SYLLABUS
(With effect from 2023 -24)

ಮುಂದುವರೆ (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]

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

Professionalism
Empathy
Synergy
Commitment
Ethics
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)

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course Code</th>
<th>Course Title</th>
<th>Teaching Department</th>
<th>Hrs / Week</th>
<th>Credits</th>
<th>Examination Marks</th>
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<td>1</td>
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**Total:** 21

### Professional Elective Course – I (P21ME503X)

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<td>P21ME5031</td>
<td>Theory of Elasticity</td>
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<tr>
<td>P21ME5032</td>
<td>Non Traditional Machining</td>
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<tr>
<td>P21ME5033</td>
<td>Aircraft and Rocket Propulsion</td>
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<tr>
<td>P21ME5034</td>
<td>Design of Experiments</td>
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### Open Elective – I (P21MEO505X)

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<tr>
<td>P21MEO5051</td>
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<tr>
<td>P21MEO5052</td>
<td>Robotics and Automation</td>
</tr>
<tr>
<td>P21MEO5053</td>
<td>Experimental Stress Analysis</td>
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<td>P21MEO5054</td>
<td>Fundamentals of Thermal Sciences</td>
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### Bachelor of Engineering (VI – Semester)

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<th>Examination Marks</th>
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<td>3</td>
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**Total:** 21

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<td>P21ME6022</td>
<td>Finite Element Methods</td>
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<td>P21ME6023</td>
<td>Heating, Ventilation and Air Conditioning</td>
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<td>P21ME6024</td>
<td>Materials Selection and Failure Analysis</td>
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<td>P21ME6032</td>
<td>Electric and Hybrid Vehicles</td>
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<td>P21ME6033</td>
<td>Control Engineering</td>
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<td>P21ME6034</td>
<td>Production Management</td>
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### Open Elective – II (P21MEO605X)

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<th>Course Title</th>
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<tr>
<td>P21MEO6051</td>
<td>Alternate Fuels, Energy Conversion and Conservation</td>
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<tr>
<td>P21MEO6052</td>
<td>Introduction to Finite Element Methods</td>
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<tr>
<td>P21MEO6053</td>
<td>Maintenance Engineering</td>
</tr>
<tr>
<td>P21MEO6054</td>
<td>Operations Research</td>
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<tr>
<td>P21ME6035</td>
<td>Theory of Plasticity</td>
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</table>
# MANAGEMENT, ENTREPRENEURSHIP AND PROFESSIONAL ETHICS

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

## SEMESTER – V

<table>
<thead>
<tr>
<th>Course Code: P21ME501</th>
<th>L-T-P: 3-0-0</th>
<th>Credits: 03</th>
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<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50% ; SEE: 50%</td>
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</tbody>
</table>

### Course Learning Objectives:
- 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


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:

Reference Books:

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

Course 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1 Apply</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO2 Apply</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO3 Analyze</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>CO4 Make use of</td>
<td></td>
<td>3</td>
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<td>COs</td>
<td>Marks Distribution</td>
<td>Total Marks</td>
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</tr>
<tr>
<td></td>
<td>Unit I</td>
<td>Unit II</td>
</tr>
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<td>2+9</td>
<td>2+9</td>
</tr>
<tr>
<td>CO2</td>
<td>2+9</td>
<td>2+9</td>
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<tr>
<td>CO3</td>
<td>9</td>
<td>9</td>
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<tr>
<td>CO4</td>
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<td>9</td>
</tr>
<tr>
<td></td>
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</table>

Application = 80%, Analysis = 20%
P.E.S. College of Engineering, Mandya
Department of Mechanical Engineering

DESIGN OF MACHINE ELEMENTS-I
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

<table>
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<tr>
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<th>L-T-P: 3-0-0</th>
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<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
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</table>

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.

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

8 Hrs

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.

Self study component: Impact stresses due to bending load.

8 Hrs

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.

Self study component: Design against lateral rigidity.

8 Hrs

UNIT-IV


Self study component: Differential and compound screws.

8 Hrs

UNIT-V


Self study component: Diamond or Lozenge joint.

Design data hand book:
Text Books:


Reference Books:


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-zNnHVjnn5E5Gk
https://www.youtube.com/watch?v=HutOKnuY9GA
https://www.youtube.com/watch?v=Z38Aq9ykUCM
https://www.youtube.com/watch?v=WooOb-2lutlg
https://www.youtube.com/watch?v=9y93VZcxO0g

Course 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

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<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
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<tr>
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SEE- Course Assessment Plan

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<th>Unit III</th>
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Application = 22%, Analysis=18%, Design=60%
**THEORY OF ELASTICITY**  
[As per Choice Based Credit System (CBCS) & OBE Scheme]  

**SEMESTER – V**

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<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50% ; SEE: 50%</td>
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</table>

**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.

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

8 Hrs

### 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.

**Self-study component:** Mohr’s circle for strain system

8 Hrs

### UNIT-III  

**Self-study component:** Theorem of Virtual work

8 Hrs

### 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.

**Self-study component:** Cauchy integral theorem

8 Hrs

### 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.

**Self-study component:** Torsion of general prismatic bar

8 Hrs

**Text Books:**  

**Reference Books:**  


e- Resources:

https://www.youtube.com/watch?v=DzyIEz3dKXQ&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0A
https://www.youtube.com/watch?v=oXBiwkeRi2I&list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av
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

Course 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

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

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<thead>
<tr>
<th>Unit I</th>
<th>Unit II</th>
<th>Unit III</th>
<th>Unit IV</th>
<th>Unit V</th>
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<tbody>
<tr>
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<td>CO2 9</td>
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</table>

Application=60%, Analysis=40%
NON TRADITIONAL MACHINING
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

Course Code: P21ME5032 | L-T-P: 3:0:0 | Credit: 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 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.

