", Sage Publication, 1st edition, 2016. ISBN: 9789351508953.

Reference Books:

OP Khanna, "**Industrial Engineering and Management**", Dhanpath rai Publications, 4th edition, 2018. ISBN: 978-8189928353

Paul Henry and Kenneth H. Blanchard, "**Management of Organizational Behavior**" Prentice Hall of India, 3rd edition, 1996. ISBN: 0-13-548875-3

T.R. Banga and S.C. Sharma, "**Industrial Engineering and Management**", Khanna Publications, 17th edition, 2017. ISBN: 978-81-933284-60

Stephen P Robbins and Timothy, "**Organizational Behaviour**", Pearson Publication, 17th edition, 2016. ISBN: 978-1-292-14630-0

e- Resources:

https://www.youtube.com/watch?v=TsZukmeaewc&list=PLF1DBCAC25C2BC963
https://www.youtube.com/watch?v=UEXrsZ3vkx0&list=PLF1DBCAC25C2BC963&index=4
https://www.youtube.com/watch?v=PHDHITqX5Bg&list=PLF1DBCAC25C2BC963&index=10
https://www.youtube.com/watch?v=ICYqc5_mJ5g
https://www.youtube.com/watch?v=CRpqsuM36oo&list=PLyqSpQzTE6M8SdzVBPSXRz2K0715DnxXx
https://www.youtube.com/watch?v=uyeISA692gw
https://www.youtube.com/watch?v=JPMrR6si5xA

urse Outcomes: At the end of the course, students will be able to,

Apply fundamentals of Industrial Management, Entrepreneurship and Professional Ethics, concepts for stress management.
Apply the knowledge in Development of Entrepreneurship, structurization of organization.
Analyze appropriate Organizational Culture and Group Behavior.
Make use of Organization Behaviour and Stress Management as an individual or as a team member for effective communication and working environment.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** fundamentals of Industrial Management, Entrepreneurship and Professional Ethics, concepts for stress management.	3							2						
CO2	**Apply** the knowledge in Development of Entrepreneurship, structurization of organization.	3													
CO3	**Analyze** appropriate Organizational Culture and Group Behavior.		3									1			
CO4	**Make use of** Organization Behavior and Stress Management as an individual or as a team member for effective communication.		3						1	1					

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	2+9				22	22%
CO2			2+9	2+9	2+9	33	33%
CO3	9	9				18	18%
CO4			9	9	9	27	27%
	20	20	20	20	20	100	100%
Application = 80% , Analysis =20%							

DESIGN OF MACHINE ELEMENTS-I

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code: P21ME502		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

- Understand the basic concepts of Machine elements and its functions.
- Understand basic procedures in machine design.
- Apply the standard material properties and codes in designing machine elements.
- Design some of the commonly used machine elements.

Course Content

UNIT-I

Basic design concept: Introduction, designation of Engineering Materials, design considerations, Basic procedure of design of machine elements, factor of safety, criteria for selection of factor of safety, design of simple machine members subjected to static loading (including eccentric load and limited to biaxial stresses). **Theories of failure:** Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory and simple numerical. **Stress concentration:** Stress concentration factor, design of simple elements with stress raisers.

8 Hrs

Self study component: Maximum strain theory [St.Venant's theory] of failure and brittle/ductile fracture.

UNIT-II

Design against fatigue load: Introduction, types of fluctuating stresses, Low cycle fatigue, High cycle fatigue, Rotating beam bending test, S-N Diagram, endurance limit, endurance limit modifying factors: load, size and surface factors, Stress concentration effects; notch sensitivity, design for infinite life, combined steady and variable stress, Soderberg and Goodman relationship, stresses due to combined loading. **Impact loading:** Impact stresses due to axial load.

8 Hrs

Self study component: Impact stresses due to bending load.

UNIT-III

Design of shafts: Introduction, shafts and axles, transmission shafts subjected to combined bending and twisting (solid shafts only) based on strength and torsional rigidity, ASME code for shaft design. Design of Muff coupling and rigid flange coupling.

8 Hrs

Self study component: Design against lateral rigidity.

UNIT-IV

Threaded joints: Introduction, Stresses in threaded fasteners due to static loading, elastic analysis of bolted joints, initial tension in bolts, eccentrically loaded threaded joints. **Power screws** - Introduction, Types of screw threads, Design of Power Screws, efficiency, self-locking and over hauling.

8 Hrs

Self study component: Differential and compound screws.

UNIT-V

Riveted joints – Introduction, methods of riveting, Types of rivets, rivet materials, types of riveted joints, failures of riveted joints, joint efficiency, design of boiler Joints. **Welded joints -** Introduction, types of welded joints, design of welded joints (butt joints, fillet welds).

8 Hrs

Self study component: Diamond or Lozenge joint.

Design data hand book:

K. Mahadevan and Balaveera Reddy, "**Design Data Hand Book",** CBS Publication, 4th Edition, 2013, ISBN:978-8123923154.

Text Books:

V. B. Bhandari, "**Design of Machine Elements"** Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2017, ISBN: 9789339221126.

Robert L Norton, "**Machine design**", Pearson, 5th Edition, 2013. ISBN: 978-0133356717.

Reference Books:

Alfred S. Hall, A. R. Holowenko and H. G. Laughlin, "**Schaum's Outlines of Machine Design**", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2007. ISBN: 9780070634589.

Maleev, V. L., & Hartman, J. B, "**Machine design**", International Textbook Co., CBS, 5th edition, December 2011, ISBN-13:978-8123906379.

Richard G Budynas and Keith J Nisbett, "**Shigley's Mechanical Engineering Design"**, McGraw Hill Education, 9th Edition, 2011, ISBN: 9780071077835.

e- Resources:

https://www.youtube.com/watch?v=ae1Tl2oJFuM
https://www.youtube.com/watch?v=uCoQlj5zH9Q
https://www.youtube.com/watch?v=6CLEWA2WNqM
https://www.youtube.com/watch?v=6fGnkzwBiKg
https://www.youtube.com/watch?v=3Hjmile-cNU&list=PL4K9r9dYCOoo-snj8qm-zNnHVjjn5E5Gk
https://www.youtube.com/watch?v=HutOKnuY9GA
https://www.youtube.com/watch?v=Z38Aq9ykUCM
https://www.youtube.com/watch?v=WoOb-2lutig
https://www.youtube.com/watch?v=9y93VZcxO0g

urse Outcomes: At the end of the course, students will be able to,

Apply the basic design concept in static, impact and fatigue loading conditions.

Analyse the static and fatigue failure theories and stresses induced in machine elements subjected to various loading conditions.

Design transmission elements, power screw and **analyse** for safe design.

Design the permanent and temporary joints for structural applications and **analyse** the same for safe design.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the basic design concept in static, impact and fatigue loading conditions.	3												1	
CO2	**Analyse** the static and fatigue failure theories and stresses induced in machine elements subjected to various loading conditions.		3											1	
CO3	**Design** transmission elements, power screw and **analyse** for safe design.		3	3											
CO4	**Design** the permanent and temporary joints for structural applications and **analyse** the same for safe design.		3	2											2

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	2+9				22	22%
CO2	9	9				18	18%
CO3			2+9+9	9		29	29%
CO4				2+9	2+9+9	31	31%
	20	20	20	20	20	100	100%

Application = 22%, Analysis=18%, Design=60%

THEORY OF ELASTICITY [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21ME5031		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objective:
The objective of this course is to understand the mathematical and physical principles of Elasticity, with different solution strategies while applying them to practical cases.

Course Content

UNIT-I

Stress Analysis: Introduction to the general theory of elasticity, assumptions and applications of linear elasticity. Stress tensors, state of stress at a point, principal stresses, direction cosines, stress invariants, equilibrium equations, Construction of Mohr Circle for 2D stress systems.

8 Hrs

Self-study component: Mohr's circle for 3D stress system

UNIT-II

Strain Analysis: Deformation, strain-displacement relation, strain components, The state of strain at a point, principal strains, strain invariants, Equations of Compatibility for Strain, cubical dilation.

8 Hrs

Self-study component: Mohr's circle for strain system

UNIT-III

Stress–Strain Relations: Generalized Hooke's law in terms of engineering constants. Existence and uniqueness of solution, Saint Venant's principle, principle of superposition, Prandtl's membrane analogy, Kirchhoff's law, Fundamental boundary value problems, Inverse and Semi-inverse method of solving elasticity problems. General case of Plane stress and Plane strain, transformation of compatibility condition from strain component to stress components. Relation between plane stress and plane strain.

8 Hrs

Self-study component: Theorem of Virtual work

UNIT-IV

2D Problems in Cartesian Coordinates: Airy stress function, stress function for plane stress and plane strain case. Investigation for simple beam problems. Bending of narrow cantilever under end load, simply supported beam with uniform load using polynomials.

8 Hrs

Self-study component: Cauchy integral theorem

UNIT-V

Stress analysis in Axisymmetric body: Stresses in rotating Thick-walled cylinder subjected to internal and external pressures, shrink fit. **Torsion** of circular and elliptical bars, stress function, torsion of thin walled and multiple cells closed sections.

8 Hrs

Self-study component: Torsion of general prismatic bar

Text Books:

S. P. Timoshenko and J N Goodier, "**Theory of Elasticity**", McGraw Hill Book Company, 3rd Edition, 2010. ISBN: 978-0070701229

L S Srinath, "**Advanced Mechanics of Solids**", McGraw Hill Book Company, 3rd edition, 2009, ISBN: 978-0070139886

Reference Books:

Sadhu Singh and Khanna publisher, "**Theory of Elasticity**", Khanna Publishers, 4th edition, 2012. ISBN: 81-7409-060-6.

Wang. C. T., "**Applied Elasticity**", McGraw Hill Book Company, 1963, ISBN: 978-0070681255.

T. G. Sitharam and Govindaraju, "**Applied Elasticity**", Interline publishing, Revised edition, 2008,

ISBN: 81-7296-083-2.

Arthur P Boresi and Richard J Schmidt, "**Advanced Mechanics of Materials**", Wiley publisher, 6th edition, 2002, ISBN:978-8126522163.

e- Resources:

https://www.youtube.com/watch?v=DzyIEz3dKXQ&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1&index=8
https://www.youtube.com/watch?v=oXBiwkeRi2I&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1&index=12
https://www.youtube.com/watch?v=o0jav8mpHGM
https://www.youtube.com/watch?v=qIhzc9L1HyA
https://www.youtube.com/watch?v=IQB0bJRCRxo&list=PL27C4A6AEA552F9E6&index=18

urse Outcomes: At the end of the course, students will be able to,

Apply the concept of stress strain in solving elasticity problems.
Apply the concepts of basic engineering mathematics in obtaining the expressions for stress strain in 2D system and in axisymmetric body.
Analyse the structural member like shafts, beams and cylinders subjected to torsion, bending and pressure respectively.
Analyse the 2D problems in Cartesian co-ordinate system.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** the concept of stress strain in solving elasticity problems.	3													
CO2	**Apply** the concepts of basic engineering mathematics in obtaining the expressions for stress strain in 2D system and in axisymmetric body.	3													
CO3	**Analyse** the structural member like shafts, beams and cylinders subjected to torsion, bending and pressure respectively.		3												
CO4	**Analyse** the 2D problems in Cartesian co-ordinate system.	1	3												

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	9+2					11	11
CO2	9	2+9+9	2+9+9			49	49
CO3				2+9	2+9+9	31	31
CO4				9		9	9
	20	20	20	20	20	100	100%

Application=60%, Analysis=40%

<table>
<tr><td colspan="4" align="center">NON TRADITIONAL MACHINING
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – V</td></tr>
<tr><td colspan="2">Course Code: P21ME5032</td><td>L-T-P: 3:0:0</td><td>Credit: 03</td></tr>
<tr><td>Contact Period: Lecture: 40 Hrs</td><td>Exam: 3 Hrs</td><td colspan="2">Weightage : CIE- 50%, SEE-50%</td></tr>
<tr><td colspan="4">Course Learning Objectives:
The objectives of this course are to,
Understand the need and characteristics of nontraditional machining processes.
Prepare students for industries that require advanced machining capabilities, such as aerospace, defence, sports, automotive and medical device manufacturing.</td></tr>
<tr><td colspan="4" align="center">Course Content</td></tr>
<tr><td colspan="4"> UNIT-1 Introduction to Non-traditional Machining Processes: Need for nontraditional machining processes, process selection, classification, comparison between conventional and non-conventional machining process. Ultrasonic Machining: Working principle, mechanism of metal removal, tool feed mechanism, effect of process parameters, advantages, disadvantages and applications. 08 Hrs Self study component: Principle of micro machining and its application.</td></tr>
<tr><td colspan="4"> UNIT-2 Abrasive Jet Machining: Working principle, effect of process parameters, advantages, disadvantages and applications. Electric Discharge Machining (EDM): Working principle, mechanism of metal removal, basic EDM circuitry, spark erosion generators, analysis of relaxation type of circuit, material removal rate in relaxation circuits, critical resistance parameters in Ro circuit, die electric fluids, electrodes for spark erosion, surface finish, applications, pollution and safety issues. 08 Hrs Self study component: Principle and applications of Abrasive water jet machining.</td></tr>
<tr><td colspan="4"> UNIT-3 Chemical Machining: Introduction, fundamental principle, maskants, etchants, process characteristics, advantages, disadvantages, applications and environmental issues. Electrochemical Machining (ECM): Introduction, working principle, chemistry of the ECM process, classification of ECM, effect of process parameters, determination of the metal removal rate, dynamics of ECM process, polarization, tool design, working principles of electro chemical grinding, electro chemical honing, electrochemical deburring. 08 Hrs Self study component: Advantages, disadvantages and applications of electrochemical machining</td></tr>
<tr><td colspan="4"> UNIT-4 Laser Beam Machining: Introduction, principle of generation of laser, equipment and machining procedure, types of lasers, process characteristics, advantages, limitations and applications. Ion Beam Machining: Introduction, working principle, mechanism of metal removal, associated equipment, process characteristics, safety issue and applications. 08 Hrs Self study component: Advantages and disadvantages of Ion beam Machining</td></tr>
<tr><td colspan="4"> UNIT-5 Plasma Arc machining: Introduction, working principle, mechanism of metals removal, process parameters, process characteristics, types of torches and applications. Electron Beam machining: Introduction, working principle, thermal & non thermal type, process characteristics, applications and safety issues. 08 Hrs Self study component: Safety precautions of plasma arc machining.</td></tr>
</table>

Text Books:
P. C. Pandey and H. S. Shan, **"Modern Machining Process",** Tata McGraw-Hill, 2000, ISBN: 9780070965539. V K Jain "**Advanced Machining Process**", Allied Publisher Pvt. Ltd., 2007, ISBN:9788177642940, 8177642944.
Reference Books:
Hindustan Machine Tools, **"Production Technology"**, Tata McGraw Hill., 2001, ISBN: 978-0070964433. P.K.Mishra, **"Non-Conventional Machining",** The Institution of Engineers (India) Test book series, Narosa Publishing House, 2007, ISBN: 9788173191381.
e- Resources:
https://www.youtube.com/watch?v=XXm4Cf_N9CA https://www.youtube.com/watch?v=fOc65syJvDM https://www.youtube.com/watch?v=mgaukC25Hqk https://www.google.com/search?q=non+traditional+machining+process https://www.youtube.com/watch?v=J3fUPsBI-BU https://www.google.com/search?q=nmt+process+selection+stanadrar+chart&rlz=1C1FKPE_enIN977IN977&oq=nmt+process+selection+stanadrar+chart&aqs=chrome..69i57j33i10i160l2.15511j0j15&sourceid=chrome&ie=UTF-8
Course Outcomes: At the end of the course, students will be able to, **Apply** the principles, processes, and techniques of non-traditional machining methods. **Compare** and selection of non-conventional machining processes for suitable applications. **Apply** the concepts and techniques learned in the course to solve real-technical manufacturing problems and analyse the economic and environmental issues. **Analyse** the process parameters and characteristics of operating specialized equipment's of non-traditional machines.

Course Articulation Matrix															
Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** the principles, processes, and techniques of non-traditional machining methods.	3	1										1		1
CO2	**Compare** and selection of non-conventional machining processes for suitable applications.	3	2										1		1
CO3	**Apply** the concepts and techniques learned in the course to solve real-technical manufacturing problems and analyse the economical and environmental issues.	3	2				1						1		1
CO4	**Analyse** the process parameters and characteristics of operating specialized equipments of non traditional machines.		3	1									1		1

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO 1	2+9	9		9	2+9	40	40%
CO 2	9	2+9			9	29	29%
CO 3			2+9			11	11%
CO 4			9	2+9		20	20%
	20	20	20	20	20	100	100%
Application =80%, Analysis = 20%							

AIRCRAFT AND ROCKET PROPULSION [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21ME5033		**L-T-P:3-0-0**	**Credits: 03**
Contact Period -Lecture: 40 Hrs.	**Exam: 3Hrs.**	**Weightage:CIE:50%; SEE:50%**	

Course Learning Objectives:

The objectives of this course are to,

Describe the fundamental components and working of air breathing propulsive devices and rocket engines.

Apply the thermodynamic concepts to determine the performance parameters of turbojet and rocket engines.

Course Content

UNIT-I

Aircraft Propulsion: Review of thermodynamic principles, aerospace propulsion, principle of jet propulsion, aircraft component nomenclature, Classification of propulsive devices: basic working of Airscrew, Turbojet, Turboprop, Turbofan: bypass ratio, multispool technology, Turboshaft, Ramjet, Turboramjet and Scramjet engines.

7 Hrs

Self-study component: Types of military aircrafts

UNIT-II

Theory of propulsion: Performance parameters: Thrust, general thrust equation, thrust power, thrust specific fuel consumption, propulsive efficiency and thermal efficiency of turbojet engine. Energy flow diagram of turbojet engine. Simple numericals on the performance parameters of turbojet engines. Component efficiencies of turbojet engine. Ideal and actual turbojet engine cycle. Thermodynamic analysis of turbojet engine, Simple numericals. Thrust augmentation: After burning (description only).

8 Hrs

Self-study component: Propellers: nomenclature, terminology and types

UNIT-III

Jet engine Components: Basic description of jet engine components: Intake-Subsonic (description only). Axial flow compressor: basic requirement in aircraft, construction and working. Axial flow turbines: construction and working, blade materials, need and types of blade cooling: Combustion chamber: requirements of the combustion chamber, the process of combustion, types of gas turbine combustion chambers. Nozzles: (description only) Convergent nozzle.

9 Hrs

Self-study component: Inlets and nozzles of supersonic military aircrafts

UNIT-IV

Rocket propulsion: Chemical Rockets: general operating principle Classification, performance parameters for chemical rockets and their relationships, energy and efficiencies. Simple numericals on performance parameters of chemical rockets. Solid propellant rockets: working, solid propellants: characteristics, classification, burning rate, grain configurations, typical fuels and oxidizers, properties, igniters. Comparison of air breathing and rocket propulsion.

8 Hrs

Self-study component: Types of missiles

UNIT-V

Rocket Engines: Basic description of liquid and hybrid propellant rocket systems: Liquid propulsion rockets, feed systems, gas pressure feed system, turbo pump feed system, injectors, types of injectors, liquid propellants, cooling of rocket motors Hybrid propellant rockets, propellant oxidizer configurations. Flight Performance: rocket equation, altitude gain in simplified vertical rocket, staging of rockets.

8 Hrs

Self-study component: Space launch vehicles

Text Books:

V. Ganesan, **"Gas Turbines",** McGraw Hill, 3rd Edition, 2017, ISBN: 9780070681927.

George P. Sutton, Oscar Biblarz, **"Rocket Propulsion Elements",** Wiley, 9th Edition, 2017, ISBN: 978-1118753651.

Reference Books:

Saeed Farokhi, **"Aircraft Propulsion"**, Wiley, 2nd Edition, 2014, ISBN: 9781118806777.

Philip Hill, Carl Peterson. **"Mechanics and Thermodynamics of Propulsion",** Pearson, 2nd Edition,1991, ISBN: 9780201146592.

H.S. Mukunda, **"Understanding Aerospace Chemical Propulsion",** IK International Publishing House Pvt. Ltd, 1st Edition, 2017, ISBN: 978-9385909429.

S.M. Yahya, **"Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion",** New Age International Publishers, 6th Edition, 2018, ISBN: 9789386649911.

V. Babu, **"Fundamentals of Propulsion"**, Springer, 1st Edition, 2021, ISBN: 9783030799441.

Balachandran P, **"Fundamentals of Compressible Fluid Dynamics"**, Prentice Hall India Learning Private Limited, 2006, 1st Edition, ISBN: 9788120328570.

e- Resources:

https://www.youtube.com/watch?v=Hlj2eVt1Vbk
https://www.youtube.com/watch?v=Af0-5r5HJlI
https://www.youtube.com/watch?v=2INUkeutjBY
https://www.youtube.com/watch?v=HYk8x3i-zwk
https://www.brahmos.com/content.php?id=10&sid=9
https://www.youtube.com/watch?v=oLRMdW3WHLo&list=PLOzRYVm0a65ey1nPhnbfrz59Hvu-NVob7&index=7

<u>Course Outcomes</u>: At the end of the course, students will be able to,

Apply the knowledge of thermodynamics to describe the working of air breathing and rocket engines.

Apply the basic principles of thermodynamics and fluid mechanics to describe the working of aircraft engine components.

Analyze the performance of air breathing engine and its components.

Analyze the working and performance of rocket engines.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** the knowledge of thermodynamics to describe the working of air breathing and rocket engines.	3													
CO2	**Apply** the basic principles of thermodynamics and fluid mechanics to describe the working of aircraft engine components.	3													
CO3	**Analyze** the performance of air breathing engine and its components.		3											2	
CO4	**Analyze** the working and performance of rocket engines.		3											2	

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9			2+9	2+9	33	33%
CO2	9	2+9	2+9			31	31%
CO3		9	9			18	18%
CO4				9	9	18	18%
	20	20	20	20	20	100	100%
Application =64%, Analysis = 36%							

Course Title: **DESIGN OF EXPERIMENTS**			
Course Code: **P21ME5034**	Semester: V	L-T-P:2-2-0	Credits: 03
Contact Period -Lecture: 40 Hrs.	Exam: 3Hrs.	Weightage:CIE:50%; SEE:50%	

Course Learning Objectives:

The objectives of this course are to,

Plan design analysis and conduct experimental investigations efficiently and effectively.

Choose appropriate experiment parameters for practical applications.

Course Content

UNIT-I

Introduction: Need for research, design of experiments, terminologies-Response, factor, level and replication, experimental design techniques, strategy of experimentation, typical applications of experimental design- marketing, production, finance and personnel. Basic principles of design of experiments.

8 Hrs

Self Study Component: Guidelines for designing experiments.

UNIT-II

Basic statistical concepts: Concepts of random variable, probability, density function, cumulative distribution function, sample and population, measure of central tendency, mean median and mode, measures of variability, concept of confidence level. Statistical distributions: normal, log normal and weibull distributions. Probability plots, choice of sample size. Illustration through numerical examples.

8 Hrs

Self Study Component: Hypothesis testing.

UNIT-III

Experimental design: Classical experiments, Factorial experiments, interactions, treatment combination, randomization. Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, factor effects, factor interactions, fractional design, saturated designs. Illustration through Numerical examples.

8 Hrs

Self Study Component: Central composite designs.

UNIT-IV

Analysis and interpretation methods: Measures of variability, ranking method, column effect method &plotting method, Analysis of Variance (ANOVA) in Factorial Experiments: YATE’s algorithm for ANOVA, regression analysis, and mathematical models from experimental data. Illustration through Numerical examples.

8Hrs

Self Study Component: Case study on ANOVA, Grey relational analysis.

UNIT-V

Experiment design using Taguchi's orthogonal arrays: Types of orthogonal Arrays, selection of standard orthogonal arrays, linear graphs and interaction assignment, dummy level technique, compound factor method, modification of linear graphs. Illustration through Numerical examples.

8 Hrs

Self Study Component: Robust parameter design using response surface methodology.

Text Books:

D.C. Montgomery 2017, "**Design and Analysis of Experiments**", 8th Edition, John Wiley & Sons. Inc. ISBN 978-1118-14692-7

R. Panneerselvam. Hess 2012, "**Design and Analysis of Experiments**", 2nd Edition, PHI New Delhi. ISBN-978-81-203-4499

Reference Books:

R. L. Mason, R. F. Gunst and J.L. Hess 2003, Statistical Design and Analysis of Experiments with Applications to Engineering and Science, 2nd Edition, John Wiley & Sons. Inc. ISBN-978-0-471-37216-5

T.B. Barker, Quality by Experimental Design, 2005, 3rd Edition, CRC Press, ISBN 0-8247-2309-0.

Madhav S Phadke, "Quality Engineering using Robust Design" , 1989, Pearson education, ISBN 13:9780137451078.

e-Resources:

https://nptel.ac.in/courses/102106051
https://www.youtube.com/watch?v=Srq9Q-yd1Rk
https://www.youtube.com/watch?v=p5I_vRPyUc0
https://www.youtube.com/watch?v=ERSWvYybOrk

Course Outcomes:

At the end of the course, the students will be able to,

Apply the fundamental concepts with mathematical knowledge, methodologies to bring knowledge of Design of Experiments.

Apply a wide range of problems between the purpose of a model and the appropriate level of complexity.

Choose an appropriate experiment to **analyze** a new product design or process improvement through experimentation strategy.

Analyze the nature of variable, statistical inference, influence parameter selection, factorial concepts, conduct design of experiments.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** the fundamental concepts with mathematical knowledge, methodologies to bring knowledge of Design of Experiments.	3		1											
CO2	**Apply** a wide range of problems between the purpose of a model and the appropriate level of complexity.	3									2				
CO3	**Choose** an appropriate experiment to **Analyse** a new product design or process improvement through experimentation strategy.	3	2							1					
CO4	**Analyze** the nature of variable, statistical inference, influence parameter selection, factorial concepts, conduct design of experiments		3												

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	9			9	29	29%
CO2	9	2+9				20	20%
CO3			2+9	9		20	20%
CO4			9	2+9	2+9	31	31%
	20	20	20	20	20	100	100%
Application = 49%, Analyse = 51%							

<table>
<tr><td colspan="4" align="center">THEORY OF MACHINE- I (Integrated)
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – V</td></tr>
<tr><td colspan="2">Course Code: P21ME504</td><td>L-T-P: 2-2-2</td><td>Credits: 04</td></tr>
<tr><td>Contact Period-Lecture: 40 Hrs.
Practical: 24 Hrs.</td><td>Exam: 3 Hrs.</td><td colspan="2">Weightage: CIE: 50 %; SEE: 50%</td></tr>
<tr><td colspan="4">Course Learning Objective:
The objective of this course is to understand the basic concepts and the working principles of simple planar mechanisms, gears, cams and enabling them to understand the kinematic and dynamic analyses of simple planar mechanisms.</td></tr>
<tr><td colspan="4" align="center">Course Content</td></tr>
<tr><td colspan="4"> UNIT-I Introduction to Mechanisms: Introduction, Rigid and Resistant bodies, kinematic pairs, degrees of freedom (without numerical), Grubler’s criterion, Kinematic chain, mechanism, machine and structure. Mobility of Mechanisms, Inversions of mechanisms: Four bar chain, Single slider crank chain and Double slider crank chain. Simple Mechanisms: Intermittent motion mechanisms- Geneva mechanism, Ratchet and pawl mechanism. Peaucelliar’s Straight line mechanism, Toggle mechanism, Pantograph, Ackerman steering mechanism, Davis steering gear mechanism. 8 Hrs Self-study component: Working principle and application of universal joint.</td></tr>
<tr><td colspan="4"> UNIT-II Velocity analysis of mechanisms: Introduction, vectors, addition and subtraction of vectors, absolute and relative motions, motion of a link, velocity analysis of a link by relative velocity method, velocity analysis of four-bar mechanism, slider-crank mechanism and crank and slotted lever mechanism by relative velocity method. 8 Hrs Self-study component: Instantaneous centre, Kennedy’s theorem.</td></tr>
<tr><td colspan="4"> UNIT-III Static force analysis: Introduction, Static equilibrium, Equilibrium of two force, three force and four force members, Members with two forces and torque, Free body diagrams, Static force analysis (graphical) of four bar mechanism and slider-crank mechanism without friction. 8 Hrs Self-study component: Principle of Virtual work.</td></tr>
<tr><td colspan="4"> UNIT-IV Gears and Gear trains: Classification & application of different types of gears, Spur Gear terminology, Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Tabular method of finding velocity ratio of epicyclic gear trains. Estimation of Tooth load and torque in epicyclic gear trains. Governors: Introduction, Types, working principle and application [without numerical]. 8 Hrs Self-study component: Application and limitations of different types of gears.</td></tr>
<tr><td colspan="4"> UNIT-V Cams: Types of cams, types of followers, Types of follower motion - SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion. Displacement, Velocity and acceleration of follower for different types of motion; Displacement diagram for follower motion, Construction of cam profiles - Disc cam with reciprocating follower having knife-edge, roller and flat –faced follower. 8 Hrs Self-study component: Applications of different types of cams.</td></tr>
<tr><td colspan="4"> <u>Practical Content</u> 24 Hrs 1. To find area of complex shape by using Planimeter.</td></tr>
</table>

2. To find the gear ratio using simple and compound gear trains.
3. To find centrifugal force and plot speed v/s lift for Watt governor.
4. To find centrifugal force and plot speed v/s lift for Porter governor.
5. To find centrifugal force and plot speed v/s lift for Proell governor.
6. To find centrifugal force and plot speed v/s lift for Hartnell governor.
7. To find valve timing diagram by using disc cam.
8. Demo of Steering mechanism.
9. Demo of Oldham's, Quick return motion, Elliptical trammel, Ratchet and Pawl mechanism.

Text Books:

S.S. Rattan, **"Theory of Machines",** Tata McGraw-Hill, New Delhi, 4^{th} edition, 2015. ISBN: 9789351343479

V.P. Singh, "**Theory of Machines**", Dhanpat Rai & Co., 3rd Edition, 2013, ISBN: 9788177000528

Reference Books:

Sadhu Singh, "**Theory of Machines",** Person Eduction (Singapore) Pvt. Ltd Indian Branch, New Delhi, 2^{nd} Edition, 2006. ISBN: 9788177581270

R. S. Khurmi and J. K. Gupta, "**Theory of Machines",** S. Chand and Co., 2005, ISBN: 9788121925242.

P. L. Ballaney, "**Theory of Machines and Mechanisms",** Khanna Publishers, New Delhi, 24^{th} edition, 2005, ISBN: 9788174091222.

R. K. Bansal, "**Theory of Machines-I",** Laxmi Publications, 1^{st} edition, 2013, ISBN:9788131809846.

e- Resources:

https://www.youtube.com/watch?v=yDEJxYGAoso&list=PLbRMhDVUMngdCkMipemSKP_dCgZLLfOe8
https://www.youtube.com/watch?v=jJlJNzQ2DnY
https://www.youtube.com/watch?v=JhGonPl2JpY
https://www.youtube.com/watch?v=lu_Qw4Y4XRQ
https://www.youtube.com/watch?v=55tKVBVQDUY

urse Outcomes: At the end of the course, students will be able to,
Apply the basic concepts of mechanical elements like links, chains, gears and cams in understanding the construction and working of mechanisms.
Apply the basic concepts in understanding, degrees of freedom in different mechanisms and working principles of governors.
Analyze the gear trains, static force, velocity in four bar and slider crank mechanisms, and **develop** cam profile for various follower motion.
Make use of experimental data for writing a report as an individual or as a team member to **communicate** effectively.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the basic concepts of mechanical elements like links, chains, gears and cams in understanding the construction and working of mechanisms.	3												1	
CO2	**Apply** the basic concepts in understanding, degrees of freedom in different mechanisms and working principles of governors.	3													
CO3	**Analyze** the gear trains, static force, velocity in four bar and slider crank mechanism, and **develop** cam profile for various follower motion.		3	3										2	
CO4	**Make use of** experimental data for writing a report as an individual or as a team member to **communicate** effectively.	3								3	3			2	

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	9+2			2+9		22	22%
CO2	9			9		18	18%
CO3		2+9+9	2+9+9		2+9+9	60	60%
CO4	**Note: Assessment only in CIE**						
	20	20	20	20	20	100	100%
Application=40%, Analysis=60%							

MECHATRONICS AND MICROPROCESSOR [As per Choice Based Credit System (CBCS) & OBE Scheme] **SEMESTER – V**			
Course Code: P21MEO5051		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objective:
The objective of this course is to understand the basic concepts of Mechatronics, Mechatronic products and their applications, Different Electrical and Mechanical actuation systems, Signal condition process, Basic concepts of Microprocessor and data representation using different number systems.

Course Content

UNIT-I

Introduction: Introduction to Mechatronics systems, measurement systems, control systems, Open & Closed loop control systems, basic elements of closed loop control system, sequential controllers, programmable logic controller (PLC), examples of mechatronic systems, the digital camera and autofocus, engine management system, classification of sensors, light sensors, Tactile sensors, inputting data by switches, their merits and demerits, Hall – effect sensors, eddy-current Proximity sensors, selection of sensors.

8 Hrs

Self-study component: Vetronics, Bio-mechatronics, Smart manufacturing (Industry 4.0)

UNIT-II

Electrical actuation systems: Electrical systems, Mechanical switches, relays, solid state switches, diodes, thyristors and triacs, bipolar transistors, power MOSFETS, solenoids, DC motors, brush type (permanent magnet) DC motors, brush type DC motors with field coils, brushless permanent magnet DC motors, AC motors, stepper motors, stepper motors specifications.

8 Hrs

Self-study component: Control of brush type d. c motors, stepper motor control.

UNIT-III

Signal conditioning: Signal conditioning processes, Operational amplifiers, inverting and non- inverting operational amplifiers, protection, filtering, wheat stone bridge, Digital signals, Analog to Digital Conversion, sampling theorem, digital to analog conversion, Multiplexers, Data Acquisition system, pulsed modulation.

8 Hrs

Self-study component: Digital signal processing, summing & Differential Amplifiers

UNIT-IV

Introduction to Microprocessor: Evolution of Microprocessor, Organization of Microcomputer, Microprocessor programming, instructions, machine and mnemonics codes, machine, assembly and High level language programming, organization of the 8085 and 8086, data and address busses, addressing the I/O devices, registers in the 8085 and 8086, instruction set of the 8085 and 8086. **Number System:** Positional number system, binary number system, octal number system, decimal number system, Hexadecimal number system, conversion from one number system to another, negative number representation, representation of floating-point numbers, accuracy and range in floating point numbers.

8 Hrs

Self-study component: Selecting a micro controller, Applications of Micro controlling

UNIT-V

Industrial Automation Techniques: Automated Guided Vehicle Systems. Micro Electro Mechanical Systems (MEMS), Automated Storage Systems: Storage System Performance, Automated Storage/Retrieval Systems, Work-in-process Storage, Product identification system: Barcode, Radio Frequency Identification (RFID), Design for Automated Assembly, Types of Automated Assembly Systems. Different control technologies in automation, Inspection and testing, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.

8 Hrs

Self-study component: Basics of Arduino & Raspberry Pai, Types of automation.

Text Books:

W. Bolton, **"Mechatronics",** Addison Wesely Longman, Inc.(Pearson Education, Essex, England), Indian edition published by Dorling Kindersley, India Pvt. Ltd. Copyright, 4th edition, 2010. ISBN: 978-81-317-3253-3.

Aditya P Mathur, "**Introduction to microprocessor**", Tata McGraw-Hill Publishing Co. Ltd., 3rd edition, 2015. ISBN: 0-07-460222-5, 978-0-07-460222-5.

Reference Books:

R S Ganokar, **"Microprocessor Architecture, programming and applications with 8085/8085A",** Wiley Eastern Publication, 6th edition, 1993, ISBN: 978-0852262979.

Malvino, **"Digital computer Electronics",** McGraw Hill Education, 3rd edition, 2001, ISBN: 978-0074622353.

K P Ramachandran, G K Vijaya Raghava and M S Bala Sundaram, **"Mechatronics & Microprocessors",** Wiley precise India, 1st Edition, 18th May 2009, ISBN: 978-8126519859.

e- Resources:

https://www.youtube.com/watch?v=zVVITxiec7g&list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U
https://www.youtube.com/watch?v=UrST2yu8zQ&list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U&idex=2
https://www.youtube.com/watch?v=4lilX8cHDHI&list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U&index=3
https://www.youtube.com/watch?v=n7Fs7WZY0CA&list=PLLy_2iUCG87BNHXRb6L2pWEpMcLoFaY_U&index=20

urse Outcomes: At the end of the course, students will be able to,

Apply the basic concepts of different elements used in mechatronics system in understanding the various types of transducers, actuators, sensors and their applications and signals and processing.

Apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems.

Apply the concepts of number systems and data representation in microprocessor programming and interfacing.

Analyze the mechatronic systems by considering the interaction between mechanical components, sensors, actuators, and control systems.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the basic concepts of different elements used in mechatronics system in understanding the various types of transducers, actuators and their applications and signals and processing.	3												1	
CO2	**Apply** the principles of mechatronics, sensors and automation for the development of productive and efficient manufacturing systems.	3													
CO3	**Apply** the concepts of number systems and data representation in microprocessor programming and interfacing.	3											1	1	
CO4	**Analyze** the mechatronic systems by considering the interaction between mechanical components, sensors, actuators, and control systems.	1	2										1		

SEE- Course Assessment Plan							
COs	Marks Distribution					Total Marks	Weightage (%)
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9					11	11%
CO2	9	2+9	9		2+9	40	40%
CO3			2+9	2+9		22	22%
CO4		9		9	9	27	27%
	20	20	20	20	20	100	100%
Application=73 %, Analysis=27 %							

ROBOTICS AND AUTOMATION

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code: P21MEO5052	**L-T-P: 3-0-0**	**Credits: 03**
Contact Period - Lecture: 40Hrs. Exam: 3Hrs.	**Weightage: CIE:50%; SEE:50%**	

Course Learning Objectives:

The objectives of this course are to,

Familiarize students with brief history of robot and basic concepts of industrial robot.

Expose the students to programming languages of robot.

Make the students familiar with various robots in industrial applications.

Course Content

UNIT-I

INTRODUCTION: Automation and robotics, brief history of robotics, robot anatomy, joints and links, wrist and its motions, classifications of robots, geometrical configuration, advantages and applications of each, work volume, resolution, accuracy and repeatability, simple numerical.

08Hrs

Self- study Component: Pay load and Stability of robots.

UNIT-II

STRUCTURE OF ROBOTIC SYSTEM: End effectors- types of grippers and tools. Robot drive system: hydraulic, electric and pneumatic. Types of actuators. Feedback components: position and velocity sensors. Internal state sensors-encoders, potentiometer and resolver. External state sensor-tactile, proximity and range sensors.

08Hrs

Self Study Component: Force and Torque sensors.

UNIT-III

ROBOT PROGRAMMING: Introduction, methods of robot programming-lead through method, textual robot language method. Robot language structure- wait, signal and delay commands, branching, elements and functions, simple programs.

08Hrs

Self Study Component: Generations of robot programming Languages.

UNIT-IV

AUTOMATION: Basic elements of an automated system, advanced automation functions, levels of automation, computer process control and its capabilities. Forms of computer process control, levels of industrial process control.

08Hrs

Self Study Component: Direct Digital Control.

UNIT-V

ROBOTS IN MANUFACTURING: Material Transfer: general considerations in robot material handling- pick and place, palletizing operations. Machine loading and unloading- Die casting, Plastic moulding, Forging, machining and stamping press operations. Processing operations- features of spot welding, arc welding and robot spray coating.

08Hrs

Self Study Component: Recent developments in industrial applications of robot.

Text Books:

Michell Grover, Mitchel weiss, Roger nagel "**Industrial Robots**", McGraw Hill 2012,India,2nd edition, ISBN-13:9780070265097.

Yoramn Koren, "**Robotics for Engineers**" McGraw hill Intl. Book Co., Newdelhi 1987, ISBN-13:9780070353992.

Reference Books;

Robert J. Schilling, "**Fundamentals of Robotics**", PHI, 1st edition 2011, ISBN- 13:9788120310476.
K.S. Fu, R.C. Gonzales and Lee, "**Robotics**", McGraw Hill Intl. India, 1st edition, 2008, ISBN-13:9780070265103.
Richard D. Klafter,C Thomas A, "**Robotic Engineering**" PHI,1993, ISBN- 13:9788120308428.
R.K. Mittal and J. Nagarath, "**Robotics and Control**" Tata McGraw Hill, Delhi, 6th edition 2007, ISBN:0070482934.

e- Resources:

https://nptel.ac.in/courses/112105249
https://nptel.ac.in/courses/112101098

Course Outcomes

At the end of the course, students will be able to,

Identify the components of a robot and distinguish the types of robot configurations
Apply and identify sensors/drives for automation and robots.
Analyze and develop robot task programs using robot language.
Analyze models and integrate the drives for industrial robots and automation systems.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Identify** the components of a robot and distinguish the types of robot configurations.	3													
CO2	**Apply** and identify sensors/drives for automation and robots.	3													
CO3	**Analyze** and develop robot task programs using robot language.		3	1									1		1
CO4	**Analyze** models and integrate the drives for industrial robots and automation systems.		3	2											

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9+9					20	20%
CO2		2+9		9	9	29	29%
CO3			2+9+9			20	20%
CO4		9		2+9	2+9	31	31%
	20	20	20	20	20	100	100%
Application =49% Analysis = 51%							

EXPERIMENTAL STRESS ANALYSIS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21MEO5053		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

Provide the knowledge about the experimental techniques to analyze the stresses induced in the engineering components.

Deal with the direct and indirect methods associated with the measurement of stresses.

Comprise the concepts of brittle coatings, analysis of coating data, crack detection methods and many other photo elastic techniques.

Course Content

UNIT-I

Data acquisition and processing: General data acquisition system, signal conditioning revisited data transmission, analog to digital and digital to analog conversion, basic component (storage and display) of data acquisition system. **Analysis of experimental data**: cause and types of experimental errors, error analysis, statistical analysis of experimental data, probability distribution, Gaussian, normal distribution, chi-square test, method of least square, standard deviation of mean.

8 Hrs

Self study component: Correlation coefficient multivariable regression method.

UNIT-II

Strain gauge: Characteristics of strain gauge, LVDT, electrical strain gauge, gauge factor, temperature compensation methods. **Strain rosette**: Two element and three element rectangular and delta rosette. Wheatstone bridge - balanced and unbalanced, balancing technique, Potentiometer circuit, sensitivity, range.

8 Hrs

Self study component: Applications of strain gauge and potentiometer.

UNIT-III

Two dimensional photoelasticity: Introduction, nature of light, wave theory of light, polarization, natural double refraction, stress optic law, effect of stressed models in plane and circular polariscopes, isoclinics, isochromatics, fringe order determination, fringe sharpening, numerical problems.

8 Hrs

Self study component: separation method-shear difference method

UNIT-IV

Coating methods: Birefringence coating technique, reflection polariscope, sensitivity of birefringent coating separation of principal stresses. **Brittle coating:** Coating technique, laws of failure of brittle coating, isostatics and isoentatics, crack pattern, crack detection technique, Types of brittle coating.

8 Hrs

Self study component: Properties of stress coat materials.

UNIT-V

Holography and Moire Technique: Holography: Equation for plane waves and spherical waves, intensity, coherence, recording process, reconstruction process, holographic interferometer. **Moire techniques:** Moiré phenomenon, fringe analysis, geometrical approach, displacement approach.

8 Hrs

Self study component: Advantages and applications of Moire techniques.

Text Books

Sadhu Singh, "**Experimental Stress Analysis**", Khanna Publishers, 4th Edition, 2009. ISBN: 978-8174091826.

Dally and Riley, "**Experimental Stress Analysis**", McGraw Hill Education, 3rd Edition, 1991, ISBN: 978-0070152182.

Reference Books

Srinath and Lingaiah, "**Experimental Stress Analysis**", Tata McGraw Hill Education, 1st Edition, 1984, ISBN: 9780074519264.

M.M Froncht, "**Photoelasticity Vol I and II,"** John Wiley and Sons, 1st Edition, 1941, 1948, New York.

Kuske Albrecht and Robertson, "**Photoelastic Stress Analysis**", John Wiley and Sons, 1st Edition, 1974, ISBN: 978-0471511014.

Nakra and Chaudhary, "**Instrumentation, Measurement and Analysis**", Tata McGraw Hills Companies, New York, 7th Edition, 2006, ISBN: 978-9385880629.

e- Resources

https://archive.nptel.ac.in/courses/112/106/112106068/
https://onlinecourses.nptel.ac.in/noc23_me11/preview
https://structures.dhu.edu.cn/_upload/article/files/17/08/7d3cfbb24537870263a545aeb205/adfab16f-074f-4897-b786-97755efbbac9.pdf

urse Outcomes: At the end of the course, students will be able to,

Apply the concept of data acquisition, processing, electrical resistance strain gauges, potentiometer and **analyse** the experimental data.

Apply methods of photo elasticity and **analyze** stress strain behavior of solid bodies.

Analyze stress strain behavior of solid bodies using different coating techniques and strain gauges.

Make use of Holography and Moire Techniques in experimental stress analysis.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** the concept of data acquisition, processing, electrical resistance strain gauges, potentiometer and **analyse** the experimental data.	3	2												1
CO2	**Apply** methods of photo elasticity and **analyze** stress strain behavior of solid bodies.	3	2												1
CO3	**Analyze** stress strain behavior of solid bodies using different coating techniques and strain gauges.		3												
CO4	**Make use of** Holography and Moire Techniques in experimental stress analysis.	3	2												

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage (%)
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9	2+9+9				31	31%
CO2			2+9+9			20	20%
CO3	9			2+9	9	29	29%
CO4				9	2+9	20	20%
	20	20	20	20	20	100	100%
Application = 71%, Analysis = 29%							

FUNDAMENTALS OF THERMAL SCIENCES [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21ME5054		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objective of this course is to understand the fundamental principles of thermal sciences and be able to apply them to analyze and solve engineering problems related to energy transfer, conversion, and thermal system performance.

Course Content

UNIT-I

Energy Transfer: Basic concepts and definitions, Thermodynamic systems, Thermodynamic properties, introduction to Laws of thermodynamics, thermometry - Importance and applications of temperature measurement, Energy conservation, Heat and work interactions. **Heat Transfer:** Conduction heat transfer, Convection heat transfer, Radiation heat transfer, Heat exchangers. **Combustion and Fuels:** Combustion process and principles, Fuel properties and characteristics. **8 Hrs**

Self study component: Applications of energy transfer

UNIT-II

Energy Conversion Technologies: Working of Steam power plants, Internal combustion engines, Gas turbines and Heat pumps. Solar energy conversion (photovoltaics, solar thermal), Wind energy conversion (wind turbines), Geothermal energy conversion, Biomass energy conversion (Introduction of Biogas, Bioethanol and Biodiesel). **Energy Storage Technologies:** Overview of energy storage systems, Battery technologies (lithium-ion, flow batteries, etc.) and Thermal energy storage.

8 Hrs

Self study component: Types of Biogas Digesters.

UNIT-III

Introduction to Thermal Engineering Applications: Overview of thermal engineering principles and applications, Definition and scope of thermal engineering, Importance and applications of thermal engineering in various industries (Power Plants, Heating Ventilation and Air Conditioning, Automotive, etc.), Environmental impacts and sustainability considerations in thermal engineering. **Thermal Systems and Components:** Classification, Overview of components: boilers, heat exchangers, turbines, compressors, pumps, etc. **8 Hrs**

Self study component: Different types of blowers and fans.

UNIT-IV

Refrigeration and Air Conditioning (RAC): Overview of refrigeration and air conditioning systems, Importance and applications of refrigeration and air conditioning technology, Historical developments and milestones in the field, Working of RAC systems (Window, Split and Central Air conditioning). Refrigerants and refrigerant properties, Working of Vapour Compression refrigeration system, Introduction to HVAC system. **8 Hrs**

Self study component: Refrigerants used in domestic and commercial refrigerators and their properties.

UNIT-V

MEMS and Nanotechnology: Role of Thermal Engineering in MEMS and Nanotechnology. **Thermal Management:** Introduction to heat management systems (heat sinks, micro coolers, micro & Nano fluidic channels). Introduction to thermal Actuators and Sensors and thermal Barrier Coatings. **8 Hrs**

Self study component: Applications of actuators and sensors.

Text Books

Mahesh M Rathore, "**Thermal Engineering-II**", McGraw Hill Education, 1st edition, 2018, ISBN: 978-9353165048.

G D Rai, "**Non-Conventional Energy Sources**", Khanna publishers, 6th Edition 2004, ISBN: 9788174090737.

Reference Books

Khurmi R S & Gupta J K, "**A Textbook of Thermal Engineering**", S Chand Publishers, 1st edition, 2018, ISBN: 978-81-219-2573-0.
B H Khan, "**Non-Conventional Energy Resources**", McGraw Hill Education India Private Limited, 3rd edition, 1 July 2017, ISBN: 9789352601882.
Subhas P Sukhatme, J K Nayak, "**Solar energy**", Tata McGraw Hill India, 3rd Edition, 2009, ISBN: 9780070142961.
A R Jha, "**MEMS and Nanotechnology-Based Sensors and Devices for Communications, Medical and Aerospace Applications**", CRC Press Inc., 19 September 2019, ISBN: 978-0367387532.
Sunipa Roy, "**MEMS and Nanotechnology for Gas Sensors**", CRC Press; 1st edition (30 June 2020), ISBN: 978-0367575526.

e- Resources

https://youtu.be/2LPQX4F-GoA
https://youtu.be/9GMBpZZtjXM
https://youtu.be/nlsNmhiID74
https://youtu.be/j9y0gfN9WMg
https://youtu.be/ebO38bbq0_4

urse Outcomes: At the end of the course, students will be able to,

Apply a basic understanding of the laws and principles of thermal engineering, including energy forms, thermodynamics, and heat transfer mechanisms.
Apply the basic concepts and principles to analyze the different types of thermal systems and components used in various industries and applications.
Apply the environmental and sustainability aspects of thermal engineering to recognize the importance of clean and energy technologies.
Identify the impact of thermal engineering in modern fields of technologies.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** a basic understanding of the laws and principles of thermal engineering, including energy forms, thermodynamics, and heat transfer mechanisms.	3													
CO2	**Apply** the basic concepts and principles to analyze the different types of thermal systems and components used in various industries and applications.	3	2												
CO3	**Apply** the environmental and sustainability aspects of thermal engineering to recognize the importance of clean and energy technologies.	3	2					2						2	
CO4	**Identify** the impact of thermal engineering in modern fields of technologies.	3	2											1	

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage (%)
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9+9					20	20%
CO2		2+9+9	2+9+9			40	40%
CO3				2+9+9		20	20%
CO4					2+9+9	20	20%
	20	20	20	20	20	100	100%
Application = 100%							

ENERGY CONVERSION LABORATORY [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code: P21MEL506		**L-T-P:0-0-2**	**Credits:01**
Contact Period-Lecture: 30 Hrs.	**Exam: 3 Hrs.**	**Weightage%: CIE:50; SEE:50**	

Course Learning Objectives:
The objectives of this course are to,
Practically determine the thermal and physical properties of fuels and lubricant oils.
Evaluate the performance of four stroke internal combustion engines.

Course Content

PART-A

15 Hrs

ments on Fluid Properties

Expt.-1: Determination of Flash point and Fire point of lubricating oil using Cleveland Open-Cup Apparatus.

Expt.-2: Determination of Viscosity of lubricating oil using Redwoods, Say bolts and Torsion Viscometers.

Expt.-3: Determination of Calorific value of solid fuel using Lewis Thomson calorimeter.

Expt.-4: Determination of Calorific value of gaseous fuels using Junkers Gas calorimeter.

Expt.-5: Determination of thermal conductivity of liquids.

PART-B

15 Hrs

ments on Performance Parameters

Expt.-6: Performance test on Four Stroke Diesel Engine.

Expt.-7: Performance test on Four Stroke Petrol Engine.

Expt.-8: Morse test on Multi Cylinder Engine.

Expt.-9: Preparation of biodiesel and to determine the performance parameters using diesel engine test rig.

Reference Books:

P.K. Nag, **“Basic and Applied Thermodynamics”** Tata McGraw Hill, 3rd Edition, 2006, ISBN: 9780070260627
M. L. Mathur and R. P. Sharma, “**Internal Combustion Engine**,” Dhanpat Rai Publications, 22 July 2016, ISBN: 978-9383182428.
Dr. Jagadish Lal **“Fluid Mechanics and Hydraulics”** Metropolitan Book Co. Pvt. Ltd, New Delhi, 2002, ISBN: 9788120002722
Dr. R.K.Bansal, “**Fluid mechanics and hydraulic machines”**Laxmi publications Ltd., New Delhi. 9th edition, 2015, ISBN: 9788131808153.

e-Resources:

https://www.youtube.com/watch?v=2b0YaDrdO1I
https://www.youtube.com/watch?v=DjjbItLWNVQ
https://www.youtube.com/watch?v=Z4RreJmT9C4&t=1063s

urse Outcomes: At the end of the course, students will be able to,

Apply the basic principles of fluid mechanics and thermodynamics to determine the thermo physical properties of liquids.

Analyze the performance parameters of four stroke IC engines using conventional and biofuels.

Make use of experimental data for writing a report as an **individual** or **as a team** member to **communicate** effectively.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** the basic principles of fluid mechanics and thermodynamics to determine the thermo physical properties of liquids**.**	3	2								1		1	1	
CO2	**Analyze** the performance parameters of four stroke IC engines using conventional and biofuels.	3	3								1		1	1	
CO3	**Make use of** experimental data for writing a report as an **individual** or **as a team** member to **communicate** effectively.	3								3	3		1	1	

SEE- Course Assessment Plan

COs	**Marks Distribution**			**Total Marks**	**Weightage**
	Part A	**Part B**	**Viva- Voce**		
CO1	20			20	40%
CO2		20		20	40%
CO3			10	10	20%
	20	20	10	50	100%
Application =40% , Analysis = 40%, Communication =20%					

Internship - II [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – V			
Course Code:	**P21INT507**	**Credits:**	**02**
Teaching Hours/Week (L:T:P)	**0:0:0**	**CIE Marks:**	**-**
Total Number of Teaching Hours:	**-**	**SEE Marks:**	**100**

All the students registered to III year of BE shall have to undergo a mandatory internship of 04 weeks during the vacation of IV semesters in industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship/AICTE Intern Shala/College Partnered Industries. A Semester End Examination (Presentation followed by Question Answer session) shall be conducted during V semester and the prescribed credit shall be included in the V semester grade card. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent Semester End Examination after satisfying the internship requirements. (The faculty coordinator or mentor has to monitor the students' internship progress and interact to guide them for the successful completion of the internship.)