Course Content

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.

Self study component: Principle of micro machining and its application.

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.

Self study component: Principle and applications of Abrasive water jet machining.

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.

Self study component: Advantages, disadvantages and applications of electrochemical machining.

UNIT-4

Self study component: Advantages and disadvantages of Ion beam Machining.

UNIT-5

Self study component: Safety precautions of plasma arc machining.
Text Books:


Reference Books:


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=J3fUPsBU
https://www.google.com/search?q=nmt+process+selection+standard+chart&rlz=1C1FKPE_enIN97 7IN97&qo=nmt+process+selection+standard+chart&aqs=chrome..69i57j33i10i160i2.15511j0j15&sourceid=chrome&ie=UTF-8

Course Outcomes:

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

1. **Apply** the principles, processes, and techniques of non-traditional machining methods.
2. **Compare** and selection of non-conventional machining processes for suitable applications.
3. **Apply** the concepts and techniques learned in the course to solve real-technical manufacturing problems and analyse the economic and environmental issues.
4. **Analyse** the process parameters and characteristics of operating specialized equipment’s of non-traditional machines.

Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 <strong>Apply</strong> the principles, processes, and techniques of non-traditional machining methods.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>CO2 <strong>Compare</strong> and selection of non-conventional machining processes for suitable applications.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO3 <strong>Apply</strong> the concepts and techniques learned in the course to solve real-technical manufacturing problems and analyse the economical and environmental issues.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>CO4 <strong>Analyze</strong> the process parameters and characteristics of operating specialized equipments of non-traditional machines.</td>
<td>3</td>
<td>1</td>
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<tr>
<td>COs</td>
<td>Marks Distribution</td>
<td>Total Marks</td>
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<td></td>
<td>Unit I</td>
<td>Unit II</td>
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<td>2+9</td>
</tr>
<tr>
<td>CO 4</td>
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<td>2+9</td>
</tr>
</tbody>
</table>

Application = 80%, Analysis = 20%
# AIRCRAFT AND ROCKET PROPULSION

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

<table>
<thead>
<tr>
<th>SEMESTER – V</th>
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</table>

<table>
<thead>
<tr>
<th>Course Code: P21ME5033</th>
<th>L-T-P:3-0-0</th>
<th>Credits: 03</th>
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<tbody>
<tr>
<td>Contact Period - Lecture: 40 Hrs.</td>
<td>Exam: 3Hrs.</td>
<td>Weightage:CIE:50%; SEE:50%</td>
</tr>
</tbody>
</table>

## 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

8 Hrs

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

### UNIT-III

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

P21 Scheme - V & VI Semester Syllabus
Text Books:


Reference Books:

e- Resources:
https://www.youtube.com/watch?v=Hlj2eVt1Vbk
https://www.youtube.com/watch?v=Af0-5r5HJII
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=OLRMdW3WHL0&list=PLOzRYVm0a65ey1nPhnbfrz59Hvu-NVob7&index=7

Course Outcomes: 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>1</th>
<th>2</th>
<th>3</th>
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<th>7</th>
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<tr>
<td>CO1 Apply the knowledge of thermodynamics to describe the working of air breathing and rocket engines.</td>
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<tr>
<td>CO2 Apply the basic principles of thermodynamics and fluid mechanics to describe the working of aircraft engine components.</td>
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<td>3</td>
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<td>CO3 Analyze the performance of air breathing engine and its components.</td>
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<td>CO4 Analyze the working and performance of rocket engines.</td>
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### SEE - Course Assessment Plan

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<tr>
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</table>

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:** 3 Hrs.  
**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.

8 Hrs

**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:

Reference Books:

e-Resources:
https://nptel.ac.in/courses/102106051
https://www.youtube.com/watch?v=Srq9Q-yd1Rk
https://www.youtube.com/watch?v=p5L_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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>P</th>
<th>S</th>
<th>O</th>
</tr>
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<tbody>
<tr>
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<td>1</td>
<td>2</td>
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<td>4</td>
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<tr>
<td>CO1 Apply the fundamental concepts with mathematical knowledge, methodologies to bring knowledge of Design of Experiments.</td>
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<tr>
<td>CO2 Apply a wide range of problems between the purpose of a model and the appropriate level of complexity.</td>
<td>3</td>
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<tr>
<td>CO3 Choose an appropriate experiment to Analyse a new product design or process improvement through experimentation strategy.</td>
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<td>CO4 Analyze the nature of variable, statistical inference, influence parameter selection, factorial concepts, conduct design of experiments</td>
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## SEE- Course Assessment Plan

<table>
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<tbody>
<tr>
<td></td>
<td>Unit I</td>
<td>Unit II</td>
<td>Unit III</td>
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<tr>
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<tr>
<td>CO4</td>
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</table>

Application = 49%, Analyse = 51%
# THEORY OF MACHINE- I (Integrated)

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

## SEMESTER – V

<table>
<thead>
<tr>
<th>Course Code: P21ME504</th>
<th>L-T-P: 2-2-2</th>
<th>Credits: 04</th>
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<tr>
<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
</tr>
<tr>
<td>Practical: 24 Hrs.</td>
<td></td>
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</tbody>
</table>

### 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.

### Course Content

#### 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. Peaucellier’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.