Internship-II: SEE component will be the only seminar/Presentation and question answer session

Social Connect and Responsibility
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code:	**P21UHV509**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1:0:0**	**CIE Marks:**	**100**
Total Number of Teaching Hours:	**25+5**	**SEE Marks:**	**--**

Course Outcomes: This course will enable the students to:

- **Identify** the needs of the community and involve them in problem solving.
- **Demonstrate** the knowledge about the culture and societal realities.
- **Develop** sense of responsibilities and bond with the local community.
- **Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.
- **Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.

PART-I

Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excpert either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature – Objectives, Visit, case study, report, outcomes.

PART-II

Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives, Visit, case study, report, outcomes.

PART-III

Organic farming and waste management: Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus.

PART-IV

Water conservation: Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes.

PART-V

Food walk: City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes.

Course Outcomes: On completion of this course, students are able to:

COs	Course Outcomes with *Action verbs* for the Course topics	Bloom's Taxonomy Level	Level Indicator
CO1	**Identify** the needs of the community and involve them in problem **solving.**	Knowledge / Apply	L1 & L3
CO2	**Demonstrate** the knowledge about the culture and societal realities.	Understand	L2
CO3	**Develop** sense of responsibilities and bond with the local community	Apply	L4
CO4	**Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.	Apply	L4
CO5	**Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions for individual and community problems.	Create	L6

<u>Course Articulation Matrix</u>

Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

Sl. No.	Course Outcome	Programme Outcomes												Programme Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	**Identify** the needs of the community and involve them in problem **solving.**	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
2	**Demonstrate** the knowledge about the culture and societal realities.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
3	**Develop** sense of responsibilities and bond with the local community.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
4	**Make use** of the Knowledge gained towards significant contributions to the local community and the society at large.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-
5	**Develop** among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems.	-	-	-	-	-	2	2	3	3	3	-	3	-	-	-

Guideline for Assessment Process:

Continuous Internal Evaluation (CIE) :

After completion of the social connect and responsibility course, the student shall prepare, with daily diary/ report as reference and a comprehensive report in consultation with the faculty/mentor to indicate what he has observed and learned in the social connect period.

The report shall be evaluated on the basis of the following below criteria's or other relevant criteria pertaining to the activity completed.

- Planning and scheduling the social connect.
- Information/Data collected during the social connect.
- Analysis of the information/data and report writing.
- Presentation and interaction.

CIE Rubrics for Evaluation.

Report	Video presentation	Interaction	Total
10	05	05	20

Note:

- Video presentation of **4 to 5 min** in a team to be presented and the same to be uploaded in the department YouTube channel.
- The number of students in each team can be from **4 to 5** members.
- Each activities has to be evaluated on above basis that is [20 * 5 = 100 marks] for final total marks.

Duration : A total of 25 – 30 hours engagement per semester is required for the 5th semester of the B.E./B.Tech. program. The students will be divided into groups and each group will be handled by faculty mentor.

Pedagogy – Guidelines:

Special Note: NO SEE – Semester End Exam – Completely Practical and activities based evaluation

It may differ depending on local resources available for the study as well as environment and climatic differences, location and time of execution.

Sl No	Topic	Group size	Location	Activity execution	Reporting	Evaluation Of the Topic
1.	**Plantation and adoption of a tree:**	May be individual or team	Farmers land/ parks / Villages / roadside/ community area / College campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
2.	**Heritage walk and crafts corner:**	May be individual or team	Temples / monumental places / Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Site selection /proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
3.	**Organic farming and waste management:**	May be individual or team	Farmers land / parks / Villages visits / roadside/ community area / College campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
4.	**Water conservation:** & conservation techniques	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers / campus etc…..	site selection / proper consultation/Continuous monitoring/ Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty
5.	**Food walk: Practices in society**	May be individual or team	Villages/ City Areas / Grama panchayat/ public associations/Government Schemes officers/ campus etc…..	Group selection / proper consultation / Continuous monitoring / Information board	Report should be submitted by individual to the concerned evaluation authority	Evaluation as per the rubrics Of scheme and syllabus by Faculty

Employability Enhancement Skills (EES) - V
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – V

Course Code:	**P21HSMC508**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**28**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable students to:

- Apply programming constructs of C language to solve the real-world problem.
- Explore user-defined data structures like arrays, structures and pointers in implementing solutions to problems.
- Design and Develop solutions to problems using functions.

UNIT – I	10 Hours

Problem solving through C -

Flow Control: If…else, for Loop, while Loop, break and continue, switch…case, goto, Control Flow Examples, Simple Programs.
Functions: Functions, User-defined Functions, Function Types, Recursion, Storage Class, Programs
Arrays: Arrays, Multi-dimensional Arrays, Arrays & Functions, Programs.

Self-Study: Variables and constants

UNIT – II	10 Hours

Problem solving through C -

Pointers: Pointers, Pointers & Arrays, Pointers and Functions, Memory Allocation, Array & Pointer Examples.
Strings: String Functions, String Examples, Programs.
Self-Study: Evaluation of Expression.

UNIT – III	08 Hours

Problem solving through C -

Structure and Union: Structure, Struct & Pointers, Struct & Function, Unions, Programs.
Programming Files: Files Input/output

Self-Study: Error handling during I/O operations.

Course Outcomes: On completion of this course, students are able to:

CO – 1:	Apply suitable programming constructs of C language to solve the given problem.
CO – 2:	Explore user-defined data structures like arrays in implementing solutions to problems like searching and sorting.
CO – 3:	Design and Develop solutions to problems using functions.

Text Book(s):

1. The C Programming Language (2nd edition) by Brian Kernighan and Dennis Ritchie.
2. C in Depth by S K Srivastava and Deepali Srivastava.
3. Computer fundamentals and programming in c, "Reema Thareja", Oxford University, Second edition, 2017.

Reference Book(s):

1. E. Balaguruswamy, Programming in ANSI C, 7th Edition, Tata McGraw-Hill. Brian W. Kernighan and Dennis M. Ritchie, The 'C' Programming Language, Prentice Hall of India.

Web and Video link(s):

1. Problem Solving through Programming in C - https://archive.nptel.ac.in/courses/106/105/106105171/

COURSE ARTICULATION MATRIX [Employability Enhancement Skills (EES) - V**]**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2	2	-	-	-	-	-	-	-	-	-
CO-2	2	2	2	-	-	-	-	-	-	-	-	-
CO-3	2	2	1	-	-	-	-	-	-	-	-	-

<table>
<tr><td colspan="4" align="center">DESIGN OF MACHINE ELEMENTS-II
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI</td></tr>
<tr><td colspan="2">Course Code: P21ME601</td><td>L-T-P: 2-2-0</td><td>Credits: 03</td></tr>
<tr><td>Contact Period-Lecture: 40 Hrs.</td><td>Exam: 3 Hrs.</td><td colspan="2">Weightage: CIE: 50 %; SEE: 50%</td></tr>
<tr><td colspan="4">Course Learning Objectives:
The objectives of this course are to,
Learn and apply systematic design methodologies for machine elements, including the selection of appropriate materials, consideration of functional requirements, adherence to design standards and safety factors.
Develop a comprehensive understanding of machine elements used in various mechanical systems such as curved beams, cylinders, gears, bearings and springs.</td></tr>
<tr><td colspan="4" align="center">Course Content</td></tr>
<tr><td colspan="4"> UNIT-I Curved Beams: Introduction, stresses in curved beams, design of curved beams. Springs: Introduction, types of springs, terminology, stresses and deflection in helical coil springs of circular and non-circular cross sections, springs under fluctuating loads, Leaf Springs, stresses in leaf springs, equalized stresses, length of spring leaves.
8 Hrs
Self study component: Surge in springs, buckling in compression spring.</td></tr>
<tr><td colspan="4"> UNIT-II Cylinders & cylinder heads: Introduction, thick cylindrical shells subjected to internal and external pressure, Lame’s Equations, compoundcylinders, stresses due to different types of fits, autofrettage, circular and rectangular coverplates.
8 Hrs
Self study component: Study of Barlow’s, Birnie’s and Clavarino’s equation</td></tr>
<tr><td colspan="4"> UNIT-III Spur Gears: Introduction, spur gears- terminology, standard proportions ofgear systems, stresses in gear tooth, Lewi’s equation and form factor, design for spur gears based on strength, dynamic load and wear load. Bevel Gears- terminology, formative number of teeth, design of bevel gears based on strength, dynamic and wears loads. Fault detection of gear using signal processing technique and machine learning approach.
8 Hrs
Self study component: Causes of Gear tooth failure, Effect of material defects on gear functioning.</td></tr>
<tr><td colspan="4"> UNIT-IV Clutches & Brakes: Introduction, types of clutches, design of Clutches (single plate and multi plate clutches). Difference between single and multi plate clutches. Brakes- Types, energy absorption, heat dissipation. Design of single block brakes and simple band brakes. Safety issues in brakes.
8 Hrs
Self study component: Thermal rating of worm Gearing, Working of Centrifugal clutch.</td></tr>
<tr><td colspan="4"> UNIT-V Lubrication and Bearings: Introduction, principle of hydrodynamic lubrication, assumptions in hydrodynamic lubrication, bearing characteristic number and modulus, Summerfield number, coefficient of friction, power loss, heat generation and heat dissipation, Design of journal bearings. Fault detection of bearing using signal processing technique and machine learning approach.
8 Hrs
Self study component: Properties of sliding contact bearing materials.</td></tr>
<tr><td colspan="4">Design data hand book:</td></tr>
<tr><td colspan="4">K. Mahadevan and Balaveera Reddy, “Design Data Hand Book”, CBS Publication, 4th Edition, 2013,</td></tr>
</table>

ISBN: 978-8123923154.

Text Books

V. B. Bhandari, "**Design of Machine Elements",** Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th Edition 2016, ISBN: 9789339221126.

R S Khurmi & J K Gupta, Publisher: **"Design of Machine Elements",** 34th Revised edition , S Chand Publications, ISBN:9788121925372.

Reference Books

K. Raghavendra, **"Design of Machine Elements II"**, 1st edition CBS publishers and distributors Pvt. Ltd., ISBN: 978-81-239-2633-9.

Budynas, Richard G. (Richard Gordon), **"Shigley's mechanical engineering design"** 9th Edition. McGraw-Hill series in mechanical engineering, ISBN 978-0-07-352928-8.

e-Resources

https://www.youtube.com/watch?v=eG3THCih3II
https://www.youtube.com/watch?v=7EtF7AowZqk&list=PLOiT2XTdTTBd0htcmHydMoekittqX5-F2
https://www.youtube.com/watch?v=AS0zQhMfJUw&list=PLSGws_74K01_e499POG3gczxcnlJEHMWE.
https://www.youtube.com/watch?v=vyRc92-mySc&list=PLH1r3LGlktds-TCu7rJaZqYr3hfqA3CSu.
https://www.youtube.com/watch?v=Fm5aChFkXJQ
https://www.youtube.com/watch?v=64EfZpMuOho
https://www.sciencedirect.com/science/article/pii/S2215098621001695
https://link.springer.com/chapter/10.1007/978-981-15-5693-7_28
https://www.emerald.com/insight/content/doi/10.1108/JQME-11-2015-0058/full/html

urse Outcomes: At the end of the course, students will be able to;

Apply the basic concepts of materials engineering to design cylinders, springs, gears, clutches and brakes.
Apply the Lame's theorem, Lewi's form factor for **designing** cylinders and gears respectively.
Analyze the stresses induced in beams, cylinders and gears for **designing** a sustainable mechanical component
Analyze the tribological characteristics to **design** the clutches, brakes and bearings.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the basic concepts of materials engineering to design cylinders, springs, gears, clutches and brakes.	3					1								1
CO2	**Apply** the Lame's theorem, Lewi's form factor for **designing** cylinders and gears respectively.	3		2											
CO3	**Analyze** the stresses induced in beams, cylinders and gears for **designing** a sustainable mechanical component.		2	3											
CO4	**Analyze** the tribological characteristics to **design** the clutches, brakes and bearings.		2	3											1

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2	2	2	2	2	10	10%
CO2	9	9	9			27	27%
CO3	9	9	9			27	27%
CO4				9+9	9+9	36	36%
	20	20	20	20	20	100	100%

Application = 37%, Analysis = 63%

COMPUTER INTEGRATED MANUFACTURING

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI		
Course Code: P21ME6021	**L-T-P: 3-0-0**	**Credits: 03**
Contact Period - Lecture: 40Hrs. Exam: 3Hrs.	**Weightage: CIE:50%; SEE:50%**	

Course Learning Objectives:

The objectives of this course are to,

Understand the concepts of CAD and CAM.

Recognize the importance of automation and additive manufacturing techniques in industries.

Write the CNC programming using G codes and M codes.

Course Content

UNIT-I

Introduction: Production System, classification of production systems, automation, types of automation, Introduction to CIM, evolution of CIM, scope of CAD/CAM and CIM, production concepts – cycle time, production time and production rate, plant capacity, utilization and availability, manufacturing lead time, work-in-progress, WIP and TIP ratio. Numerical.

8 Hrs

Self Study Component: Advantages and Limitations of Automation.

UNIT-II

CAD and Computer Graphics Software: The design process, applications of computers in design, software configuration, functions of graphics package, constructing the geometry. **Computerized Manufacture Planning and Control System**: Computer aided process planning, retrieval and generative systems, benefits of CAPP, production planning and control systems.

8 Hrs

Self -Study Component: Standardization of Graphics.

UNIT-III

Flexible Manufacturing Systems: Fundamentals of flexible manufacturing systems, types of FMS, FMS components, Material handling and storage system, applications, benefits, FMS planning and design issues, automated storage and retrieval systems. **Additive Manufacturing Techniques:** Introduction to AM, AM evolution, Steps in AM, Classification of AM processes, advantages, disadvantages and applications of AM, Working principle of Stereo-lithography (SL) and Fused Deposition Modeling (FDM).

8 Hrs

Self -Study Component: Distinction between AM & CNC machining.

UNIT-IV

Numerical Control and CNC Machine Tools: Basic components of NC Systems, NC procedure, co-ordinate system, open loop & closed loop system, NC motion control system, advantage & limitations of NC, application of NC.CNC programming, manual part programming, G Codes, M Codes, programming of simple components in turning, drilling and milling systems.

8 Hrs

Self Study Component: Feedback devices, Axes-standards.

UNIT-V

Future of Automated Factory: Industry 4.0, functions and benefits. Components of Industry 4.0, Internet of Things (IoT), IoT applications in manufacturing, Big-Data and Cloud Computing for IoT, IoT for smart manufacturing, influence of IoT on predictive maintenance.

8 Hrs

Self Study Component: supply chain optimization, supply-chain & logistics.

Text Books

Mikell P Groover, **"Automation, Production Systems and Computer-Integrated Manufacturing"**, TATA McGraw-Hill, 4th Edition, 2015, ISBN- 13: 978-0-13-349961-2.

P N Rao, "**CAD / CAM**" Tata McGraw-Hill 3rd Edition, 2015 ISBN: 0070482934

Reference Books

Zeid Ibrahim, "Mastering CAD/CAM", Tata McGraw Hill. 4th Edition,2015, ISBN: 00706343437

Boucher, T. O., Chapman & Hall **"Computer Automation in Manufacturing",**London, UK, 1996. ISBN 10: 0-13-349961-8

Alasdair Gilchrist, **"Industry 4.0 The Industrial Internet of Things",** Apress, 2017 ISBN-13 : 978-1-4842-2046-7.

e- Resources

https://industri.fatek.unpatti.ac.id/wp-content/uploads/2019/03/245-Automation-Production-Systems-and-Computer-Integrated-Manufacturing-Mikell-P.-Groover-Edisi-4-2015.pdf
https://link.springer.com/book/10.1007/978-1-4842-2047-4
https://www.youtube.com/watch?v=54XQ_vw6LVI
https://www.youtube.com/watch?v=9fqygvj-O2s

Course Outcomes

At the end of the course, students will be able to,

Analyze the concepts of CIM
Apply the concepts of mathematical equation in material handling and AS/RS and Automation System
Develop manual part programs for complex profiles and **Analyze** latest developments in CNC system
Analyze the techniques involved in Automation and FMS and AMT.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Analyze** the concepts of CIM.	3													
CO2	**Apply** the concepts of mathematical equation in material handling and AS/RS and Automation System.	3													
CO3	**Develop** manual part programs for complex profiles and **Analyze** latest developments in CNC system.			3											
CO4	**Analyze** the techniques involved in Automation, FMS and AMT.	3	2												

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9				2+9	22	22%
CO2	9	9+2	9			29	29%
CO3				2+9		11	11%
CO4		9	9+2	9	9	38	38%
	20	20	20	20	20	100	100%
Application =29%, Analysis = 71%							

FINITE ELEMENT METHODS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code: P21ME6022		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %; SEE: 50%**	

Course Learning Objectives:

The objectives of this course are to,

Provide an introductory approach to finite element method as a basic numerical tool for solving mechanical engineering problems.

It also highlights various analyses of axially loaded uniformly tapered and stepped bars, truss members, beams and heat transfer problems.

Course Content

UNIT-I

Introduction to FEM: Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM, Discretization process - types of elements (1D,2D,3D), size of the elements, location of nodes, node numbering scheme, Method of solution of linear algebraic equations - Gauss elimination method. Basic elastic equations – body force and traction force, strain-displacement relations. Principle of minimum potential energy and derivation of potential energy functional for a 3D elastic body, concept of plane stress and plane strain and their stress-strain relations.

8 Hrs

Self-study component: Methods for FEM formulation, Gaussian Quadrature for 1D integrals.

UNIT-II

Interpolation Models: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM, Interpolation or shape functions for 1D linear and quadratic bar elements in cartesian and natural co-ordinate systems. Lagrangian polynomial–Shape functions for linear quadrilateral element (QUAD-4) and quadratic quadrilateral element (9-noded), Iso-parametric, sub-parametric and super-parametric elements. **8 Hrs**

Self study component: Simplex, complex and multiplex Elements, Pascal's pyramid for 3D.