#### 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.

#### 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.

#### 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.

#### 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.

### Practical Content

1. To find area of complex shape by using Planimeter.
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:

Reference Books:

e-Resources:
- https://www.youtube.com/watch?v=yDEJxYGAos0&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=55tKVBDQDUY

Course Outcomes:
- 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>CO1</th>
<th>CO2</th>
<th>CO3</th>
<th>CO4</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>PSO 1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>CO1 Apply the basic concepts of mechanical elements like links, chains, gears and cams in understanding the construction and working of mechanisms.</td>
<td>3</td>
<td>1</td>
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<td></td>
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</tr>
<tr>
<td>CO2 Apply the basic concepts in understanding, degrees of freedom in different mechanisms and working principles of governors.</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CO3 Analyze the gear trains, static force, velocity in four bar and slider crank mechanism, and develop cam profile for various follower motion.</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4 Make use of experimental data for writing a report as an individual or as a team member to communicate effectively.</td>
<td>3</td>
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### SEE- Course Assessment Plan

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**Note:** Assessment only in CIE

Application=40%, Analysis=60%
### MECHATRONICS AND MICROPROCESSOR
[As per Choice Based Credit System (CBCS) & OBE Scheme]

**SEMESTER – V**

<table>
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<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
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</table>

#### 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**

Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods.


8 Hrs

Text Books:

81-317-3253-3.


Reference Books:

R S Ganokar, “Microprocessor Architecture, programming and applications with 8085/8085A”,

0074622353.

K P Ramachandran, G K Vijaya Raghava and M S Bala Sundaram, “Mechatronics &

e- Resources:

https://www.youtube.com/watch?v=zVVTxie7g&list=PLLy_2iUCG87BNHXRB6L2pWEpMcLoFaY_U
https://www.youtube.com/watch?v=UrST2yu8zQ&list=PLLy_2iUCG87BNHXRB6L2pWEpMcLoFaY_U&index=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

Course 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

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<th>Program Outcomes</th>
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<tbody>
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Application=73 %, Analysis=27 %
### ROBOTICS AND AUTOMATION

**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:
- 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.

**Self Study Component:** Pay load and Stability of robots.

#### UNIT-II

**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.

**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.

**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.

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

**Text Books:**
Reference Books:

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.

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<td>CO1 Identify the components of a robot and distinguish the types of robot configurations.</td>
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<td>CO2 Apply and identify sensors/drives for automation and robots.</td>
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<td>CO3 Analyze and develop robot task programs using robot language.</td>
<td>3 1</td>
<td>1 1</td>
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<tr>
<td>CO4 Analyze models and integrate the drives for industrial robots and automation systems.</td>
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SEE- Course Assessment Plan

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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.

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.

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.

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.

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.

Self study component: Advantages and applications of Moire techniques.

Text Books

Reference Books


e- Resources

https://archive.nptel.ac.in/courses/112/106/112106068/
https://onlinecourses.nptel.ac.in/noc23_me11/preview

Course 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<th>PSO</th>
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<tr>
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<td>CO1 Apply</td>
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Application = 71%, Analysis = 29%

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<td>CO4</td>
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<tr>
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Application = 71%, Analysis = 29%
# FUNDAMENTALS OF THERMAL SCIENCES
[As per Choice Based Credit System (CBCS) & OBE Scheme]

## SEMESTER – V

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<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
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</table>

### 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. **Self study component**: Applications of energy transfer

8 Hrs

#### 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. **Self study component**: Types of Biogas Digesters

8 Hrs

#### 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. **Self study component**: Different types of blowers and fans.

8 Hrs

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

8 Hrs

#### 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. **Self study component**: Applications of actuators and sensors. **Text Books**

Reference Books

e-Resources
https://youtu.be/2LPQX4F-GoA
https://youtu.be/9GMbpZZTjXM
https://youtu.be/nIsNmhiID74
https://youtu.be/j9y0gfN9WMg
https://youtu.be/ebO38bbq0_4

Course 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<th>PSO</th>
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<tbody>
<tr>
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<tr>
<td>CO1 Apply a basic understanding of the laws and principles of thermal engineering, including energy forms, thermodynamics, and heat transfer mechanisms.</td>
<td>3</td>
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<tr>
<td>CO2 Apply the basic concepts and principles to analyze the different types of thermal systems and components used in various industries and applications.</td>
<td>3 2</td>
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<tr>
<td>CO3 Apply the environmental and sustainability aspects of thermal engineering to recognize the importance of clean and energy technologies.</td>
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<tr>
<td>CO4 Identify the impact of thermal engineering in modern fields of technologies.</td>
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SEE- Course Assessment Plan

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Application = 100%
Course Code: P21MEL506  

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

Experiments 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.-4: Determination of Calorific value of gaseous fuels using Junkers Gas calorimeter.
Expt.-5: Determination of thermal conductivity of liquids.

PART-B 15 Hrs

Experiments 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:

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
Course 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

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<td>CO1 Apply the basic principles of fluid mechanics and thermodynamics to determine the thermo physical properties of liquids.</td>
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<td>CO2 Analyze the performance parameters of four stroke IC engines using conventional and biofuels.</td>
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<td>CO3 Make use of experimental data for writing a report as an individual or as a team member to communicate effectively.</td>
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Application = 40%, Analysis = 40%, Communication = 20%
Internship - II
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – V

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<td>-</td>
</tr>
<tr>
<td>Total Number of Teaching Hours:</td>
<td>-</td>
<td>SEE Marks:</td>
<td>100</td>
</tr>
</tbody>
</table>

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**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Credits:</th>
</tr>
</thead>
<tbody>
<tr>
<td>P21UHV509</td>
<td>01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching Hours/Week (L:T:P):</th>
<th>CIE Marks:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:0:0</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Number of Teaching Hours:</th>
<th>SEE Marks:</th>
</tr>
</thead>
<tbody>
<tr>
<td>25+5</td>
<td>--</td>
</tr>
</tbody>
</table>

**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 excerpt 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:

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

Course Articulation Matrix

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

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

<table>
<thead>
<tr>
<th>Report</th>
<th>Video presentation</th>
<th>Interaction</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>05</td>
<td>05</td>
<td>20</td>
</tr>
</tbody>
</table>

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.

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

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

#### SEMESTER – V

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>P21HSMC508</th>
<th>Credits:</th>
<th>01</th>
</tr>
</thead>
</table>

| 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.

<table>
<thead>
<tr>
<th>UNIT – I</th>
<th>10 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem solving through C -</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Flow Control:</strong> If…else, for Loop, while Loop, break and continue, switch…case, goto, Control Flow Examples, Simple Programs. <strong>Functions:</strong> Functions, User-defined Functions, Function Types, Recursion, Storage Class, Programs <strong>Arrays:</strong> Arrays, Multi-dimensional Arrays, Arrays &amp; Functions, Programs. <strong>Self-Study:</strong> Variables and constants</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNIT – II</th>
<th>10 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem solving through C -</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pointers:</strong> Pointers, Pointers &amp; Arrays, Pointers and Functions, Memory Allocation, Array &amp; Pointer Examples. <strong>Strings:</strong> String Functions, String Examples, Programs. <strong>Self-Study:</strong> Evaluation of Expression.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNIT – III</th>
<th>08 Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem solving through C -</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Structure and Union:</strong> Structure, Struct &amp; Pointers, Struct &amp; Function, Unions, Programs. <strong>Programming Files:</strong> Files Input/output <strong>Self-Study:</strong> Error handling during I/O operations.</td>
<td></td>
</tr>
</tbody>
</table>

#### 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.

Reference Book(s):

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]

<table>
<thead>
<tr>
<th>COs</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
<th>PO4</th>
<th>PO5</th>
<th>PO6</th>
<th>PO7</th>
<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
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<tbody>
<tr>
<td>CO-1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
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<tr>
<td>CO-2</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>CO-3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
# DESIGN OF MACHINE ELEMENTS-II

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

## SEMESTER – VI

<table>
<thead>
<tr>
<th>Course Code: P21ME601</th>
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</thead>
<tbody>
<tr>
<td><strong>L-T-P:</strong> 2-2-0</td>
</tr>
<tr>
<td><strong>Credits:</strong> 03</td>
</tr>
</tbody>
</table>

### 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.

### Course Content

#### 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.

**Self study component:** Surge in springs, buckling in compression spring.

8 Hrs

#### UNIT-II

**Cylinders & cylinder heads:** Introduction, thick cylindrical shells subjected to internal and external pressure, Lame’s Equations, compound cylinders, stresses due to different types of fits, autofrettage, circular and rectangular coverplates.

**Self study component:** Study of Barlow’s, Birnie’s and Clavarino’s equation

8 Hrs

#### UNIT-III

**Spur Gears:** Introduction, spur gears - terminology, standard proportions of gear 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.

**Self study component:** Causes of Gear tooth failure, Effect of material defects on gear functioning.

8 Hrs

#### 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.

**Self study component:** Thermal rating of worm Gearing, Working of Centrifugal clutch.

8 Hrs

#### 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.

**Self study component:** Properties of sliding contact bearing materials.

**Design data hand book:**


Text Books


Reference Books


e-Resources

https://www.youtube.com/watch?v=eG3THCih3II
https://www.youtube.com/watch?v=7EtF7AowZqk&list=PLOiT2XTdTBTd0htcmHydMoeqIttX5-F2
https://www.youtube.com/watch?v=AS0zQhMfJUw&list=PLSGws_74K01_e499POG3gcxzcnJEHMWE
https://www.youtube.com/watch?v=vyRc92-mySc&list=PLH1r3LGktlds-TCu7rJaZqYr3hfaA3CSu
https://www.youtube.com/watch?v=Fn5aChFKXJQ
https://www.youtube.com/watch?v=64EfZpMuOho

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

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

Course Articulation Matrix

<table>
<thead>
<tr>
<th></th>
<th>Program Outcomes</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8</td>
<td>9 1 1 1 1 2</td>
</tr>
<tr>
<td>CO1</td>
<td>Apply the basic concepts of materials engineering to design cylinders, springs, gears, clutches and brakes. 3</td>
<td>1</td>
</tr>
<tr>
<td>CO2</td>
<td>Apply the Lame’s theorem, Lewi’s form factor for designing cylinders and gears respectively. 3</td>
<td>2</td>
</tr>
<tr>
<td>CO3</td>
<td>Analyze the stresses induced in beams, cylinders and gears for designing a sustainable mechanical component. 2</td>
<td>3</td>
</tr>
<tr>
<td>CO4</td>
<td>Analyze the tribological characteristics to design the clutches, brakes and bearings. 2</td>
<td>3</td>
</tr>
</tbody>
</table>

SEE- Course Assessment Plan

<table>
<thead>
<tr>
<th>COs</th>
<th>Marks Distribution</th>
<th>Total Marks</th>
<th>Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit I</td>
<td>Unit II</td>
<td>Unit III</td>
</tr>
<tr>
<td>CO1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2</td>
<td>9</td>
<td>9</td>
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</tr>
<tr>
<td>CO3</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>CO4</td>
<td>9+9</td>
<td>9+9</td>
<td>9+9</td>
</tr>
</tbody>
</table>

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


Self Study Component: Advantages and Limitations of Automation.