UNIT-III

Element Stiffness Matrix and Load Vectors: Strain displacement matrix, Stiffness matrix and load vector for linear and quadratic bar element. Assembly of elements by direct stiffness method, Treatment of boundary conditions- elimination and penalty methods. Analysis of axially loaded uniformly tapered and stepped bars. **8 Hrs**

Self study component: Stress vector for CST element under plane stress and plane strain condition.

UNIT-IV

Analysis of Plane Trusses and Beams: stiffness matrix for plane truss element, analysis of truss members. Hermite shape function for beam element in Cartesian coordinates (Description), Stiffness matrix and load vector (Description) for beam element, element shear force and bending moment, analysis of beams. **8 Hrs**

Self study component: Differences between Hermite shape function and Lagrange interpolation function. Case studies on Electronic components.

UNIT-V

Analysis of Heat Transfer Problems: Steady state heat transfer, 1D heat conduction- governing equation, boundary conditions, one-dimensional element, Galerkin's approach to heat conduction, heat flux boundary condition. 1D heat transfer in thin fins-Formulation of equations. Simple numerical of 1D heat transfer problems on composite walls with conduction and convection. **8 Hrs**

Self study component: Different types of boundary conditions in heat transfer problem. Case studies on Electronic components.

Text Books:

- Chandrakanth S Desai and J.F. Abel, "**Introduction to the Finite Element Method**", CBS, 1st edition, 2005, ISBN: 978-8123908953.
- T R Chandrupatla and A D Belegundu, "**Introduction to Finite Elements in engineering**", Pearson, 4th edition, 19th October 2011, ISBN: 978-0132162746.

Reference Books:

- O.C. Zienkiewicz, "**The FEM its basics and fundamentals**", Elsevier Publisher, 6th edition, 2007, ISBN: 978-8131211182.
- J.N. Reddy, "**Finite Element Method**", McGraw Hill International Edition, 2005, ISBN: 9780072466850.
- Daryl. L. Logon, "**Finite Element Methods**", Thomson Learning 5th edition, 1st Jan 2011, ISBN: 978-0495668251.
- David V. Hutton, "**Fundamentals of Finite Element Analysis**", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 10th June 2005, ISBN: 978-0070601222.
- Singiresu S Rao, "**The Finite Element Method in engineering**", Elsevier Publisher, 5th edition, 2008 ISBN: 978-9380931555.
- Nitin S. Gokhale, "**Practical Finite Element Analysis**", Finite To Infinite, 2008th edition, 2020, ISBN: 978-8190619509.

e- Resources:

https://nptel.ac.in/courses/112/105/112105308/
https://nptel.ac.in/courses/112106135
https://youtu.be/KR74TQesUoQ

urse Outcomes: At the end of the course, students will be able to,

Understanding the fundamental principles of FEM such as discretization, interpolation and numerical integration and **apply** it for solving complex engineering problems.
Formulate element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.
Utilize finite element formulations in **analyzing** the stresses, strains and reactions of trusses and transversely loaded beams.
Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques to **analyze** conduction and convection heat transfer problems.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	Understanding the fundamental principles of FEM such as discretization, interpolation and numerical integration and **apply** it for solving complex engineering problems.	3	1										1		
CO2	Formulate element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.	3	2	1									1		
CO3	Utilize finite element formulations in **analyzing** the stresses, strains and reactions of trusses and transversely loaded beams.		3	1									1		
CO4	Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques to **analyze** conduction and convection heat transfer problems.		3	2			1						1		

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	9				20	20%
CO2	9	2+9	2+9			31	31%
CO3			9	2+9+9		29	29%
CO4					2+9+9	20	20%
	20	20	20	20	20	100	100%
Analysis = 80%; Application = 20%							

HEATING, VENTILATION AND AIR CONDITIONING [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code: P21ME6023		**L-T-P: 2-2-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:
The objectives of this course are to,
Study the principles, design, and operation of heating, ventilation and air conditioning (HVAC) systems.
Learn about the fundamentals of heat transfer, psychrometrics, equipment selection, system design, and energy efficiency in HVAC systems.

Course Content

UNIT-I

Introduction to HVAC Systems: History of Air Conditioning, Overview of HVAC systems, Components and their applications, Importance of HVAC systems in buildings, Sustainability and Green Buildings, Roles and responsibilities of HVAC engineers. **Single-zone Air Conditioning Systems** (Summer air conditioning systems, Summer air conditioning systems with reheat, Winter air conditioning systems, Air conditioning systems using evaporative cooling). **Multi-zone Air Conditioning Systems** (Multi-zone systems with reheat, Dual-duct multi-zone air conditioning systems, Variable air volume (VAV) systems).

8 Hrs

Self-study component: Trends in Energy Use and Impact, Overview of HVAC Design Procedure.

UNIT-II

Psychrometric Principles of HVAC: Introduction, Basic Psychrometric Processes: Mixing of two moist air streams, Sensible heating or cooling, Dehumidification by cooling, Humidification of air, Evaporative cooling and Space condition line. Numerical. **The Psychrometric Chart:** Constant dry-bulb temperature lines, Saturation curve and constant relative humidity lines, Constant wet-bulb temperature lines, Constant specific volume lines, Enthalpy–moisture protractor, and Sensible heat ratio protractor. Numerical.
Case Study: MATLAB Code for Psychrometric Properties.

8 Hrs

Self-study component: Applications of Psychrometric Processes.

UNIT-III

Basics of Design considerations in HVAC systems: Introduction, Outdoor Design Conditions, **Thermal Comfort and Indoor Design Conditions:** Heat transfer from the human body, Indoor design conditions, Indoor air quality. **Internal Heat Sources in Buildings:** Heat gain from people, Heat gain from lighting, Heat gain from equipment. T**ransient Effects in Building Energy Transfer:** Transient heat conduction through walls, Heat gain by a thin surface.

8 Hrs

Self-study component: Moisture Transport in Building Structures - Fick's law.

UNIT-IV

Cooling and Heating Load Calculations: Cooling Load Calculation Methods: Heat balance method (HBM), Radiant time series (RTS) method, Application of the RTS method and the Central Air Treatment (CTS) method. Heating Load Calculation Methods. Numerical. **Basics of Duct and Pipe Sizing**: Duct Systems, Fans, Air-Diffusing Equipment, Pipe, Tube, and Fittings, Pumps.
Case Study: MATLAB Code for Cooling Load due to People.

8 Hrs

Self-study component: MATLAB Code for Cooling Load due to Wall Conduction

UNIT-V

Building Energy Estimating and Modeling Methods: Introduction, Degree–Day Method for Estimating Energy Use. **Bin Method for Estimating Energy Use:** Generation of bin data, Applications of the bin method, Cycling of furnaces, Air-source heat pumps, Cooling towers, Variable occupancy rates. **Simulation Methods for Estimating Energy Use:** Central HVAC systems, Simulation of multi-chiller

systems, Simulation of water-loop heat pump system (WLHPS). Numerical.
Case Study: *MATLAB Code for Bin Data and Degree–Days*

8 Hrs

Self-study component: Discuss future of HVAC**.**

Text Books

Nihal E Wijeysundera, **"Principles of Heating, Ventilation, and Air Conditioning with worked examples",** published by world scientific publishing Co. Pte. Ltd, ISBN: 978-981-4667-76-0.
John W. Mitchell, James E. Braun**, "Principles of Heating, Ventilation, and Air Conditioning in Buildings",** 1st Edition, ISBN: 978-1-118-81215-0 March 2014.

Reference Books

R.S. Khurmi and J.K. Guptaa, "**A Textbook of Refrigeration and Air Conditioning**", S Chand Publications, 5th Edition, ISBN: 978-81-219-2781-9
Ronald. H. Howell, **"Principles of Heating Ventilating and Air Conditioning, Based on the 2017 ASHRAE Handbook—Fundamentals",** 8th Edition, ISBN: 978-1-939200-73-0 (hardback) and ISBN: 978-1-939200-74-7 (PDF).
C P Arora, "**Refrigeration and Air Conditioning**", 3rd edition, McGraw-Hill Publications, ISBN-13: 978-0-07-008390-5.

e-Resources:

https://nptel.ac.in/courses/112105129

Course Outcomes: At the end of the course, students will be able to,
Interpret the various components of HVAC systems using the principles of heating and cooling.
Apply heat transfer principles to **design** heating and cooling requirements for different spaces and **analyze** heat loads to perform psychrometric study.
Apply energy-efficient practices in HVAC system design, operation, and maintenance.
Develop MATLAB codes based on ASHRAE Handbook of Fundamentals.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Interpret** the various components of HVAC systems using the principles of heating and cooling.	3	3											1	
CO2	**Apply** heat transfer principles to **design** heating and cooling requirements for different spaces and **analyze** heat loads to perform psychrometric study.	2	3	1										1	
CO3	**Analyze** energy-efficient practices in HVAC system design, operation, and maintenance.		3	1			2							2	
CO4	**Develop** MATLAB codes based on ASHRAE Handbook of Fundamentals.		3	2		1								1	1

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9	2+9		2+9		33	33%
CO2			2+9		2+9	22	22%
CO3	9		9			18	18%
CO4		9		9	9	27	27%
	20	20	20	20	20	100	100%
Application =55% Analysis = 18% Develop = 27%							

MATERIALS SELECTION AND FAILURE ANALYSIS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI		
Course Code: P21ME6024	**L-T-P: 2-2-0**	**Credits: 03**
Contact Period - Lecture: 40 Hrs. Exam: 3Hrs.	**Weightage: CIE: 50 %; SEE: 50%**	

Course Learning Objectives:
The course aims at enabling the students to understand the concepts of material science and metallurgy and failure analysis tools to select appropriate material based on applications.

Course Content

UNIT-I

Introduction: Classification of engineering materials: metals, ceramics, glasses, elastomers, polymers. Definition of material properties, material selection, material selection and manufacturing, design process, procedure for martial selection, additional factors to consider, consideration of the manufacturing process, ultimate objective, material substitution, effect of product liability on material selection.

8 Hrs

Self Study Component: Material selector issue of materials engineering.

UNIT-II

Material and alloy selection: Selection strategy, property limits, material indices-The material index for a light-strong-tie, light-stiff beam and light-strong beam, performance maximizing criteria, strengthening mechanisms. Material property charts: modulus - density, strength - density, modulus - strength, and stiffness - specific strength, etc. **8 Hrs**

Self Study Component: Material property charts: thermal conductivity –thermal diffusivity

UNIT-III

Material selection- case studies: Materials for oars, materials for large telescopes, materials for table legs, materials for flywheels, materials for high flow fans, materials for springs, elastic hinges, materials for seals, pressure actuators, and safe pressure vessels. **8 Hrs**

Self Study Component: Materials for passive solar heating.

UNIT-IV

Selection of materials and shape: Shape factors, elastic extension, elastic bending and twisting, failure in bending and twisting, axial loading and column buckling, efficiency of standard sections, material limits for shape factors, microscopic shape and shape factors. Case studies on selection of materials and shape-Forks for a racing bicycle. **8 Hrs**

Self Study Component: Material indices which include shape.

UNIT-V

Failure analysis tools : Reliability concept and hazard function, life prediction, life extension, application of Poisson, exponential and Weibull distributions for reliability, bath tub curve, parallel and series systems, MTBF, MTTR, FMEA-design FMEA, process FMEA, analysis of causes of failure modes, ranks of failure modes. Illustration through Numerical examples. **8 Hrs**

Self Study Component: Fault tree analysis; Industrial case studies on FMEA.

Text Books:

Michael F Ashby, 2016, "**Materials Selection in Mechanical Design**", 3rd Edition, Butterworth – Heinemann, ISBN: 0750643579.
Anderson T L, 2017, "**Fracture Mechanics: Fundamentals and Applications**", 4th Edition, Taylor and Francis, ISBN 9781315370293.

Reference Books:

Courtney T H, 2006, Mechanical Behavior of Materials, Overseas Press (India) Private Limited, ISBN: 9781577664253.
Vijendra Singh, 2020, Physical Metallurgy, Standard Publishers Distributors, ISBN: 978-8186308639
William D Callister, 2017, Material Science and Engineering, John Wiley & Sons Inc, 9th edition,

ISBN:9781118324578.

e-Resources:

http://link.springer.com/book/10.1007%2F978-1-4899-6826-5
http://phindia.com/bookdetails/materials-science-and-engineering-raghavan-v--isbn-
http://nptel.ac.in/courses/Webcoursecontents/IIScBANG/Material%20Science/New_index1.html

Course Outcomes:

At the end of the course, the students will be able to .

Choose the most appropriate material and shape based on applications.
Apply the knowledge of mechanical properties and behaviour of materials.
Apply engineering problems using failure analysis tools.
Analyze and Quantify mechanical integrity and failure in materials.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Choose** the most appropriate material and shape based on applications.	3	1												
CO2	**Apply** the knowledge of mechanical properties and behaviour of materials.	3													
CO3	**Apply** engineering problems using failure analysis tools.	3	1								2				
CO4	**Analyze** and Quantify mechanical integrity and failure in materials.		3												

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9	9			9	29	29%
CO2	9	2+9				20	20%
CO3			9	2+9		20	20%
CO4			2+9	9	2+9	31	31%
	20	20	20	20	20	100	100%

Application = 69% Analysis= 31%

<table>
<tr><td colspan="4" align="center">ADVANCED ENGINEERING MATERIALS
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI</td></tr>
<tr><td colspan="2">Course Code: P21ME6031</td><td>L-T-P: 3-0-0</td><td>Credits: 03</td></tr>
<tr><td>Contact Period-Lecture: 40 Hrs.</td><td>Exam: 3 Hrs.</td><td>Weightage: CIE: 50 %;</td><td>SEE: 50%</td></tr>
</table>

Course Learning Objectives:

The objectives of this course are to,

- Distinguish various classes of advanced materials, their processing, properties and applications
- Interpret new terms and information advanced and emerging materials.

Course Content

UNIT-I

Metal Matrix and Ceramics Composites: Characteristics of MMC, various types of metal matrix composites, alloy vs. MMC, advantages of MMC, limitations of MMC, Metal matrix reinforcements: particles, fibres. Effect of reinforcement, volume fraction, rule of mixtures, Processing of MMC, powder metallurgy process, diffusion bonding, stir casting, squeeze casting.

8 Hrs

Self study components: Differentiate the MMCs and alloys.

UNIT-II

Recent Advances of Ceramics composites , Refractories: Ceramic Materials: Basic ceramic structure, types of ceramics, applications of ceramics, processing of ceramics: glass-forming processes, particulate forming processes, Various types of Ceramic Matrix composites: oxide ceramics, non oxide ceramics, aluminium oxide , silicon nitride, reinforcements : particles, fibres, whiskers. **Refractories:** Refractoriness, types of refractories, properties of refractories, **Silica and Silicates**: Crystalline and non-crystalline forms of silica, configuration of minerals.

8 Hrs

Self study component: High-Silica Glasses and Photochromic- Zena Glasses

UNIT-III

Nano-materials: Introduction, processes to prepare nano-materials, uses, future prospects, nano-electromechanical systems, applications of CNT. **Super-alloys**: Nickel Alloys, types of super-alloys, heat-resisting alloys, hastelloy, nickel–molybdenum steel alloy, cryogenic steels (or extremely low temperature purpose alloys), Ni-based cryogenic steels. **Shape Memory Alloys**: Introduction, concept, shape memory effect (SME), material systems of different shape memory alloys, preparation of SMA, applications.

8 Hrs

Self study component: Biomedical Materials applications.

UNIT-IV

Sandwich Composite Materials: Introduction, types: honeycombs and foams, types of face (skin) materials for sandwich constructions and their characteristics, special applications: spacecraft grade sandwich composites, marine grade sandwich composites, aircraft grade sandwich composites, automobile grade sandwich composites, current fields of research in sandwich composites/constructions. **Biocomposite Materials:** Biodegradable plant fibre-reinforced composite, advantages, disadvantages, applications, and different types of plant fibres for green composite.

8 Hrs

Self study component: Custom sandwich composite for paddle surfboard.

UNIT-V

Emerging and Futuristic Materials: Introduction, applications, FGMS in construction, functionally graded fibre-reinforced concrete applications, functionally graded fibre cement, mixture design for choosing fibre cement, Epoxy–TiO_2 particulate-filled functionally graded, functionally graded nanoelectronic, optoelectronic and thermoelectric materials, applications of FGM. **Biomimetic Materials:** Moth eye–inspired biomimetic materials, termite-inspired biomimetic materials, mosquito bite–inspired biomimetic materials.

8 Hrs

Self study component: PbTe-Based FGM Thermoelectric Materials

Text Books:

Advanced Engineering Materials: Principles and Applications by K.M. Gupta, ISBN: 978-9385676107,I.K. International Publishing House, 2014

Engineering Materials, M.F. Ashby: 4th Edition, Elsevier, 2005.

Reference Books:

Handbook of Cellular metals, Production, processing, Application, Edited by Hans Peter Degischer and Brigitte Kriszt, Wiley - VCH, 2002.

Biomaterials Science, An Introduction to Materials in Medicine, Edited by B.D. Ratner, A.S. Hoffman, F.J. Sckoen, and J.E.L Emons, Academic Press, second edition, 2004.

Handbook of Materials for Medical Devices, Edited by J. R. Davis, ASM international, 2003.

e- Resources:

https://www.youtube.com/watch?v=KMcsjCXfLQw&list=PLyAZSyX8Qy5Am_2StOOQ5vCUE3VIcAenE

https://www.youtube.com/watch?v=2rxbxNem1iI&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ

https://www.youtube.com/watch?v=649fIwvIvRc&list=PLwdnzlV3ogoVE2AIC-G4Uew8XsaINwJGo

https://www.youtube.com/watch?v=MtqugJcsHZs&list=PLbRMhDVUMngdzwQyMgoUgdaGBqi_p4nVM

https://www.youtube.com/watch?v=ebO38bbq0_4&list=PLbMVogVj5nJTdeiLvuGSB_AE8hloTAHWJ

urse Outcomes: At the end of the course, students will be able to,

Apply the concept of structure, properties, and relationships of advanced and emerging engineering materials and predict material behavior based on these relationships.

Identify the various advanced materials for different processing techniques.

Apply different advanced material characterization techniques to emphases the various engineering materials.

Analyze the properties and behavior of structural materials.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the concept of structure, properties, and relationships of advanced and emerging engineering materials and predict material behavior based on these relationships.	2	2												
CO2	**Identify** the various advanced materials for different processing techniques.	3													
CO3	**Apply** different advanced material characterization techniques to emphases the various engineering materials.	3													
CO4	**Analyze** the properties and behavior of structural materials.		3												

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2	2	2	2	2	10	10%
CO2	9	9				18	18%
CO3	9	9	9	9	9	45	45%
CO4			9	9	9	27	27%
	20	20	20	20	20	100	100%

Application = 73%, Analyze = 27%

<table>
<tr><td colspan="4">ELECTRIC AND HYBRID VEHICLES
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI</td></tr>
<tr><td colspan="2">Course Code: P21ME6032</td><td>L-T-P: 3-0-0</td><td>Credits: 03</td></tr>
<tr><td>Contact Period-Lecture: 40 Hrs.</td><td>Exam: 3 Hrs.</td><td>Weightage: CIE: 50 %;</td><td>SEE: 50%</td></tr>
</table>

Course Learning Objectives:

The objectives of this course are to,

Present a comprehensive overview of Electric and Hybrid Electric Vehicles.

Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.

Identify various communication protocols and technologies used in vehicle networks.

Course Content

UNIT-I

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electricvehicles, impact of modern drive-trains on energy supplies, Interdisciplinary Nature of HEVs, State of the Art of HEVs. **Conventional Vehicles:** Basics of vehicle performance, vehicle power source characterization, transmission characteristics.

8 Hrs

Self Study Component: Sustainable Transportation, Challenges and Key Technology of HEVs.

UNIT-II

Hybrid Electric Drive-trains: 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.

8 Hrs

Self Study Component: Induction Motor Drives, Permanent Magnet Motor Drives.

UNIT-III

Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives. **Sizing the drive system:** Matching the electric machine and the Internal Combustion Engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

8 Hrs

Self Study Component: Design and Sizing of Traction Motors.

UNIT-IV

Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEVs Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, PHEVs Design. **Component Sizing:** Component Sizing of EREVs, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Vehicle-to-Grid Technology.

8 Hrs

Self Study Component: EV and PHEV Battery Chargers.

UNIT-V

Energy Storage and Charging Stations: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage, Fuel Cell based energy storage, Type of charging station, Selection and Sizing of charging station, Components of charging station, Single line diagram of charging station. **Communications, Supporting Subsystems:** In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies.

8 Hrs

Self Study Component: Comparison of different energy management strategies.

Text Books

Iqbal Husain, "**Electric and Hybrid Vehicles: Design Fundamentals**", CRC Press, 2003, ISBN-10: 0849314666, ISBN-13 9780429101588.

Chris Mi, M Abul Masrur, Davi D Wenzhog Gao, **"Hybrid Electric Vehicles principles and Applications with Practical Perspectives"**, Wiley, 2011, ISBN-10: 0470747730, ISBN-13: 9780470747735.

Reference Books

James Larminie, John Lowry, **"Electric Vehicle Technology Explained"**, Wiley, 2012, ISBN - 978-1-119-94273-3.

Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, CRC Press, 2004, ISBN-10: 0849331544, ISBN-13: 978-0849331541.

e-Resources:

https://www.youtube.com/watch?v=h5ysddrlXLw
https://www.researchgate.net/publication/347161983_Plug-In_Hybrid_Electric_Vehicles_PHEVs
https://www.youtube.com/watch?v=6H5vtu5_SF4
https://archive.nptel.ac.in/courses/108/103/108103009/

urse Outcomes: At the end of the course, students will be able to,

Apply the knowledge of basic science to study components of HEVs.
Apply basic concepts for designing electric and hybrid electric vehicles.
Identify the different sources of energy and communications in Hybrid and Electric Vehicles.
Analyze the architecture and power technologies in HEVs and Plug-in Hybrid EVs.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** the knowledge of basic science to study components of HEVs.	3						1							
CO2	**Apply** basic concepts for designing electric and hybrid electric vehicles.	3		1											
CO3	**Identify** the different sources of energy and communications in Hybrid and Electric Vehicles.	2						3							
CO4	**Analyze** the architecture and power technologies in HEVs and Plug-in Hybrid EVs.		2												

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage (%)
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9		9		9	29	29%
CO2		2+9	2+9			22	22%
CO3	9				2+9	20	20%
CO4		9		2+9+9		29	29%
	20	20	20	20	20	100	100%

Application = 71%, Analyze = 29%

CONTROL ENGINEERING

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code: P21ME6033		**L-T-P: 2-2-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

Design and analysis of linear control systems to improve their static and transient behavior.

Analyse the frequency and time response of the different control system.

Apply the concepts of stability of control system by using different plots.

Course Content

Unit-1

Introduction: Concept of automatic controls, open and closed loop control systems, concepts of feedback control systems, requirement of an ideal control system. Examples of control systems - home heating system, traffic control system, liquid level control system. **Mathematical Models of Physical Systems:** Definition of Laplace transformation, transfer function models, mathematical models of mechanical systems, models of DC and AC motors, models of hydraulic systems and models of thermal systems.

9 Hrs

Self-Study Component: Concept of superposition for linear systems with examples.

Unit-2

Block Diagrams and Signal Flow Graphs: Transfer functions definition, block diagram representation of system elements, reduction of block diagrams (Numerical based on shifting of take-off point and interchanging of summing point only). **Signal flow graphs** – Terminologies, Signal flow graph from block diagram, Manson’s gain formula.

7 Hrs

Self-Study Component: Transfer function of multiple input multiple output control Systems

Unit-3

Time Response Analyses: Introduction, transient and steady state response of control system. First order system response to step and ramp inputs, concepts of time constant and its importance in speed of response. Second order system response to step input, transient response specifications (description and numerical). Steady-state error analysis, steady-state error constants- static position error constant, static velocity error constant and static acceleration error constant.

8 Hrs

Self-Study Component: Study of various controllers in automated machines.

Unit-4

Mathematical Concept of Stability: Stability definition, characteristic root locations and stability, Routh’s stability criterion, special cases of Routh’s criterion. **Frequency Response Analysis:** Polar plots, relative stability- concepts phase margin and gain margin. Frequency response analysis using Bode plot: Bode attenuation diagrams, stability analysis using Bode plots.

8 Hrs

Self-Study Component: System compensation: Series and feedback compensation

Unit-5

Root Locus Analysis: Introduction, definition of root loci, general rules for constructing root loci, root locus analysis of control systems. **State-Space Analysis:** Introduction, definitions, state-space equations, transformation matrix, controllability, and observability, Kalman and Gilberts test.

8 Hrs

Self-Study Component: MATLAB program to generate root-locus plot.

Text Books

Katsuhiko Ogata, "**Modern Control Engineering"**, PHI Learning Pvt. Ltd, 5th Edition, 2010, ISBN: 9788120340107.
Rao V Dukkipati, "**Control Systems"**, Narosa Publishing House, Standard Edition, 2008, ISBN: 978-8173195549.

Reference Books

Joseph J. Distefano, Allen R. Stubberud and Avan J. Williams, **"Feedback and Control Systems"**, Schaum's Outlines series, Tata McGraw Hill, New Delhi, 2nd Edition, 2003, ISBN: 9780070582880.
I. J. Nagarath and M. Gopal, "**Control systems**", New age International publishers, 4th Edition, 2006, ISBN: 9788122417753.
F. Golnaraghi and B.C. Kuo, "**Automatic Control Systems"**, John Wiley and Sons, 9th Edition, 2009, ISBN: 9780470048962.
Ashfaq Husain and Haroon Ashfaq, "**Control Systems**", Dhanpat Rai and Co., 2015, ISBN: 9788177000276.

e- Resources:

https://www.youtube.com/watch?v=7LZSjgZz-Qw&list=PLxn52v8fxX5l5tGzU1NAxRDkgqxK0k5UZ
https://www.youtube.com/watch?v=Pv0i-9wWrCI&list=PLSGws_74K018thqvpXHrs5DkeJcx8lX7u

urse Outcomes: At the end of the course, students will be able to,
Identify the components of control systems given real life situation.
Develop transfer function models and state-space models of single input single output, linear time invariant systems.
Analyse the time response of first and second order systems.
Apply the concept stability in control systems using various methods.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Identify** the components of control systems given real life situation.	3												2	
CO2	**Develop** transfer function models and state-space models of single input single output, linear time invariant systems.	2		3											
CO3	**Analyse** the time response of first and second order systems and reduction of block diagram.	1	3												
CO4	**Apply** the concept stability in control systems using various methods.	3		1											

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage (%)
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9					11	11%
CO2	9				2+9+9	29	29%
CO3		2+9+9	2+9+9			40	40%
CO4				2+9+9		20	20%
	20	20	20	20	20	100	100%

Application =31%, Analysis = 40%, Develop=29%

PRODUCTION MANAGEMENT
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI

Course Code: P21ME6034	**L-T-P: 3-0-0**	**Credits:03**
Contact Period-Lecture: 40 Hours	**Exam:3 Hours**	**Weightage%:CIE:50,SEE:50**

Course Learning objectives:
The objectives of this course are to,
Identify the demand of the products that has to be produced in future using forecasting technique.
Use of scheduling techniques and inventory control method to optimize the facility location and plant layout to improve the quality of product.

Course Content

Unit-1

Introduction: Introduction, Meaning and concepts of Production Management (PM), evolution of PM. **Productivity:** strategies to improve productivity, product strategies, product and process focused system, product life cycle, world class manufacturing. **Organization of the Operations Functions:** Process focused organization, product focused organization structure, difference between process and product focused Organization.

8 Hrs

Self Study Component: Functions of Production Management, production to stock or to order, productive system positioning strategies

Unit-2

Forecasting: Need for forecasting, objectives and limitations of forecasting, costs of forecasting, **Classification of Forecasting Methods**: Time series method, components time series methods, simple moving average, weighted moving averages, simple exponential smoothing method, least square or regression, Delphi technique.

8 Hrs

Self Study Component: Mean Absolute Deviation (MAD), Mean Square Error (MSE), Mean Absolute Percentage Error (MAPE).

Unit-3

Facilities Location and Plant Layout: Introduction, general procedure for location, factors affecting location, cost analysis, quantitative method, GRID method. **Plant Layout:** objectives of plant layout, factors affecting plant layout, types of plant layouts, process layout method: numerical on load distance analysis, systematic layout planning. **8 Hrs**

Self Study Component: Factors to be considered to select foreign locations, list the computer approaches to layout design.

Unit-4

Scheduling: Define scheduling, scheduling strategies, Forward and backward scheduling, Johnson's rule for 2 machines, 3 machines and n machines, graphical method for 2 machines and n jobs, indexing method**.**

8 Hrs

Self Study Component: Scheduling sequence operation, standard scheduling techniques, different types of control charts

Unit-5

Inventory Control: Types of inventory control, cost associated with inventory control, classification of inventory items , problems on ABC analysis on inventory, deterministic model in inventory control: problems only on economic lot size with uniform rate of demand and instantaneous replenishment, finite rate of replenishment with shortages. **Quality control:** Introduction to Quality control, Plan Do Check Act (PDCA Cycle), Quality circle, Kaizen, 5S, Six Sigma, Introduction to ISO standards. **8 Hrs**

Self Study Component: KANBAN-system, JIT, POKEYOKE.

Text Books

Joseph G.Monks, **"Operations Management"**, Tata McGraw-Hill, 2nd Edition, 2004, ISBN: 0070588708.

R. Panneerselvam, **"Production and Operations Management"**, PHI Publishers, 3rd Edition, 2006, ISBN: 9788120345553.

Reference Books

Barry Shore, **"Operations Management"**, Mc Graw Hill Inc., 1973, ISBN:9780070570450.

Samuel Eilon, **"Elements of Production Planning and Control"**, Universal Publishing Corporation, 1991, ISBN:9788185027098.

Buffa and Sarin, **"Modern Production/Operations Management"**, Wiley India Pvt. Ltd., 8th Edition, 2007, ISBN:9788126513727.

T.R. Banga and S.C. Sharma **"Industrial Engineering & Management, Including Production Management",** 12th edition, 2017, ISBN: 978-81-933284-6-0.

e- Resources

https://nptel.ac.in/courses/110107141
https://nptel.ac.in/courses/112107238
https://archive.nptel.ac.in/courses/112/102/112102106/

urse Outcomes: At the end of the course, students will be able to,

Apply various production management techniques and tools to improve productivity and efficiency in manufacturing or service operations.

Evaluate different types of production systems and **analyze** the factors affecting production system design, capacity planning, and layout configuration.

Analyze the production processes to achieve cost-effectiveness, minimize waste, reduce lead time and improve overall operational performance.

Analyze statistical process control, quality assurance techniques and control quality throughout the production process.

Apply the leadership and teamwork abilities within the context of production management.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** various production management techniques and tools to improve productivity and efficiency in manufacturing or service operations.	3								2	2				
CO2	**Evaluate** different types of production systems and **analyze** the factors affecting production system design, capacity planning, and layout configuration.		3												
CO3	**Analyze** the production processes to achieve cost-effectiveness, minimize waste, reduce lead time and improve overall operational performance.		3												
CO4	**Analyze** statistical process control, quality assurance techniques and control quality throughout the production process.		3												
CO5	**Apply** the leadership and teamwork abilities within the context of production management.	3								3	2				

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9					11	11%
CO2		2+9+9				20	20%
CO3			2+9+9	2+9+9		40	40%
CO4					2+9	11	11%
CO5	9				9	18	18%
	20	20	20	20	20	100	100%
Application = 49% , Analyse=51%							

THEORY OF PLASTICITY [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI				
Course Code: P21ME6035		**L-T-P: 3-0-0**		**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**		**SEE: 50%**

Course Learning Objective:
The objective of this course is to provide a basic understanding of the plasticity theory as applied to metal working processes and their analysis for improved quality and productivity.

Course Content

UNIT-I

Fundamental of Elasticity: Concept of stress, equilibrium equation stress transformation laws, spherical and deviator stress tensors, octahedral stresses, concept of strain, representation strain, compatibility equations, deviator and spherical strain tensors, strain transformation laws, elastic strain energy, theories of strength, numerical.

9 Hrs

Self Study Component: Maximum principal stress theory (Rankine), maximum shear stress theory (Tresca).

UNIT-II

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystalization and grain growth, flow figures (Luder's lines).**Yield Criteria:** Introduction, yield or plasticity conditions, Tresca and Von-Mises criteria, experimental evidence for yield criteria (a) Lode's experiment (b) Quinney's experiment. The Haigh-Westergaard stress space.

8 Hrs

Self Study Component: Maximum principal strain theory (Saint-Venant), total strain energy per unit volume (Haigh).

UNIT-III

Stress- Strain Relations: Introduction, types of materials, empirical equations, theories of plastic flow, experimental verification of Saint-Venant's theory of plastic flow, concept of plastic potential, maximum work hypothesis, concepts of stress rate.

7 Hrs

Self Study Component: Mechanical work for deforming a plastic substance.

UNIT-IV

Slip Line Field Theory: Introduction, basic equations for incompressible two dimensional flow, continuity equations (Geiringer equation), stresses in conditions of plain strain, convention for slip lines, solutions of plastic deformation problem, geometry of slip line filed, properties of slip lines, construction of slip line nets.

8 Hrs

Self Study Component: Velocity discontinuity at certain slip lines.

UNIT-V

Bending of Beams: Introduction, analysis of stresses, linear and non-linear stress-strain curve, shear stress distribution, residual stresses in plastic bending, numerical. **Torsion of Bars:** Introduction, plastic torsion of a circular bar, elastic- perfectly - plastic material, elastic work hardening material, residual stresses and numerical.

8 Hrs

Self Study Component: Plane strain bending of beam and plastic torsion of a circular bar.

Text Books:

Sadhu Singh, "**Theory of Plasticity and Metal Forming Processes**", Khanna Publishers, 3rd Edition, 2015, ISBN: 9788174090509.
J. Chakraborty, "**Theory of plasticity**", Butter-Heinemann publisher, 3rd Edition, 2007, ISBN: 9789380931715.

Reference Books:

R. A. W. Slater, "**Engineering Plasticity: Theory and Application to Metal Forming Processes**", McMillan Press Ltd, 1st Edition, 1977, ISBN: 9780333157091.
Jacob Lubliner, "**Plasticity Theory**", Dover publications Inc, 1st Edition, 2008, ISBN: 9780486462905.
Avitzur, B., "**Metal Forming Processes and Analysis**", McGraw Hill, 1st Edition, 1968, ISBN: 9780070025103.
L. M. Kachanov, "**Fundamentals of the Theory of Plasticity**", Dover Publication, 1st Edition, 2004, ISBN: 9780486435831.

e- Resources

https://www.youtube.com/watch?v=tb0yGRdK9lw
https://www.youtube.com/watch?v=yc8UPMZ1FNA&list=PLwdnzlV3ogoUH_9gN_6royr0u04Eq_z-T

urse Outcomes: At the end of the course, students will be able to,
Apply the equation for stress transformation, spherical, deviator, octahedral stresses and strains, and **analyse** the same.
Identify factors affecting plastic deformation, strain hardening, recovery, recrystalization, cubical dilation, true stress – strain.
Analyse the plastic flow of material using various theories, stress distribution in plastic bending of beams and residual stresses in torsion of bars.
Develop basic equation for incompressible two dimensional flows, continuity equation and **analyse** the slip line field and Yield stress.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	**Apply** the equation for stress transformation, spherical, deviator, octahedral stresses and strains, and **analyse** the same.	3	2												
CO2	**Identify** factors affecting plastic deformation, strain hardening, recovery, recrystalization, cubical dilation, true stress – strain.	3													
CO3	**Analyse** the plastic flow of material using various theories, stress distribution in plastic bending of beams and residual stresses in torsion of bars.	2	3												
CO4	**Develop** basic equation for incompressible two dimensional flows, continuity equation and **analyse** the slip line field and Yield stress.		3	2											

SEE- Course Assessment Plan

COs	Marks Distribution					Total Marks	Weightage
	Unit I	Unit II	Unit III	Unit IV	Unit V		
CO1	2+9+9					20	20%
CO2		2+9				11	11%
CO3			2+9+9		2+9+9	40	40%
CO4		9		2+9+9		29	29%
	20	20	20	20	20	100	100%

Application =31%, Analysis = 40%, Develop=29%

HEAT AND MASS TRANSFER

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code: P21ME604		**L-T-P: 3-0-2**	**Credits: 04**
Contact Period - Lecture: 40+24 (P) Hrs	**Exam: 3Hrs.**	**Weightage: CIE: 50%; SEE:50%**	

Course Learning Objective:
The objective of this course is to cover the basic principles of heat transfer, to present a wealth of real-world engineering examples to give students a feel for how heat transfer is applied in engineering practice and to develop an intuitive understanding of the subject matter by emphasizing the physics and physical arguments.