8 Hrs

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.

Self-Study Component: Standardization of Graphics.

8 Hrs

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).

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

8 Hrs

UNIT-IV

Numerical Control and CNC Machine Tools: Basic components of NC Systems, NC procedure, coordinate 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.

Self Study Component: Feedback devices, Axes-standards.

8 Hrs

UNIT-V


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

8 Hrs

Text Books

Reference Books

e- Resources
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.

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PS O</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SEE- Course Assessment Plan**

<table>
<thead>
<tr>
<th>COs</th>
<th>Unit I</th>
<th>Unit II</th>
<th>Unit III</th>
<th>Unit IV</th>
<th>Unit V</th>
<th>Total Marks</th>
<th>Weightage</th>
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<tbody>
<tr>
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<td></td>
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<td></td>
<td>22</td>
<td>22%</td>
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<tr>
<td>CO2</td>
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<td>9+2</td>
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<td></td>
<td></td>
<td>29</td>
<td>29%</td>
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<tr>
<td>CO3</td>
<td></td>
<td></td>
<td></td>
<td>2+9</td>
<td></td>
<td>11</td>
<td>11%</td>
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<tr>
<td>CO4</td>
<td>9</td>
<td>9+2</td>
<td>9</td>
<td>9</td>
<td>20</td>
<td>38</td>
<td>38%</td>
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</table>

Application =29%, Analysis = 71%
# FINITE ELEMENT METHODS

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

## SEMESTER – VI

<table>
<thead>
<tr>
<th>Course Code: P21ME6022</th>
<th>L-T-P: 3-0-0</th>
<th>Credits: 03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
</tr>
</tbody>
</table>

## 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.

**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.

**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.

**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.

**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.

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


Reference Books:


e- Resources:

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

Course Outcomes:

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

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

Course Articulation Matrix

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>CO1</strong></td>
<td>Understanding the fundamental principles of FEM such as discretization, interpolation and numerical integration and apply it for solving complex engineering problems.</td>
<td>3</td>
</tr>
<tr>
<td><strong>CO2</strong></td>
<td>Formulate element stiffness matrices and load vectors for different elements using variational principle and analyze axially loaded bars.</td>
<td>3</td>
</tr>
<tr>
<td><strong>CO3</strong></td>
<td>Utilize finite element formulations in analyzing the stresses, strains and reactions of trusses and transversely loaded beams.</td>
<td>3</td>
</tr>
<tr>
<td><strong>CO4</strong></td>
<td>Formulate finite element equations for heat transfer problems using Variational and Galerkin techniques to analyze conduction and convection heat transfer problems.</td>
<td>3</td>
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## SEE- Course Assessment Plan

<table>
<thead>
<tr>
<th>COs</th>
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<th>Total Marks</th>
<th>Weightage (%)</th>
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<td>Unit III</td>
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Analysis = 80%; Application = 20%
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<th>L-T-P: 2-2-0</th>
<th>Credits: 03</th>
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<tbody>
<tr>
<td>Contact Period-Lecture: 40 Hrs.</td>
<td>Exam: 3 Hrs.</td>
<td>Weightage: CIE: 50 %; SEE: 50%</td>
</tr>
</tbody>
</table>

**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

**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.

Self-study component: Applications of Psychrometric Processes.

8 Hrs

**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. **Transient Effects in Building Energy Transfer:** Transient heat conduction through walls, Heat gain by a thin surface.

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

8 Hrs

**UNIT-IV**


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

8 Hrs

**UNIT-V**

systems, Simulation of water-loop heat pump system (WLHPS). Numerical.

**Case Study:** MATLAB Code for Bin Data and Degree–Days

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

**Text Books**


**Reference Books**


**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**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<tbody>
<tr>
<td>Interpret the various components of HVAC systems using the principles of heating and cooling.</td>
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<td>3</td>
</tr>
<tr>
<td>2</td>
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</tr>
<tr>
<td>Apply heat transfer principles to design heating and cooling requirements for different spaces and analyze heat loads to perform psychrometric study.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
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<tr>
<td>Analyze energy-efficient practices in HVAC system design, operation, and maintenance.</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Develop MATLAB codes based on ASHRAE Handbook of Fundamentals.</td>
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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 material 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:


Reference Books:

e-Resources:
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**

<table>
<thead>
<tr>
<th>Course Outcomes</th>
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<td>CO4 Analyze</td>
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**SEE - Course Assessment Plan**

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<tr>
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</table>

Application = 69%  Analysis = 31%
ADVANCED ENGINEERING MATERIALS
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

Course Code: P21ME6031  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,
- 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.

Self study components: Differentiate the MMCs and alloys.

8 Hrs

UNIT-II


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

8 Hrs

UNIT-III


Self study component: Biomedical Materials applications.

8 Hrs

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.

Self study component: Custom sandwich composite for paddle surfboard.

8 Hrs

UNIT-V

biomimetic materials.

Self study component: PbTe-Based FGM Thermoelectric Materials

8 Hrs

Text Books:


Reference Books:

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


e-Resources:

https://www.youtube.com/watch?v=KMcsjCXfLQw&list=PLyAZSyX8Qy5Am_2StOOQ5vCUE3VicAen

https://www.youtube.com/watch?v=2rxbxNem1lil&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYJS

https://www.youtube.com/watch?v=649f1wv1vRc&list=PLWdhnZlV3ogoVE2AIC-G4Uew8XsalNwJGo

https://www.youtube.com/watch?v=MtqugJcsHZs&list=PLbRMhDVUMngdzыватьMgoUgdaGBqi_p4nVM

https://www.youtube.com/watch?v=ebO38bbq0_4&list=PLbMVogVj5nJTdeilvuGBs_AE8hloTAHWJ

Course 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 emphasize the various engineering materials.

Analyze the properties and behavior of structural materials.

Course Articulation Matrix

<table>
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<tbody>
<tr>
<td></td>
<td>1  2  3  4  5  6  7  8  9 10 11 12 1 2</td>
<td></td>
</tr>
<tr>
<td>CO1 Apply the concept of structure, properties, and relationships of advanced and emerging engineering materials and predict material behavior based on these relationships.</td>
<td>2</td>
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</tr>
<tr>
<td>CO2 Identify the various advanced materials for different processing techniques.</td>
<td>3</td>
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<tr>
<td>CO3 Apply different advanced material characterization techniques to emphasize the various engineering materials.</td>
<td>3</td>
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<tr>
<td>CO4 Analyze the properties and behavior of structural materials.</td>
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SEE- Course Assessment Plan

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</table>

Application = 73%, Analyze = 27%
ELECTRIC AND HYBRID VEHICLES
[As per Choice Based Credit System (CBCS) & OBE Scheme]

P21 Scheme - V & VI Semester Syllabus

Course Code: P21ME6032
Contact Period-Lecture: 40 Hrs.
Exam: 3 Hrs.
L-T-P: 3-0-0
Credits: 03
Weightage: CIE: 50 %; SEE: 50%

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 electric vehicles, 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.

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.

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.

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 EREV, Component Sizing of Blended PHEVs, HEV to PHEV Conversions, Vehicle-to-Grid Technology.

Self Study Component: EV and PHEV Battery Chargers.

UNIT-V

Self Study Component: Comparison of different energy management strategies.

Text Books


Reference Books


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/

Course 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

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>CO1 Apply the knowledge of basic science to study components of HEVs.</td>
<td>CO2 Apply basic concepts for designing electric and hybrid electric vehicles.</td>
<td>CO3 Identify the different sources of energy and communications in Hybrid and Electric Vehicles.</td>
</tr>
<tr>
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<td>1 2 3 4 5 6 7 8 9 10 11 12 1 2</td>
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COs

<table>
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<tr>
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<tr>
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<tr>
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</table>

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


8 Hrs

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

Unit-4


8 Hrs

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

Unit-5


8 Hrs

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

Text Books


Reference Books

e-Resources:
https://www.youtube.com/watch?v=7LZSjgZz-Qw&list=PLxn52v8fxX51stGzU1NAXRDkgxK0k5UZ
https://www.youtube.com/watch?v=Pv0i-9wWrCI&list=PLSGws_74K018thqvpXHrs5DkeJcx8lX7u

Course 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.
Analyze the time response of first and second order systems.
Apply the concept stability in control systems using various methods.

Course Articulation Matrix

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<td>Identify the components of control systems given real life situation.</td>
<td></td>
</tr>
<tr>
<td>CO2</td>
<td>Develop transfer function models and state-space models of single input single output, linear time invariant systems.</td>
<td></td>
</tr>
<tr>
<td>CO3</td>
<td>Analyse the time response of first and second order systems and reduction of block diagram.</td>
<td></td>
</tr>
<tr>
<td>CO4</td>
<td>Apply the concept stability in control systems using various methods.</td>
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SEE- Course Assessment Plan

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Application =31%, Analysis = 40%, Develop=29%
PRODUCTION MANAGEMENT
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

<table>
<thead>
<tr>
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<th>L-T-P: 3-0-0</th>
<th>Credits:03</th>
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<tr>
<td>Contact Period-Lecture: 40 Hours</td>
<td>Exam:3 Hours</td>
<td>Weightage%:CIE:50,SEE:50</td>
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</tbody>
</table>

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.

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

8 Hrs

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.

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

8 Hrs

Unit-3

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

8 Hrs

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.

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

8 Hrs

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.

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

8 Hrs

Text Books

P21 Scheme - V & VI Semester Syllabus


Reference Books


e- Resources

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

Course 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

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<tr>
<td>CO1 Apply various production management techniques and tools to improve productivity and efficiency in manufacturing or service operations.</td>
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<tr>
<td>CO2 Evaluate different types of production systems and analyze the factors affecting production system design, capacity planning, and layout configuration.</td>
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<tr>
<td>CO3 Analyze the production processes to achieve cost-effectiveness, minimize waste, reduce lead time and improve overall operational performance.</td>
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<tr>
<td>CO4 Analyze statistical process control, quality assurance techniques and control quality throughout the production process.</td>
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<tr>
<td>CO5 Apply the leadership and teamwork abilities within the context of production management.</td>
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## SEE Course Assessment Plan

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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

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 | Fundamentals of Elasticity:
Concept of stress, equilibrium equation, stress transformation laws, spherical and deviator stress tensors, octahedral stresses, concept of strain, compatibility equations, deviator and spherical strain tensors, strain transformation laws, elastic strain energy, theories of strength, numerical.  
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, recrystallization 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.  
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.  
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.  
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.  
Self Study Component:
Plane strain bending of beam and plastic torsion of a circular bar.  |

Text Books:

Reference Books:

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

Course 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

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</table>

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


UNIT-II


UNIT-III


Self study component: Forced Convection cooling of electronic devices.

UNIT-IV


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

Self study component: Shell & tube, compact & multipass heat exchangers.

7 Hrs

**Practical Content**

| Exp-1: | Determination of thermal Conductivity of a Metal Rod. |
| Exp-3: | Determination of Effectiveness and Efficiency of a Metallic fin. |

**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**


**Reference Books**


**e-Resources:**

- https://www.youtube.com/watch?v=qa-PQOjS3zA&list=PL5F4F46C1983C6785
- https://www.youtube.com/watch?v=ledD23t5jI4&list=PLSGws_74K01_ojmo4aRFpP3gUU0VFKE SJ
- https://www.youtube.com/watch?v=sKnE5qvz0fc&list=PLbRMhDVUMngeygd_uWilQa3fzA2h7vdRx
- https://www.youtube.com/watch?v=ledD23t5jI4&list=PLpCr5N2IS7NmU22MOgDWOI0sSlpUUNU z3
- 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.

<table>
<thead>
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<tbody>
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SEE- Course Assessment Plan

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Note: Assessment only in CIE

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  \( \text{L-T-P: 3-0-0} \)  \( \text{Credits: 03} \)

Contact Period-Lecture: 40 Hrs.  \( \text{Exam: 3 Hrs.} \)  \( \text{Weightage: CIE: 50 \%; SEE: 50\%} \)

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 (LH₂).

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

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
Reference Books


e –Resources:
https://nptel.ac.in/courses/103103206
https://nptel.ac.in/courses/115105127

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

1. Apply the knowledge of alternate fuels to study their properties, production methods and potential applications.
2. Analyze energy-efficient technologies to conserve energy in design principles and behavior modification approaches to reduce energy consumption.
3. Apply emerging trends in technological advancements and innovations in the field of alternate fuels and energy conservation.
4. Analyze energy planning and management techniques to optimize energy use and waste recovery.

Course Articulation Matrix

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1. 2 3 4 5 6 7 8 9 10 11 12 1 2

<table>
<thead>
<tr>
<th>Application</th>
<th>Analysis</th>
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</table>

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
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- governingequation, 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
Text Books:


Reference Books:


e- Resources:

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

Course 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.

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

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**Analysis = 80%; Application = 20%**
### 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
8 Hrs

**Self Study Component:** Benefits of PPM.

#### Unit-3
8 Hrs

**Computers in Maintenance – Introduction, Computer-Aided Maintenance, Maintenance Decision Making, Computerized Maintenance Planning.**

**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.  
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:

Reference Books:

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

Course 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

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

SEE- Course Assessment Plan

<table>
<thead>
<tr>
<th>COs</th>
<th>Marks Distribution</th>
<th>Total Marks</th>
<th>Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1</td>
<td>2+9+9</td>
<td>20</td>
<td>20%</td>
</tr>
<tr>
<td>CO2</td>
<td>2+9+9</td>
<td>20</td>
<td>20%</td>
</tr>
<tr>
<td>CO3</td>
<td>2+9</td>
<td>2+9+9</td>
<td>31</td>
</tr>
<tr>
<td>CO4</td>
<td>9</td>
<td>2+9+9</td>
<td>29</td>
</tr>
</tbody>
</table>

Applications=71%, Analysis=29%
# OPERATIONS RESEARCH

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

<table>
<thead>
<tr>
<th>SEMESTER – VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course Code: P21MEO6054</td>
</tr>
<tr>
<td>Contact Period - Lecture: 40 Hrs; Exam: 3 Hrs.</td>
</tr>
</tbody>
</table>

## 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.

## Course Content

### 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.

### 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.

### 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.

### 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.

### 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.

## Text Books:

## Reference Books:

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

Course Outcomes: 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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>CO1 Formulate real world problems as a Linear programming model and demonstrate solution by graphical method and analysis technique.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO2 Apply the specific LPP like transportation and assignment and analyse the solution.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO3 Apply the different project model analyze the solution.</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>CO4 Apply the game and Queuing strategy with their characteristics and analyse the solutions.</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

SEE- Course Assessment Plan

<table>
<thead>
<tr>
<th>COs</th>
<th>Marks Distribution</th>
<th>Total Marks</th>
<th>Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unit I</td>
<td>Unit II</td>
<td>Unit III</td>
</tr>
<tr>
<td>CO1</td>
<td>2+9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>CO2</td>
<td>2+9</td>
<td>2+9</td>
<td>9</td>
</tr>
<tr>
<td>CO3</td>
<td>9</td>
<td>9</td>
<td>2+9</td>
</tr>
<tr>
<td>CO4</td>
<td>20</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Application = 49%,  Analysis=51%
# COMPUTER AIDED MODELING AND ANALYSIS LABORATORY

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

## SEMESTER – VI

<table>
<thead>
<tr>
<th>Course Code: P21MEL606</th>
<th>L-T-P: 0-0-2</th>
<th>Credits: 1</th>
</tr>
</thead>
</table>

**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:


### e-Resources:

- [https://www.youtube.com/watch?v=p6iEJ1fQvh0](https://www.youtube.com/watch?v=p6iEJ1fQvh0)
- [https://www.youtube.com/watch?v=9mu-mxtFTMU](https://www.youtube.com/watch?v=9mu-mxtFTMU)
- [https://www.youtube.com/watch?v=1dvEmK6To7M](https://www.youtube.com/watch?v=1dvEmK6To7M)
- [https://www.youtube.com/watch?v=bMBuZjZjG80](https://www.youtube.com/watch?v=bMBuZjZjG80)
- [https://www.youtube.com/watch?v=3pz2-g3oQqU](https://www.youtube.com/watch?v=3pz2-g3oQqU)
- [https://www.youtube.com/watch?v=3BwhuqzLzBM](https://www.youtube.com/watch?v=3BwhuqzLzBM)
- [https://www.youtube.com/watch?v=NwJYZHu61kU](https://www.youtube.com/watch?v=NwJYZHu61kU)
- [https://www.youtube.com/watch?v=Zm2QmeDU5R4](https://www.youtube.com/watch?v=Zm2QmeDU5R4)
- [https://www.youtube.com/watch?v=RgQTS8mDW1Q](https://www.youtube.com/watch?v=RgQTS8mDW1Q)
- [https://www.youtube.com/channel/UCNuB-vNeYDoDLuIZ4ILWeLw](https://www.youtube.com/channel/UCNuB-vNeYDoDLuIZ4ILWeLw)
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

<table>
<thead>
<tr>
<th>Course Outcomes</th>
<th>Program Outcomes</th>
<th>PSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO1 Apply the basic concepts of FEM using ANSYS tool.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO2 Analyse the mechanical structure by validating the numerical results with analytical solution.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO3 Apply the concept of control engineering to analyze the mechanical system using MATLAB.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>CO4 Make use of post processor results for writing a report to communicate effectively.</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

SEE - Course Assessment Plan

<table>
<thead>
<tr>
<th>COs</th>
<th>Marks Distribution</th>
<th>Total Marks</th>
<th>Weightage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Part A</td>
<td>Part B</td>
<td>Viva- Voce</td>
</tr>
<tr>
<td>CO1</td>
<td>8</td>
<td>8</td>
<td>16%</td>
</tr>
<tr>
<td>CO2</td>
<td>7</td>
<td>7</td>
<td>14%</td>
</tr>
<tr>
<td>CO3</td>
<td>25</td>
<td>25</td>
<td>50%</td>
</tr>
<tr>
<td>CO4</td>
<td>10</td>
<td>10</td>
<td>20%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>P21HSMC608</th>
<th>Credits:</th>
<th>01</th>
</tr>
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<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P):</td>
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<td>CIE Marks:</td>
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<tr>
<td>Total Number of Teaching Hours:</td>
<td>28</td>
<td>SEE Marks:</td>
<td>50</td>
</tr>
</tbody>
</table>

**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

**Quantitative Aptitude:** Race and games, Linear equations

**Logical Reasoning:** Number and letter series

**Self-Study:** Types of cryptarithm.

#### UNIT – II

**Quantitative Aptitude:** Mensuration, Height & distance.

**Logical Reasoning:** Game based assessments.

**Self-Study:** Inferred meaning, Chain rule.

#### UNIT – III

**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:

<table>
<thead>
<tr>
<th>CO – 1:</th>
<th>Solve the problems based on Race and games, Linear equations, mensuration, height and distance.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO – 2:</td>
<td>Solve logical reasoning problems based on Number, letter series and Game based assessments.</td>
</tr>
<tr>
<td>CO – 3:</td>
<td>Solve the problems based on HCF &amp; LCM, averages and partnerships.</td>
</tr>
</tbody>
</table>

### 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
3. CAT Mathematics by Abhijith Guha, PHI learning private limited.

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

<table>
<thead>
<tr>
<th>COs</th>
<th>PO1</th>
<th>PO2</th>
<th>PO3</th>
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<th>PO8</th>
<th>PO9</th>
<th>PO10</th>
<th>PO11</th>
<th>PO12</th>
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</thead>
<tbody>
<tr>
<td>CO-1</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO-2</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>CO-3</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
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</tbody>
</table>
Universal Human Values and Professional Ethics  
[As per Choice Based Credit System (CBCS) & OBE Scheme]

SEMESTER – VI

<table>
<thead>
<tr>
<th>Course Code:</th>
<th>P21UHV609</th>
<th>Credits:</th>
<th>01</th>
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</thead>
<tbody>
<tr>
<td>Teaching Hours/Week (L:T:P):</td>
<td>1 : 0 : 0</td>
<td>CIE Marks:</td>
<td>50</td>
</tr>
<tr>
<td>Total Number of Teaching Hours:</td>
<td>25 + 5</td>
<td>SEE Marks:</td>
<td>50</td>
</tr>
</tbody>
</table>

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
<table>
<thead>
<tr>
<th>Module - 2</th>
<th>Harmony in the Human Being : (3 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module - 3</th>
<th>Harmony in the Family and Society : (3 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module - 4</th>
<th>Harmony in the Nature/Existence : (3 hours)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Module - 5</th>
<th>Implications of the Holistic Understanding – a Look at Professional Ethics : (3 hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>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</td>
</tr>
</tbody>
</table>

**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 Teacher’s Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G

Reference Books

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
12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

**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=OgdNx0X923I
- https://www.youtube.com/watch?v=nGRcbRpvGoU
- https://www.youtube.com/watch?v=sDxGXOgYEKM