Course Content

UNIT-I

General introduction: Modes and basic laws of heat transfer.3D-general heat conduction equation in Cartesian coordinates, heat conduction equation in cylinder and spherical co-ordinates (no derivation). Boundary conditions of conduction problems. Numerical. **One Dimensional steady state heat conduction:** slab, hollow cylinder, hollow sphere and their composites. One Dimensional heat conduction with internal heat generation in slab. Critical thickness of insulations, Numerical Problems.

9 Hrs

Self study component: Combined Heat Transfer Mechanism, Thermal Resistances in Series and Parallel.

UNIT-II

Theory of fins: Governing partial differential equation – One Dimensional fin of uniform cross-section –Numerical problems. **Transient Heat Conduction:** Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Chart solution, Numerical problems.

8 Hrs

Self-study component: Applications of Fins, Numerical methods for 1D & 2D steady state Heat conduction.

UNIT-III

Convection: Concept of boundary layers (hydro dynamic and thermal) - critical Reynolds number. Drag-co-efficient and heat transfer coefficient, Reynold's – Colburn analogy. Application of dimensional analysis for free & forced convection problems, significance of Reynolds, Prandtl, Nusselt and Grashoff numbers. **Free convection:** free convection from vertical, horizontal and inclined flat plates, vertical and horizontal cylinder. Numerical Problems. **Forced convection**: Flow over a flat plate, over a cylinder and across a tube bundle, flow through tubes and ducts. Numerical Problems.

9 Hrs

Self-study component: Forced Convection cooling of electronic devices.

UNIT-IV

Radiation: Introduction- absorption, reflection and transmission of radiation, black and grey body concept , Kirchoff's Law, Planck's law, Wein's displacement law, Lamberts cosine law, radiation intensity- total emissive power, radiation between two parallel black surfaces, gray surfaces, radiation shield, Hottel's cross string formula. Numerical Problems.

7 Hrs

Self study component: Fundamental principles of white, Opaque and transparent body.

UNIT-V
Heat exchangers: Classification of heat exchangers overall heat transfer coefficient, fouling and fouling factor; LMTD, effectiveness- NTU methods of analysis of heat exchangers. Numerical Problems. **Heat transfer with phase change (boiling and condensation**). Types of condensation, Nusselt's theory for laminar condensation on a vertical flat surface, regimes of pool boiling, Numerical Problems. **Mass transfer**: Mass transfer concept and Fick's law of diffusion (no numericals) **7 Hrs** **Self study component:** Shell & tube, compact & multipass heat exchangers.
Practical Content **24 Hrs** **Exp-1:** Determination of thermal Conductivity of a Metal Rod. **Exp-2:** Determination of Overall Heat Transfer Coefficient of a Composite wall. **Exp-3:** Determination of Effectiveness and Efficiency of a Metallic fin. **Exp-4:** Determination of free Convective Heat Transfer Coefficient of a vertical Cylinder. **Exp-5:** Determination of Heat Transfer Coefficient in Forced Convection. **Exp 6:** Determination of Effectiveness in Parallel Flow and Counter Flow Heat Exchangers. **Determine the following using suitable software/programming language:** Develop code using suitable software to determine thermal conductivity in slab with and without heat generation using Fourier's law of heat conduction. Develop code using suitable software to determine heat transfer coefficients in convection methods. Develop code using suitable software to determine emissivity of a surface and Stefan's Boltzmann constant.
Text Books
A Basic approach by M Necati, Ozisik, **"Heat Transfer,"** Mc-Graw Hill International edition, 1988, ISBN: 978-0070479821 Frank Kreith, Mark Bohn, **"Principles of Heat Transfer,"** Cengage Learning, 6th edition, 2006, ISBN: 978-8131500385.
Reference Books
Yunus A Cengel, **"Heat transfers a practical approaches,"** Tata Mc-Graw Hill, Mc-graw Hill, 2nd edition 1st October, 2002, ISBN: 978-0072458930. James Sucec, **"Heat Transfer,"**Jaico Book house, 2002, ISBN: 978-8172247799. Er. R K Rajput **"Heat & Mass Transfer,"** S ChandPublications, 2008, ISBN: 978-8121926171. P.K. Nag, **"Heat & Mass Transfer,"** Tata Mc-Graw Hill, 3rd edition, 2011, ISBN: 978-0070702530. R.C.Sachdeva, **"Fundamentals of Engg. Heat & Mass Transfer,"** New Age, 4th edition, 2010, ISBN: 978-8122427851. J.P. Holman, Souvik Bhattacharyya**"Heat Transfer,"** Tata Mc-Graw Hill, 10th edition, 2011, ISBN: 978-0071069670.
e-Resources:
https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785 https://www.youtube.com/watch?v=IedD23t5jI4&list=PLSGws_74K01_ojmo4aRFPp3gUU0VFKESJ https://www.youtube.com/watch?v=sKnE5qvz0fc&list=PLbRMhDVUMngeygd_uWiLqa3fzA2h7vdRx https://www.youtube.com/watch?v=IedD23t5jI4&list=PLpCr5N2IS7Nmu22MOgDWOr0sSlIpUNUz3 https://www.youtube.com/watch?v=ljmWQlKm61U&list=PLbRMhDVUMnge4mnym5cCEKm_gTR_FLVve

Course Outcomes: At the end of the course, students will be able to,

Apply fundamentals of heat transfer to **formulate** the governing differential equation to solve one-dimensional steady and unsteady state heat conduction process.

Apply the concepts of convection heat transfer to **analyse** the problems using both analytical and empirical approaches.

Apply the concepts of heat transfer to **design** and **analyse** the thermal systems.

Interpret experimental data and validate by writing codes and prepare report as an individual or as a team member to communicate effectively.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO 1	**Apply** fundamentals of heat transfer to **formulate** the governing differential equation to solve one-dimensional steady and unsteady state heat conduction process.	3	2											1	
CO 2	**Apply** the concepts of convection heat transfer to **analyse** the problems using both analytical and empirical approaches.	3	3											2	
CO 3	**Apply** the concepts of heat transfer to **design** and **analyse** the thermal systems.	3	3	1										1	1
CO 4	**Interpret** experimental data and validate by writing codes and prepare report as an individual or as a team member to communicate effectively.					2				3	3				2

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9+9	2+9+9		2	2	44	44%
CO2			2+9+9			20	20%
CO3				9+9	9+9	36	36%
CO4	**Note: Assessment only in CIE**						
	20	20	20	20	20	100	100%
Application = 48 % , Analysis = 42 %, Design = 10%							

ALTERNATE FUELS, ENERGY CONVERSION AND CONSERVATION
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI

Course Code: P21MEO6051		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

Identify different types of alternate fuels and explore the advantages, disadvantages and application of alternate fuels.

Understand the economic concept of energy and explore various energy storage techniques and systems, focusing specifically on mechanical energy storage methods.

Course Content

UNIT-I

Introduction: Types of energy sources and their availability, need for alternative energy sources, Non-conventional energy sources, Classification of alternative fuels and drivetrains. Technological up gradation required, Implementation barriers for alternative fuels, stakeholders of alternative fuels. **Solar energy** Introduction to solar energy, solar energy collectors; Liquid flat plate collectors, solar air heaters, concentrating collectors (Cylindrical, parabolic), application of solar energy.

8 Hrs

Self-Study Component: Site selection considerations for wind Energy, Scenario of conventional auto fuels.

UNIT-II

Gaseous alternative fuels: Introduction, properties, production, storage, transportation, advantages, disadvantages and application of hydrogen, compressed natural gas (CNG), liquefied natural gas (LNG), adsorbed natural gas and landfill gas(LFG).

8 Hrs

Self-Study Component: Natural gas, liquefied petroleum gas (LPG), liquefied hydrogen (LH_2).

UNIT-III

Biomass Energy: Introduction, properties, production, storage, advantages, disadvantages and applications of Biogas, Biomethane, Methanol, Ethanol, straight vegetable oil (SVO) and biodiesel.

8 Hrs

Self-Study Component: Khadi and Village Industries Commission, Butanol.

UNIT-IV

Alternative power trains: Components of an Electrical Vehicles (EV), batteries, chargers, drives, transmission and power devices. Advantages and disadvantages of EVs. **Hybrid electric vehicles (HEV**): Drive train components, advantages of HV. **Dual fuel:** History of dual fuel technology, Duel fuel engine operation. Advantages, disadvantages and application of duel fuel technology.

8 Hrs

Self-Study Component: Advanced technology in Electric vehicles & Hybrid Electric vehicles.

UNIT-V

Energy Conservation: Economic concept of energy, principles of energy conservation and energy audit, energy conservation approach, Co-Generation, Waste heat utilization, Heat recuperators, heat regenerators, energy storage, energy storage system; Mechanical energy storage.

8 Hrs

Self-Study Component: Combined cycle power generation, Heat pipes, Electrical storage.

Text Books

S.S. Thipse "**Alternative Fuels**", JAICO Publishing House, 2010. 10: ISBN-10 8184950780 ISBN-13: 978-8184950786.

G.D. Rai "**Non-Conventional Energy Sources**" 6th edition, Khanna Publishing, 2017, New Delhi. 110006, ISBN:978-81-7409-073-8.

Reference Books

Richard L Bechtold P.E., **"Alternative Fuels Guide book"**, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.

S P Sukhatme, J K Nayak **"Solar energy"** Mc Graw Hill 3rd Edition New Delhi. ISBN: 9780070142961, 9780070260641, 0070142963, 0070260648

M. Poulton- **"Alternative fuels for vehicle book** "1994. 978-1562522254

Richard L. Bechtold, **"Automotive Fuels Guide Book",** SAE Publications, 1997. ISBN-10 1853123013

T.N. Veziroglu-**"Alternative energy sources",** McGraw Hill ISBN-10 : 007067471X ISBN-13 : 978-0070674714

A Primer on **"Hybrid Electric vehicles"**, ISBN No. 978-93-5570-356-9

Pavan K N, Ramesh Kurbet, "**Renewable Energy Technology**", 2023, Notion press, ISBN-13:9798889353621.

e –Resources:

https://nptel.ac.in/courses/103103206
https://nptel.ac.in/courses/115105127
https://www.un.org/en/climatechange/what-is-renewable-energy

urse Outcomes: At the end of the course, students will be able to,

Apply the knowledge of alternate fuels to study their properties, production methods and potential applications.

Analyze energy-efficient technologies to conserve energy in design principles and behavior modification approaches to reduce energy consumption.

Apply emerging trends in technological advancements and innovations in the field of alternate fuels and energy conservation.

Analyze energy planning and management techniques to optimize energy use and waste recovery.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Apply** the knowledge of alternate fuels to study their properties, production methods and potential applications.	3						1							
CO2	**Analyze** energy-efficient technologies to conserve energy in design principles and behavior modification approaches to reduce energy consumption.		2					1							
CO3	**Apply** emerging trends in technological advancements and innovations in the field of alternate fuels and energy conservation.	3						1							
CO4	**Analyze** energy planning and management techniques to optimize energy use and waste recovery.		2					1							

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	9				20	20%
CO2			2+9	2+9	2+9	33	33%
CO3	9	2+9				20	20%
CO4			9	9	9	27	27%
	20	20	20	20	20	100	100%

Application = 40%, Analysis =60%

INTRODUCTION TO FINITE ELEMENT METHODS [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code: P21MEO6052		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:
The objectives of this course are to,
Provide an introductory approach to finite element method as a basic numerical tool for solving mechanical engineering problems.
It also highlights various analyses of axially loaded uniformly tapered and stepped bars, truss members, beams and heat transfer problems.

Course Content

UNIT-I

Introduction to FEM: Need for use of FEM, Advantages and disadvantages of FEM, Engineering Applications of FEM, Steps involved in FEM, Discretization process - types of elements (1D,2D,3D), size of the elements, location of nodes, node numbering scheme, Method of solution of linear algebraic equations - Gauss elimination method. Basic elastic equations – body force and traction force, strain-displacement relations. Principle of minimum potential energy and derivation of potential energy functional for a 3D elastic body, concept of plane stress and plane strain and their stress-strain relations.

8 Hrs

Self-study component: Methods for FEM formulation, Gaussian Quadrature for 1D integrals.

UNIT-II

Interpolation Models: Displacement function, selection of the order of displacement function, convergence criteria, geometric isotropy, Pascal's triangle for 2D polynomial, Different co-ordinate systems used in FEM, Interpolation or shape functions for 1D linear and quadratic bar elements in cartesian and natural co-ordinate systems. Lagrangian polynomial–Shape functions for linear quadrilateral element (QUAD-4) and quadratic quadrilateral element (9-noded), Iso-parametric, sub-parametric and super-parametric elements.

8 Hrs

Self study component: Simplex, complex and multiplex Elements, Pascal's pyramid for 3D.

UNIT-III

Element Stiffness Matrix and Load Vectors: Strain displacement matrix, Stiffness matrix and load vector for linear and quadratic bar element. Assembly of elements by direct stiffness method, Treatment of boundary conditions- elimination and penalty methods. Analysis of axially loaded uniformly stepped bars.

8 Hrs

Self study component: Analysis of axially loaded uniformly tapered bars.

UNIT-IV

Analysis of Plane Trusses and Beams: stiffness matrix for plane truss element, analysis of truss members. Hermite shape function for beam element in Cartesian coordinates (Description), Stiffness matrix and load vector (Description) for beam element, element shear force and bending moment, analysis of beams. **8 Hrs**

Self study component: Differences between Hermite shape function and Lagrange interpolation function. Case studies on Electronic components.

UNIT-V

Analysis of Heat Transfer Problems: Steady state heat transfer, 1D heat conduction- governing equation, boundary conditions, one-dimensional element, Galerkin's approach to heat conduction, heat flux boundary condition. Simple numerical of 1D heat transfer problems on composite walls with conduction and convection. **8 Hrs**

Self study component: Different types of boundary conditions in heat transfer problem. Case studies on

Electronic components.

Text Books:

Chandrakanth S Desai and J.F. Abel, "**Introduction to the Finite Element Method**", CBS, 1st edition, 2005, ISBN: 978-8123908953.

T R Chandrupatla and A D Belegundu, "**Introduction to Finite Elements in engineering**", Pearson, 4th edition, 19th October 2011, ISBN: 978-0132162746.

Reference Books:

O.C. Zienkiewicz, "**The FEM its basics and fundamentals**", Elsevier Publisher, 6th edition, 2007, ISBN: 978-8131211182.

J.N. Reddy, "**Finite Element Method**", McGraw Hill International Edition, 2005, ISBN:9780072466850.

Daryl. L. Logon, "**Finite Element Methods**", Thomson Learning 5th edition, 1st Jan 2011, ISBN: 978-0495668251.

David V. Hutton, "**Fundamentals of Finite Element Analysis**", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 10th June 2005, ISBN: 978-0070601222.

Singiresu S Rao, "**The Finite Element Method in engineering**", Elsevier Publisher, 5th edition, 2008 ISBN: 978-9380931555.

Nitin S. Gokhale, "**Practical Finite Element Analysis**", Finite To Infinite, 2008th edition, 2020, ISBN: 978-8190619509.

e- Resources:

https://nptel.ac.in/courses/112/105/112105308/
https://nptel.ac.in/courses/112106135
https://youtu.be/KR74TQesUoQ

urse Outcomes: At the end of the course, students will be able to,

Understanding the fundamental principles of FEM such as discretization, interpolation and numerical integration and **apply** it for solving complex engineering problems.

Formulate element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.

Utilize finite element formulations in **analyzing** the stresses, strains and reactions of trusses and transversely loaded beams.

Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques to **analyze** conduction and convection heat transfer problems.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	Understanding the fundamental principles of FEM such as discretization, interpolation and numerical integration and **apply** it for solving complex engineering problems.	3	1										1		
CO2	Formulate element stiffness matrices and load vectors for different elements using variational principle and **analyze** axially loaded bars.	3	2	1									1		
CO3	Utilize finite element formulations in **analyzing** the stresses, strains and reactions of trusses and transversely loaded beams.		3	1									1		
CO4	Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques to **analyze** conduction and convection heat transfer		3	2			1						1		

	problems.														

SEE- Course Assessment Plan							
COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	9				20	20%
CO2	9	2+9	2+9			31	31%
CO3			9	2+9+9		29	29%
CO4					2+9+9	20	20%
	20	20	20	20	20	100	100%
Analysis = 80%; Application = 20%							

MAINTENANCE ENGINEERING [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code: P21MEO6053		**L-T-P: 3-0-0**	**Credits: 03**
Contact Period-Lecture: 40 Hrs.	**Exam: 3 Hrs.**	**Weightage: CIE: 50 %;**	**SEE: 50%**

Course Learning Objectives:

The objectives of this course are to,

Strengthen the Maintenance and management capabilities of the students.

Enable the students to handle the different maintenance requirements and management that are commonly used in machinery and minimize equipment failure.

Course Content

Unit-1

Maintenance Concept: Introduction, Maintenance Definition, Systems Approach, Challenges in Maintenance, Maintenance Objectives, Maintenance Levels ,Responsibilities of Maintenance Department, Types of Maintenance Systems, Benefits of Maintenance, Effects of Maintenance Concept of Maintainability , Principles of Maintenance.

8 Hrs

Self study component: Role of Overhauling in Maintenance.

Unit-2

Planned Preventive Maintenance: Introduction, Scope of Preventive Maintenance, Elements of Planned Preventive Maintenance (PPM), Implementation of PPM, Administrative Structure, Work Planning and Scheduling, Workload Estimation, Manpower Estimation, Scheduling PPM, Work-order Procedure, Creating a Set of Priority Functions, Forecasting Maintenance Requirements, Planned Maintenance Procedure, Effectiveness of Preventive Maintenance, Maintenance by Objectives.

8 Hrs

Self Study Component: Benefits of PPM.

Unit-3

Maintenance Planning and Scheduling: Introduction, Planning of Maintenance Function, Manpower Allocation, Long-range Planning, Development of Maintenance Department, Short-range Planning, Planning Techniques, Planning Procedure, Estimation of Maintenance Work, Maintenance Control, Maintenance Scheduling. **Computers in Maintenance** – Introduction, Computer-Aided Maintenance, Maintenance Decision Making, Computerized Maintenance Planning.

8 Hrs

Self Study Component: Computer Application In Inventory Control.

Unit-4

Condition Monitoring: Introduction, Basic Concept, Levels of Condition Monitoring, Condition-Monitoring Techniques, Future of Condition Monitoring, Case Study. **Maintenance Evaluation** – Introduction, Background of Maintenance Function, Need of Evaluation, Maintenance Function Requirements, Benefits of Maintenance Evaluation, Types of Evaluation, Objectives of Evaluation, Selection of Work Measurement Methods.

8 Hrs

Self Study Component: Cost of Maintenance Evaluation.

Unit-5

Advances in Maintenance: Introduction, Reliability and Maintenance, Telematic Maintenance Services, Decision Support System Based on Artificial Intelligence, Use of Radio Frequency Identification (RFID), Optimization of Maintenance Activities, Risk-based Maintenance Planning, Total Productive Maintenance (TPM), Maintenance Management, Quality Control in Maintenance, Effective Maintenance Organization.

8 Hrs

Self Study Component: Root Cause Analysis (RCA), Maintenance Outsourcing.

Text Books:

R. C. Mishra and K Pathak, "**Maintenance Engineering and Management**", PHI, Learing Pvt. Ltd., 2nd edition, 2012, ISBN: 9788120345737.

Morrow L C, "**Maintenance Engineering Hand book**", McGraw-Hill Inc., US; 2nd revised edition, 1967, ISBN: 9780070432017.

Reference Books:

Frank Herbaty, "**Hand book of Maintenance Management**", Noyes Publication, 2nd edition, 1990, ISBN: 9780815512042.

W.Grant Ireson, Eugene L. Grant, "**Hand book of Industrial Engg & Management**," 2000.

Herbert F. Lund, "**Industrial Pollution Control Handbook**," McGraw-Hill Publication, 1st edition, 1971, ISBN: 9780070390959.

e- Resources:

https://youtu.be/f58SW0Hwcf0
https://www.digimat.in/nptel/courses/video/112107241/L11.html

urse Outcomes: At the end of the course, students will be able to,

Identify maintenance engineering functions in different organizations.
Apply maintenance policy techniques in mechanical systems and **analyse** job and spare parts control.
Apply condition monitoring techniques in industries and adopt advance techniques in maintenance engineering.
Analyse the Root Cause for failure of machines.

Course Articulation Matrix

Course Outcomes		**Program Outcomes**												**PSO**	
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	**Identify** maintenance engineering functions in different organizations.	3											1		
CO2	**Apply** maintenance policy techniques in mechanical systems and **analyse** job and spare parts control.	3	2												1
CO3	**Apply** condition monitoring techniques in industries and adopt advance techniques in maintenance engineering.	3	1												1
CO4	**Analyse the** Root Cause for failure of machines.		3											1	

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9+9					20	20%
CO2		2+9+9				20	20%
CO3			2+9	2+9+9		31	31%
CO4			9		2+9+9	29	29%
	20	20	20	20	20	100	100%
Applications=71%, Analysis=29%							

<table>
<tr><td colspan="3">OPERATIONS RESEARCH
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI</td></tr>
<tr><td>Course Code: P21MEO6054</td><td>L-T-P: 2-2-0</td><td>Credits: 03</td></tr>
<tr><td>Contact Period - Lecture: 40 Hrs; Exam: 3 Hrs.</td><td colspan="2">Weightage % : CIE: 50-SEE:50</td></tr>
<tr><td colspan="3">Course Learning Objectives:
The objectives of this course are to,
Understand the basic concepts of Operations Research.
Identify and develop operation research models from the verbal description of real life and optimize the solutions.</td></tr>
<tr><td colspan="3">Course Content</td></tr>
<tr><td colspan="3">Unit-1
Introduction: Definition, scope of Operations Research (OR) approach and limitations of OR models, characteristics and phases of OR, mathematical formulation of linear programming problems. Graphical solution for maximization and minimization problems.
8 Hrs
Self Study Component: Advantages and applications of OR.</td></tr>
<tr><td colspan="3">Unit-2
Linear Programming Problems: Simplex method, slack, surplus and artificial variables, degeneracy and procedure for resolving degeneracy. Big M method, two phase method.
8 Hrs
Self Study Component: Dual simplex method.</td></tr>
<tr><td colspan="3">Unit-3
Transportation and Assignment: Formulation of transportation problem, initial feasible solution methods, optimality test, degeneracy in transportation problem, assignment problem, Hungarian method, travelling salesman problem.
8 Hrs
Self Study Component: Unbalanced transportation and assignment problems.</td></tr>
<tr><td colspan="3">Unit-4
Network Analysis in Project Planning (PERT and CPM): Project, project planning, project scheduling, project controlling, network terminologies, PERT and CPM.
8 Hrs
Self Study Component: Crashing of networks.</td></tr>
<tr><td colspan="3">Unit-5
Game Theory: Formulation of games, two people-zero sum game, games with and without saddle point, graphical solution (2 x n, m x 2 game) and dominance property. Queuing Theory: Queuing system and their characteristics. The M/M/1 Queuing system, steady state performance analyzing of M/M/ 1 System.
8 Hrs
Self Study Component: Competitive games.</td></tr>
<tr><td colspan="3">Text Books:</td></tr>
<tr><td colspan="3">Taha H.A, “Operations Research and Introduction”, Pearson Education, 9th edition, 2017, ISBN:978-93-325-1822-3,
Prem Kumar Gupta and D.S. Hira,S Chand, “Operations Research”, 2014, Pub, New delhi.,7th edition, ISBN:978-51-219-0281-6</td></tr>
<tr><td colspan="3">Reference Books:</td></tr>
<tr><td colspan="3">R Panneerselvam, “Operation Research”, PHI, 2nd edition, 2010, ISBN:978-81-203-2928-7.
S.D. Sharma, “Operations Research”, Kedarnath Ramnath & Co , 2002 , 978-93-325-1811-1</td></tr>
</table>

H. A. Eiselt, Carl-Louis Sandblom, “**Operations Research: A Model-Based Approach”**, ISBN: 978-3-642-10325-4 (Print) 978-3-642-10326-1 (Online) Frederick S. Hillier, Gerald J. Lieberman, “**Introduction to Operation Research”**, McGraw Hill, Seventh Edition.
e-Resources:
https://www.youtube.com/watch https://www.edx.org/course/quantitative-marketing-research https://www.edx.org/course/uconn-cybersecurity-boot-camp https://www.edx.org/professional-certificate
<u>Course Outcomes</u>: After learning all the units of the course, the student is able to, **Formulate** real world problems as a Linear programming model and demonstrate solution by graphical method and **analysis** technique. **Apply** the specific LPP like transportation and assignment and **analyse** the solution. **Apply** the different project mathematical model and **analyze** the solution. **Apply** the game and Queuing strategy with their characteristics and **analyse** the solutions.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Formulate** real world problems as a Linear programming model and demonstrate solution by graphical method and **analysis** technique.	2	2										1		
CO2	**Apply** the specific LPP like transportation and assignment and **analyse** the solution.	2	2										1		
CO3	**Apply** the different mathematical and project model **analyze** the solution.	2	2										1		
CO4	**Apply** the game and Queuing strategy with their characteristics and **analyse** the solutions.	2	2										1		

SEE- Course Assessment Plan

COs	**Marks Distribution**					**Total Marks**	**Weightage (%)**
	Unit I	**Unit II**	**Unit III**	**Unit IV**	**Unit V**		
CO1	2+9	9		9	9	38	38%
CO2		2+9	2+9			20	20%
CO3	9		9	2+9		29	29%
CO4					2+9	18	18%
	20	20	20	20	20	100	100%
Application = 49%, Analysis=51%							

COMPUTER AIDED MODELING AND ANALYSIS LABORATORY

[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code: P21MEL606		**L-T-P:0-0-2**	**Credits:1**
Contact Period-Lecture: 30(P) Hrs.	**Exam: 3 Hrs.**	**Weightage:CIE:50%; SEE:50%**	

Course Learning Objectives:

The objectives of this course are to,

Apply the concept of Finite Element Method (FEM) in design engineering using ANSYS package.

Apply the concept of control engineering using MATLAB.

Course Content

PART-A (ANSYS)

15 Hrs

Exp-1: Analysis of plane trusses.

Exp-2: Analysis of Beams for SFD and BMD.

Exp-3: 2D conduction and convection heat transfer analysis.

Exp-4: Analysis of bars with constant cross section area and tapered cross section area.

Exp-5: Plane stress analysis of plate with hole.

Exp-6: Modal and Harmonic analysis of fixed - fixed beam.

PART-B (MATLAB)

15 Hrs

Exp-7: Solving of simultaneous equations.

Exp-8: Unit-step response plot of control system for open loop transfer function, state-space equation and to determine rise time, peak time, maximum overshoot and settling time.

Exp-9: Root locus plot of control systems for open loop transfer function and state-space equation.

Exp-10: Bode plot of control systems for open loop transfer function and state-space equation.

Reference Books:

SaeedMoaveni, **"Finite Element Analysis Theory and Application with ANSYS"**, Pearson Education, 3rd edition, 2007, ISBN: 978-0131890800.

Nitin S Gokhale, Sanjay S Deshpande, Sanjeev V Bedekare and Anand N Thite, "**Practical Finite Element Analysis**", 2008th edition, 1 February 2020, ISBN-12:978-8190619509, Finite To Infinite Publisher.

Rao V Dukkipati, **"Control Systems",** Narosa Publishing House, 2008, ISBN: 978-8173195549.

e-Resources:

https://www.youtube.com/watch?v=p6iEJ1fQvh0
https://www.youtube.com/watch?v=9mu-mxtFTMU
https://www.youtube.com/watch?v=1dvEmK6To7M
https://www.youtube.com/watch?v=bMBuZjZjG80
https://www.youtube.com/watch?v=3pz2-g3oQqU
https://www.youtube.com/watch?v=3BwhuqzLzBM
https://www.youtube.com/watch?v=NwJYZHu61kU
https://www.youtube.com/watch?v=Zm2QmeDU5R4
https://www.youtube.com/watch?v=RgQTS8mDW1Q
https://www.youtube.com/channel/UCNuB-vNeYDoDLuIZ4lLWeLw

Course Outcomes: At the end of the course, students will be able to,

Apply the basic concepts of FEM using ANSYS tool.
Analyse the mechanical structure by validating the numerical results with analytical solution.
Apply the concept of control engineering to **analyze** the mechanical system using MATLAB.
Make use of post processor results for writing a report to **communicate** effectively.

Course Articulation Matrix

Course Outcomes		Program Outcomes												PSO	
		1	2	3	4	5	6	7	8	9	10	11	12	01	02
CO1	**Apply** the basic concepts of FEM using ANSYS tool.	3				3									2
CO2	**Analyse** the mechanical structure by validating the numerical results with analytical solution.	3	3											2	
CO3	**Apply** the concept of control engineering to **analyze** the mechanical system using MATLAB.	3	3			2									2
CO4	**Make use of** post processor results for writing a report to **communicate** effectively.									3	3				

SEE- Course Assessment Plan

COs	**Marks Distribution**			**Total Marks**	**Weightage (%)**
	Part A	**Part B**	**Viva- Voce**		
CO1	8			8	16%
CO2	7			7	14%
CO3		25		25	50%
CO4			10	10	20%
	15	25	10	50	100%

Application =16% Analysis = 64% Communication =20%

Mini - Project [As per Choice Based Credit System (CBCS) & OBE Scheme] SEMESTER – VI			
Course Code:	**P21MEMP607**	**Credits:**	**02**
Teaching Hours/Week (L:T:P)	**0:0:2**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**26**	**SEE Marks:**	**50**

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students. (or Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications)

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. **The marks awarded for the project report shall be the same for all the batch mates.**

(ii) **Interdisciplinary**: CIE shall be group-wise at the college level with the participation of all the guides of the college through Dean (III). The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

SEE for Mini-project:

- **Single discipline**: Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department through Viva-Voce examination.
- **Interdisciplinary**: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) through Viva-Voce examination conducted separately at the departments to which the student/s belongs to.

Employability Enhancement Skills (EES) - VI *[As per Choice Based Credit System (CBCS) & OBE Scheme]* **SEMESTER – VI**			
Course Code:	**P21HSMC608**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**0:2:0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**28**	**SEE Marks:**	**50**

Course Learning Objectives: This course will enable students to:
- Explain the basic concepts in Race and games, Linear equations, mensuration, height and distance.
- Apply the logical skills in decoding Number, letter series and Game based assessments.
- Calculations involving Time, Speed and distance, HCF & LCM, Averages and Partnerships

UNIT – I	**10 Hours**

Quantitative Aptitude: Race and games, Linear equations

Logical Reasoning: Number and letter series

Self-Study: Types of cryptarithm.

UNIT – II	**10 Hours**

Quantitative Aptitude: Mensuration, Height & distance.

Logical Reasoning: Game based assessments.

Self-Study: Inferred meaning, Chain rule.

UNIT – III	**08 Hours**

Quantitative Aptitude: Time, Speed and distance, HCF & LCM, Averages and Partnerships

Self-Study: Decimal fractions

Course Outcomes: On completion of this course, students are able to:

CO – 1:	Solve the problems based on Race and games, Linear equations, mensuration, height and distance.
CO – 2:	Solve logical reasoning problems based on Number, letter series and Game based assessments.
CO – 3:	Solve the problems based on HCF & LCM, averages and partnerships.

Text Book(s):
1. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
2. Verbal reasoning by Dr. R. S Agarwal, published by S. Chand private limited.

Reference Book(s):

1. Quantitative Aptitude by Arun Sharma, McGraw Hill Education Pvt Ltd
2. A Modern Approach to Verbal & Non-Verbal Reasoning by R.S. Agarwal.
3. CAT Mathematics by Abhijith Guha, PHI learning private limited.

COURSE ARTICULATION MATRIX [Employability Enhancement Skills (EES) - VI**]**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO-1	2	2	-	-	-	-	-	-	-	-	-	2
CO-2	2	2	-	-	-	-	-	-	-	-	-	2
CO-3	2	2	-	-	-	-	-	-	-	-	-	2

Universal Human Values and Professional Ethics
[As per Choice Based Credit System (CBCS) & OBE Scheme]
SEMESTER – VI

Course Code:	**P21UHV609**	**Credits:**	**01**
Teaching Hours/Week (L:T:P):	**1 : 0 : 0**	**CIE Marks:**	**50**
Total Number of Teaching Hours:	**25 + 5**	**SEE Marks:**	**50**

Course objectives:
This course is intended to:
1. 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.
2. 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.
3. 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.
4. This course is intended to provide a much-needed orientation input in value education to the young enquiring minds.

Teaching-Learning Process (General Instructions)
These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.
1. The methodology of this course is explorational and thus universally adaptable. It involves a systematic and rational study of the human being vis-à-vis the rest of existence.
2. In addition to the traditional lecture method, different types of innovative teaching methods may be adopted so that the activities will develop students’ theoretical and applied skills.
3. State the need for UHV activities and its present relevance in the society and Provide real-life examples.
4. Support and guide the students for self-study activities.
5. You will also be responsible for assigning homework, grading assignments and quizzes, and documenting students’ progress in real activities in the field.
6. This process of self-exploration takes the form of a dialogue between the teacher and the students to begin with, and then to continue within the student in every activity, leading to continuous selfevolution.
7. Encourage the students for group work to improve their creative and analytical skills.

Module - 1

Introduction to Value Education **(3 hours)**
Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) Understanding Value Education, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfil the Basic Human Aspirations

Module - 2
Harmony in the Human Being : (3 hours)
Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health
Module - 3
Harmony in the Family and Society : (3 hours)
Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order
Module - 4
Harmony in the Nature/Existence : (3 hours)
Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence
Module - 5
Implications of the Holistic Understanding – a Look at Professional Ethics : (3 hours)
Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics Holistic Technologies, Production Systems and Management Models-Typical Case Studies, Strategies for Transition towards Value-based Life and Profession
Course outcome (Course Skill Set) At the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); • They would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. • They would have better critical ability. • They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). • It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction. Expected to positively impact common graduate attributes like: 1. Ethical human conduct 2. Socially responsible behaviour 3. Holistic vision of life 4. Environmentally responsible work 5. Having Competence and Capabilities for Maintaining Health and Hygiene 6. Appreciation and aspiration for excellence (merit) and gratitude for all
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.
- CIE paper shall be set for 25 questions, each of the 02 marks. The pattern of the question paper is MCQ (multiple choice question). The time allotted for SEE is 01 hour. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

The sum of two tests, will be out of 100 marks and will be scaled down to 50 marks
Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.
Semester End Examinations (SEE)
SEE paper shall be set for **50 questions,** each of the 01 marks. **The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:
Books for READING:
Text Book and Teachers Manual

- The Textbook A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034- 47-1
- The Teacher‟s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amar kantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj – Pandit Sunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
11. India Wins Freedom - Maulana Abdul Kalam Azad
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)
14. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
15. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
16. A Nagraj, 1998, Jeevan Vidya Ek Parichay, Divya Path Sansthan, Amarkantak.
17. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
18. A N Tripathy, 2003, Human Values, New Age International Publishers.
19. SubhasPalekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) KrishiTantraShodh, Amravati.
20. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers , Oxford University Press

21. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
22. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
23. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Web links and Video Lectures (e-Resources):

Value Education websites,

- https://www.uhv.org.in/uhv-ii,
- http://uhv.ac.in,
- http://www.uptu.ac.in
- Story of Stuff,
- http://www.storyofstuff.com
- Al Gore, An Inconvenient Truth, Paramount Classics, USA
- Charlie Chaplin, Modern Times, United Artists, USA
- IIT Delhi, Modern Technology – the Untold Story
- Gandhi A., Right Here Right Now, Cyclewala Productions
- https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw
- https://fdp-si.aicte-india.org/8dayUHV_download.php
- https://www.youtube.com/watch?v=8ovkLRYXIjE
- https://www.youtube.com/watch?v=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM