## Mechanical Engineering

**Preamble:** The curriculum of B. Tech. (Mechanical Engineering) program offered by the Department of Mechanical Engineering under Academic Regulation 2020 is prepared in accordance with the curriculum framework of AICTE, UGC and Andhra Pradesh State Council of Higher Education (APSCHE). Further this Outcome Based Curriculum (OBC) is designed with Choice Based Credit and Semester System (CBCSS) enabling the learners to gain professional competency with multi-disciplinary approach catering the minimum requirement (Program Specific Criteria) of Lead Societies like American Society of Mechanical Engineers (ASME) and other Professional Bodies as per the Engineering Accreditation Commission (EAC) of ABET and NBA. In addition, the curriculum and syllabi are designed in a structured approach by deploying Feedback Mechanism on Curriculum from various stakeholders viz. Industry, Potential Employers, Alumni, Academia, Professional Bodies, Research Organizations and Parents to capture their voice of the respective stakeholders.

The Curriculum design, delivery, and assessment, the three major pillars of academic system are completely aligned in line with Outcome Based Education (OBE) to assess and evaluate the learning outcomes facilitating the learners to achieve their Professional and Career Accomplishments.

### The Vision

To train the students to be professional and competent Mechanical Engineers to take up the challenges in the society and strive continuously for excellence in education and research

### The Mission

- To provide quality education for successful career and higher studies in Mechanical Engineering
- To emphasize academic and technical excellence in the profession
- To take up consultancy and research in solving the problems related to Mechanical Engineering

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**Visakhapatnam-531173**

## Program Educational Objectives (PEOs)

The PEOs are the educational goals that reflect Professional and Career Accomplishments that a graduate should attain after 4 – 5 years of his/her graduation.

The graduates of Mechanical Engineering of NSRIT will

1. Continue to excel in professional mechanical related careers or chosen career path that apply 21st century skills following ethical standards and practices contributing towards sustainable development by providing feasible and viable technical solutions catering the real-time engineering problems
2. Engage in experiential learning through their professional practices and adapt to changing skills sets in the pursuit of lifelong learning
3. Continue to demonstrate the skill sets that are very much essential to work successfully for a rewarding career in a multidisciplinary setting

## Program Outcomes (POs)

The POs are the transactional statements of graduate attributes (GAs) that each graduating engineer should possess in terms of knowledge, skill and behavior with a minimum target performance level at the time of graduation as fixed by the program of study seeking continuous improvement year on year.

The graduates of Mechanical Engineering of NSRIT will be able to demonstrate the following outcomes in terms knowledge, skill, and behavioral competencies at the time of graduation with the expected target performance level

1. Apply the knowledge of basic sciences and fundamental engineering concepts in solving engineering problems (Engineering Knowledge)
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (Problem Analysis)
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations (Design/Development of Solutions)
4. Perform investigations, design and conduct experiments, analyse and interpret the results to provide valid conclusions (Investigation of Complex Problems)
5. Select/develop and apply appropriate techniques and IT tools for the design & analysis of the systems (Modern Tool Usage)
6. Give reasoning and assess societal, health, legal and cultural issues with competency in professional engineering practices (The Engineer and Society)
7. Demonstrate professional skills and contextual reasoning to assess environmental/societal issues for sustainable development (The Environment and Sustainability)
8. Demonstrate Knowledge of professional and ethical practices (Ethics)
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multi-disciplinary situations (Individual and Team Work)
10. Communicate effectively among engineering community, being able to comprehend and writeeffectively reports, presentation and give / receive clears instructions (Communication)
11. Demonstrate and apply engineering & management principles in their own / team projects in multidisciplinary environment (Project Finance and Management)

12. Recognize the need for, and have the ability to engage in independent and lifelong learning (Life Long Learning)

**Program Specific Outcomes (PSOs)**

1. Demonstrate adequate core competency in designing and fabricating mechanical systems, thermal and hydraulic machines, materials and similar others, and thereby providing sustainable computer aided solutions maintaining professional standards and value system
2. Demonstrate adequate knowledge in the allied specialization of Mechanical Engineering that adds value addition for professional practices

**Category-wise Credit Distribution of Courses**

| Category | | AICTE | APSCHE | NSRIT (A) |
|---|---|---|---|---|
| HS | Humanities and Social Science | 12.0 | 10.5 | 10.5 |
| BS | Basic Science | 25.0 | 18.0 | 18.0 |
| ES | Engineering Science | 24.0 | 22.5 | 24.0 |
| PC | Professional Core | 48.0 | 55.5 | 54.0 |
| PE | Professional Elective | 18.0 | 15.0 | 15.0 |
| OE | Open Elective | 18.0 | 12.0 | 12.0 |
| PW | Internship (s), Project & Seminars | 15.0 | 16.5 | 16.5 |
| SC | Skill Oriented Courses | - | 10.0 | 10.0 |
| MC | Mandatory Courses | - | - | - |
| AC | Audit Course | - | - | - |
| | Total no. of credits | 160 | 160 | 160 |

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# Mechanical Engineering

Credit requirement for the award of the degree under academic Regulation 2020 – 2021 for the candidates admitted from the academic year 2021 onwards

| | Four Years | Three Years |
|---|---|---|
| B. Tech. (Regular Degree) | 160 | 121 |
| B. Tech. (Honors Degree) | 180 | 141 |
| B. Tech. (With Minor specialization other than Chosen Branch of Engg. & Tech.) | 180 | 141 |

## Semester I

| No. | Code | Course | Pos | Contact Hours L | T* | P | C | |
|---|---|---|---|---|---|---|---|---|
| 01 | 20HSX01 | Communicative English | 10 | 3 | 0 | 0 | 3.0 | HS |
| 02 | 20BSX11 | Linear Algebra and Differential Equations | 1, 12[1] | 3 | 1 | 0 | 3.0 | BS |
| 03 | 20BSX21 | Engineering Chemistry | 1 | 3 | 0 | 0 | 3.0 | BS |
| 04 | 20ESX01 | Engineering Drawing | 1, 5, 10 | 1 | 0 | 4 | 3.0 | ES |
| 05 | 20ESX02 | Programming for Problem Solving Using 'C' | 1 | 3 | 0 | 0 | 3.0 | ES |
| 06 | 20HSX02 | Communicative English Lab | 10 | 0 | 0 | 3 | 1.5 | HS |
| 07 | 20BSX22 | Engineering Chemistry Lab | 1, 4 | 0 | 0 | 3 | 1.5 | BS |
| 08 | 20ESX07 | Programming for Problem Solving Using 'C' Lab | 1 | 0 | 0 | 3 | 1.5 | ES |
| | | | Sub-total | 13 | 01 | 13 | **19.5** | |

## Semester II

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 01 | 20BSX12 | Partial Differential Equations and Vector Calculus | 1 | 3 | 1 | 0 | 3.0 | BS |
| 02 | 20BSX31 | Engineering Physics | 1 | 3 | 0 | 0 | 3.0 | BS |
| 03 | 20ESX05 | Basic Electrical and Electronics Engineering | 1 | 3 | 1 | 0 | 3.0 | ES |
| 04 | 20ESX04 | Engineering Mechanics | 1, 2, 4 | 3 | 1 | 0 | 3.0 | ES |
| 05 | 20ME201 | Computer Aided Engineering Drawing | 1, 5, 10 | 1 | 0 | 4 | 3.0 | ES |
| 06 | 20BSX32 | Engineering Physics Lab | 1, 4 | 0 | 0 | 3 | 1.5 | BS |
| 07 | 20ESX08 | Basic Electrical and Electronics Engineering Lab | 1, 4 | 0 | 0 | 3 | 1.5 | ES |
| 08 | 20ESX06 | Engineering Workshop | 4 | 0 | 0 | 3 | 1.5 | ES |
| 09 | 20MCX01 | Environmental Science | - | 2 | 0 | 0 | - | MC |
| | | | Sub-total | 15 | 03 | 13 | **19.5** | |

## Semester III

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 01 | 20BSX13 | Numerical Methods and Transforms | 1 | 3 | 1 | 0 | 3.0 | BS |
| 02 | 20ME302 | Thermodynamics | 1, 2, 4, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20ME303 | Material Science and Metallurgy | 1, 7, 12 | 3 | 0 | 0 | 3.0 | PC |
| 04 | 20ME304 | Mechanics of Solids | 2, 3, 12, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 05 | 20ME305 | Manufacturing Processes | 1, 6, 12 | 3 | 0 | 0 | 3.0 | PC |
| 06 | 20ME306 | Material Science and Metallurgy Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME307 | Mechanics of Solids Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20ME308 | Manufacturing Processes Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 09 | 20MES01 | Computer Aided Modelling | 5, 10, PSO 1 | 1 | 0 | 2 | 2.0 | SC |
| 10 | 20MCX02 | Constitution of India | - | 2 | 0 | 0 | - | MC |
| | | | Sub-total | 18 | 03 | 11 | **21.5** | |

## Semester IV

| No. | Code | Course | Pos | Contact Hours L | T | P | C | |
|---|---|---|---|---|---|---|---|---|
| 01 | 20HSX03 | Managerial Economics and Financial Analysis | 11 | 3 | 0 | 0 | 3.0 | HS |
| 02 | 20CS403 | Python Programming | 1 | 3 | 1 | 0 | 3.0 | ES |
| 03 | 20ME403 | Kinematics of Machinery | 2, 3, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 04 | 20ME404 | Fluid Mechanics and Hydraulic Machines | 2, 3, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 05 | 20ME405 | Internal Combustion Engines and Gas Turbines | 2, 3, PSO 2 | 3 | 1 | 0 | 3.0 | PC |
| 06 | 20ME406 | Fluid Mechanics and Hydraulic Machines Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME407 | Thermal Engineering Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20CS407 | Python Programming Lab | 1 | 0 | 0 | 3 | 1.5 | ES |
| 09 | 20MES02 | Computer Numerical Control Programming | 1, 2, 4, 5, 10 | 1 | 0 | 2 | 2.0 | SC |
| | | | Sub-total | 16 | 04 | 11 | **21.5** | |

* Suggested hours for tutorial

[1] By default all courses are mapped to PO 12 as they are weakly contributing

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Semester V** | | | | | | | | |
| 01 | 20ME501 | Dynamics of Machinery | 2, 3, 4,12, PSO 1, PSO2 | 3 | 1 | 0 | 3.0 | PC |
| 02 | 20ME502 | Design of Machine Elements I | 2, 3, 4,12, PSO 1, PSO 2 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20ME503 | Metal Cutting and Machine Tools | 1, 6, 12, PSO 1, PSO 2 | 3 | 0 | 0 | 3.0 | PC |
| 04 | - | Professional Elective I | - | 3 | 0 | 0 | 3.0 | PE |
| 05 | - | Open Elective I | - | 3 | 0 | 0 | 3.0 | OE |
| 06 | 20ME506 | Dynamics of Machinery Lab | 1, 4, PSO 1, PSO 2 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME507 | Metal Cutting and Machine Tools Lab | 1, 3, 4, PSO 1, PSO 2 | 0 | 0 | 3 | 1.5 | PC |
| 08 | - | MOOCs | 12 | 0 | 0 | 0 | 2.0 | SC |
| 09 | 20MCX03 | Intellectual Property Rights and Patents | - | 2 | 0 | 0 | - | MC |
| 10 | - | Summer Internship #1[2] | 5, 8, 9, 10, PSO 1 | 0 | 0 | 0 | 1.5 | IN |
| 11 | - | Technical Paper Writing | - | 0 | 0 | 2 | - | AC |
| | | | Sub-total | 17 | 02 | 14 | **21.5** | |
| **Semester VI** | | | | | | | | |
| 01 | 20ME601 | Mechanical Measurements and Metrology | 1, 6, 12, PSO 1, PSO 2 | 3 | 0 | 0 | 3.0 | PC |
| 02 | 20ME602 | Design of Machine Elements II | 2, 3, 4, PSO 1, PSO 2 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20ME603 | Heat Transfer | 1, 2, 3, 4, PSO 1, PSO 2 | 3 | 1 | 0 | 3.0 | PC |
| 04 | - | Professional Elective II | - | 3 | 0 | 0 | 3.0 | PE |
| 05 | - | Open Elective II | - | 3 | 0 | 0 | 3.0 | OE |
| 06 | 20ME606 | Computer Aided Machine Drawing | 1, 5, 10, PSO 1 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME607 | Mechanical Measurements and Metrology Lab | 1, 4, PSO 1, PSO 2 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20ME608 | Heat Transfer Lab | 1, 3, 4, PSO 1, PSO 2 | 0 | 0 | 3 | 1.5 | PC |
| 09 | 20MES04 | Computer Aided Analysis | 1, 4, 5 | 0 | 0 | 4 | 2.0 | SC |
| 10 | 20MCX04 | Indian Traditional Knowledge | - | 2 | 0 | 0 | - | MC |
| | | | Sub-total | 17 | 02 | 13 | **21.5** | |
| **Semester VII** | | | | | | | | |
| 01 | - | Professional Elective III | - | 3 | 0 | 0 | 3.0 | PE |
| 02 | - | Professional Elective IV | - | 3 | 0 | 0 | 3.0 | PE |
| 03 | - | Professional Elective V | 12 | 3 | 0 | 0 | 3.0 | PE |
| 04 | - | Open Elective III | - | 3 | 0 | 0 | 3.0 | OE |
| 05 | - | Open Elective IV | 12 | 3 | 0 | 0 | 3.0 | OE |
| 06 | 20HSX04 | Professional Ethics | 8 | 3 | 0 | 0 | 3.0 | HS |
| 07 | 20MES05 | Applications of Mechatronics | - | 0 | 0 | 4 | 2.0 | SC |
| 08 | - | Summer Internship #2[2] | 5, 8, 9, 10, PSO 1 | 0 | 0 | 0 | 3.0 | IN |
| | | | Sub-total | 16 | 0 | 08 | **23.0** | |
| **Semester VIII** | | | | | | | | |
| 01 | - | Full Semester Internship[3] | 5-10, PSO 1, PSO 2 | 0 | 0 | 0 | 06 | IN |
| 02 | - | Capstone Project[3] | 5-10, PSO 1, PSO 2 | 0 | 0 | 0 | 06 | IN |
| | | | Sub-total | 0 | 0 | 0 | **12.0** | |
| | | | **Total Credits** | - | - | - | **160** | |

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[2] The work pertaining to Summer Internship #1 and #2 shall be completed at the end of Semesters IV and VI respectively. The assessment shall be carried out during Semesters V and VII

[3] The students opting for FSI in VII Semester should take up the courses of VII Semester in VIII Semester

## List of Electives

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Professional Elective #1 | | | | | | | | |
| 1 | 20ME001 | Applied Thermodynamics | - | 3 | 0 | 0 | 3.0 | PE |
| 2 | 20ME002 | Unconventional Machining Processes | - | 3 | 0 | 0 | 3.0 | PE |
| 3 | 20ME003 | Rotor Dynamics | - | 3 | 0 | 0 | 3.0 | PE |
| 4 | 20ME004 | Composite Materials | - | 3 | 0 | 0 | 3.0 | PE |
| 5 | 20ME005 | Product Design | - | 3 | 0 | 0 | 3.0 | PE |
| 6 | 20ME006 | Production Planning and Control | - | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #2 | | | | | | | | |
| 7 | 20ME007 | Refrigeration and Air Conditioning | - | 3 | 0 | 0 | 3.0 | PE |
| 8 | 20ME008 | Flexible Manufacturing Systems | - | 3 | 0 | 0 | 3.0 | PE |
| 9 | 20ME009 | Optimization Techniques | - | 3 | 0 | 0 | 3.0 | PE |
| 10 | 20ME010 | Material Characterization | - | 3 | 0 | 0 | 3.0 | PE |
| 11 | 20ME011 | CAD/CAM | - | 3 | 0 | 0 | 3.0 | PE |
| 12 | 20ME012 | Total Quality Management | - | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #3 | | | | | | | | |
| 13 | 20ME013 | Power Plant Engineering | - | 3 | 0 | 0 | 3.0 | PE |
| 14 | 20ME014 | Advanced Welding Technology | - | 3 | 0 | 0 | 3.0 | PE |
| 15 | 20ME015 | Finite Element Method | - | 3 | 0 | 0 | 3.0 | PE |
| 16 | 20ME016 | Condition Monitoring | - | 3 | 0 | 0 | 3.0 | PE |
| 17 | 20ME017 | Computer Integrated Manufacturing | - | 3 | 0 | 0 | 3.0 | PE |
| 18 | 20ME018 | Operations Research | - | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #4 | | | | | | | | |
| 19 | 20ME019 | Gas Dynamics and Jet Propulsion | - | 3 | 0 | 0 | 3.0 | PE |
| 20 | 20ME020 | Advance Metal Casting | - | 3 | 0 | 0 | 3.0 | PE |
| 21 | 20ME021 | Design Innovations | - | 3 | 0 | 0 | 3.0 | PE |
| 22 | 20ME022 | Non Destructive Evaluation | - | 3 | 0 | 0 | 3.0 | PE |
| 23 | 20ME023 | Robotics and Automation | - | 3 | 0 | 0 | 3.0 | PE |
| 24 | 20ME024 | Project Planning and Management | - | 3 | 0 | 0 | 3.0 | PE |
| Professional Elective #5 | | | | | | | | |
| The curriculum provides academic flexibility to choose any of the domain specific courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self-study mode. The course shall be of 45 – 60 hours duration (4-credits) and the assessment shall be as per the academic regulation 2020. | | | | | | | | PE |
| Open Elective #1 | | | | | | | | |
| 25 | 20CEO01 | Urban Environmental Health | - | 3 | 0 | 0 | 3.0 | OE |
| 26 | 20CSO01 | Data Structures and Algorithms | - | 3 | 0 | 0 | 3.0 | OE |
| 27 | 20AIO01 | Machine Learning for Engineers | - | 3 | 0 | 0 | 3.0 | OE |
| 28 | 20DSO01 | Introduction to Database Management Systems | - | 3 | 0 | 0 | 3.0 | OE |
| 29 | 20ECO01 | Architectures and Algorithms of IoT | - | 3 | 0 | 0 | 3.0 | OE |
| 30 | 20EEO01 | Introduction to Renewable Energy Sources | - | 3 | 0 | 0 | 3.0 | OE |
| 31 | 20MEO01 | Nano Technology | - | 3 | 0 | 0 | 3.0 | OE |
| 32 | 20SHO01 | Women and Society | - | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #2 | | | | | | | | |
| 33 | 20CEO02 | Ecology, Environment and Resources Management | - | 3 | 0 | 0 | 3.0 | OE |
| 34 | 20CS004 | Internet of Things | - | 3 | 0 | 0 | 3.0 | OE |
| 35 | 20AIO02 | Fundamentals of Deep Learning | - | 3 | 0 | 0 | 3.0 | OE |
| 36 | 20DSO02 | Introduction to Data Science | - | 3 | 0 | 0 | 3.0 | OE |
| 37 | 20ECO02 | IoT for Smart Grids | - | 3 | 0 | 0 | 3.0 | OE |
| 38 | 20EEO02 | Electrical Safety and Management | - | 3 | 0 | 0 | 3.0 | OE |
| 39 | 20MEO02 | Fundamentals of Automobile Engineering | - | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #3 | | | | | | | | |
| 40 | 20CEO03 | Disaster, Risk Mitigation and Management | - | 3 | 0 | 0 | 3.0 | OE |
| 41 | 20CS302 | Operating Systems | - | 3 | 0 | 0 | 3.0 | OE |
| 42 | 20AIO03 | Intelligent Robots and Drone Technology | - | 3 | 0 | 0 | 3.0 | OE |
| 43 | 20DSO03 | Introduction to Big Data | - | 3 | 0 | 0 | 3.0 | OE |
| 44 | 20ECO03 | Privacy and Security in IoT | - | 3 | 0 | 0 | 3.0 | OE |
| 45 | 20EEO03 | Low-cost Automation | - | 3 | 0 | 0 | 3.0 | OE |
| 46 | 20MEO03 | Industrial Automation | - | 3 | 0 | 0 | 3.0 | OE |
| 47 | 20SHO03 | Design Thinking | - | 3 | 0 | 0 | 3.0 | OE |

Open Elective #4

The curriculum provides academic flexibility to choose any of the inter-disciplinary courses from MOOCs as approved by the respective Board of Studies and Academic Council. The students can take up this course on self-study mode. The course shall be of 45 – 60 hours duration and the assessment shall be as per the academic regulation 2020. OE

B. Tech. (Honors)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category I** | | | | | | | | |
| 1 | 20MEH01 | Advanced Thermodynamics | - | 4 | 0 | 0 | 4.0 | HO |
| 2 | 20MEH02 | Advanced Heat Transfer | - | 4 | 0 | 0 | 4.0 | HO |
| 3 | 20MEH03 | Jet Propulsion and Rocket Engineering | - | 4 | 0 | 0 | 4.0 | HO |
| **Category II** | | | | | | | | |
| 4 | 20MEH04 | Powder Metallurgy | - | 4 | 0 | 0 | 4.0 | HO |
| 5 | 20MEH05 | Advanced Manufacturing Methods | - | 4 | 0 | 0 | 4.0 | HO |
| 6 | 20MEH06 | Rapid Prototyping | - | 4 | 0 | 0 | 4.0 | HO |
| **Category III** | | | | | | | | |
| 7 | 20MEH07 | Advanced Strength of Materials | - | 4 | 0 | 0 | 4.0 | HO |
| 8 | 20MEH08 | Advanced Finite Element Analysis | - | 4 | 0 | 0 | 4.0 | HO |
| 9 | 20MEH09 | Advanced Optimization Techniques | - | 4 | 0 | 0 | 4.0 | HO |
| **Category IV** | | | | | | | | |
| 10 | 20MEH10 | Integrated Computer Aided Design | - | 4 | 0 | 0 | 4.0 | HO |
| 11 | 20MEH11 | Industrial Robotics | - | 4 | 0 | 0 | 4.0 | HO |
| 12 | 20MEH12 | Design of Smart Technologies | - | 4 | 0 | 0 | 4.0 | HO |

B. Tech. (Minor with Specialization)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Category I** | | | | | | | | |
| 1 | 20CEM01 | Air Pollution | - | 3 | 0 | 0 | 3.0 | MI |
| 2 | 20CSM01 | E-Commerce | - | 3 | 0 | 0 | 3.0 | MI |
| 3 | 20MEM01 | Biomaterials | - | 3 | 0 | 0 | 3.0 | MI |
| 4 | 20EEM01 | Basic Control Systems | - | 3 | 0 | 0 | 3.0 | MI |
| 5 | 20ECM01 | Fundamentals of Electronics | - | 3 | 0 | 0 | 3.0 | MI |
| 6 | 20AIM01 | Fundamentals of Neural Networks | - | 3 | 0 | 0 | 3.0 | MI |
| 7 | 20DSO03 | Introduction to R Programming | - | 3 | 0 | 0 | 3.0 | MI |
| **Category II** | | | | | | | | |
| 8 | 20CEM02 | Climate Change Mitigation and Adaptation | - | 3 | 0 | 0 | 3.0 | MI |
| 9 | 20CSM02 | Knowledge Discovery and Databases | - | 3 | 0 | 0 | 3.0 | MI |
| 10 | 20MEM02 | Micro Electromechanical Systems | - | 3 | 0 | 0 | 3.0 | MI |
| 11 | 20EEM02 | Design of Photovoltaic systems | - | 3 | 0 | 0 | 3.0 | MI |
| 12 | 20ECM02 | Digital Electronics | - | 3 | 0 | 0 | 3.0 | MI |
| 13 | 20AIM02 | Machine Learning with Python | - | 3 | 0 | 0 | 3.0 | MI |
| 14 | 20DSM02 | Data Management and Analysis | - | 3 | 0 | 0 | 3.0 | MI |
| **Category IIII** | | | | | | | | |
| 15 | 20CEM03 | Sustainability and Pollution Prevention Practices | - | 3 | 0 | 0 | 3.0 | MI |
| 16 | 20CSM03 | Database Security | - | 3 | 0 | 0 | 3.0 | MI |
| 17 | 20MEM03 | Surface Engineering | - | 3 | 0 | 0 | 3.0 | MI |
| 18 | 20EEM03 | Electrical Engineering Material Science | - | 3 | 0 | 0 | 3.0 | MI |
| 19 | 20ECM03 | Analog Electronic Circuits | - | 3 | 0 | 0 | 3.0 | MI |
| 20 | 20AIM03 | Interpretable Deep Learning | - | 3 | 0 | 0 | 3.0 | MI |
| 21 | 20DSM03 | Data Governance | - | 3 | 0 | 0 | 3.0 | MI |

List of Honors offered by Mechanical Engineering Program

1. Advanced Thermal Systems
2. Smart Manufacturing
3. Advanced Design Systems
4. Integrated Product Development

List of Minor with Specialization offered by Mechanical Engineering Program

1. Electromechanical Systems using Biomaterials and Surface Engineering

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## PC 20ME501 Dynamics of Machinery 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO4 | PSO1 | PSO2 | |
| 20ME501.1 | Determine gyroscopic couple and its effect and analyze dynamic forces in slider crank mechanism | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |
| 20ME501.2 | Compute frictional losses, torque transmission of mechanical systems of bearings, clutches, breaks and dynamometers and its types. | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |
| 20ME501.3 | Calculate turning moment in flywheels and equilibrium speed for governors. | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |
| 20ME501.4 | Develop knowledge of analytical and graphical methods for calculate balancing of rotary and reciprocating masses. | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |
| 20ME501.5 | Apply knowledge of vibrations and find out the methods to calculate the natural frequencies of different vibration systems | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Gyroscopes and Dynamic Force Analysis 12 Hours

Gyroscopes: Angular velocity, angular acceleration, gyroscopic couple, gyroscopic effect on aeroplanes, ships, stability of four-wheel and two- wheel automobiles, rigid disc at an angle fixed to a rotating shaft. Dynamic Force Analysis: Slider crank mechanism, dynamically equivalent system, engine force analysis.

*inertia of connecting rod.*, turning moment of crankshaft

### Unit II: Bearings, Clutches, Breaks and Dynamometers 12 Hours

Pivots, Collars and Clutches: Pivots and collars, uniform pressure, uniform wear, Types of clutches– single-, and multi-plate. Brakes and Dynamometers: Types of brakes – Block brake, band brake, disc brake, band and block brake, internal expanding shoe brake, effect of brake. Types of dynamometers - Prony, rope brake, belt transmission, epicyclic train.

*Bevis-Gibson torsion dynamometers.*

### Unit III: Flywheels and Governors 12 Hours

Flywheels: Turning moment diagrams, fluctuation of energy, flywheels, dimensions of flywheel rim, applications. Governors: Types of governors, principles of inertia and centrifugal governors- Watt, Porter, Proell, Hartnell, Hartung, Sensitiveness, hunting, isochronism, stability, power

*Effort, controlling force of a governor.*

### Unit IV: Balancing 12 Hours

Static and dynamic balancing of rotating masses, force balancing of four bar linkage, Primary and Secondary balancing of reciprocating engine, balancing of inline four stroke engines (2,4,6 cylinders), V-engines, three cylinder radial engines, direct and reverse crank method, introduction to field balancing.

*Wheel balancing, Advanced balance technology.*

### Unit V: Vibrations 12 Hours

Free Vibration of spring mass system – oscillation of pendulums, centers of oscillation and suspension. transverse loads, vibrations of beams with concentrated and distributed loads. Dunkerly's methods, Raleigh's method, whirling of shafts, critical speeds, torsional vibrations, two and three rotor systems, Simple problems on forced damped vibration, vibration isolation and transmissibility.

*Advanced Vibration Technology, Damping Technology*

### Text Books

1. Rattan S. S, Theory of Machines, 4th Edition, Tata McGraw Hill, New Delhi– 2014
2. Thomas Bevan, The Theory of Machines: A textbook for Engineering students, Pearson, New Delhi-2010
3. Hubert Hahn, Rigid Body Dynamics of Mechanisms: 1 Theoretical Basis, Springer; Softcover reprint of hardcover 1st ed.2002 edition (30 November 2010)
4. Khurmi R. S, Theory Of Machines, S Chand; 14th edition (4 March 2020)

### Reference Books

1. Sadhu Singh. Theory of machines: kinematics and dynamics, 3rd Edition, Pearson Education India- 2012
2. Norton RC, Kinematics and Dynamics of Machinery, 3rd Edition in SI Units, Tata McGraw Hill Education Pvt. Ltd-2011

**Web References**

1. https://nptel.ac.in/courses/112/104/112104114/
2. https://nptel.ac.in/courses/112/101/112101096/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write about gyroscopic planes?
2. State the applications of cone clutch?
3. List the advantages of slider crank mechanism?
4. Write about sensitiveness?
5. Define hammer blow and swaying couple?
6. Write about vibration isolation and transmissibility?
7. Identify the physical terms used to explain gyroscopic action on the sailing ship?
8. Write short note on Raleigh's method?
9. Define the sensitiveness of a governor?
10. What is static balancing?

**L2: Understand**

1. Explain about the effect of precession motion on the stability of moving vehicles such as motor car?
2. What are the differences between Porter and Proell Governors? Why the speed range of Proell governor is less than that of a similar Porter type?
3. Derive from first principles, the expression for the frictional moment (or torque due to friction) of a conical pivot assuming uniform pressure
4. With a neat sketch, explain the working of a Hartnell governor
5. Explain the terms: variation of tractive force, swaying couple, and hammer blow.
6. Distinguish the longitudinal, transverse and torsional free vibrations
7. What are the differences between reverse and direct crank methods of balancing of reciprocating engines?
8. What are the functions of a governor? Classify mechanical governors?

**L3: Apply**

1. The rotor of a marine turbine has a moment of inertia of 750kg.m2 and rotates at 3000rpm clockwise when viewed from aft. If the ship pitches with angular simple harmonic motion having a periodic tile of 16 seconds and an amplitude of 0.1 radian, find the
   i) Maximum angular velocity of the rotor axis
   ii) Maximum value of the gyroscopic couple
   iii) Gyroscopic effect as the bow dips
2. Draw the turning moment diagram for a four stroke cycle internal combustion engine. A single cylinder four stroke cycle engine develops 15 kW Power at 330 rpm. The maximum fluctuation of energy is 80% of the indicated energy per cycle .The engine is connected through a gearing to a machine having a speed of 726 rpm .the moment of inertia of rotating parts of the engine is 104 kg-m 2 and that of the machine is 9.5 kg-m 2 . Determine the weight of additional flywheel that will be required to keep the overall range of speed variation to 0.75% of mean speed. Radius of gyration of the flywheel is 0.45 m.
3. A,B,C and D are four masses carried by a rotating shaft at radii 100mm, 150mm, 150mm and 200mm respectively. The planes in which masses rotate are spaced at 500mm apart and the magnitude of the masses, B, C and D are 9Kg, 5Kg and 4Kg respectively. Find the required mass A and the relative angular settings of the 4 masses so that the shaft shall be in complete balance.

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## PC 20ME502 Design of Machine Elements I

**3 1 0 3**

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PS01 | PS02 | |
| 20ME502.1 | Calculate different stresses in the machine components subjected to various static loads, failures and suitability of a material for an engineering application. | 2 | 3 | 3 | 3 | 3 | L1, L2 |
| 20ME502.2 | Calculate dynamic stresses in the machine components subjected to variable loads. | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME502.3 | Design riveted, welded, bolted joints, keys, cotters and knuckle joints subjected to static loads and their failure modes | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME502.4 | Design the machine shafts and suggest suitable coupling for a given application. | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME502.5 | Calculate stresses in different types of springs subjected to static loads and dynamic loads. | 2 | 3 | 3 | 3 | 3 | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: INTRODUCTION:** **12 Hours**

General considerations in the design of Engineering Materials and their properties – selection –Manufacturing consideration in design–BIS codes of steels.

**STRESSES IN MACHINE MEMBERS:** Simple stresses – combined stresses – torsional and bending stresses – impact stresses – stress strain relation – various theories of failure – factor of safety – design for strength and rigidity – preferred numbers. the concept of stiffness in tension, bending, torsion and combined situations – static strength design based on fracture toughness.

*Failure modes (bending - pitting - micro pitting - scuffing)*

**Unit II: STRENGTH OF MACHINE ELEMENTS:** **12 Hours**

Stress concentration – theoretical stress concentration factor – fatigue stress concentration factor notch sensitivity – design for fluctuating stresses – endurance limit – estimation of endurance strength – goodman's line – soderberg's line – modified goodman's line, Gerber's parabola.

*Gear types (spur - helical - bevel - worm)*

**Unit III: RIVETED AND WELDED JOINTS** **12 Hours**

Design of joints with initial stresses – eccentric loading. Bolted joints – design of bolts with pre-stresses – design of joints under eccentric loading – locking devices – bolts of uniform strength.

**KEYS, COTTERS AND KNUCKLE JOINTS:** Design of keys-stresses in keys-cotter joints-spigot and socket, sleeve and cotter, jib and cotter joints- knuckle joints.

*Gear configurations (parallel axis, orthogonal axis, planetary)*

**Unit IV: SHAFTS:** **12 Hours**

Design of solid and hollow shafts for strength and rigidity – design of shafts for combined bending and axial loads – shaft sizes – BIS code. Use of internal and external circlips, gaskets and seals (stationary & rotary).

**SHAFT COUPLING:** Rigid couplings – muff, split muff and flange couplings: rigid flanged coupling, protected rigid flanged coupling, Bushed pin type flexible coupling.

*Examples of gearboxes (motorcycle and car transmissions)*

**Unit V: MECHANICAL SPRINGS:** **12 Hours**

Stresses and deflections of helical springs – extension -compression springs – springs for fatigue loading, energy storage capacity – helical torsion springs – co-axial springs, leaf springs.

*Belts (flat - V - ropes),Pressure vessels*

Note: Design data book is NOT Permitted for examination.

**Text Books**

1. Machine Design/ Shigley, J.E/McGraw Hill.2007
2. Machine Design/V.B.Bhandari/ McGrawHill Education,2011
3. RAGHAVENDRA/Design Of Machine Elements I Dme I (Pb 2020)

4. A Textbook Of Machine Design/ R.S. Khurmi / Paperback– 7 May 2012

**Reference Books**

1. Machine design / Schaum Series/McGrawHill Professional
2. Machine Design / Norton/ Pearson publishers
3. Machine design / NC Pandya & CS Shah/Charotar Publishing House Pvt. Limited

**Web Reference**

1. https://www.youtube.com/watch?v=wG2MBL-NqeM&list=PLGiGNMkNq6Qu7h6mqBe1LdXEWCRtVhjBA
2. https://www.youtube.com/watch?v=3fqilT1OpiU&list=PLGiGNMkNq6Qu7h6mqBe1LdXEWCRtVhjBA&index=2

**Internal Assessment Pattern**

| Cognitive Level | InternalAssessment#1 (%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Derive an expression for the impact stress induced due to a falling load.
2. Write short notes on maximum shear stress theory.
3. Define factor of safety for fatigue loading.
4. Define the terms pitch, back pitch, diagonal pitch, and margin.

**L2: Understand**

1. Write short notes on flexible couplings.
2. Derive an expression for bending stress in torsional helical spring.

**L3: Apply**

1. Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values of the spring material: Permissible shear stress=350 Mpa Modulus of rigidity =84 KN/mm2. Wahl's factor =(4C-1)/(4C-4) +0.615/C, where C is spring index.

2. Design and draw muff coupling to connect two shafts transmitting 40 kW at 120 rpm. The permissible shear and crushing stress for the shaft and key material(mild steel) are 30 MPa and 80 MPa respectively. The material of muff is cast iron with permissible shear stress of 15 MPa. Assume that the maximum torque transmitted is 25 percent greater than the mean torque.

3. Find the diameter of a shaft to transmit twisting moment varying from 800N-m to 1200N-m. The ultimate tensile strength for the material is 600MPa and yield stress is 450MPa. Assume the stress concentration factor=1.2, surface finish factor=0.8 and size factor=0.85.

4. A circular steel bar 50 mm diameter and 200 mm long is welded perpendicularly to steel plate to form a cantilever to beloaded with 5 KN at the free end. Determine the size of the weld, assuming the allowable stress in the weld as100 MPa.

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## PC 20ME503 Metal Cutting and Machine Tools 3 0 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PSO1 | PSO2 | |
| 20ME503.1 | Apply cutting mechanics to metal machining upon machining force and power | 2 | 2 | 1 | 3 | 3 | L1, L2, L3 |
| 20ME503.2 | Demonstrate turning, milling machines, drill press, grinding machines | 2 | 2 | 1 | 3 | 3 | L2 |
| 20ME503.3 | Select cutting tool materials and tool geometries for different machining processes. | 2 | 2 | 1 | 3 | 3 | L3 |
| 20ME503.4 | Select suitable machining processes and conditions for different metals. | 2 | 2 | 1 | 3 | 3 | L3 |
| 20ME503.5 | Explain the principles of finishing processes | 2 | 2 | 1 | 3 | 3 | L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Fundamentals of Machining — 12 Hours

Elementary treatment of metal cutting theory – element of cutting process – geometry of single point cutting tool, tool angles, chip formation and types of chips – built up edge and its effects, chip breakers, mechanics of orthogonal cutting –Merchant's force diagram, cutting forces, cutting speeds, feed, depth of cut, tool life, tool wear, machinability, tool materials and properties.

*Study and illustrate the various tool angles for various conditions*

### Unit II: Lathe Machines — 12 Hours

Engine lathe – principle of working, specification of lathe – types of lathe – work holders tool holders – box tools taper turning, thread turning – for lathes and attachments, constructional features of speed gear box and feed gear box. Turret and capstan lathes – collet chucks – other work holders – tool holding devices – box and tool layout. Principal features of automatic lathes – classification – single spindle and multi-spindle automatic lathes – tool layout and cam design for automats.

*Calculate the cutting tools angles for single point cutting tools, Solve the simple problems*

### Unit III: Surface Machining and Drilling — 12 Hours

SHAPING, SLOTTING AND PLANNING MACHINES: Principles of working – principal parts – specifications, operations performed, machining time calculations.

DRILLING & BORING MACHINES: Principles of working, specifications, types, operations performed – tool holding devices – twist drill – Boring Machines – fine Boring Machines – jig boring machine, deep hole Drilling Machine.

*Study the tool wear monitoring methods associated to shaping, drilling and boring machines*

### Unit IV: Surface Machining with Milling Machines — 12 Hours

Principles of working – specifications – classification of Milling Machines – principal features of horizontal, vertical and universal Milling Machine, machining operations, types of cutters, geometry of milling cutters – methods of indexing, accessories to milling machines.

*Compare the CNC milling and conventional milling machine operations and their functional performance*

### Unit V: Finishing Processes — 12 Hours

Theory of grinding – classification of grinding machines, cylindrical and surface grinding machines, tool and cutter grinding machines, different types of abrasives, bonds, specification and selection of a grinding wheel. Lapping, Honing & Broaching operations, comparison to grinding.

*Study the Unconventional Machining process, Inspection of quality of finishing processed components*

### Text Books


1. Kaushish J. P, Manufacturing Processes, 2nd Edition PHI Publishers-2007
2. Rao P. N, Manufacturing Technology Vol-II, 2nd Edition Tata McGraw Hill, 2008
3. Jain K. C & Chitaley A. K, Production Engineering, 4th Edition ,PHI Publishers, 2007
4. Kalpakjian S & Steven R Schmid ,Manufacturing Processes for Engineering Materials- 5th Edition Pearson Publications , 2008


### Reference Books


1. Geoffrey Boothroyd, Winston A.Knight , Metal cutting and machine tools, Taylor & Francis, 4th Edition, 2008

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define tool life
2. How does the rake angle affect the life of the cutting tool?
3. What special tooling is associated with the turret lathe?
4. Differentiate between Turret and Capstan lathes.
5. List the factors affecting tool life
6. State the functions of clapper box in shaper
7. Draw the Straddle milling with a neat sketch
8. What are the functions of a grinding fluid?
9. What are the applications of super finishing operations?
10. What are the principle parts of shaping machine tool

**L2: Understand**

1. Explain the different types of tool post with neat sketches
2. Draw a neat sketch of taper turning by taper turning attachment method
3. Differentiate between shaping, planning and slotting machines
4. Sketch a few work holding devices used in drilling machine
5. Compare the column type milling machine and knee type milling machine
6. Explain briefly the lapping process. Give the examples of lapping work

**L3: Apply**

1. Explain in detail the single-spindle automatic lathe and compare it with multispindle automatic lathe
2. In an orthogonal cutting experiment with a tool of rake angle $\alpha=7^0$, the chip thickness was found to be 2.5 mm when the uncut chip thickness was set to 1 mm. Find: i) the shear angle, $\beta$, ii) the friction angle $\gamma$, assuming that Merchant's formula holds good
3. Sketch and describe any one quick return mechanism of shaper
4. Apply the different types of cutters used in milling operations and give an application of each type
   Select the different types of indexing methods with example for special purpose gear

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## PC 20ME506 Dynamics of Machinery Lab 0 0 3 1.5

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

| Code | Course Outcomes | Mapping with POs | | | |
|---|---|---|---|---|---|
| | | PO1 | PO4 | PSO1 | PSO2 |
| 20ME506.1 | Analyze the motion of motorized gyroscopic couple | 1 | 2 | 3 | 2 |
| 20ME506.2 | Determine the position of sleeve against the controlling force and speed in governors | 1 | 2 | 3 | 2 |
| 20ME506.3 | Measure the frequency of damped and un-damped vibrations of a spring mass system | 1 | 2 | 3 | 2 |
| 20ME506.4 | Determine balancing mass for rotating and reciprocating mass systems. | 1 | 2 | 3 | 2 |
| 20ME506.5 | Determine drive train ratios. | 1 | 2 | 3 | 2 |
| 20ME506.6 | Measure speed of rotating machinery components | 1 | 2 | 3 | 2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### List of Experiments

1. Determine whirling speed of shaft theoretically and experimentally
2. Plot follower displacement vs. cam rotation for various Cam Follower systems
3. Determine the position of sleeve against controlling force and speed of a Hartnell governor and plot the characteristic curve of radius of rotation.
4. Analyze the motion of a motorized gyroscope when the couple is applied along its spin axis.
5. Determine the frequency of un-damped free vibration of an equivalent spring mass
6. system.
7. Determine the frequency of damped force vibration of a spring mass system.
8. Find the moment of inertia of a flywheel.
9. Find coefficient of friction between belt and pulley
10. Plot slider displacement, velocity and acceleration against crank rotation for single crank mechanism/Four bar mechanism
11. Study various types of gears- Spur, Helical, Worm and Bevel Gears
12. Study the static and dynamic balancing using rigid blocks

### References

1. Lab Manual for Dynamics of Machinery Lab, Department of Mechanical Engineering, NSRIT

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**MC 20MCX03 Intellectual Property Rights and Patents** **2 0 0 0**

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

| Code | Course Outcomes | Mapping with POs PO11 | PO12 | DoK |
|---|---|---|---|---|
| 20MCX03.1 | Acquireknowledgeonintellectualpropertyrights | - | - | L1,L2 |
| 20MCX03.2 | Knowabouttheacquisition oftrademarks. | - | - | L1,L2 |
| 20MCX03.3 | Identifytheimportanceofcopyrights,patentsand transferofOwnership. | - | -- | L1, L2 |
| 20MCX03.4 | Reciprocatetonewdevelopmentsofintellectualpropertyrights | - | - | L1, L2 |
| 20MCX03.5 | International overview of IPR | - | - | L1,L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unitl: Introduction to Intellectual property:** **4 Hours**

Concepts, types of intellectual property,international organizations, agencies and importance of intellectual propertyrights.IndustrialProperty,technologicalResearch,InventionsandInnovations – Important examples of IPR.,IPR in India and Abroad

**Unit II: Introduction toTrade Marks:** **4 Hours**

Purpose and function of trademarks, acquisition of trade markrights,selecting and evaluating trademark ,trademark registration processes.Trade Secrets and Industrial Design registration in India and Abroad

**Unit III: Registration of Copy Rights** **4 Hours**

Fundamentals of copy right law,rights of reproduction, rights to perform the work publicly, copy right ownership issues, copyrightregistration, international copyright laws.
**Law of patents:** Foundation of patent law, patent searching process, ownership rights andtransfer.

**Unit IV: Latest development of intellectual property Rights** **4 Hours**

New developments in trademark law; copy right law, patent law, intellectual property audits. Infringementof IPRs,Enforcement Measures,Emerging issues–

**Unit V:Enforcement Of IPRs** **4 Hours**

International overview on intellectual property, international – trade mark law, copy right law, international patent law international development in trade secrets law.

**Text Books**

1. Intellectualpropertyright,Deborah,E. Bouchoux,cengagelearning.
2. Intellectual property right - Unleashing the knowledge economy, Prabuddha Ganguli,TataMcGraw Hill PublishingCompanyLtd.

3. Cornish,WilliamRodolph&Llewelyn,David.Intellectualproperty:patents,copyright,trademarks andallied rights. Sweet& Maxwell,8/e,2013.

**Reference Books**

1. Cornish,WilliamRodolph.Casesandmaterialsonintellectualproperty.Sweet&Maxwell, 5/e,2006.
2. Lo,JackandPressman,David.Howtomakepatentdrawings:apatentityourselfcompanion. Nolo, 5/e 2007.

Web References

1. https://www.investopedia.com/terms/i/intellectualproperty.asp
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3217699/
3. https://www.wto.org/english/tratop_e/trips_e/intel1_e.htm

Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 60 | 60 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is Industrial property?
2. What are the fundamentals of copy rights
3. Define patents and its approval process
4. Define copy right law.
5. Define transfor of trade marks.

**L2: Understand**

1. Explain the role trade scerets in company law.
2. Explain the concept owenership rights of patents with suitable examples
3. Explain the international patent law.
4. Distinguish between copy rights and patents.
5. Explain copt right registration.

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| | | | | | |
|---|---|---|---|---|---|
| IN | **Summer Internship #1** | **0** | **0** | **0** | **1.5** |

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

| No. | Course Outcomes |
|---|---|
| 1 | Demonstrate the theoretical learning outcomes |
| 2 | Integrate theory and practice during graduation |
| 3 | Comprehend the industry practices in the relevant and allied field of study |
| 4 | Develop communication skills in terms of oral, written, and graphical communications |
| 5 | Develop problem solving skills |
| 6 | Develop work habits and teamwork in a multidisciplinary setting for a successful career after graduation |

**Note:** All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes

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## AC Technical Paper Writing

**0 0 2 0**

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

| No. | Course Outcomes |
|---|---|
| 1 | Develop searching latest relevant literature pertaining to the topic of interest |
| 2 | Develop self-learning ability to become a lifelong independent learner |
| 3 | Develop the habit of writing technical manuscript as per the requirement |
| 4 | Develop presentation skills and speak with appropriate technical phrases |
| 5 | Explore the research topics and develop research interests |
| 6 | Comprehend the latest technologies, techniques, tools, and methodologies |

**Note:** All the above course outcomes are relatively mapped to all POs as it caters to all program outcomes

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## PC 20ME601 Mechanical measurements & Metrology 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PSO1 | PSO2 | |
| 20ME601.1 | Describe the construction and working principles of measuring instruments for measurement of displacement and speed and select appropriate instrument for a given application | 3 | 2 | 1 | 1 | 1 | L1, L2 |
| 20ME601.2 | Describe the construction and working principles of measuring instruments for strain, force, Torque, power, acceleration and Vibration and select appropriate instrument for a given application. | 3 | 2 | 1 | 1 | 1 | L2 |
| 20ME601.3 | Explain shaft basis system and hole basis systems for fits and represent tolerances for a given fit as per the shaft basis system and hole basis system and design limit gauges based on the tolerances for quality check in mass production. | 3 | 2 | 1 | 1 | 1 | L2 |
| 20ME601.4 | Explain methods for linear, angle and flatness measurements and select a suitable method and its relevant instrument for a given application. | 3 | 2 | 1 | 1 | 1 | L2 |
| 20ME601.5 | To measure the threads, gear tooth profiles, surface roughness and flatness using appropriate instruments and analyze the data | 3 | 2 | 1 | 1 | 1 | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Measurement Of Displacement And Speed** **12 Hours**

Basic principles of measurement – measurement systems, generalized configuration and functional descriptions of measuring instruments – examples. dynamic performance characteristics – sources of error, classification and elimination of error. **MEASUREMENT OF DISPLACEMENT**: Theory and construction of various transducers to measure displacement – piezo electric, inductive, capacitance, resistance, ionization and photo electric transducers, calibration procedures.

**MEASUREMENT OF SPEED** : Mechanical tachometers – electrical tachometers – stroboscope,

*Contact and noncontact type of tachometer*

**Unit II: Measurement Stress, Acceleration,Force** **12 Hours**

**STRESS STRAIN MEASUREMENTS**: Various types of stress and strain measurements – electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending compressive and tensile strains – usage for measuring torque, strain gauge rosettes.

**MEASUREMENT OF FORCE, TORQUE AND POWER**- Elastic force meters, load cells, torsion meters, dynamometers. **MEASUREMENT OF ACCELERATION AND VIBRATION**: Different simple instruments – principles of seismic instruments – Vibrometer and accelerometer using this principle.

*VibrationTechnology and damper Technology*

**Unit III: Systems OF Limits and Limit Gauges** **12 Hours**

**SYSTEMS OF LIMITS AND FITS**: Introduction, nominal size, tolerance, limits, deviations, fits -Unilateral and bilateral tolerance system, hole and shaft basis systems- interchange ability, deterministic & statistical tolerances, selective assembly. International standard system of tolerances, selection of limits and tolerances for correct functioning.

**LIMIT GAUGES**: Taylor's principle – design of go and no go gauges; plug, ring, snap, gap, taper, profile and position gauges.

*Gauge design, gauge factor*

**Unit IV: Measurement of Linear, Angles And Tapers** **12 Hours**

**LINEAR MEASUREMENT**: Length standards, end standards, slip gauges- calibration of the slip gauges, dial indicators, micrometers.

**MEASUREMENT OF ANGLES AND TAPERS**: Different methods – bevel protractor, angle slip gauges- angle dekkor- spirit levels- sine bar- sine table, rollers and spheres used to measure angles and tapers.

**OPTICAL MEASURING INSTRUMENTS**: Tools maker's microscope and uses - autocollimators, optical projector, optical flats and their uses. Interferrometry- Interference of light, Michelson's interferometer, NPL flatness interferometer, and NPL gauge

interferometer.
**COMPARATORS:** Types - mechanical, optical , electrical and electronic, pneumatic comparators and their uses.
*NPL Technology And Advanced Technologys In Optics*

**Unit V: Measurement of Surface Roughness, Gear and Screw Threads** **12 Hours**

**SURFACE ROUGHNESS MEASUREMENT**:Differences between surface roughness and surface waviness –Numerical assessment of surface finish-CLA, Rt., R.M.S. Rz, R10 values, Method of measurement of surface finish – Profilograph, Talysurf, ISI symbols for indication of surface finish.
**GEAR MEASUREMENT**: Nomenclature of gear tooth, tooth thickness measurement with gear tooth vernier & flange micro meter, pitch measurement, total composite error and tooth to tooth composite errors, rolling gear tester, involute profile checking.
**SCREW THREAD MEASUREMENT**: Elements of measurement – errors in screw threadsconcept of virtualeffective diameter, measurement of effective diameter, angle of thread and thread pitch, and profile thread gauges.
*Advanced measurement in gears, Advanced measurement in screws*

## Text Books

1. Engineering Metrology / R.K.Jain / Khanna Publishers
2. Measurement Systems: Applications & design / D.S Kumar/
3. Engineering Metrology / Mahajan / Dhanpat Rai Publishers
4. Dr.J.P.HolmanThermodynamics –, McGrawHill-6thEdition , McGraw Hill- 2013

## Reference Books

1. Measurement systems: Application and design/Doeblin Earnest. O. Adaptation/ TMH
2. Experimental Methods for Engineers / J.P.Holman/McGraw Hill
3. Mechanical and Industrial Measurements / R.K. Jain/ Khanna Publishers.
4. Instrumentation, measurement & analysis / B.C.Nakra&K.K.Choudhary/TMH

## Web References

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://nptel.ac.in/courses/112/105/112105266/
3. https://nptel.ac.in/courses/101/104/101104063/

## Internal Assessment Pattern

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 40 |
| L3 | 20 | 30 |
| Total(%) | 100 | 100 |

## Sample Short and Long Answer Questions of Various Cognitive Levels

### L1: Remember

1. Define the term metrology and applied to engineering industry. State its significance
2. Describe briefly the sysem of obtaining different types of fits with suitable example
3. Explain the terminology of surface roughness as per Indian standard. Draw neat sketch.
4. Explain the principle of measuring shaft torque using strain gauge torsion meter?
5. Explain instrumental, environmental and observational errors by citing suitable examples. Explain the measures taken to minimize these errors

### L2: Understand

1. Explain terms line standards and end standards with example
2. Describe the uses and advantages of dial indicator
3. hat are the measuring techniques employed in optical projector
4. Define displacement. Suggest a suitable transducer for the measurement of a small linear motion. Give reasons to justify your choice

5. Explain hole basis system and shaft basis system with a neat sketch

**L3: Apply**

1. Describethe working principle and uses of lever type dial test indicator
2. How to measure gear tooth thickness?
3. Explain any four alignment test of milling machine
4. Explain the working principle of pneumatic load cell for the measurement offorce.
5. Describe briefly the sysem of obtaining different types of fits with suitable example

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## PC 20ME602 Design of Machine Elements II

3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PSO1 | PSO2 | |
| 20ME602.1 | Select the suitable bearing based on the application of the loads and predict the life of the bearing | 2 | 3 | 3 | 3 | 3 | L1, L2 |
| 20ME602.2 | Design of IC Engines parts. | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME602.3 | Design of power transmission elements such as gears, belts, chains, pulleys, ropes, levers and power screws. | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME602.4 | Design spur & helical gear for different engineering applications | 2 | 3 | 3 | 3 | 3 | L2 |
| 20ME602.5 | Design of Machine tool elements | 2 | 3 | 3 | 3 | 3 | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: BEARINGS — 12 Hours

Classification of bearings- applications, types of journal bearings – lubrication – bearing modulus – full and partial bearings – clearance ratio – heat dissipation of bearings, bearing materials – journal bearing design – ball and roller bearings – static loading of ball & roller bearings.

*Bearing life.*

### Unit II: ENGINE PARTS — 12 Hours

Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – cranks and crank shafts, strength and proportions of over hung and center cranks – crank pins, crank shafts. Pistons, forces acting on piston – construction design and proportions of piston.

*Cylinder, cylinder liners*

### Unit III: POWER TRANSMISSIONS SYSTEMS, PULLEYS — 12 Hours

Transmission of power by belt and rope drives , transmission efficiencies, belts – flat and V types – ropes - pulleys for belt and rope drives, materials, chain drives.

**DESIGN OF POWER SCREWS:** Design of screw, square ACME, buttress screws, design of nut, compound screw, differential screw.

*Ball screw- possible failures.*

### Unit IV: SPUR & HELICAL GEAR DRIVES — 12 Hours

Spur gears- helical gears – load concentration factor – dynamic load factor, surface compressive strength – bending strength – design analysis of spur gears – estimation of centre distance, module and face width, check for plastic deformation.

*Check for dynamic and wear considerations.*

### Unit V: MACHINE TOOL ELEMENTS: — 12 Hours

Levers and brackets: design of levers – hand levers-foot lever – cranked lever – lever of a lever loaded safety valve- rocker arm straight – angular- design of a crank pin – brackets- hangers- wall boxes. Wire Ropes: Construction, Designation, Stresses in wire ropes, rope sheaves and drums. Design of curved Beams: introduction, stresses in curved beams, expression for radius of neutral axis for rectangular, circular, trapezoidal and t-section.

*Design of crane hooks, c –clamps.*

Note: Design data book is permitted for examination

### Text Books

1. Machine Design/V.B.Bhandari/TMH Publishers
2. Machine Design/ NC Pandya & CS Shaw/ Charotar publishers
3. Design data book
4. Machine Design-Norton/Pearson Publications

**Reference Books**

1. Machine Design: An integrated Approach / R.L. Norton / Pearson Education
2. Mech. Engg. Design / JE Shigley/Tata McGraw Hill education
3. Design of machine elements- spots/Pearson Publications

**Web Reference**

1. https://www.youtube.com/watch?v=_0qkzumn1FI&list=PLZOPOIoQ19tF7kN2ByTot-oCzkYCrZq8e&index=1
2. https://www.youtube.com/watch?v=O1LrOI6jDOw&list=PLZOPOIoQ19tF7kN2ByTot-oCzkYCrZq8e&index=2

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Derive the expression for finding the life of the bearing subjected to variable loading.
2. Explain the stresses developed in the connecting rod. What do you mean by whipping stress?
3. Derive the expression for the radius of the neutral axis for a trapezoidal section.
4. Explain the design procedure of Power screw and screw jack and write the condition for
5. self - locking screws.

**L2: Understand**

1. Explain the design procedure of Power screw and screw jack and write the condition for self - locking screws.
2. Describe the interference phenomenon in involute gears. Also, state the conditions to avoid interference.

**L3: Apply**

1. A roller chain is used to connect two shafts spaced 25 pitches apart to transmit 75 kW at 300 rpm of a 17 tooth driver sprocket to 34 tooth driven sprocket. The working period is 18 hours per day with abnormal service conditions. Specify the length and size of the chain.

2. A 3 kN load is supported by a journal bearing of 75 mm diameter and 75 mm length. Diametric clearance 0.05 mm and bearing is lubricated by the oil of 0.0207 paS viscosity at operating temperature. Determine the maximum speed of rotation of bearing when it is capable of dissipating 80 watts by heat transfer.

3. Design an overhung crankshaft with two main bearings for an I.C engine with the following data:
Cylinder bore=250 mm, Stroke length=300 mm, Flywheel weight=25 kN, Maximum pressure=2.5 N/mm2 , Maximum torque at crank rotation 300 , the pressure at that instant = 1.7 N / mm2 .

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## PE 20ME603 Heat Transfer 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PSO1 | PSO2 | |
| 20ME603.1 | Illustrate the basic principles of heat transfer to basic engineering systems and can solve problems involving steady state heat conduction with and without heat generation in simple geometries. | 2 | 3 | 2 | 3 | 3 | L1,L2, L3 |
| 20ME603.2 | Apply Heisler's charts for transient heat conduction problems and explain velocity and thermal boundary layers in flow over flat plate and through circular pipe. | 2 | 3 | 2 | 3 | 3 | L1,L2, L3 |
| 20ME603.3 | Enumerate Nusselt numbers in forced and natural convection using empirical relations. | 2 | 3 | 2 | 3 | 3 | L1,L2, L3 |
| 20ME603.4 | Draw pool boiling curve, describe film wise condensation, and use LMTD and NTU methods in designing heat exchangers. | 2 | 3 | 2 | 3 | 3 | L1,L2, L3 |
| 20ME603.5 | Illustrate radiation laws and estimate radiate heat exchange between different surfaces and with radiation shields. | 2 | 3 | 2 | 3 | 3 | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Introduction and One Dimensional Steady State Heat Conduction 12 Hours

Modes of heat transfer – Fourier's law of heat conduction– general heat conduction equation in Cartesian and cylindrical coordinates. Steady state heat conduction in a slab - Composite slab, coaxial cylinders and concentric spheres conduction-convection systems - overall heat transfer coefficient - electrical analogy- critical radius of insulation - types of fins– rectangular fin with insulated tip – fin effectiveness and fin efficiency.
*Application to error measurement of temperature.*

### Unit II: One Dimensional Transient Heat Conduction and Dimensional Analysis 12 Hours

Lumped heat capacity analysis Biot and Fourier numbers – solution of transient conduction systems for slabs, cylinders and spheres using Heisler's charts.
Buckingham-Pi-theorem–dimensional analysis applied of forced convection and natural convection–significance of Reynolds', *Prandtl and Nusselt numbers.*

### Unit III: Convection 12 Hours

Fundamentals Of Convection: Velocity and thermal boundary layers in flow on a horizontal flat plate - velocity and thermal boundary layers in laminar flow through a circular pipe – hydrodynamic and thermal entry lengths - Reynolds and Colburn analogies.
Forced Convection: Empirical correlations for Nusselt numbers for flow over flat plates – Empirical correlations for Nusselt numbers for flow through pipes.
Natural Convection: Velocity and thermal boundary layers in heat transfer by naturalconvection from a vertical plate (derivations not included) – Boussinesq approximation – empirical correlations for vertical plates and cylinders for laminar and turbulent natural convection.
*Applications of Convections*

### Unit IV: Boiling, Condensation and Heat Exchangers 12 Hours

Regimes of saturated pool boiling – Drop wise and film wise condensation- Nusselt's analysis for laminar film wise condensation on a vertical plate.
Heat Exchangers: Parallel and counter flow double pipe heat exchangers- overall heat transfer coefficient – fouling factors - LMTD method of heat exchanger analysis – effectiveness
*NTU method of heat exchanger analysis.*

### Unit V: Thermal Radiation 12 Hours

Emissive power – black body – Stefan-Boltzmann's law– Emissivity– Kirchhoff's law- radiation heat exchange between two black isothermal surfaces – concept of radiation shape factor- heat exchange between two large gray planes, and concentric cylinders – exchange between a small gray bodies in a large enclosure
*Radiation shields. advantages, disadvantages and applications.*

**Text Books**

1. Sachdeva R.C,"Fundamentals of Engg. Heat and Mass Transfer",5thEdition, NewAge International Publications, 2013
2. Nag P.K , "Heat Transfer", 3rdEdition, TMH, 2015
3. Rajput R.K.,"Heat and Mass Transfer",RevisedEdition, S.Chand Publications, 2014
4. Cengel, "Heat and Mass Transfer", 5th Edition, McGraw Hill Publications, 2015.

**Reference Books**

1. Incropera F.P, Dewitt D.P, Bergman T.L, Lavine A.S, Seetharamu K.S, Seetharam T.R,"Fundamentals of Heat and Mass Transfer",Wiley India, 1st Edition,McGrawHill, 2013.
2. Frank Kreith, Manglik R. M & Bohn M. S, "Principles of Heat Transfer",Special Edition,Cengage learning publishers, 2012.
3. Kumar D.S, "Heat and Mass Transfer", 3rd Edition, S.K.Kataria& Sons Publications, 2012.
4. Holman J. P, "Heat Transfer", Indian Edition, TMH Publications, 2014.

**Web References**

1. https://nptel.ac.in/courses/112101097/
2. http://web.mit.edu/lienhard/www/ahttv212.pdf/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-051-introduction-to- heat-transfer-fall-2015/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Whatarethedifferent modes of heat transfer?
2. DefineFin.
3. Define Fin effectiveness and fin efficiency
4. State and explain Buckingham π theorem.
5. Define Stefan Boltzman Law.
6. What are different types of convective heat transfer?
7. Define Heat Exchanger and list out various types of heat exchangers.
8. Define the term overall heat transfer coefficient? And explain its significance.
9. List and explain various non dimensional numbers using in heat transfer.
10. Name the different boiling regimes in the order they occur in a vertical tube during flow boiling.

**L2: Understand**

1. Explain the concept of momentum and energy equation.
2. Discuss the detailed classification of convective heat transfer.
3. Explain the regimes of pool boiling.
4. Differentiate between pool boiling and flow boiling.
5. Differentiate between film condensation and drop wise condensation.
6. Distinguish between a black body and grey body.
7. Explain the phenomena of natural convection over a vertical hot plate.

**L3: Apply**

1. Derive general heat conduction equation in cylindrical coordinates.
2. Identify the different modes of heat transfer in the following systems/operations.
   (i) Steam raising in a steam boiler
   (ii) Condensation of steam in a condenser
   (iii) Heat transfer from a vacuum flask
   (iv) Heating of water in a bucket with an immersion heater
3. Water at a rate of 4080 kg/h is heated from 35°C to 75°C by the oil of Cp 1.9 kJ/kg.K. The heat exchanger is a double pipe counter flow. Oil enters at 110°C and leaves at75°C. Determine: i) mass flow rate of oil, ii) area of the heat exchanger to handle heat duty if the overall heat transfer coefficient is 320 W/m2K.

4. Water flows at 45°C over a flat plate 1m x 1m size maintained at 22°C with a velocity of 1.5 m/s. Estimate the variation of heat transfer coefficient along the length of heating starts from 0.25 m from the leading edge.
5. A 50 cm x 50 cm copper slab, 6 mm thick at a uniform temperature of 350°C suddenly has its surface temperature lowered to 30°C. Find the time at which the slab temperature becomes 100°C. h = 100 W/m²°C. Also, find the rate of cooling after 60 seconds.
6. A cylinder 5 cm diameter and 50 cm long, is provided with 14 longitudinal straight fins of 1 mm thick and 2.5 mm height. Calculate the heat loss from the cylinder per second if the surface temperature of the cylinder is 200°C. Take h=25W/m²K, k=80W/m0K and ambient temperature=45°C.
7. A large aluminum plate of thickness 200 mm originally at a temperature of 530°C is suddenly exposed to an environment at 30°C. The convective heat transfer coefficient between the plate and the environment if 500 W/(m² K). Determine with the help of Heisler's charts, the temperature at a depth of 20 mm from one of the faces 225 seconds after the plate is exposed to the environment. Also calculate how much energy has been lost per unit area of the plate during this time? Take for aluminum, Thermal Diffusivity = 8 x 10^-5m 2/s and k = 200 W/(m K).
8. Liquid sulphur dioxide in a saturated state flows inside a 5 m long tube and 25 mm internal diameter with a mass flow rate of 0.15 kg/s. The tube is heated at a constant fluid temperature of -10°C and the inlet fluid temperature is -40°C. Determine the exit fluid temperature by making use of Sieder and Tate equation.

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**PC** **20ME606 Computer Aided Machine Drawing** **0 0 3 1.5**

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

| Code | Course Outcomes | Mapping with POs | | | | |
|---|---|---|---|---|---|---|
| | | PO1 | PO5 | PO10 | PSO1 | DoK |
| 20ME606.1 | Identify the national and international standards pertaining to machine drawing. | 3 | 3 | 3 | 3 | L2 |
| 20ME606.2 | Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings. | 3 | 3 | 3 | 3 | L2 |
| 20ME606.3 | Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies | 3 | 3 | 3 | 3 | L2 |
| 20ME606.4 | Interpret the Machining and surface finish symbols on the component drawings. | 3 | 3 | 3 | 3 | L2 |
| 20ME606.5 | Preparation of the part or assembly drawings as per the conventions. | 3 | 3 | 3 | 3 | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**PART-A** **12 Hours**

introduction: Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section). Hidden line conventions. Precedence of lines. Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. Conversion of pictorial views into orthographic projections of simple machine parts. Hidden line conventions. Precedence of lines. Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part). Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

**PART-B** **12 Hours**

Keys: Parallel key, Taper key, Feather key, Gib-head key and Woodruff key.
Joints: Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
Couplings: Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, and universal coupling (Hooks' Joint)

**PART-C** **12 Hours**

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry.
Assembly Drawings: (Part drawings shall be given)
1. Plummer block (Pedestal Bearing)
2. Lever Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool head of shape

**Text Books**

1. Machine Drawing – N.Siddeswar, K.Kannaiah&V.V.S.Sastry – TMH, 2007
2. Machine Drawing –K.L.Narayana, P.Kannaiah& K. Venkata Reddy / New Age/ Publishers,2003
3. Production Drawing- K.L.Narayana, P.Kannaiah& K. Venkata Reddy / New Age/ Publishers ,2000

**Reference Books**

1. Machine Drawing – P.S.Gill,
2. Machine Drawing – Luzzader
3. Machine Drawing – Rajput
4. Machine Drawing – N.D. Junnarkar, Pearson
5. Machine Drawing – Ajeeth Singh, McGraw Hill
6. Machine Drawing – KC John, PHI
7. Machine Drawing – B Battacharya, Oxford
8. Machine Drawing – Gowtham and Gowtham, Pearson
9. Machine Drawing- Dhawan R K- S.chand&Company

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## PC 20ME607 Mechanical Measurements & Metrology Lab 0 0 3 1.5

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

| Code | Course Outcomes | Mapping with POs | | | |
|---|---|---|---|---|---|
| | | PO1 | PO4 | PSO1 | PSO2 |
| 20ME607.1 | Explain different instruments that are available for linear, angular, roundness and roughness measurements | 2 | 3 | 3 | 3 |
| 20ME607.2 | Select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy, etc) | 2 | 3 | 3 | 3 |
| 20ME607.3 | Know requirement of calibration, errors in measurement etc. | 2 | 3 | 3 | 3 |
| 20ME607.4 | Perform accurate measurements | 2 | 3 | 3 | 3 |
| 20ME607.5 | Demonstrate principles of modern instruments | 2 | 3 | 3 | 3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

**List of Experiments**

**Metrology Lab**

1. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micro meter for checking the chordal thickness of spur gear.
4. Measurement using Mechanical comparator.
5. Measurements using Optical Projector.
6. Measurement of alignment using Autocollimator.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

**Mechanical Measurements Lab**

1. Calibration of pressure gauge.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge.
5. Calibration of thermocouple.
6. Calibration of capacitive transducer.
7. Study and calibration of photo and magnetic speed pickups.
8. Calibration of resistance temperature detector.
9. Study and calibration of a rotameter.
10. Study and use of a seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of Mcleod gauge for low pressure.

**References**

1. Lab Manual for Manufacturing Process Lab, Department of Mechanical Engineering, NSRIT

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## PC 20ME608 Heat Transfer Lab

0 0 3 1.5

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

| Code | Course Outcomes | Mapping with POs | | | |
|---|---|---|---|---|---|
| | | PO1 | PO4 | PSO1 | PSO2 |
| 20ME608.1 | Apply the basic heat transfer mechanisms for various heat transfer phenomenon. | 2 | 3 | 3 | 3 |
| 20ME608.2 | Evaluate the COP of refrigeration system. | 2 | 3 | 3 | 3 |
| 20ME608.3 | Determine the thermal conductivity of different metallic materials. | 2 | 3 | 3 | 3 |
| 20ME608.4 | Examine the rate of heat transfer between solid boundaries. | 2 | 3 | 3 | 3 |
| 20ME608.5 | Select the appropriate dimensional and functional parameters for heat transfer devices. | 2 | 3 | 3 | 3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### List of Experiments

1. Determination of overall heat transfer co-efficient of a composite slab
2. Determination of thermal conductivity of a metal rod.
3. Determination of heat transfer rate through alagged pipe.
4. Determine the heat transfer coefficient of air in tube by forced convection.
5. Determine the heat transfer coefficient of vertical cylinder by natural convection
6. Estimate the effectiveness and fin efficiency by forced convection.
7. Calculate and compare The Stefan Boltzmann constant.
8. Determine the effectiveness and overall heat transfer coefficient in parallel flow heat exchanger.
9. Determine the effectiveness and overall heat transfer coefficient in counter flow heat exchanger.
10. COP of VCR System with Capillary and thermal expansion valve.
11. Determine the emissivity of test plate by using black surface.
12. Determination of Thermal conductivity ofl Liquids and gases.
13. Determination of critical heat flux.
14. Estimation of heat transfer by unsteady state heat conduction.

### References

1. Lab Manual for Manufacturing Process Lab, Department of Mechanical Engineering, NSRIT

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## SC 20MES04 Computer Aided Analysis 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | DoK |
|---|---|---|---|---|---|
| | | PO1 | PO4 | PO5 | |
| 20MESO4.1 | Acquire the knowledge on basic geometric and solid modelling. | 3 | 3 | 3 | L2 |
| 20MESO4.2 | Ability to design orthographic and perspective projections using software. | 3 | 3 | 3 | L2 |
| 20MESO4.3 | Acquire basic approaches for various Algebraic and geometric forms | 3 | 3 | 3 | L2 |
| 20MESO4.4 | Acquire basic approaches for various coordinate systems for solid modelling. | 2 | 2 | 2 | L2 |
| 20MESO4.5 | Gain the knowledge required formulation of load vector of nano-structured materials, Gauss-quadrature Solution of 2D plane stress solid mechanics problems (linear static analysis) | 3 | 3 | 3 | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Introduction to CAD — 12 Hours

Introduction to CAD Historical developments, Industrial look at CAD, Comparison of CAD with traditional designing, Application of computers in Design.. Basics of geometric and solid modelling,. Hardware in CAD components, user interaction devices, design database, graphic Standards, data Exchange Formats, virtual Reality.

### Unit II: Transformations — 12 Hours

Transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling Shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.

### Unit III: Splines and Curves — 12 Hours

Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves. Plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, Bezier surface, B-spline surfaces and their modelling techniques.

### Unit IV: Finite Element Analysis — 12 Hours

Solid models and representation scheme, boundary representation, constructive solid geometry. Sweep representation, cell decomposition, spatial occupancy enumeration, coordinate systems for solid modeling. Introduction to finite element analysis - steps involved in FEM-Preprocessing phase – discretization - types of elements

### Unit V: 1-D and 2-D boundary conditions — 12 Hours

Formulation of stiffness matrix (direct method, 1-D element) - formulation of load vector - assembly of global equations - implementation of boundary conditions - solution procedure - post processing phaseInterpolation – selection of interpolation functions - CST element – isoparametric formulation (using minimum PE theorem) – Gauss- quadrature Solution of 2D plane stress solid mechanics problems (linear static analysis)

### Text Books

1. Groover M.P, Zimmers E.M, Jr.CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, 1987
2. Chandrupatla T. R and Belagundu A. D, Introduction to Finite Elements in Engineering, Pearson Education, 2001

**Reference Books**


1. Chris Mcmahon and Jimmie Browne - CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England,1998
2. D. F. Rogers and J. A. Adams, Mathematical Elements in Computer Graphics, McGraw- Hill,1990
3. Daryl Logan, A First course in Finite Element Method, Thomson Learning,2007
4. David V Hutton, Fundamentals of Finite Element Analysis, THM,2003
5. Donald Hearn, M. Pauline Baker and Warren Carithers, Computer Graphics with open GL, Pearson Education,2001
6. GrigoreBurdea, Philippe Coiffet, Virtual Reality Technology, John Wiley and sons,2003
7. Ibrahim Zeid, CAD/ CAM Theory and Practice, McGraw Hill,2007
8. P. Radhakrishnan and S. Subramanyan, CAD / CAM / CIM, New Age Int. Ltd.,2008 A Layton Introductory


**Web References**

https://nptel.ac.in/courses/112/104/112104031/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What are user interaction devices?
2. Discuss the Historical developments of CAD?
3. Discuss the Comparison of CAD with traditional designing.
4. Give the applications of design data base.
5. What are graphic standards?
6. Define solid modelling

**L2: Understand**

1. Explain how blending function are used.
2. Write a detailed note on iso parametric formulation (using minimum PE theorem).
3. Explain B-spline surfaces and their modelling techniques.
4. Explain post processing phase Interpolation?

**L3: Apply**

1. List out the applications and limitations of CAA.
2. Comment about stress solid mechanics problems.

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## 20MCX04 Indian Traditional Knowledge 0 0 3 0

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

| Code | Course Outcomes | Mapping with POs | | | | DoK |
|---|---|---|---|---|---|---|
| | | PO1 | PO6 | PO7 | PO12 | |
| 20MCX03.1 | Identify the concept of Traditional knowledge and its importance | 1 | 3 | 3 | 2 | L1, L2 |
| 20MCX03.2 | Explain the need and importance of protecting traditional knowledge | 1 | 2 | 3 | 2 | L1, L2 |
| 20MCX03.3 | Illustrate the various enactments related to the protection of traditional knowledge | 1 | 3 | 3 | 2 | L1, L2 |
| 20MCX03.4 | Interpret the concepts of Intellectual property to protect the traditional knowledge | 1 | 2 | 3 | 2 | L1, L2 |
| 20MCX0.35 | Explain the importance of Traditional knowledge in Agriculture and Medicine | 1 | 3 | 3 | 2 | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create

**UNIT-I: Introduction to traditional knowledge** **6hours**

Define traditional knowledge, nature and characteristics, scope and importance, kinds of traditional knowledge, Indigenous Knowledge (IK), characteristics, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge Vs western knowledge traditional knowledge

**UNIT-2: Protection of traditional knowledge** **6hours**

The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.

**UNIT-3: Legal framework and TK:** **6hours**

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, Plant Varieties Protection and Farmer's Rights Act, 2001 (PPVFR Act); The Biological Diversity Act 2002 and Rules 2004, the protection of traditional knowledge bill, 2016.

**UNIT-4: Traditional knowledge and intellectual property:** **6hours**

Systems of traditional knowledge protection, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge

**UNIT-5: Traditional Knowledge in Different Sectors:** **6hours**

Traditional knowledge and engineering, Traditional medicine system, TK in agriculture, Traditional societies depend on it for their food and healthcare needs, Importance of conservation and sustainable development of environment, Management of biodiversity, Food security of the country and protection of TK

**Text Books:**

1. Traditional Knowledge System in India, by Amit Jha, 2009.

**Reference Books:**

1. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.

2. "Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino2.

**Web Links:**

1.https://www.youtube.com/watch?v=LZP1StpYEPM

2.http://nptel.ac.in/courses/121106003/

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**Mechanical Engineering**
N.S. Raju Institute of Technology (A)
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## PE 20ME001 Applied Thermodynamics 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME001.1 | Relate the laws of thermodynamics with different cycles. | L1 |
| 20ME001.2 | Demonstrate the principle of boilers, its working and required characteristics. | L1,L2 |
| 20ME001.3 | Explain the function of steam nozzles and turbines with their specifications. | L1,L2 |
| 20ME001.4 | Illustrate the mechanical details of reaction turbines and its classification. | L1,L2,L3 |
| 20ME001.5 | Interpret the application of compressors with their classification. | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: VAPOUR POWER CYCLES AND COMBUSTION 9 Hours

Carnot, Rankine cycle - schematic layout, thermodynamic analysis, concept of mean temperature of heat addition, methods to improve cycle performance – regeneration & reheating. Fuels and combustion, concepts of heat of reaction, adiabatic flame temperature, Stoichiometry, flue gas analysis.

*Closed control volumes, Dynamic systems*

### Unit II: BOILERS 9 Hours

Classification – working principles of L.P & H.P boilers with sketches – mountings and accessories – working principles, boiler horse power, equivalent evaporation, efficiency and heat balance – Draught: classification – height of chimney for given draught and discharge, condition for maximum discharge, efficiency of chimney – artificial draught, induced and forced.

*Open control volumes, Gas dynamics*

### Unit III: STEAM NOZZLES 9 Hours

Function of a nozzle – applications - types, flow through nozzles, thermodynamic analysis – assumptions -velocity of fluid at nozzle exit-Ideal and actual expansion in a nozzle, velocity coefficient, condition for maximum discharge, critical pressure ratio, criteria to decide nozzle shape: Super saturated flow - its effects, degree of super saturation and degree of under cooling, Wilson line.

**STEAM TURBINES** Classification – impulse turbine; mechanical details – velocity diagram – effect of friction – power developed, axial thrust, blade or diagram efficiency – condition for maximum efficiency. De-laval turbine - methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, velocity and pressure variation along the flow – combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency.

*Departure Functions, Simple vapour*

### Unit IV: REACTION TURBINE 9 Hours

Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency – calculation of blade height

**STEAM CONDENSERS** Requirements of steam condensing plant – classification of condensers – working principle of different types – vacuum efficiency and condenser efficiency – air leakage, sources and its affects, air pump, cooling water requirement.

*liquid equilibrium, Multicomponent Phase Equilibrium*

### Unit V: COMPRESSORS 9 Hours

Classification –Reciprocating type, Principle of operation, work required, Isothermal efficiency, volumetric efficiency and effect of clearance, multi stage compression, saving of work, minimum work condition for two stage compression

**Rotary (Positive displacement type)**

Roots Blower, vane sealed compressor, Lysholm compressor – mechanical details and principle of working – efficiency considerations.

**Rotary (non positive displacement type)**

**Centrifugal compressors**: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, velocity diagrams.

**Axial Flow Compressors:** Mechanical details and principle of operation, velocity diagrams

*Chemical equilibrium, Legendre transform*

**Text Books**

1. Basics & Applied Thermodynamics- P.K.Nag – 4th edition- McGraw Hill 2017
2. Thermal Engineering - RK Rajput- Lakshmi Publications, 8th Edition 2014
3. YunusACenegel,MichaelABoles,Thermodynamics,anEngineeringApproach,8thEdition-MCH- 2014
4. Dr.J.P.HolmanThermodynamics–,McGrawHill-6thEdition,McGrawHill- 2013

**Reference Books**

1. Applied Thermodynamics - Eastop& McConkey- Pearson Publications, 5th Edition
2. Thermal Engineering-M.L.Marthur& Mehta- Jain bros. Publishers, 3rd Edition 2017.
3. Dr.Y.V.C.Rao-An Introduction to Thermodynamics– Universities presses publications- 2012.
4. W.Z.Black&J.G.Hartley, Thermodynamics, 3rd Edition- Pearson Publications- 2010.

**Web References**

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://nptel.ac.in/courses/112/105/112105266/
3. https://nptel.ac.in/courses/101/104/101104063/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 60 | 20 |
| L2 | 40 | 40 |
| L3 | | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write a short note on exhaust blowdown?
2. Write the qualities of an ideal ignition system..
3. Write about anti knock additives.
4. What is heat balance sheet?
5. Write the applications of air compressor.
6. Draw the velocity diagram of a centrifugal blower.

**L2: Understand**

1. What is a cycle? What is the difference between an ideal and actual cycle?
2. What is supercharging? How is it achieved?
3. ``Auto-ignition is the cause of detonation``. Justify the statement.
4. What do you mean by performance of IC engine?
5. What do you understand by a slip factor in dynamic compressors?

**L3: Apply**

1. Compare actual cycle and air standard cycle of SI engine Illustrate First law applied to a flow system.
2. The following data was recorded during testing of a 4-stroke cycle gas engine. Diameter= 10 cm, Stroke= 10 cm, Speed= 1200 rpm, Area of the positive loop of the indicator diagram=5.75 cm2 , Area of the negative loop of the indicator diagram=0.25 cm2 , Length of the indicator diagram= 55 mm, Spring constant= 3.5 bar/cm. Find the indicated power of the engine..
3. Derive the expression for work per kg of air compressed in a single cylinder reciprocating air compressor considering clearance and neglecting clearance..
4. A single-stage double-acting air compressor is required to 14 m3 of air per minute measured at 1.013 bars and 200C. The delivery pressure is 6 bar and the speed 300 rpm. Take the clearance volume as 5% of the swept volume with the compression and expansion index of n=1.3. Calculate: (i) Swept volume of the cylinder (ii) The delivery temperature (iii) Indicated power .

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## PE 20ME002 Unconventional Machining Processes 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME002.1 | Get the knowledge of principle of working, mechanism of metal removal in the Ultrasonic machining process and identify the process parameters, their effect and applications of different processes | L1,L2 |
| 20ME002.2 | Learn Abrasive jet machining, Water jet machining and its applications | L1,L2 |
| 20ME002.3 | Impart the knowledge of Electro chemical machining and Its Applications | L1,L2 |
| 20ME002.4 | Know the Thermal metal removal processes and selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface | L1,L2 |
| 20ME002.5 | Impart the knowledge of Plasma Machining, Application of plasma for machining and electron beam machining | L1,L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### Unit I: Introduction- Ultrasonic Machining 9 Hours

History, need, classification, comparison between conventional and nonconventional machining process and selection.
Ultrasonic Machining (USM) - Introduction, equipment details, cutting tool system design, mechanism of metal removal, effect of parameters, USM process characteristics, applications, advantages & disadvantages of USM.
*Advanced contact and Non contact methods*

### Unit II: Abrasive Jet Machining 9 Hours

Abrasive jet machining, Water jet machining and abrasive water jet machining: Basic principles, equipments, process variables, mechanics of material removal, MRR, application and limitations.
*Abrasive materials and its functioning*

### Unit III: Electro Chemical Machining 9 Hours

Fundamentals of electro chemical machining, electro chemical grinding, electro chemical honing and deburringprocess, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM, Simple problems for estimation of metal removal rate, fundamentals of chemical machining, advantages and applications.
*Applications of ECM*

### 9 Hours

General principle and applications of Electric Discharge Machining, Electric Discharge Grinding and wire EDM – Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface.
*Advance metal removal rate, Main functions on MRR*

### Unit V: Electron And Laser Beam Machining, Plasma Machining 9 Hours

Electron Beam Machining, Laser Beam Machining - Basic principle and theory, mechanics of material removal, process parameters, efficiency & accuracy, applications
Plasma Machining: Application of plasma for machining, metal removal mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries.
*Advanced machining process and its technique's*

### Text Books

1. Hassan Abdel, Fundamentals of Machining Processes-Conventional and non – conventional processe Gawad El-Hafy/CRC Press-2016.
2. Abdel H. and El-Hofy G., Advanced Machining Processes, McGraw-Hill,USA, 2005.
3. Anup Goel, A. Jacob Moses, Unconventional Machining Processes, Technical Publications, 1st, 2020
4. P C. Pandey, H S. Shan, MODERN MACHINING PROCESSES, mc Graw Hill

**Reference Books**

1. Gary F. Benedict, Non Traditional Manufacturing Processes, CRCPress-2017
2. VK Jain, Advanced machining processes, Alliedpublishers-2007

**Web References**

1. https://nptel.ac.in/courses/112/105/112105212/
2. https://nptel.ac.in/noc/courses/noc16/SEM2/noc16-me15/

**Internal Assessment Pattern**

| Cognitive Level | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 60 | 60 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. State the need for unconventional machining process.
2. What do you mean by recast layer with reference to the EDM?
3. What is the purpose of deflection coil in EBM process?
4. Write the various types of torches used in plasma arc machining
5. Name different gases used in AJM.

**L2: Understand**

1. Explain the factors that should be considered during the selection of an appropriate unconventional machining process for a given job.
2. With a neat sketch explain shaped tube electrolytic machining.
3. Explain the following in EDM with neat sketch
4. i) Electrode feed control system
   ii) Factors to be considered for EDM machine tool selection

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## PE 20ME003 Rotor Dynamics 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME003.1 | Explain rotor bearing interaction | L1, L2 |
| 20ME003.2 | Identify the types & classifications of components and *Bearings,* | L2 |
| 20ME003.3 | Demonstrate the stability of deformation | L2 |
| 20ME003.4 | Describe the principle of *Transfer Matrix* | L2 |
| 20ME003.5 | Use of *Measurement Techniques in Rotor dyanamics* | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### Unit I: Rotor-Bearing 9 Hours

Rotor-Bearing Interaction, Flexural Vibration, Critical Speeds of Shafts, Jeffcott Rotor Model, Unbalance Response, Effect of Damping, Campbell Diagram, Effects of Anisotropic Bearings, Unbalanced Response of an Asymmetric Shaft, Parametric Excitation, Gyroscopic Effects,

### Unit II: Discs 9 Hours

Rotor with Non-central Disc, Rigid-rotor of Flexible Bearings, Stodola Model, Effect of Spin Speed on Natural Frequency, Forward and Backward Whirling Motion, Aerodynamic Effects.

### Unit III: Rotor Shafts 9 Hours

Instability: Rub, Tangential forces, Rotor-shaft Continuum, Effect of Rotary Inertia and Shear-Deformation within the Shaft, Equivalent Discrete System, Finite Element model for Flexural Vibration, Torsional Vibration, Geared and Branched Systems

### Unit IV: Bearings 9 Hours

Transfer Matrix Model, Fluid Film Bearings: Steady State Characteristics of Bearings, Reynolds's Equation, Oil-Whirl, Rigid And Flexible Rotor Balancing,

### Unit V: Vibration 9 Hours

Active Vibration Control of Rotor-Bearing System: Active Magnetic Bearing, Condition Monitoring of Rotating Machinery, Measurement Techniques. Rolling element bearings, Fault diagnosis.

### Text Books

1. Rao J. S, Rotor Dynamics, Third ed., New Age, New Delhi, 1996 (2009 reprint).
2. Goodwin M. J, Dynamics of Rotor-Bearing Systems, Unwin Hyman, Sydney, 1989.
3. Adams M.L, Rotating machinery vibration: from analysis to troubleshooting, Second ed., CRC Press, Boca Raton, 2010.
4. Kicinski J, Rotor dynamics, Tech. Book, New Delhi, 2010. 6. D. Childs, Turbomachinery Rotordynamics: Phenomena, Modeling and Analysis, Wiley, New York, 1993.

### Reference Books

1. Krämmer E, Dynamics of Rotors and Foundation, Springer-Verlag, New York, 1993.
2. Genta G, Dynamics of Rotating Systems, Springer, New York, 2005.
3. Vance J.M, Rotordynamics of Turbomachinery, Wiley, New York, 1988.

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1. https://www.youtube.com/watch?v=uvcvudNhsAc&list=PLbMVogVj5nJQuAmYkqn_qpAK1fOpmcT5j&index=2
2. https://www.youtube.com/watch?v=HARypmuVEBQ&list=PLbMVogVj5nJQuAmYkqn_qpAK1fOpmcT5j
3. https://www.youtube.com/watch?v=3z3LtneDQ68

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Rotor-Bearing Interaction
2. Jeffcott Rotor Model
3. Rigid-rotor of Flexible Bearings

**L2: Understand**

1. Derive Effect of Rotary Inertia and Shear-Deformation within the Shaft.
2. Explain Transfer Matrix Model

**L3: Apply**

1. Two-point masses of 0.3kg and 0.7kg are fixed at the ends of a rod which is of length 1.4m and of negligible mass. The rod is set rotating about an axis perpendicular to its length with a uniform angular speed. The point on the rod through which the axis should pass in order that the work required for rotation of the rod is minimum is located at a distance of0.42 m from the mass of 0.3kg
   0.70 m from the mass of 0.7kg
   0.98m from the mass of 0.3kg
   0.98m from the mass of 0.7kg

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## PE 20ME004 Composite Material 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME004.1 | Explain the basic fundamental methods of composite technology | L1,L2, L3 |
| 20ME004.2 | Develop the constituent proportions to make composite materials | L1,L2, L3 |
| 20ME004.3 | Demonstrate the associated Mechanical Properties -Stiffness and Strength of composite materials | L1,L2, L3 |
| 20ME004.4 | Explain the practical difficulties of composite material usage | L1,L2, L3 |
| 20ME004.5 | Apply the concept of composite materials for industrial and other applications | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal.

*Ceramic and polymer matrix composites.*

**Unit II: Manufacturing methods** **9 Hours**

Hand and spray lay - up, injection molding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs. Fibre/Matrix Interface, mechanical. Measurement of interface strength. Characterization of systems.

*Carbon fibre/epoxy, glass fibre/polyester*

**Unit III: Mechanical Properties -Stiffness and Strength** **9 Hours**

Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibers, Shortfiber systems, woven reinforcements –Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension.

*compression, flexure and shear.*

**Unit IV: Laminates** **9 Hours**

Plate Stiffness and Compliance, Assumptions, Strains, Stress Resultants, Plate Stiffness and Compliance, Computation of Stresses, Types of Laminates -, Symmetric Laminates, Antisymmetric Laminate, Balanced Laminate, Quasi-isotropic Laminates, Cross-ply Laminate, Angleply Laminate. Orthotropic Laminat.

*Laminate Moduli, Hygrothermal Stresses.*

**Unit V: Joining Methods and Failure Theories** **9 Hours**

Joining –Advantages and disadvantages of adhesive and mechanically fastened joints. Typical bond strengths and test procedures.

*Advanced Joining methods and Failures*

**Text Books**

1. Introduction to Composite Materials Design, Ever J. Barbero, Taylor and Francis, Philadelphia, PA, 1998
2. Materials characterization, Vol. 10, ASM hand book,2000
3. Mechanical Metallurgy by G. Dieter Mc-Graw Hi,2007

**Reference Books**

1. Thermal Analysis of Materials by R.F. Speyer, Marcel Decker
2. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall India

**Web References**

1. NPTEL Syllabus - Introduction to Composites
2. www.eng.usf.edu/~kaw/class/composites/syllabus.fall2015.pdf

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write about composite materials?
2. State the applications of composite materials?
3. List the advantages and disadvantages?
4. Write about manufacturing methods?
5. Define laminates?
6. Write about mechanical properties, strength and stiffness?
7. Identify the joining methods?
8. Write short note on failure theories?

**L2: Understand**

1. Explain about the effect of composite materials?
2. What are the differences between alloy and composite?
3. Derive from various manufacturing methods
4. With a neat sketch, explain the working of a laminates
5. Explain the terms: variation of mechanical properties, strength and stiffness
6. Distinguish the various joining methods and failure analysis

**L3: Apply**

1. The flexural tests are conducted to determine the mechanical properties of resin and laminated fiber composite materials. Further, these tests are used to determine the interlaminar shear strength of a laminate, shear modulus, shear strength, tensile and compression moduli along with flexural and shear stiffness. These tests are not only used for composites but also for sandwich beams.

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## PE 20ME005 Product Design 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME005.1 | Demonstrate the technical and business aspects of the product development process | L1, L2 |
| 20ME005.2 | Explain Skilled in implementation of gathering data from customers and establish technical specification | L2 |
| 20ME005.3 | Develop product functional decomposition | L2 |
| 20ME005.4 | Describe engineering problem solving | L2 |
| 20ME005.5 | Apply the product modularisation, to be able to understand intellectual property issues in product development | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Engineering Design 9 Hours

Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- societal considerations in engineering design –generic product development process – various phases of product development-planning for products –establishing markets- market segments- relevance of market research.

*Create Innovative Products and Designs*

### Unit II:Quality 9 Hours

Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams – needs importance- establishing engineering characteristics-competitive benchmarking- quality function deployment- house of quality.

*Product Design Specification-Case Studies*

### Unit III: Design Thinking 9 Hours

Creative thinking –creativity and problem solving- creative thinking methods- generating design concepts-systematic methods for designing –functional decomposition – physical decomposition –functional representation –morphological methods

*TRIZ- axiomatic design*

### Unit IV: Product Architecture 9 Hours

Decision making –decision theory –utility theory –decision trees –concept evaluation methods –Pugh concept selection method-weighted decision matrix –analytic hierarchy process – introduction to embodiment design –product architecture – types of modular architecture.

*Steps In Developing Product Architecture.*

### Unit V: Industrial Product design 9 Hours

Industrial design – human factors design –user friendly design – design for serviceability – design for environment – prototyping and testing – cost evaluation –categories of cost – overhead costs – activity based costing –methods of developing cost estimates.

*Manufacturing Cost, Value Analysis In Costing.*

### Text Books


1. Ulrich, K.T., Eppinger, S.D.: Product Design And Development; McGraw-Hill; 2004. ISBN 0-07-247146-8 0 0 Otto, K.N., Wood,2000
2. K.L.: PRODUCT DESIGN – Techniques In Reverse Engineering And New Product Development; Prentice Hall; 2001. ISBN 0-13-021271-7 0 0 Pahl G., Beitz W.2003
3. Feldhusen J., Grote K.H.: Engineering Design - A Systematic Approach, Springer 2007., ISBN 978-1-84628-318-5,2007
4. Chitale A. K, Product Design and Manufacturing Paperback – 26 January 2014, Prentice Hall India Learning Private Limited; 6th edition, 2014

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1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9
2. Clive L.Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7
3. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9
4. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education,ISBN 9788177588217
5. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141


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2. https://www.youtube.com/watch?v=QIdu_aULUG8
3. https://www.youtube.com/watch?v=07sZheNRiLc
4. https://www.youtube.com/watch?v=2OSLyFnvpw4

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What are the different mechanical feeders? Explain working and constructionalfeatures of any two mechanical feeders.
2. List out the parameters considered for effect of quality levels of parts in indexing machines and explain any one of it.
3. Classify the different types of automated assembly system with schematic diagram.
4. Discuss briefly the effect of part thickness and part size on handling time.
5. Sketch and explain spiral elevators.
6. Draw the schematic diagram of a orienting system analysis and explain each term.

**L2: Understand**

1. Derive the expression for maximum feed rate for external gate feeder.
2. Derive an expression of proportion down time for free transfer machines and list out the values of buffer storage capacity be on the basis of factor k.
3. What are objective meet by the product design for assembly handbook.
4. With suitable example, discuss the two kinds of symmetry for a part.

**L3: Apply**

1. Briefly discuss the effect of parts quality on downtime.
2. What are the fundamental strategies employed to smoothen the automation and explain them?
3. List out the simple rules to be considered in designing of produce and parts in automatic assembly.
4. Deduce the empirical expression to estimate the manual insertion time.
5. What are the basic principles of automation and how it improves quantity of production?
6. What are the various feeding systems used in practice and explain about construction and Working of a feeder?
7. Sketch and explain various position orientation systems used in practice.

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## PE 20ME006 Production Planning and control 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME006.1 | Recognize the objectives, functions, applications of PPC and forecasting techniques | L2 |
| 20ME006.2 | Explain different forecast techniques. | L2 |
| 20ME006.3 | Explain different inventory techniques. | L2 |
| 20ME006.4 | Summarize various routing techniques. | L2 |
| 20ME006.5 | Apply way of integrating different departments to execute Scheduling and dispatchingfunctions | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department.
*internal organization of department.*

**Unit II: Forecasting** **9 Hours**

Forecasting – importance of forecasting – types of forecasting, their uses – general principles of forecasting – forecasting techniques
*qualitative methods and quantitive methods.*

**Unit III: Inventory Control** **9 Hours**

Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems. Introduction to MRP I, MRP II, ERP, LOB (Line of Balance),
*JIT and KANBAN system.*

**Unit IV:** Routing **9 Hours**

Routing – definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition *difference with loading.*

**Unit V: Scheduling** **9 Hours**

Scheduling policies – techniques, standard scheduling methods. Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.
Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up.
*applications of computer in production planning and control.*

### Text Books

1. Elements of Production Planning and Control / Samuel Eilon, 2000.
2. Manufacturing, Planning and Control, Partik Jonsson Stig-Arne Mattsson, Tata Mc Graw Hill.2000
3. Production Planning and Control, Mukhopadyay, PHI.2001
4. Production Control A Quantitative Approach / John E. Biegel.2003

### Reference Books

1. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

### Web Reference

1. https://www.youtube.com/watch?v=9qBZyzjoqAo
2. https://www.youtube.com/watch?v=y24meNZbUoU
3. https://www.youtube.com/watch?v=9qBZyzjoqAo
4. https://www.youtube.com/watch?v=Ic_El2DkpjA&list=RDCMUCdVa6bQpMlyMkG6k6VgXHzQ&index=3

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Explain the scope of production planning and control.
2. Explain different types of production systems and differentiate between them.
3. Distinguish between production planning and production control and state their objectives.
4. Discuss organization of Production planning and control department.
5. Define follow up and explain different types of the follow up in detail.
6. Define follow up and explain different types of the follow up in detail

**L2: Understand**

1. Describe 'Least Square Method' of sales forecasting with its advantages and limitations.
2. Bring out any four differences between scheduling and loading
3. What is aggregate planning? Write its functions, merits and demerits.
4. Discuss in detail the sequential steps involved in dispatching.
5. Describe 'Least Square Method' of sales forecasting with its advantages and limitations. b) Describe the Survey of buyers intention method of sales fore casting with its advantages and limitations.
6. Explain the various elements of JIT.

**L3: Apply**

1. Forecast the production for next two years when the production quantity for last ten years is as follows: 200, 225, 235, 240, 255, 260, 265, 275, 270, 271 Use the following methods and comment on results. (i) Moving average (3 years and 5 years) ii) Exponential smoothing for $\alpha$=0.3 and 0.7.
2. Alpha industry estimates that it will sell 12000 units of its product for the forthcoming year. The ordering cost is Rs. 100 per order and the carrying cost per unit per year is 20% of the purchase price per unit. The purchase price per unit is Rs.50.Find i) Economic Order quantity, ii) No. of orders per year and iii) Time between successive orders.

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**PC** **20ME007 Refrigeration and Air- Conditioning** **3 0 0 3**

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME007.1 | Understand the necessity and application of refrigeration system. | L1 |
| 20ME007.2 | Gain the knowledge regarding working and essential components of simple vapour refrigeration cycle. | L1,L2 |
| 20ME007.3 | Understand the desirable properties & classification of refrigerants and explanation on different components of vapour compression refrigeration system. | L1,L2 |
| 20ME007.4 | Discussion on vapour absorption system,its components and its classification. | L1,L2,L3 |
| 20ME007.5 | Familiarize the basic principle psychometric properties of vapour in air-conditioning system and classification pf air-conditioning equipments. | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: INTRODUCTION TO REFRIGERATION** **9 Hours**

Necessity and applications – unit of refrigeration and C.O.P. –Mechanical refrigeration – types of ideal cycles of refrigeration. air refrigeration: bell coleman cycle - open and dense air systems – refrigeration systems used in air crafts and problems.

**Unit II: VAPOUR COMPRESSION REFRIGERATION** **9 Hours**

Working principle and essential components of the plant –simple vapour compression refrigeration cycle – COP – representation of cycle on T-S and p-h charts – effect ofsub cooling and super heating – cycle analysis – actual cycle influence of various parameters on system performance – use of p-h charts – numerical problems.

**Unit III: REFRIGERANTS** **9 Hours**

Desirable properties – classification - refrigerants used – nomenclature – ozone depletion –global warming
**VCR SYSTEM COMPONENTS-** Compressors – general classification – comparison – advantages and disadvantages. condensers – classification – working principles evaporators – classification – working principles expansion devices – types – working principles

**Unit IV: VAPOR ABSORPTION SYSTEM** **9 Hours**

Calculation of maximum COP – description and working of NH3 – water system and Li Br –water ( Two shell & Four shell) System, principle of operation three fluid absorption system, salient features.
**STEAM JET REFRIGERATION SYSTEM**: Working Principle and basic components. principle and operation of (i) thermoelectric refrigerator (ii) vortex tube.

**Unit V: INTRODUCTION TO AIR CONDITIONING** **9 Hours**

Psychometric properties & processes – characterization ofsensible and latent heat loads — need for ventilation, consideration of infiltration – load concepts of RSHF,GSHF- problems, concept of ESHF and ADP temperature. Requirements of human comfort and concept of effective temperature- comfort chart –comfort air conditioning –requirements of industrial air conditioning, air conditioning load calculations.
**AIR CONDITIONING SYSTEMS:** Classification of equipment, cooling, heating humidification and dehumidification, filters, grills and registers, fans and blowers. heat pump – heat sources – different heat pump circuits.

**Text Books**

1. A Course in Refrigeration and Air conditioning , SC Arora & DomkundwarPublications 2016
2. Refrigeration and Air Conditioning / CP Arora / Tata MacGrawHill Publications-2017
3. Refrigeration and Air Conditioning, R.S.Khurmi , S.Chand Publications-2013

**Reference Books**

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age Publications-2017.
2. Principles of Refrigeration /Dossat / Pearson Education-2012
3. Basic Refrigeration and Air-Conditioning / Ananthanarayanan / TMH-2015

**Web References**

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://nptel.ac.in/courses/112/105/112105266/
3. https://nptel.ac.in/courses/101/104/101104063/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define COP of refrigeration.
2. Define Tonne of Refrigeration.
3. Sketch the P-h and T-s diagrams of sub-cooling?
4. Write short note on ozone layer depletion
5. Define Global warming

**L2: Understand**

1. What is the effect of sub cooling and super heating in vapor compression.
2. Distinguish between dry and wet compression?
3. What do you understand by effective room sensible heat factor?
4. List out the advantages and disadvantages of viscous filters over dry filters?
5. How do SHF and GSHF differ from one another?

**L3: Apply**

1. An air refrigeration system working on Bell-coleman cycle operates between 1 bar and 7 bar. The temperature maintained in the cooler is 130 C. The air leaving the compressor is cooled to 370 C. The compression follows the law pv1.3=C and the expansion follows the law pv1.35=C. Find (i) theoretical COP (ii) Mass flow rate of air required to manufacture ice at 00 C when water supplied at 300 C at a rate of 5 tons/day. Take latent heat of ice=335 kJ/kg.
2. An ice plant is working on a reversed Carnot cycle produces 15 tons of ice per day. The ice is formed at 00 C and water supplied is also at 00 C. The heat is rejected to atmosphere at 250C. The heat pump used to run the plant is coupled to a Carnot engine receives heat from a source at 2200 C and it rejects the heat to atmosphere. The fuel Calorific value, 44.5 MJ/kg is used for supplying the heat. Determine the following (i) power developed by the engine and (ii) fuel used/hr. Take enthalpy of fusion of ice=334.5 kJ/kg..
3. Explain the factors considered in selecting the refrigeration system for aircrafts.
4. Explain the working of Flooded evaporator with neat sketch. Specify the fields of their applications.
5. A window air conditioner is required for an office size 5 x 3 x 4 m high. The structure load is estimated to be 6000 kJ/h. There are 10 persons doing moderate work. There is no smoking. The ambient and inner conditions are Tdb=310 K, Ø=50% and Tdb=395 K and Twb=290 K, respectively. There are five 40 W tube lights. Obtain the capacity of the air conditioner.Find the enthalpy and entropy of a steam, When the pressure is 2 MPaand specificvolumeis0.09 $m^3$/kg.

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## PE 20ME008 Flexible Manufacturing Systems 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME302.1 | Apply to plan schedule and control of flexible manufacturing system. | L1, L2, L3 |
| 20ME302.2 | Understand the various system modeling techniques in association to flexible manicuring systems | L2 |
| 20ME302.3 | Compare the system modeling issues in terms of Manufacturing approach | L2 |
| 20ME302.4 | Apply the different performance analysis methods to manufacturing systems | L3 |
| 20ME302.5 | Apply the preventive measures in the mass production systems | L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Overview of Flexible Manufacturing Systems 9 Hours

Introduction: Definitions of manufacturing with input-output model, definition of system, basic problems concerning systems and system design procedure, modes of manufacturing – job/batch/flow and multi- product,
*Small batch manufacturing.*

### Unit II: System Modelling Issues 9 Hours

System modeling issues: Centralized versus distributed control; Real-time vs discrete event control; Forward vs. backward scheduling approaches with finite/infinite capacity loading; Modeling of absorbing states and deadlocks; Conflicts
*Concurrency, and synchronization.*

### Unit III: System Modelling Tools And Techniques 9 Hours

System Modeling Tools and Techniques: Introduction to mathematical modeling, optimization, and simulation; issues related with deterministic and stochastic models.
Continuous and discrete mathematical modeling methods -discrete event, monte carlo method; Basic concepts of Markov chains and processes; The M/M/1 and M/M/m queue; Models of manufacturing systems including transfer lines
*flexible manufacturing systems, introduction to Petri nets.*

### Unit IV: Performance Analysis 9 Hours

Performance Analysis: Transient analysis of manufacturing systems, analysis.
*Advanced Manufacturing systems*

### Unit V: Preventative Maintenance 9 Hours

Preventive maintenance, Karban system, implementation issues
*Various issues in maintenance*

### Text Books

1. N. K. Jha, "Hand Book of Flexible Manufacturing Systems", 1st Edition, Academic Press, 2013.
2. Talichi Ohno, "Production System beyond Large Scale Production", 1st Edition, Toyota Productivity Press India Pvt. Ltd, 2010.
3. H K Shivanand, "Flexible Manufacturing Systems", 1st Edition, New Age International, 2006.
4. P. Radha Krishnan, "CAD/ CAM/ CIM", 4th Edition, New Age International, 2016

### Reference Books

1. Farid Amirouche, "Principles of Computer-Aided Design and Manufacturing, 2nd Edition, New Age International, 2004.

### Web References

1. http://www.ignou.ac.in/upload/UNIT6-55.pdf
2. http://www.journals.elsevier.com/computer-aided-design
3. https://www.elsevier.com/books/surface-modeling-for-cad-cam/choi/978-0-444-88482-4

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. List the basic components of FMS.
2. Distinguish between continuous and discrete modeling techniques
3. What is scheduling?
4. Define FMS
5. What are the various system Modeling issues?
6. What is meant by job order production?
7. Identify Basic concepts of Markov chains
8. How the concept of system design procedures is useful in Production?
9. Identify the system modeling issues and control them.
10. Explain the concept of scheduling.

**L2: Understand**

11. Explain the basic concepts of FMS.
12. Describe the concept of system design procedures
13. Demonstrate the system modeling issues and control them.
14. Distinguish between continuous and discrete modeling techniques.
15. Design models of manufacturing systems.

**L3: Apply**

16. Apply the concept of system design procedures to different levels of Production.
17. Apply the concept of scheduling.
18. Understand and Apply system model techniques.
19. Illustrate the continuous and discrete modeling techniques.
20. Adapt the design models of manufacturing systems.

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**PE** **20ME009 Optimization Techniques** **3 0 0 3**

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME009.1 | Recognize classification of optimization problem and apply classical optimization techniques | L1,L2, L3 |
| 20ME009.2 | Apply unconstrained optimization techniques using various methods | L1,L2, L3 |
| 20ME009.3 | Recognize the characteristics and approaches of constrained optimization techniques | L1,L2, L3 |
| 20ME009.4 | Analyze optimized solutions using constrained and unconstrained geometric programming | L1,L2, L3 |
| 20ME009.5 | Perceive integer programming methods | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

**Unit I: Introduction to Optimization and Classical Optimization Techniques** **9 Hours**

Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.
Single variable optimization- multivariable optimization with equality constraints
*Multivariable optimization with inequality constraints.*

**Unit II: Unconstrained Optimization Techniques** **9 Hours**

Pattern search method- Rosen Brock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.
*Advance applications to unconstrained optimization techniques*

**Unit III: Constrained Optimization Techniques** **9 Hours**

Characteristics of constrained problem- methods of feasible directions - basic approach in the penalty function method- interior penalty function method.
*Convex programming problem- exterior penalty function method.*

**Unit IV: Geometric Programming** **9 Hours**

Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. Primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P).
*Complimentary geometric programming (C.G.P)*

**Unit V:Integer Programming** **9 Hours**

Graphical representation. Gomory's cutting plane method. Bala's algorithm for zero-one programming problem.
*Integer and non linear programming.*

**Text Books**

1. S.S.Rao,"Optimization Theory and Applications",3rdEdition, Wiley Eastern Limited, New Delhi, 1996
2. Kalyanmanai Deb, "Engineering Optimization", 8thEdition, Prentice Hall of India, New Delhi, 2005
3. C.Mohan& Kusum Deep, "Optimization Techniques-Theory and applications", 1st Edition, New Age International, 2013.

**Reference Books**

1. S.D.Sharma, "Operations Research", 6th Edition,MacMillan Publishers,2014.

**Web References**

1. https://nptel.ac.in/courses/111/105/111105039/
2. https://onlinecourses.nptel.ac.in/noc21_me10/preview

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write the typical applications of optimization in the field of mechanical engineering.
2. What are the various applications of optimization problems?
3. What are the differences between elimination and interpolation methods?
4. State the optimization problem. Explain various types of optimization problems with examples.
5. What are the limitations of integer programming?
6. State the Kuhn–Tucker conditions.

**L2: Understand**

1. Explain the computational procedure used in geometric programming..
2. Explain in detail the principle of optimality
3. Explain Kuhn-Tucker conditions applicable to non-linear programming problem.
4. Explain various types of optimization problems with examples.

**L3: Apply**

1. Use simplex method to solve the following LP problem minimize Z=5x+6y subject to the following constraints: 2x+5y≥1500; 3x+y≥ 1200 and x, y≥0.
2. Using Powel's method Minimize f(x) =x1-$x_2$ + 2$x_1^2$ +2$x_1x_2$ +$x^2$ from the starting point x1= (0,0)
3. Use dynamic programming technique to solve the following problem. Max Z = $X_1.X_2.X_3.X_4$ Subject to $X_1 + X_2 + X_3 + X_4 = 12$ , $X_1, X_2, X_3, X_4 \geq 0$
4. Find all the basic solutions corresponding to the system of equations:
   $2x_1 + 3x_2 - 2x_3 - 7x_4 = 1$
   $x_1 + x_2 + x_3 + 3x_4 = 6$
   $x_1 - x_2 + x_3 + 5x_4 = 4$

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**PE** **20ME010 Material Characterization** **3 0 0 3**

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME501.1 | Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials | L1,L2, L3 |
| 20ME501.2 | Choose and appropriate electron microscopy techniques to investigate microstructure of materials at high resolution | L1,L2, L3 |
| 20ME501.3 | Determine crystal structure of specimen and estimate its crystallite size and stress | L1,L2, L3 |
| 20ME501.4 | Use appropriate spectroscopic technique to measure vibrational / electronic transitions to estimate parameters like energy band gap, elemental concentration, etc. | L1,L2, L3 |
| 20ME501.5 | Apply thermal analysis techniques to determine thermal stability of and thermodynamic transitions of the specimen. | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Introduction and Optical microscope** **9 Hours**

Introduction: Need of materials characterization and available techniques. Optical Microscopy: Optical microscope - Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarised light, Hot stage, Interference techniques), Stereomicroscopy, Photomicroscopy,
*Colour metallography, Specimen preparation, Applications.*

**Unit II: Electron microscope** **9 Hours**

Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy,
*Wavelength dispersive spectroscopy.*

**Unit III: Diffraction method** **9 Hours**

Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques,
*Electron diffraction*

**Unit IV: Surface analysis and Spectroscopy** **9 Hours**

Atomic force microscopy, scanning tunneling microscopy, X-ray photoelectron spectroscopy, Atomic absorption spectroscopy, UV/Visible spectroscopy,
*Fourier transform infrared spectroscopy, Raman spectroscopy.*

**Unit V: Thermal Analysis** **9 Hours**

Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimeters, Thermo mechanical analysis and dilatometers
*Advanced Thermal Analysis and structures*

**Text Books**

1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008)
2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001)
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).

**Reference Books**

1. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993).
2. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).

**Web References**

1. https://nptel.ac.in/content/syllabus_pdf/115103030.pdf
2. https://www.aif.ncsu.edu/mct/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Briefly explain and Write about Optical microscope?
2. List the advantages and disadvantages of Scanning electron microscope?
3. Write about various diffraction methods?
4. Briefly explain surface analysis and various methods?
5. Write about spectroscope analysis?
6. Write short note on thermal anaysis?

**L2: Understand**

1. Explain about the Transmission electron Microscope?
2. What are the differences between spectroscope analysis and diffraction analysi?
3. With a neat sketch, explain the working principle of SEM
4. Explain the terms: variation of Differential Scanning calorimeters
5. Distinguish the various thermal analysis

**L3: Apply**

The most common type of SEM data is the secondary electron image. The SE image is a map of secondary electron emission as a function of spatial position. SE images generally display the topography of the sample. The number of secondary electrons emitted from a surface generally depends on the angle of incidence between the surface and the beam. Since the electron beam is perpendicular to the sample over the analysis area, the number of secondary electrons emitted from the sample is generally a function of the topography of the sample.

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## PE 20ME011 CAD/CAM 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME011.1 | Describe basic structure of CAD workstation, Memory types, input/output devices and display devices and computer graphics | L1 |
| 20ME011.2 | Acquire the knowledge of geometric modelling and Execute the steps required in CAD software for developing 2D and 3D models and perform transformations | L1 |
| 20ME011.3 | Explain fundamental and advanced features of CNC machines | L2 |
| 20ME011.4 | Illustrate Group Technology, CAQC and CIM concepts | L2 |
| 20ME011.5 | Ability to develop a product from conceptualization to reality. | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

**Unit I:** **9 Hours**

Computers in industrial manufacturing, product cycle, CAD / CAM Hardware, basic structure, CPU, memory types, input devices, display devices, hard copy devices, storage devices.
**COMPUTER GRAPHICS:** Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections.
*clipping, hidden surface removal.*

**Unit II:** **9 Hours**

**GEOMETRIC MODELING:** Requirements, geometric models, geometric construction models, curve representation methods, surface representation methods, modeling facilities desired.
**DRAFTING AND MODELING SYSTEMS:** Basic geometric commands, layers, display control commands, editing, dimensioning, solid modeling.
*Design and analysis of an modelling system*

**Unit III:** **9 Hours**

**PART PROGRAMMING FOR NC MACHINES:** NC, NC modes, NC elements, CNC machine tools, structure of CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming.Direct Numerical Control, Adaptive Control.
*Advanced numerical control system*

**Unit IV:** **9 Hours**

**GROUP TECHNOLOGY:** Part family, coding and classification, production flow analysis, types and advantages.Computer aided processes planning – importance, types.
**COMPUTER INTEGRATED MANUFACTURING SYSTEMS:** Types of manufacturing systems, machine tools and related equipment, material handling systems, material requrirement planning, computer control systems, human labor in manufacturing systems, CIMS benefits
*Advanced CIMS technology*

**Unit V:** **9 Hours**

**COMPUTER AIDED QUALITY CONTROL:** Terminology used in quality control, use of computers in Quality control. Inspection methods contact and noncontact types, computer aided testing, integration of CAQC with CAD/CAM.
*Advanced Computer aided quality control*

### Text Books

1. CAD / CAM / CAE E Zimmers & M.Groover/Pearson Education. 2000
2. Automation, Production systems & Computer integrated Manufacturing/ Groover/P.E,2001
3. CAD / CAM A Zimmers & P.Groover/PE/PHI, 2003
4. CAD / CAM Theory and Practice / Ibrahim Zeid / TMH,2004
5. CAD/CAM by P.N. Rao/TMH.2006

**Reference Books**


1. Automation, Production systems & Computer integrated Manufacturing/ Groover /P.E
2. CAD / CAM / CIM / Radhakrishnan and Subramanian / New Age
3. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
4. CAD/CAM: Concepts and Applications/Alavala/ PHI
5. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson.


**Web References**

1. https://www.brainkart.com/article/Product-cycle_5703/
2. https://www.designtechsys.com/articles/computer-geometric-modelling
3. https://shodhganga.inflibnet.ac.in/bitstream/10603/4512/16/16_chapter%206.pdf
4. https://www.data.org.uk/media/1180/main-applications-of-cad-cam.pdf
5. https://link.springer.com/chapter/10.1007/978-94-009-1063-8_57
6. https://www.revotechnologies.net/uploads/1/6/0/7/16078520/unit_iii-acim.pdf
7. https://www.brighthubengineering.com/cad-autocad-reviews-tips/64482-computer-aided-quality-control-or-caqc/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Define Bezier surface? Explain various characteristics of this surface.
2. In detail explain the salient features of solid modeling.
3. Differentiate Manual part programming and Computer assisted part programming.
4. Explain the concept of adaptive control of NC machines.
5. What is group technology? When is it suitable in manufacturing? What are its benefits.
6. Draw and explain the CAD/CAM product cycle.
7. What are the input devices more commonly employed for general graphics applications? Present their merits and demerits.
8. What is meant by sweep? Discuss in detail the various types of sweep techniques available for 3D geometric construction.

**L2: Understand**

1. What is CAPP? Explain the any one type of Capp with neat sketches.
2. Briefly explain some of the methods used in computer aided quality control.
3. Explain the integration of CAQC with CAD/CAM
4. Discuss the principle of material handling. Name and describe the five types of material handling devices?
5. Explain the different types of manufacturing systems.
6. Explain the difference between CNC and DNC along with neat sketches.
7. How do you overcome the difficulties in traditional process planning by adopting CAPP method?

**L3: Apply**

1. Discuss the role of human labor in manufacturing systems.
2. Explain the any one type of Non-contact inspection technique used in computer aided quality control system.
3. How do you overcome the difficulties in traditional process planning by adopting CAPP method?
4. Define computer aided quality control. Explain how it is implemented

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## PE 20ME012 Total Quality Management 3 0 0 3

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20ME302.1 | Relate the fundamental concepts of total quality management. | L2 |
| 20ME302.2 | Demonstrate the customer focus and satisfaction. | L2 |
| 20ME302.3 | Explain the organisation total quality management. | L2 |
| 20ME302.4 | Illustrate the cost of quality information. | L2 |
| 20ME302.5 | Interpret the international quality standards study and behaviour and its properties. | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Introduction: The concept of TQM, Quality and Business Performance, Attitude and Involvement of Top Management, Communication, Culture and Management Systems. Management of Process Quality: Definition of Quality, Quality Control, a Brief History, Product Inspection Vs Process Control, Statistical Quality Control.

*Control Charts and Acceptance Sampling.*

**Unit II: Customer Focus and Satisfaction** **9 Hours**

Customer Focus and Satisfaction: Process Vs Customer, Internal Customer Conflict, Quality Focus, Customer Satisfaction, Role of Marketing and Sales, Buyer – Supplier Relationships. Bench Marking: Evolution of Bench Marking, Meaning of Bench Marking, Benefits of Bench Marketing.

*Bench Marking Procedure, Pitfalls of Bench Marketing.*

**Unit III: Organizing for TQM** **9 Hours**

Organizing for TQM: The Systems Approach, Organizing for Quality Implementation, Making the Transition from a Traditional to a TQM Organization, Quality Circles, Seven Tools of TQM: Stratification, Check Sheet, Scatter Diagram, Ishikawa Diagram.

*Pareto Diagram, Kepner and Tregoe Methodology.*

**Unit IV: The Cost of Quality** **9 Hours**

Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.
*Stages of an quality control*

**Unit V: ISO9000** **9 Hours**

Universal Standards of Quality: ISO Around the World, The ISO9000 ANSI/ASQC Q-90, Series Standards, Benefits of ISO9000 Certification the Third Party Audit, Documentation ISO9000 and Services, the Cost of Certification Implementing the System.

*Stages of an ISO System*

**Text Books**

1. Total Quality Management / Joel E. Ross/Taylor and Franscis Limited/2000
2. Total Quality Management/P. N. Mukherjee/PHI/2001
3. Quality Management/Kanishka Bedi/Oxford University Press/2011
4. Total Engineering Quality Management/Sunil Sharma/Macmillan/2003

**Reference Books**

1. Total quality management /K.Shridhar bhat/ Himalaya Publishing house/2017
2. Total quality management /Dr.K.C.Arora/ S K Kataria and sons/ 2013.
3. Total Quality Management/ Nagarazan.RS,Arivalagar AA/New age International PVT LTD Publishers/2015

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is PDSA cycle?
2. What is inspection by variables?
3. Should the buyer-supplier relationship be based on trust or suspicion? Why?
4. What do you understand by delighting the customer?
5. Briefly point out the anatomy 'Quality circles'.
6. What is the purpose served by drawing fish-bone diagram?
7. Should quality be free? Why or why not?

**L2: Understand**

1. Draw a cause effect diagram for painting defects in your house.
2. What is the role of top management in organizing transition to TQM?
3. What are the objectives of ISO 9000?
4. Which are the four tiers of documentation in ISO 9000?

**L3: Apply**

1. 10 samples, each of size 50, of pipe were inspected in pressure testing. The results of the inspection are given below: Sample No. 1 2 3 4 5 6 7 8 9 10 No. of defectives 2 3 2 0 2 3 2 1 2 3 Draw a p-chart and state your conclusion.
2. Construct a Pareto diagram for the analysis of internal failures for the following data:

| S.No | Type of cost | Rupees in thousands Purchasing |
|---|---|---|
| 1 | Purchase --- Rejects | 200 |
| 2 | Design --scrap | 210 |
| 3 | Operations-rework | 321 |
| 4 | Purchasing -- rework | 21 |
| 5 | All Other | 65 |

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**OE** **20CEO01 Urban Environment and Health** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CEO01.1 | Identify urban – health relationships | | L1, L2 |
| 20CEO01.2 | Demonstrates the connection between urban built form and healthoutcomes | | L1, L2 |
| 20CEO01.3 | Discuss the distribution of health risks of urban transportation grid | | L1, L2 |
| 20CEO01.4 | Assess and plan for community needs in health-care infrastructure | | L1, L2 |
| 20CEO01.5 | Identify preliminary opportunities for advancing urban health outcomes | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Health and Planning** **9 Hours**

Introduction: The Historical Link, Dividing Health and Planning, Urban Health – Basic Conceptions in the Literature, Urban Form,Physical Activity.

*Health Promotion*

**Unit II: Built Urban Form and Health** **9 Hours**

Renewing the Health-Urban Link, the Urban Form, the Metropolitan Sprawl Index, Using Measured Urban Forms to Assess Health Effects, Environmental Factors and Physical Activity

*Alternatives to Metropolitan Sprawl Index*

**Unit III: Transportation Systems** **9 Hours**

Transport Planning, Private Motor Vehicles as Health Risks, Private Motor Vehicles and Obesity, Public Transport, Mixed-use Medium-density and Pedestrians Travel, Proximity and Individual Factors.

*Residential and Travel Preferences*

**Unit IV: Spatial Access to Health Services** **9 Hours**

Introduction, The Concept of Access, Dimensions of Spatial Access, Primary Care Supply and Access, Spatial Access and Travel Behavior, Access andMortality.

*Access to health care Aligned with Transport*

**Unit V: Challenges and Opportunities** **9 Hours**

Introduction, Challenges, Conceptual Frameworks, Investigative Methods and Data Collection, Limited Policy Capacity, Fragmented Initiatives, Opportunities, Interdisciplinary Engagement, Major Conceptual Programs, Priorities for future Research.

*Promotion of physical activity in daily routines*

**Text Books**

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 3rd Edition, University Grants Commission, 2021
2. George Luber and Jay Lemery, "Global Climate Change and Human Health", 1st Edition Jossey-Bass, 2015

**Reference Books**

1. Pataki, Diane E., et al. "Coupling biogeochemical cycles in urban environments: ecosystem services, green solutions, andmisconceptions" Frontiers in Ecology and the Environment, 2011
2. Frank, L., Engelke, P., and Schmid, T., "Health and Community Design: The Impact of The Built Environment on Physical Activity", Island Press, Washington, D.C., 2003
3. Eiichi Taniguchi, Tien Fang Fwa and Russell G Thompson, "Urban Transportation and Logistics", CRC Press, 2014

**Web References**

1. https://www.oecd.org/health/health-systems/32006565.pdf
2. https://www.pdfdrive.com/urban-environment-proceedings-of-the-10th-urban-environment-symposium-e157051203.html

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. How is natural environment different from urban environment?
2. How does the urban environment affect health and well-being?
3. How can urban areas improve health?

**L2: Understand**

1. Explain the most important problem related to health in urban area
2. Describe the differences between physical activity for transportation and physical activity for recreation
3. Consider a study that evaluates the health of people in two communities, one with sidewalks and one without. The studyauthors find that the rate of lung cancer is higher in the community without sidewalks, and conclude that sidewalks protect against lung cancer. What concerns would you have about accepting this conclusion?

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**OE** **20CSO01 Data Structures and Algorithms** **3 0 0 3.0**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CSO01.1 | Understand the advanced data structures and algorithms | - | L1, L2, L3 |
| 20CSO01.2 | Demonstrate through abstract properties of various data structures such as stacks, queues and lists to implement efficient programs using data structures. | - | L1, L2, L3 |
| 20CSO01.3 | Demonstrate through various searching & sorting techniques | - | L1, L2, L3 |
| 20CSO01.4 | Apply data structures and algorithms to solve real world problems. | - | L1, L2, L3 |
| 20CSO01.5 | Apply algorithm analysis techniques to evaluate the performance of an algorithm. | - | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction to Data Structures & Algorithms** **9 hours**

Introduction to Data Structure, Data Organization, Abstract Data Types, Elementary data types; Basic concepts of data Structures; performance measures for data structures, Time and Space Complexity. Introduction to Algorithms, Asymptotic notations and common functions. Algorithm Specifications: Performance Analysis and Measurement

*Efficiency of an Algorithm*

**Unit II: Arrays and Linked Lists** **9 hours**

Arrays- Definition, Different types of Arrays, Application of arrays, Sparse Matrices and their representations. Linked lists- Definition, Implementation of Singly Linked Lists, Doubly Linked List, Operations on a Linked List. Insertion, Deletion and Traversal. Stack-Basic Concept of Stack, Stack as an ADT and operations in stack. Queue-Basic Concept of Queue, Queue as an ADT and Operations in Queue

*Generalized Linked List, Applications of Stack and Queue*

**9 hours**

**Unit III: Trees and Graphs**

Trees- Basic concept of Binary tree, Operations in Binary Tree, Tree Height, Level and Depth, Binary Search Tree, Insertion, Deletion, Traversals, Search in BST, 2-4 trees. Graph-Matrix Representation Of Graphs, Elementary Graph operations(Breadth First Search, Depth First Search, Spanning Trees, Shortest path, Minimal spanning tree )

*Applications of Tress and Graph*

**Unit IV: Algorithm Design Techniques I** **9 hours**

Divide and Conquer-General method, Merge sort, Quick sort. Brute force- approach, bubble sort, Linear Search techniques.

*Preferences of Merge and quick sort techniques.*

**Unit V: Algorithm Design Techniques II** **9 hours**

Greedy Technique, General method, Knapsack problem, Job sequencing with deadlines, Minimal cost spanning tree algorithms (Prim's and Kruskal's), Dynamic Programming: General method, 0/1 knapsack problem, All pair shortest path algorithm

*Usages of Greedy algorithms.*

**Text Books**

1. Reema Thareja, "Data Structures Using C", Second Edition, Oxford, 2014
2. Horowitz, Sahni and Anderson Freed, "Fundamentals of Data Structures in C", Second Edition, 2008
3. Mark Allen Weis , "Data Structures and Algorithm Analysis in C", Second edition, Pearson, 1997

**Reference Books**

1. Salaria R.S., "Data Structures and Algorithms using C", Fifth Edition, Khanna Publishing, 2018
2. Richard F Gilberg, "Data Structures: A PseudoCode Approach With C++" Fifth edition, Thomson Press(India), 2004
3. Amitava Nag and Jyothi Prakash Singh, "Data Structures and Algorithms Using C", Second Edition, Vikas Publishing, 2009

**Web References**

1. https://www.springboard.com/library/software-engineering/data-structures-and-algorithms/
2. https://www.geeksforgeeks.org/data-structures/
3. https://www.programiz.com/dsa

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 20 |
| L2 | 40 | 40 |
| L3 | 20 | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Describe Data Structure and Algorithm
2. Illustrate some applications of stack
3. Describe about a Queue
4. List two applications of Data Structures

**L2: Understand**

1. Classify data structures
2. Explain about asymptotic notations
3. Differentiate Linked List, Stack and Queue
4. Explain about different sorting algorithms

**L3: Apply**

1. Implement the append method, which should add a new element onto the tail of the linked list
2. Implement stack using arrays and linked lists
3. Implement Queue using arrays and Linked Lists
4. Illustrate the importance of recursion

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**OE** **20AIO01 Machine Learning for Engineers** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIO01.1 | Describe different types of learning's | - | L1, L2 |
| 20AIO01.2 | Explain different supervised learning algorithms | | L1, L2 |
| 20AIO01.3 | Explain different unsupervised learning algorithms | | L1, L2 |
| 20AIO01.4 | Describe various types of machine learning models | | L1, L2 |
| 20AIO01.5 | Choose appropriate machine learning model and algorithm for given task | | L1, L2 |

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction to learning** **9 hours**

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – LinearSeparability – Linear Regression

*Examples of regression*

**Unit II: Linear Models** **9 hours**

Multi-layer Perceptron – Going Forwards – Going Backwards: Back Propagation Error – Multi-layer Perceptron in Practice –Examples of using the MLP – Overview – Deriving Back-Propagation – Radial Basis Functions and Splines – Concepts – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines

*Applications of perceptron*

**Unit III: Trees and Probabilistic Models** **9 hours**

Learning with Trees – Decision Trees – Constructing Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbour Methods – Unsupervised Learning – K means Algorithms – Vector Quantization

*Self-Organizing Feature Map*

**Unit IV: Dimensionality Reduction and Evolutionary Models** **9 hours**

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Geneticalgorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms

*Markov decision process*

**Unit V: Graphical Models** **9 hours**

Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Chain Monte Carlo – Graphical Models – Bayesian Networks – Markov Random Fields – Hidden Markov Models

*Tracking Methods*

**Text Books**

1. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", 2nd Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.
2. Tom M Mitchell, "Machine Learning", 1st Edition, McGraw Hill Education, 2013

**Reference Books**

1. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", 1st Edition, Cambridge University Press, 2012.
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", 1st Edition, Wiley, 2014

3. Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", 3rd Edition, MIT Press, 2014

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels L1: Remember**

1. Define Machine Learning.
2. List the types of Machine Learning.
3. State Bayes Theorem.
4. What is Regularization?

**L2: Understand**

1. Demonstrate Linear Regression.
2. Explain Back Propagation Algorithm.
3. Illustrate Decision Tree Induction process
4. Explain Genetic Operations with examples

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**OE 20DSO01 Introduction to Database Management Systems** 3 0 0 3

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

| Code | Course Outcomes | Mapping withPos | DoK |
|---|---|---|---|
| 20DSO01.1 | Describe the basic concepts of DBMS And different data models | - | L1,L2 |
| 20DSO01.2 | Apply Constrains on relations | | L2,L2,L3 |
| 20DSO01.3 | Apply SQL commands on relations | | L1,L3 |
| 20DSO01.4 | Understand PL/SQL operations | | L1,L2,L3 |
| 20DSO01.5 | Understand the principles of database normalization andTransaction management system. | | L1,L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create DoK: Depth of Knowledge

**Unit I: Introduction to Databases** **9 Hours**

Overview of Data Base Systems, Database System Applications, File System VS Database System, Data Abstraction, Levels of Abstraction, Data Independence Instances and Schemas, Different Data Models, Database Languages, Data Base Users and Administrator, Database System Structure, N-tier Architecture, Database design and ER diagrams, Design Entities, Attributes and Entity sets, Relationships and Relationship Sets, Advanced Features of ER Model

*History of DBMS*

**Unit II: Relational Model, Relational Algebra and Relational calculus** **9 Hours**

Relational Model: Introduction to the Relational Model, Integrity Constraint and key constraints over relations, Logical data base Design, Views, Destroying / Altering Tables and Views - Relational Algebra: Selection and Projection, Set Operations, Aggregate Operations, Renaming, Joins, Division, Additional Relational Algebraic operations - Relational calculus: Tuple Relational Calculus, Domain Relational Calculus

*Expressive Power of Algebra and Calculus*

**Unit III: Structured Query Language** **9 Hours**

SQL: Concept of different Database Languages over SQL - DDL, DML, DCL., Set operations, SQL Commands, Nested queries, Aggregate Functions, Null Value, Referential Integrity Constraints, views.

*Compare all Database Languages*

**Unit IV: Schema Refinement and Normalization** **9 Hours**

Understand PL/SQL block, components of PL/SQL block, Control statements and conditional statements in PL/SQL Embedded SQL, Triggers, Cursors,Stored procedures packages

*Compare all Normal Forms*

**Unit V: Normalization** **9 Hours**

Understand the principles for Relational Database Design, Functional Dependencies, Trivial and Nontrivial Dependencies, Closure Set of Functional Dependencies, Closure Set of Attributes. - Normalization: 1NF, 2NF, 3NF, BCNF, Lossless Join and Dependency Preserving decomposition, 4NF and 5N.

Transaction Concept, ACID Properties, States of Transaction, Implementation of Atomicity & Durability, Schedules,

*Concurrency Control without Locking*

**Text Books**

1. Abraham Silber Schatz, Henry F Korth, S Sudarshan, "Database System Concepts", 6th Edition, McGraw-Hill International Edition, 2013
2. Date CJ, Kannan A, Swamynathan S, "An Introduction to Database Systems", 8th Edition, PearsonEducation, 2006
3. Raghurama Krishnan, Johannes Gehrke, "Data base Management Systems", 3rd Edition, TATA McGraw Hill, 2008

**Reference Books**

1. Elmasri Navrate, "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2016
2. Peter Rob & Carlos Coronel, "Data base Systems design, Implementation, and Management", 10th Edition,Pearson Education, 2013

**Web References**

1. https://www.javatpoint.com/dbms-tutorial
2. https://www.geeksforgeeks.org/introduction-of-dbms-database-management-system-set-1/?ref=lbp

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 30 |
| L2 | 30 | 40 |
| L3 | 40 | 30 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. List types of database users
2. List out all types of data models present
3. Give syntaxes to Create and Alter a table
4. What is Redundancy?
5. List out the properties of transactions

**L2: Understand**

1. Compare the database system with conventional file system
2. Demonstrate the use of DISTINCT keyword in SQL select statement
3. Explain the following SQL constructs with examples:
   (1) Order by (2) group by and having (3) as select (4) schema
4. Explain the difference among Entity, Entity Type & Entity Set
5. Illustrate ACID properities

**L3: Apply**

1. Choose a relation R with 5 attributes ABCDE and the following FDs: A ->B, BC->E, and ED ->A. Is R in 3NF? Justify?
2. Apply Normalization technique for the following relation up to 3NF:
   Bank (acno, cust_name, ac_type, bal, int_rate, cust_city, branchId, branch_nm, br_city)
3. Construct a transaction state diagram and describe each state that a transaction goes through during its execution?
4. Demonstrate serializabulity concept

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**OE** **20ECO01 Architectures and Algorithms of IoT** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20ECO01.1 | Demonstrate the Architecture and applications of IoT | | L1, L2 |
| 20ECO01.2 | Explain the protocol concept and data bases of IoT | | L1, L2, L3 |
| 20ECO01.3 | Construct the IoT device design space and Platform design | - | L1, L2, L3 |
| 20ECO01.4 | Explain the IoT network model and Eventanalysis | | L1, L2, L3 |
| 20ECO01.5 | Demonstrate the Industrial Internet of Thingsand its Architecture | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: The IoT Landscape** **09 Hours**
What Is IoT?, Applications , Architectures , Wireless Networks, Devices, Security and Privacy , Event-Driven Systems.

*Ethernet*

**Unit II: IoT System Architectures** **09 Hours**
Introduction, Protocols Concepts, IoT-Oriented Protocols, Databases, Time Bases, Security.

*Message Queuing Telemetritransport (MQTT)*

**Unit III: IoT Devices** **09 Hours**
The IoT Device Design Space, Cost of Ownership and Power Consumption, Cost per Transistor and Chip Size, Duty Cycle andPower Consumption.

*Platform Design*

**Unit IV: Event-Driven System Analysis** **09 Hours**
IoT Network Model - Events, Networks, Devices and Hubs, Single-Hub Networks, Multi-hub Networks, Network Models andPhysical Networks, IoT Event Analysis - Event Populations, Stochastic Event Populations, Environmental Interaction Modeling.

*Event Transport and Migration*

**Unit V: Industrial Internet of Things** **09 Hours**
Introduction, Industrie 4.0, Industrial Internet of Things (IIoT), IioT Architecture, Basic Technologies, Applications and Challenges.

*Integrated IIoT*

**Textbooks**

1. Dimitrios Serpanos and Marilyn Wolf, "Internet-of-Things (IoT) Systems Architectures, Algorithms,Methodologies", Springer, Cham, 2018
2. Vijay Madisetti and Arshdeep Bahga, " Internet of Things (A Hands-on Approach)", Universities Press, 2015

**Reference Books**

1. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014
2. Olivier Hersent, David Boswarthick and Omar Elloumi, "The Internet of Things: Key Applications and Protocols", John Wiley and Sons Ltd., UK, 2012

**Web Resources**

1. https://books.google.co.in/books?isbn=1119969093
2. https://books.google.co.in/books?isbn=135123093X

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 30 |
| L2 | 35 | 35 |
| L3 | 35 | 35 |
| Total (%) | 100 | 100 |

Sample Short and Long Answer Questions of Various Cognitive Levels

**L1: Remember**

1. What is IoT?
2. List any three applications of IoT
3. Define protocol concept of IoT
4. Define data base
5. What is Duty cycle?

**L2: Understand**

1. Explain the Architecture of IoT
2. Explain the Security and privacy of IoT
3. Illustrate the Protocol Concept of IoT
4. Explain the Date bases of IoT
5. Demonstrate the IoT Device Design Space

**L3: Apply**

1. Identify the Wireless Networks for IoT
2. Model the Event-Driven Systems for IoT
3. Construct the IoT-Oriented Protocols
4. Construct the Platform Design for IoT

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Head of the Department
Mechanical Engineering
N.S. Raju Institute of Technology (A)
Visakhapatnam-530 041

**OE** **20EEO01 Introduction to Renewable Energy Sources** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20EEO01.1 | Understand the significance of solar energy | | L1, L2 |
| 20EEO01.2 | Provide the importance of Wind Energy | | L1, L2 |
| 20EEO01.3 | Understand the role of ocean energy in the Energy Generation | | L1, L2 |
| 20EEO01.4 | Explain the utilization of Biogas plants and geothermal energy | | L1, L2 |
| 20EEO01.5 | Explain the concept of energy Conservation | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

**Unit I: Solar Energy** **09 Hours**

Solar Radiation, Measurements of Solar Radiation, Flat Plate And Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals of Solar , Photo Voltaic Conversion, PV Characteristics Solar Cells, Solar PV Power Generation, Solar PV Applications.

*Thermal analysis of flat plate collectors*

**Unit II: Wind Energy** **09 Hours**

Wind Energy Estimation, Types of Wind Energy Systems, Performance, Site Selection, Wind Turbine Generator

*Betz Criteria*

**Unit III: Ocean Energy** **09 Hours**

Ocean Thermal Energy Conversion (OTEC), Principle of operation, development of OTEC plants, Tidal and wave energy, Potential and conversion techniques, mini-hydel power plants

*Open and closed OTEC Cycle*

**Unit IV: Bio Mass** **09 Hours**

Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gasdigesters, gas yield, combustion characteristics of bio-gas, utilization for cooking.

*I.C Engine Operation*

**Unit V: Geo Thermal Energy and Energy Conservation** **09 Hours**

Resources, types of wells, methods of harnessing the energy, scope in India. Principles of energy conservation, the different energy conservation appliances, cooking stoves, Benefits of improved cooking stoves over the traditional cooking stoves

*Hydro Thermal, Geo-pressured, Hot dry rocks*

**Text Books**


1. R K Gupta and S C Bhatia "Renewable Energy" Woodhead publishing India Pvt. Ltd.,2019
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", Second Edition, IEEE Press, Wiley,2013
3. Ranjan Rakesh, Kothari D. P.& Singal K. C., "Renewable Energy Sources And Emerging Technologies", 2 nd Edition, PHI, 2013
4. Mukund R. Patel, "Wind and Solar Power Systems – Design, Analysis and Operation", 2nd Edition, Taylor &Francis, 2006


**Reference Books**


1. S Sukhatme, J Nayak, "Solar Energy: Principles of Thermal Collection and Storage", 3rd Edition, Tata Mcgraw Hill , 2003.
2. Tiwari and Ghosal, "Renewable energy resources", 2nd edition, Narosa Publishing house, 2001
3. B H Khan, "Non conventional energy resources", 2 nd Edition, Tata Mcgraw Hill, 2001


**Web References**

1. https://nptel.ac.in/courses/121/106/121106014/
2. https://www.edx.org/learn/renewable-energy
3. https://www.coursera.org/learn/renewable-energy-resources-and-technologies

**Internal Assessment Pattern**

| CognitiveLevel | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 60 | 70 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What is meant by Solar Thermal Energy?
2. Give the classification of small hydro power stations.
3. What are the various losses occurring in the fuel cell?
4. List various Biomass resources.
5. What is the basic principle of Tidal Power?

**L2: Understand**

1. Explain in detail about flat plate collectors and give its advantage and disadvantages.
2. Explain the principle of working of a H2 - O2 fuel cell.
3. Explain about Dry, Wet and Hot water Geo thermal systems.
4. Compare between Geo thermal power plant and Conventional thermal power plant.
5. Explain about the site requirements to construct a Tidal Power Plant.

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**OE** **20MEO01 Nano Technology** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20MEO01.1 | *Describe* the fundamental science of nano materials | | L2 |
| 20MEO01.2 | Demonstrate the preparation of nano materials | | L1,L2 |
| 20MEO01.3 | Explain of the challenges on safe nano technology | - | L1,L2 |
| 20MEO01.4 | Develop knowledge in characteristic nano material | | L1,L2,L3 |
| 20MEO01.5 | Apply Nano science for industrial applications | | L1,L2,L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction** **09 Hours**

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nano structured materials- nano particles-quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties.

*Introduction to properties and motivation for study (qualitative only)*

**Unit II: General Methods Of Preparation** **09 Hours**

Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly,Vapour phase deposition, MOCVD, Sputtering, Evaporation.

*Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE*

**Unit III: Nano materials** **09 Hours**

Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)-methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications- Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays- functionalization and applications-Quantum wires.

*Quantum dots-preparation, properties and applications*

**Unit IV: Characterization Techniques** **09 Hours**

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy includinghigh-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA.

*SIMS-Nano-indentation*

**Unit V: Applications** **09 Hours**

NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)-Nanosensors, nano crystalline silver for bacterial inhibition.

*Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery*

**TEXT BOOKS:**

1. Edelstein A.S and Cammearata R.C, Eds., "Nanomaterials: Synthesis, Properties And Applications", Institute OfPhysics Publishing, Bristol And Philadelphia, 1996.
2. John Dinardo N, "Nanoscale Characterization Of Surfaces & Interfaces", 2nd Edition, Weinheim Cambridge, Wiley- VCH, 2000
3. Murthy B.S and Shankar P, " Nanoscience and NanoTechnology" , 1st Edition, Springer Publications,2013
4. Louis Hornyak and Tibbals H F, " Introduction to Nanoscience and NanoTechnology" , 1stEdition,Tailor Francis CRC Press,2008

**REFERENCE BOOKS:**

1. Timp G, "Nanotechnology", AIP press/Springer, 1999.
2. Akhlesh Lakhtakia, "The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations".Prentice-Hall of India (P) Ltd, New Delhi, 2007.

**Web references:**

1. http://www.nano.gov
2.http://mrsec.wisc.edu/edetc/IPSE/links.html
3.http://nptel.ac.in/courses/112105182/9
4.IOPSCIENCE—Nanotechnology

**Internal Assessment Pattern**

| CognitiveLevel | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 40 | 20 |
| L2 | 60 | 40 |
| L3 | | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What is Nano technology?
2. How does Nano Technology Works?
3. 3.What are Nano Materials?
4. Who is Developing Nano technology?

**L 2: Understand**

1. What Are Some Of The Most Interesting Nanoparticles Found In Nature (Not Manufactured In The Lab)?
2. Given The Nano-Size Of The Particles, Are There Any Effective Respirator Filters To Guard Against Inhalation?
3. What Do You Feel The Repercussions Are For Extended Life Through Utilization Of Nanotechnology?
4. What Is The Risk Of Not Developing Nanotech (In Health Care, Environmental Protection, And Economic Development)?

**L 3: Applying**

1. How are safety tests carried out in nano tech?
2. Seems that (nano)tech is moving fast. Is there a risk that results of safety testing will be out-of-date as soon as printed? How to keep up pace?
3. Discuss about targeted drug delivery using nanoparticles.

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**Visakhapatnam-531173**

**OE** **20SHO01 Women and Society** **0 0 3 0**

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CEO01.1 | This course aims to generate awareness on various factors that constructs and shapes gender identity and perpetuates gender discrimination. | | L1, L2 |
| 20CEO01.2 | This course aims to generate awareness on various factors that constructs and shapes gender identity and perpetuates gender discrimination. | | L1, L2 |
| 20CEO01.3 | The course will examine how feminist analysis & methodology redefines traditional categories and disciplinary concepts through its attention to gender as a social category | - | L1, L2 |
| 20CEO01.4 | The course further aims to sensitize students on emerging areas of gender discrimination and its possible resolution | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Objectives:** Total Hour: 40

This course aims to generate awareness on various factors that constructs and shapes gender identity and perpetuates gender discrimination.

**.UNIT -1 WOMEN AND SOCIETY** **9 Hours**

Understanding Sex- Gender, Gender shaping Institutions, Theories of Gender construction Understanding Sexism and Androcentrism, Understanding Patriarchy and Theories of Patriarchy, Private and Public dichotomy, Sexual Division of Work, Patriarchy practices in different institutions and Text Books.

**UNIT -2 FEMINIST THEORY** **9 Hours**

Rise of Feminism, Introduction to various stands of Feminism- Liberal Feminism, Radical Feminism, Marxist Feminism, Socialist Feminism, Cultural Feminism, Eco-Feminism, Post-Colonial Feminism, Post Modern Feminism. Waves of Feminism.

**UNIT -3 WOMEN'S MOVEMENT** **9 Hours**

The socio-economic conditions of women during the age of Industrial revolution the Call for Women's Rights 1848, Women's rights movement 1848-1920, Historical Developments of Social Reform Movements in India, Women's groups and organizations, Women's Movement Movements for Uniform Civil code and ShahBano case, Dalit women and the question of double marginality.

**UNIT -4 GENDER ROLES AND PSYCHOLOGY OF SEX** **9 Hours**

Difference Conceptualization of gender roles and gender role attitudes, Gender: Aggression, Achievement, Communication, Friendship and Romantic, Relationships Sex Differences in Mental Health Trauma relating to Rape, Taboo, Childhood Sexual Abuse, Domestic Violence, Sexual Harassment at Work Place, Educational Institutions, Eve Teasing etc.

**UNIT – 5 GENDER AND REPRESENTATION** **9 Hours**

Gender and Mass Media- Print Media, Gender and Mass Media-Electronic Media, Gender and

Films, Advertisements, Mega Serials, Stereotyping and breaking the norms of women's roles Women's Representation in
Literary Texts.

**Suggested reading:**

1. Basab iChakrabarti, Women's Studies: Various Aspects. UrbiPrakashani 2014
2. Arvind Narrain. Queer: Despised Sexuality Law and Social Change. Book for Change. 2005
3. Chandra Talpade Mohanty, Feminism without Borders: Decolonizing Theory, Practicing Solidarity. Duke University Press.
4. Flavia Agnes. Law and Gender Inequality: The Politics of Women's Rights in India. Oxford University Press, 2001
5. Sonia Bathla, Women, Democracy and the Media: Cultural and Political Representations in the Indian Press, Sage, New Delhi, 1998.

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**OE** **20CEO02 Ecology, Environment and Resource Management** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CEO02.1 | Discuss the role that humans play in affecting the characteristics ofthe environment | - | L1, L2 |
| 20CEO02.2 | Understand the interrelationships between land, sea, theatmosphere and the living things that occupy these environments | | L1, L2 |
| 20CEO02.3 | Distinguish between economic growth and economic developmentand outline the nature of a sustainable economy | | L1, L2 |
| 20CEO02.4 | Identify the environmental attributes to be considered for the EIAstudy | | L1, L2 |
| 20CEO02.5 | Develop a thorough understanding of Environmental Policies andlegislationspracticed in India | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Meaning, scope and evolution of ecology. Man, environment and ecosystem. Components of nature, Structure and Function, Flow of material, Ecological Succession, Tropic levels, Food chain, Food web, Ecological pyramids.

*Adaptation, Environmental Zones*

**Unit II: Ecosystem and its relevance to Environment** **9 Hours**

Resources and human settlements impact of advanced agricultural methods, Impact of urbanization and industrialization on nature. Urban ecosystem approach evolution and significance .Settlement planning.

*Energy Conservation*

**Unit III: Resource Management and Sustainable Development** **9 Hours**

Sustainable Development, Fundamentals concerning Environment and Sustainable Development, Economy, Poverty, Human Settlement Issues, Land Resources, Forests, Mountains, Agriculture, Biodiversity, Protection of Oceans, Industry and Business.

*Planning for environmentally sensitive areas*

**Unit IV: Environmental Impact Assessment** **9 Hours**

Meaning, Significance and framework. Methodologies, Checklist, Matrices, Network and social cost-benefit analysis. Sources andacquisition of environmental information. Environment impact studies of development projects.

*EIA Case Studies*

**Unit V: Environmental Policies and Legislations in India** **9 Hours**

Major environment policies and legislations in India - The Ministry of Environment & Forests, The Central Pollution Control Board. Policies to protect environment in India – Environment Protection Act, 1986, National Conservation Strategy and Policy Statementon Environment and Development, 1992, Policy Statement for the abatement of Pollution, 1992, National Environment Policy, 2006, Vision Statement on Environment and Health. Legislations and Rules for the protection of Environment in India.

*Five year plans in relation to environmental aspects*

**Text Books**

1. Erach Bharucha, "Textbook of Environmental Studies for Undergraduate Courses", 3rd Edition, University Grants Commission, 2021
2. Walter E. Westman, "Ecology, Impact Assessment and Environmental Planning", John Wiley & Sons, 1985
3. Chadwick A., "Introduction to Environmental Impact Assessment", Taylor & Francis, 2007

**Reference Books**

1. Charles H. Southwick D., "Ecology and the Quality of Our Environment", Van No strand Co New York, 1976
2. Barthwal, R.R., "Environmental Impact Assessment", New Age International, New Delhi, 2002

**Web References**

1. http://iced.cag.gov.in/?page_id=256
2. http://econdse.org/wp-content/uploads/2016/07/chapter-1-gupta.pdf
3. https://www.researchgate.net/publication/341521590_Chapter_5_Environmental_Polic y_in_India
4. https://www.preventionweb.net/files/15417_nationalenvironmentpolicyandstrateg.pdf

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What is Ecology?
2. List any three ways in which humans directly influence environmental conditions
3. What is the goal of sustainable development?
4. List the three sequential phases of EIA
5. Enlist any four principles of National Environmental Policy of India

**L2: Understand**

1. Explain the key principles of the ecosystem approach to conserving natural resources
2. Explain the impact of urbanization on nature
3. How does sustainable development make economic sense for society?
4. Discuss the importance of EIA activities for developing countries
5. Discuss the objectives and founding principles of India's National Environmental Policy

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**OE** **20CSO02 Designing the Internet of Things** **3 0 0 3.0**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20CSO02.1 | Illustrate the IoT in different contexts | | L1, L2 |
| 20CSO02.2 | Outline the Design Principles for Connected Devices | | L1, L2 |
| 20CSO02.3 | Explain the Internet Principles & Application Layer Protocols | - | L1, L2 |
| 20CSO02.4 | Apply the Prototyping concepts in IoT | | L1, L2 |
| 20CSO02.5 | Analyse the Prototyping Embedded Devices | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Overview of Internet of Things** **9 hours**

The flavour of the Internet of Things, The "Internet" of "Things", Technology of IoT, Enhanced Objects, Who is making theInternet of things.

*Applications of IoT*

**Unit II: : Design Principles for Connected Devices** **9 hours**

Calm & Ambient Technology, Magic as Metaphor, Privacy: Keeping secrets, Web Thinking for Connected Devices

*Examples of Connected Devices*

**Unit III: : Internet Principles** **9 hours**

Internet Communications-IP,TCP, The IP protocol suite(TCP/IP), UDP, IP Addresses-DNS, static IP Address assignment,Dynamic IP Address assignment, IPV6, MAC Addresses, TCP & UDP Ports, Application Layer Protocols

*HTTPS: Encrypted HTTP*

**Unit IV: Thinking About Prototyping** **9 hours**

Sketching, Familiarity, Costs versus Ease of prototyping, Prototypes & Production, Open Source versus Closed Source

*Embedded Platforms*

**Unit V: Prototyping Embedded Devices** **9 hours**

Electronics, Embedded Computing Basics, Arduino, Raspberry Pi, BeagleBone Black, Electric Imp

*Aurdino Components*

**Textbooks**

1. Adrian, McEwen & Hakim Casimally, "Designing The Internet of Things", John Wiley and Sons, 2014
2. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key Applications and Protocols", Wiley, 2019

**Reference Books**

1. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms", Morgan Kaufmann,2016
2. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, Mahendra Swain, "Internet Of things With Raspberry Pi And Arduino", CRC Press/Taylor & Francis Group, 2019

**Web Resources**

1. https://www.geeksforgeeks.org/introduction-to-internet-of-things-iot-set-1/
2. https://tutorialspoint.dev/computer-science/computer-network-tutorials/the-new-internet-internet-of- everything
3. https://www.javatpoint.com/iot-internet-of-things

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 20 |
| L2 | 30 | 40 |
| Total (%) | 100 | 100 |

**L1: Remembering**

1. Define IoT
2. What are the Enhanced objects for IoT?
3. What is a Prototype?
4. Define Sketching
5. Define DNS

**L2: Understanding**

1. Explain the following terms related to Protocols: UDP, TCP
2. Discuss in detail about MAC Addresses
3. Define Prototyping? Describe the Embedded Computing Basics
4. Explain Application Layer Protocols
5. Discuss the Costs versus Ease of prototyping

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**OE** **20AIO02 Fundamentals of Deep Learning** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIO02.1 | Describe the fundamental concept of artificial neural networks | - | L1, L2 |
| 20AIO02.2 | Describe the function of different deep neural networks | | L1, L2 |
| 20AIO02.3 | Explain different deep learning algorithms | | L1, L2 |
| 20AIO02.4 | Describe the functioning of convolution and recurrent neural networks | | L1, L2 |
| 20AIO02.5 | Choose appropriate deep neural network for given application | | L1, L2 |

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit 1: Introduction to Deep Learning** **9 hours**

Basics: Biological Neuron, Idea of computational units, McCulloch– Pitts unit and Thresholding logic, Linear Perceptron, Perceptron Learning Algorithm, Linear separability. Convergence theorem for Perceptron Learning Algorithm.

*Logic gates with perceptron*

**Unit 2: Feedforward Networks** **9 hours**

Feedforward Networks: Multilayer Perceptron, Gradient Descent, Backpropagation, Empirical Risk Minimization – Regularization, autoencoders

*Applications of multilayer perceptron*

**Unit 3: Convolution Networks** **9 hours**

Convolutional Networks: The Convolution Operation - Variants of the Basic Convolution Function - Structured Outputs – Data Types - Efficient Convolution Algorithms - Random or Unsupervised Features- LeNet, AlexNet

*Applications of CNN*

**Unit 4: Recurrent Neural Networks** **9 hours**

Recurrent Neural Networks: Bidirectional RNNs - Deep Recurrent Networks Recursive Neural Networks –The Long Short-Term Memory

*Applications of RNN*

**Unit 5: Applications of Deep Neural Networks** **9 hours**

Applications: Large-Scale Deep Learning - Computer - Speech Recognition - Natural Language Processing

*Healthcare applications*

**Text Books**

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, UK, 2017
2. Antonio Gulli and Sujit Pal, "Deep Learning with Keras ", Packt Publishing Ltd, Birmingham, UK, 2017

**Reference Books**

1. Deng & Yu, "Deep Learning: Methods and Applications", Now Publishers, 2013.
2. Michael Nielsen, Neural Networks and Deep Learning, Determination Press, 2015.

**Web References**

1. https://www.coursera.org/specializations/deep-learning

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels L1: Remember**

1. List any 4 benefits of artificial neural networks
2. List any 4 features of ANN
3. What are deep neural networks?
4. Define supervised and unsupervised learning
5. Define generalization

**L2: Understand**

1. Explain the design parameters of deep neural networks
2. Describe the dimensionality reduction techniques
3. Explain backpropagation algorithm
4. Describe any 2 applications of deep networks for image processing
5. Write about any 5 applications of deep networks

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**OE** **20DSO02Introduction to Data Science** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20DSO02.1 | Understand Fundamentals of Data Science Terminology. | | L1, L2 |
| 20DSO02.2 | Demonstrate different computing tools involved in data handling. | | L1, L2 |
| 20DSO02.3 | Understand Knime Tool. | - | L1, L2 |
| 20DSO02.4 | Understand Machine Learning Concepts | | L1, L2 |
| 20DSO02.5 | Apply domain expertise to solve real world problems using data science | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction to Data Science** **9 Hours**

Analysing the Pieces of the Data Science Puzzle, Exploring the Data Science Solution Alternatives, Defining Big Data by the ThreeVs, Grasping the Difference between Data Science and Data Engineering, Making Sense of Data in Hadoop, Identifying Alternative Big Data Solutions, Converting Raw Data into Actionable Insights with Data Analytics, Distinguishing between Business Intelligence and Data Science, Defining Business-Centric Data Science

*Identifying Data Science Users; Data Engineering in Action: A Case Study*

**Unit II: Computing for Data Science - 1** **9 Hours**

Using Python for Data Science, Using Open Source R for Data Science.

*Sorting Out the Python Data Types; R's Basic Vocabulary*

**Unit III: Computing for Data Science - 2** **9 Hours**

Using SQL in Data Science, Doing Data Science with Excel and Knime

*Basic SQL Commands; Knime Basics*

**Unit IV Machine Learning, Probability and Statistical Modelling** **9 Hours**

Defining Machine Learning and Its Processes, Considering Learning Styles, Seeing What You Can Do, Exploring Probability and Inferential Statistic, Quantifying Correlation, Reducing Data Dimensionality with Linear Algebra, Modeling Decisions with Multi-Criteria Decision Making, Introducing Regression Methods

*Linear Regression*

**Unit V Applying Domain Expertise to Solve Real-World Problems Using Data Science** **9 Hours**

Data Science in Journalism,Delving into Environmental Data Science, Data Science for Driving Growth in E-Commerce, Using Data Science to Describe and Predict Criminal Activity

*Applying statistical modeling to natural resources in the raw; Deploying web analytics to drive growthh*

**Text Books**

1. Lillian Pierson and Jake Porway,"Data Science For Dummies", 2nd Edition,For Dummies, 2017

**Reference Books**

1. Joel Grus, "Data Science from Scratch", 2nd Edition, O'Reilly Media, 2015
2. Chirag Shah, "A Hands-On Introduction to Data Science", Cambridge University Press, 2020

**Web Resources**

1. https://www.simplilearn.com/tutorials/data-science-tutorial/
2. https://www.w3schools.com/datascience/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What is data science? Identify three areas or domains in which data science is being used
2. Give three examples of structured data formats
3. Name three measures of centrality and describe how they differ
4. What is supervised learning? Give two examples of data problems where you would use Supervised learning

**L2: Understand**

1. How do data analysis and data analytics differ?
2. Relate likelihood of a model given data, and probability of data given a model. Are these two the same? Different? How?

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**OE** **20ECO02 IoT for Smart Grids** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20ECO02.1 | Demonstrate the Smart Grid concept ,Need for smart grid | | L1, L2 |
| 20ECO02.2 | Explain the Energy Management system functions | | L1, L2, L3 |
| 20ECO02.3 | Describe how modern power distribution system functions | | L1, L2 |
| 20ECO02.4 | Explain the Advanced metering infrastructureand AMI protocols | | L1, L2, L3 |
| 20ECO02.5 | Identify suitable communication networks forSmart Grid applications | | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction to Smart Grid** **09 Hours**

Introduction - Evolution of Electric Grid, Smart Grid Concept - Definitions and Need for Smart Grid – Functions – Opportunities – Benefits and challenges, Difference between conventional & Smart Grid.

*Technology Drivers*

**Unit II: Energy Management System** **09 Hours**

Energy Management System (EMS) - Smart substations - Substation Automation – Feeder Automation, SCADA – Remote Terminal Unit – Intelligent Electronic Devices – Protocols, Phasor Measurement Unit – Wide area monitoring protection and control, Smart integration of energy resources – Renewable, intermittent power sources.

*Energy Storage*

**Unit III: Distribution Management System** **09 Hours**

Distribution Management System (DMS) – Volt / VAR control – Fault Detection, Isolation and Service Restoration, Outage management System, Customer Information System, Geographical Information System, Effect of Plug in Hybrid Electric Vehicles.

*Network Reconfiguration*

**Unit IV: Smart Meters** **09 Hours**

Introduction to Smart Meters – Advanced Metering infrastructure (AMI), AMI protocols – Standards and initiatives, Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing.

*Peak Time Pricing*

**Unit V: Communication Networks & IoT** **09 Hours**

Elements of communication and networking – architectures, standards, PLC, Zigbee, GSM, BPL, Local Area Network (LAN) - House Area Network (HAN) - Wide Area Network (WAN) – Broadband over Power line (BPL) - IP based Protocols - Basics of Web Service and CLOUD Computing.

*Cyber Security for Smart Grid*

**Textbooks**

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions", CRC Press, 2012
2. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu and Akihiko Yokoyama, "Smart Grid:Technology and Applications", Wiley, 2012

**Reference Books**

1. Mini S. Thomas and John D McDonald, "Power System SCADA and Smart Grids", CRC Press, 2015
2. Kenneth C. Budka, Jayant G. Deshpande and Marina Thottan, "Communication Networks for Smart Grids",Springer, 2014

**Web Resources**

1. https://books.google.co.in/books?isbn=1119969093
2. https://books.google.co.in/books?isbn=135123093X

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 30 |
| L2 | 35 | 35 |
| L3 | 35 | 35 |
| Total (%) | 100 | 100 |

Sample Short and Long Answer Questions of Various Cognitive Levels

**L1: Remember**

1. Define a Smart grid
2. List any three Benefits of Smart grid
3. What is SCADA?
4. List any three Intelligent Electronic Devices
5. Define a Fault Detection

**L2: Understand**

1. Explain the need of Smart Grid
2. Demonstrate the Smart Grid Concept
3. Explain the Energy Management System (EMS)
4. Classify and explain the Smart integration of energy resources
5. Illustrate Effect of Plug in Hybrid Electric Vehicles

**L3: Apply**

1. Identify the Outage management System
2. How to utilize the Distribution Management System (DMS)? explain

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**OE** **20EEO02 Electrical Safety and Management** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20EEO02.1 | Understand the Indian electricity rules and their significance | | L1, L2 |
| 20EEO02.2 | Explain the safety standard in residential, commercial, and agricultural | | L1, L2 |
| 20EEO02.3 | Learn about electrical safety installation, testing and commission | - | L1, L2 |
| 20EEO02.4 | Understand about electrical safety in distribution system | | L1, L2 |
| 20EEO02.5 | Explain flash-overs and corona discharge | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

**Unit I: Indian Electricity Regulations and Acts and their Significance** **09 Hours**

Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage – earthing of system neutral – Rules regarding first aid and fire fighting facility.

*The Electricity Act2003 (Part 1,2,3,4 & 5) and Control Authority Safety Regulations*

**Unit II: Electrical Safety in Residential, Commercial and Agriculture Installations** **09 Hours**

Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

*System grounding and Equipment grounding*

**Unit III: Safety During Installation, Testing and Commissioning, Operation and Maintenance** **09 Hours**

Preliminary preparations – safe sequence – risk of plant and equipment –safety documentation – field quality and safety - personal protective equipment – safety clearance notice – safety precautions – safeguards for operators – safety

*Magnetic Hot sticks, protective clothing and industrial clothing*

**Unit IV: Electrical Safety in Hazardous Areas** **09 Hours**

Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipments for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours.

*Hazards associated with currents and voltages*

**Unit V: Electrical Safety Shocks and their Prevention** **09 Hours**

Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

*Objectives of Safety and Security Measures*

**Text Books**

1. Rao, S. and Saluja, H.L., "Electrical Safety, Fire Safety Engineering and Safety Management", Khanna Publishers, 1988.
2. Pradeep Chaturvedi, "Energy Management Policy, Planning and Utilization", Concept Publishing Company,1997
3. John M Madden, "Electrical Safety and Law, Planning and Utilization", 5th Edition, Routledge, 2017

**Reference Books**

1. Nagrath, I.J. and Kothari, D.P., "Power System Engineering", Tata McGraw Hill, 1998.
2. Martha J Boss and Gayle Nicoll, "Electrical Safety", 1st Edition, CRC Press, 2014
3. Gupta, B.R., "Electrical Safety", 1st Edition, American Technical Publishers, 2018

**Web References**

1. https://nptel.ac.in/courses/108/104/108104087/
2. https://ocw.mit.edu/courses/physics/8-311-electromagnetic-theory-spring-2004/syllabus/
3. https://www.edx.org/course/electricity-and-magnetism-maxwells-equations

**Internal Assessment Pattern**

| CognitiveLevel | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 30 | 40 |
| L2 | 70 | 60 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. Give the classification of electrical installations.
2. State the disadvantages of low power factor.
3. What is safety documentation system?
4. State preliminary preparations before commencing the installation.

**L2: Understand**

1. Write the objectives and scope of Indian Electricity Act and Indian Electricity Rule.
2. Explain the importance of earthing system neutral.
3. Write a note on Do's and Don't for safety in the use of domestic electrical appliances.
4. Explain the classification of equipment/enclosure for hazardous locations.

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Board of Studies (EEE)

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Mechanical Engineering
N.S. Raju Institute of Technology (A)
Visakhapatnam-[illegible]

**OE** **20MEO02 Fundamentals of Automobile Engineering** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20ME302.1 | Introduction to fundamentals of automobiles, lubrication, Tires and safety. | | L1, L2 |
| 20ME302.2 | Classify and identify the steering system | | L2, L3 |
| 20ME302.3 | Classify and identify the Transmission system | - | L2, L3 |
| 20ME302.4 | Define and compare the suspension, breaking and electrical system. | | L2,L4 |
| 20ME302.5 | Identify and Interpret the specifications and safety precautions.. | | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

**Unit I: Introduction** **09 Hours**

Componentsoffourwheelerautomobile–chassisandbody–powerunit–typesofautomobileengines,engineconstruction, turbo charging and super charging – engine lubrication, splash and pressure lubrication systems, oil filters, oil pumps–crank case ventilation–. Types – wheels and tyres. Safety Introduction, safety systems-seat belt, airbags, bumper, anti lock brake system(ABS),windshield, suspension sensors, traction control, mirrors, central locking and electric.

*windows, speed control.*

**Unit II: TRANSMISSION SYSTEM** **09 Hours**

Power transmission–rear wheel drive, front wheeldrive,4wheeldrive Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, construct mesh, synchromesh gear boxes, epicyclic gear box, over drive torque converter. propeller shaft – Hotch – Kiss drive.

*Torque tube drive, universal joint, differential rear axles.*

**Unit III: STEERING SYSTEM** **09 Hours**

Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism ,steering gears, –types *steeringlinkages.*

**Unit IV: SUSPENSION, BREAKING AND ELECTRICAL SYSTEM** **09 Hours**

SUSPENSION SYSTEM: Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber,Independent suspension system.
BRAKINGSYSTEM:Mechanicalbrakesystem,hydraulicbrakesystem,mastercylinder,wheelcylindertandemmastercylinderrequire ment of brake fluid
ELECTRICAL SYSTEM: Charging circuit, generator, current – voltage regulator – starting system, bendixdrivemechanismsolenoidswitch,lightingsystems,horn,wiper,fuelgauge–oilpressuregauge,enginetemperatureindicatoretc.

*pneumaticandvacuumbrakes.*

**Unit V: ENGINESPECIFICATION AND MAINTENANCE** **09 Hours**

Introduction-engine specifications with regard to power, speed, torque, no.of cylinders and arrangement, lubrication and cooling etc. engine service, reboring, decarburization ,Nitriding of crankshaft. service details of engine cylinder head, valves and valve mechanism, piston-connecting rod assembly, cylinder block, crank shaft and main bearings, engine reassembly-precautions.Types of pollutants, mechanism of formation, concentrationmeasurement,methodsofcontrolling-enginemodification,exhaustgastreatment-thermalandcatalyticconverters-useof alternative fuels for emission control

*NationalandInternationalpollutionstandards.*

**Text Books**

1. AutomotiveMechanics–Vol.1&Vol.2/KirpalSingh/standardpublishers
2. AutomobileEngineering/WilliamCrouse/TMHDistributors
3. AutomobileEngineering/P.SGill/S.K.Kataria&Sons/NewDelhi.
4. AutomobileEngineering/CSrinivasan/McGrawHill

**Reference Books**

1. Automotive EnginesTheoryandServicing/JamesD.HaldermanandChaseD.MitchellJr.,/Pearso neducationinc.
2. Automotive Engineering/KNewton,W.Steeds&TKGarrett/SAE
3. Automotive Mechanics: PrinciplesandPractices/ JosephHeitner/VanNostrandReinhold

**Web References**

1. https://nptel.ac.in/noc

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L2 | 40 | 30 |
| L3 | 40 | 30 |
| L4 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. What are the differences between two and four stroke engines.
2. Define the Octane number & Cetane number
3. Explain the significance of governor in automobiles?
4. What is an automotive differential and how does it work?
5. Why are car steering wheels round?
6. Why entropy decreases with the increase in temperature?

**L2: Understand**

1. Describe the Atkinson cycle..
2. Explain the flywheel with neat sketch.
3. What is an injector pressure in heavy vehicles? Why it is used?
4. Discuss the service the piston – connecting rod assembly with neat sketch.
5. Discuss the magneto ignition.
6. What is 3-way converter?

**L3: Classify**

1. .Name the different cooling methods with neat sketches.
2. Describe with P-V diagrams the two used cycles for internal combustion engines.

**L4: Interpret**

1. In a 4-stroke, 4-stroke cylinder diesel engine running 5000 r.p.m., how many times the fuel will be injected per second.
2. Name the car with engine having 4-valves and 5- valves per cylinder.gas at a pressure of 1.5Mpa ,the gas expands according to the process. Which represented by a straight line on a pressure volume. The final pressure is 0.15MPa. Calculate the work done on a gas by the piston

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## HO 20MEH01 Advanced Thermodynamics 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH01.1 | Describe the non-reactive mixture properties. | L1,L2 |
| 20MEH01.2 | Compare vapour and Gas power cycles | L2 |
| 20MEH01.3 | Explain importance of Direct Energy Conversion of Fuel Cells | L2 |
| 20MEH01.4 | Apply concept of thermodynamic laws | L3 |
| 20MEH01.5 | Interpret chemical reaction and combustion of gas- mixtures | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Review of Thermodynamic Laws & Corollaries:** **12 Hours**

Transient flow analysis, Second law thermodynamics, Entropy, Availability and unavailability, Thermodynamic potential. Maxwell relations, Specific heat relations, Mayer's relation.

*Evaluation of thermodynamic properties of working substance.*

**Unit II: P.V.T Surface:** **12 Hours**

Equation of state. Real gas behavior, Vander Waal's equation, Generalization compressibility factor. Energy properties of real gases. Vapour pressure, Clausius, Clapeyron equation. Throttling, Joule. Thompson coefficient. Non reactive mixtures of perfect gases. Governing laws, Evaluation of properties, Psychometric mixture properties and psychometric chart, Air-conditioning processes.

*Cooling towers. Real gas mixture.*

**Unit III: Combustion:** **12 Hours**

Combustion Reactions, Enthalpy of formation. Entropy of formation, Reference levels of tables. Energy of formation, Heat reaction, Adiabatic flame temperature generated product, Enthalpies, Equilibrium. Chemical equilibrium of ideal gasses, Effect of non reactinggasesequilibriuminmultiplereactions,TheventHoff'sequation.

*The chemical potential and phase equilibrium. The Gibbs phase rule.*

**Unit IV: Power Cycles:** **12 Hours**

Review binary vapour cycle, cogeneration and combined cycles, Second law analysts of cycles Refrigeration cycles. Thermodynamics off irreversible processes. Introduction, Phenomenological laws, On saga Reciprocity relation, Applicability of the Phenomenological relations, Heat flux and entropy production,

*Thermodynamic phenomena, Thermo electric circuits.*

**Unit V: Direct Energy Conversion Introduction** **12 Hours**

Fuel cells, Thermo electric energy, Thermo ionic power generation, Thermodynamic devices magneto hydrodynamic generations, and Photovoltaic cells.

*Applications of an direct energy conversion*

**Text Books**

1. Nag.P.K-EngineeringThermodynamics,6thEdition,McGrawHill- 2013
2. Sonntag,Borgnakke,VanWylen,FundamentalsofThermodynamics–6thEdition,Wiley-2015
3. YunusACenegel,MichaelABoles,Thermodynamics,anEngineeringApproach,8thEdition-MCH- 2014
4. Dr.J.P.HolmanThermodynamics–,McGrawHill-6thEdition,McGrawHill- 2013

**Reference Books**

1. PrasannaKumar, Thermodynamics,PearsonPublishers- 6thEdition,McGrawHill- 2011
2. Jones&Dugan, EngineeringThermodynamics–PHI- 6thEdition,McGrawHill- 2012.
3. Dr.Y.V.C.Rao-An Introduction to Thermodynamics– Universities presses publications- 2012.
4. W.Z.Black&J.G.Hartley, Thermodynamics, 3rd Edition- Pearson Publications- 2010.

**Web References**

1. https://nptel.ac.in/courses/112/105/112105123/
2. https://nptel.ac.in/courses/112/105/112105266/
3. https://nptel.ac.in/courses/101/104/101104063/

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Whatarethetypesofthermodynamicsystems?
2. Definequasi-staticprocess.
3. Whatissecondlawofthermodynamics?
4. Listtheentropycategorieswithrespecttothermodynamicrelations.
5. Write theenthalpyfunctionsofthermodynamicsproperties.
6. Whatareavailabilityandirreversibility?
7. DefineCarnot'stheorem.
8. Describethetriplepointandcriticalpoint.
9. Whatis idealgas?
10. Definedrybulbtemperatureand wetbulbtemperature.

**L2: Understand**

1. Describetheconceptofthermometryanditsreferencepoints
2. Whatarethedifferencesbetweenpointfunctionandpathfunction?
3. Describethecorollariesoffirstlawofthermodynamics
4. DemonstrateKelvinPlanckandClausiusstatement withexample
5. Whatdomeanbythetermsrelativehumidityandspecifichumidity?

**L3: Apply**

1. A pump discharges a liquid into a drum of rate of the 0.032 $m^3$ /sec .Thedrum constitute the diameter of 1.5m and 4.2 in length, which can hold 3000kg of theliquid. Find the density of the liquid at the mass flow rate of the liquid handled by thepump.
2. IllustrateFirstlawappliedtoaflowsystem.
3. An engine cylinder has a piston of area 0.12sq.m and contains gas at a pressure of1.5Mpa,thegasexpandsaccordingtotheprocessWhichrepresentedbyastraight lineon a pressure volume. The final pressure is 0.15MPa. Calculate the work done on a gasbythepiston.
4. DesignP-V-TsurfacesandT-S,h-s diagrams.
5. Find the enthalpy and entropy of a steam, When the pressure is 2 MPaand specificvolumeis0.09 $m^3$ /kg

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## HO 20MEH02 Advanced Heat Transfer 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH02.1 | Develop heat conduction equation for various conditions and able to solve 1D and 2D problems | L1,L2,L3 |
| 20MEH02.2 | Apply the conservation equations on forced convection | L1,L2,L3 |
| 20MEH02.3 | Compare the effect of various parameters on the convective heat transfer | L1,L2,L3 |
| 20MEH02.4 | Estimate the effect of various geometries on free convection and Explain the phenomenon of boiling and condensation | L1,L2,L3 |
| 20MEH02.5 | Compute the heat transfer rate through radiation and Discuss the phenomenon of convective mass transfer. | L1,L2,L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction** **12 Hours**

Brief Introduction To Different Modes Of Heat Transfer: Conduction: General heat Conduction equation, initial and boundary conditions. Transient Heat Conduction: Lumped system analysis, Heisler charts, semi infinite solid,use of shape factors in conduction,2D transient heat conduction,

*product solutions*

**Unit II: Finite Difference Methods For Conduction & Convection** **12 Hours**

**Finite Difference Methods For Conduction:** ID & 2D steady state and simple transient heat conduction problems, implicit and explicit methods. Forced Convection: Equations of fluid flow, concepts of continuity, momentum equations, derivation of energy equation, methods to determine heat transfer coefficient: Analytical methods, dimensional analysis and concept of exact solution.

*Approximate method, integral analysis.*

**Unit III: External & Internal Flows** **12 Hours**

**External Flows:** Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.

**Internal Flows:** Fully developed flow: Integral analysis for laminar heat transfer coefficient,types of flow, constant wall temperature and constant heat flux boundary conditions, hydrodynamic &thermal entry lengths;

*Use of empirical correlations.*

**Unit IV: Free & Forced Convection** **12 Hours**

**Free Convection:** Approximate analysis on laminar free convective heat transfer, boussinesque approximation ,different geometries, combined free and forced convection.

**Boiling and Condensation:** Boiling curve, correlations, Nusselts theory of film condensation on a vertical plate, assumptions & correlations of film condensation for different geometries.

*Heat Exchangers Types of Heat Exchangers, LMTD and NTU methods*

**Unit V: Radiation Heat Transfer** **12 Hours**

**Radiation Heat Transfer:** Radiant heat exchange in grey, non, grey bodies, with transmitting, Reflecting and absorbing media, specular surfaces, gas radiation, from flames.

**Mass Transfer:** Concepts of mass transfer, diffusion & convective mass transfer analogies.

*Significance of non- dimensional numbers.*

### Text Books

1. R.C.Sachdeva, "Fundamentals of Engg. Heat and Mass Transfer",5thEdition, New Age International Publications, 2013
2. P.K.Nag "Heat Transfer", 3rd Edition, TMH, 2015
3. R.K. Rajput, "Heat and Mass Transfer",RevisedEdition, S.Chand Publications, 2014

### Reference Books

1. F.P.Incropera, D.P.Dewitt, T.L.Bergman, A.S.Lavine, K.S. Seetharamu, T.R.Seetharam, "Fundamentals of Heat and Mass Transfer", Wiley India, 1st Edition, McGraw Hill, 2013.
2. Frank Kreith, R. M. Manglik & M. S. Bohn, "Principles of Heat Transfer" , Special Edition, Cengage learning publishers, 2012.
3. D.S .Kumar, "Heat and Mass Transfer", 3rd Edition, S.K. Kataria & Sons Publications, 2012.
4. J. P. Holman, "Heat Transfer", Indian Edition, TMH Publications, 2014.

5. Cengel, "Heat and Mass Transfer", 5th Edition, McGraw Hill Publications, 2015.

**Web References**

1. https://nptel.ac.in/courses/112101097/
2. http://web.mit.edu/lienhard/www/ahttv212.pdf/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-051-introduction-to- heat-transfer-fall-2015/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| L4 | - | - |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Differentiate between thermodynamics and heat transfer.
2. What are Fourier and Biot numbers?
3. State the assumptions on which Fourier's law is based.
4. What log mean area is as applied to hollow cylinder?
5. Describe efficiency and effectiveness of fin.
6. Why thermal conductivity of metals higher than that of fluids?
7. Define thermal conductance and thermal resistance.
8. State Lambert's cosine law

**L 2: Understand**

1. Explain the "Relaxation Method" in solving two dimensional heat conduction problems.
2. What is a radiation shield? Derive the expression for heat transfer through "n "number of shields between two plates.

**L 3: Applying**

1. Derive an expression for the shape factor in case of radiation between two surfaces.
2. The inside dimensions of a furnace are 3 m x 2.5 m x 2 m. The walls are 0.2 m thick and have thermal conductivity of 1.3 w/m°C. If the temperatures at the inner and outer surfaces are 300°C and 100°C respectively, calculate the rate of heat loss.
3. A 50 cm x 50 cm copper slab, 6 mm thick at a uniform temperature of 350°C suddenly has its surface temperature lowered to 30°C. Find the time at which the slab temperature becomes 100°C. h = 100 W/m²°C. Also, find the rate of cooling after 60 seconds.
4. A cylinder 5 cm diameter and 50 cm long, is provided with 14 longitudinal straight fins of 1 mm thick and 2.5 mm height. Calculate the heat loss from the cylinder per second if the surface temperature of the cylinder is 200°C. Take h=25W/m²K, k=80W/m0K and ambient temperature=45°C.

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**Head of the Department**
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N.S. Raju Institute of Technology (A)
**Visakhapatnam-531173**

## HO 20MEH03 Jet Propulsion and Rocket Engineering 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH03.1 | Explain the working of jet engines and rocket propulsion systems | L2 |
| 20MEH03.2 | Describe liquid propellant rocket engines. | L2 |
| 20MEH03.3 | Discuss solid propellant rocket engines and explain rocket motor design approach. | L2 |
| 20MEH03.4 | Classify solid propellants and discuss the characteristics | L2 |
| 20MEH03.5 | Explain the working of hybrid propellant rockets and select the process for rocket propulsion systems. | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK: Depth of Knowledge

### Unit I: Turbine

**12 Hours**

Fundamentals of Gas Turbine theory-Then-no dynamic Cycles, open closed and semi-closed — parameters of performances — cycle modifications for improvement of performance. JET PROPULSION: Historical sketch-reaction principle — essential features of propulsion devices-Thermal Engines, Classification of— Energy flow thrust,

*Thrust power and propulsion efficiency-Need for Thermal Jet Engines and applications*

### Unit II: TURBOPROP AND TURBOJET:

**12 Hours**

Thermo dynamic cycles, plant layout, essential components, principles of operation — performance evaluation. Thrust Augmentation and Thrust reversal
*Contrasting with piston Engine Propeller plant.*

### Unit III: RAMJET

**12 Hours**

RAMJET: Thermo dynamic Cycle, plant lay-out, essential components — principle of operation – performance evaluation — comparison among atmospheric thermal jet engines

*scram jet and pulse jet, elementary treatment.*

### Unit IV: Solid propellants

**12 Hours**

Solid propellants-classification, propellant characteristics, propellant ingredients, smokeless propellant, igniter propellants, physical and chemical processes, ignition process.
*extinction or thrust termination, combustion instability.*

### Unit V: Hybrid propellant rockets

**12 Hours**

Hybrid propellant rockets - applications and propellants, performance analysis and grain configuration, combustion instability. Rocket propulsion systems
*selection process, criteria for selection, interfaces.*

### Text Books

1. V Ganesan, "Gas Turbines", Tata McGraw-Hill, 2nd Edition, 2003.
2. Sutton P and Oscar Biblaz," Rocket Propulsion Elements", Wiley India Pvt.Ltd. 2010
3. Dr. M.L. Mathur And R.P. Sharma," Gas Turbines And Jet And Rocket Propulsion", Standard Publishers Distributors

### Reference Books

1. Khajuria and Dubey, "Gas Turbines & Propulsive System", DhanpatRai Publications, 2012.
2. Hill and Peterson, "Mechanics and Dynamics of Propulsion", 2nd Edition, Prentice Hall, 1991.

**Web Reference**
https://www.youtube.com/watch?v=QLcxx6MJnbA&list=PLbMVogVj5nJSCWZNo0sUSxanAp4TN2G-x
**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**
**L1: Remember**

1. What is dynamic.
2. What is Thrust reversal.
3. What are the Solid propellants

**L2: Understand**

1. Explain propellant characteristics
2. Explain Rocket propulsion systems

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## HO 20MEH04 Powder Metallurgy 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH04.1 | Compare the various ways of producing metal powders. | L1,L2, L3 |
| 20MEH04.2 | Describe the procedural of metal powder characterization. | L1,L2, L3 |
| 20MEH04.3 | Describe the various powder compaction process | L1,L2, L3 |
| 20MEH04.4 | Select appropriate sintering techniques based on the requirement. | L1,L2, L3 |
| 20MEH04.5 | Explain the role of powder metallurgy component in various fields. | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: Introduction

**12 Hours**

Powder Production, Chemical Methods, Electrolytic Methods, Atomization, Mechanical Methods, Powder Characterization (Chemical Composition and Structure, Particle Size and Surface Topography.
*Pyrophorocity and Toxicity*

### Unit II: Characteristics and Testing of Metal Powders

**12 Hours**

Sampling, chemical composition purity, surface contamination etc. Particle size. and its measurement, Principle and procedure of sieve analysis, microscopic analysis: sedimentation, elutriation, permeability. Adsorption methods and resistivity methods: particle shape, classifications, microstructure. specific surface area. apparent and tap density. green density. green strength.
*sintered compact density, porosity, shrinkage*

### Unit III:Powder Compaction

**12 Hours**

Pressure less compaction: slip casting and slurry casting. pressure compaction- lubrication, single ended and double ended compaction, isostatic pressing, powder rolling, forging and extrusion.

*Explosive compaction.*

### Unit IV: Sintering

**12 Hours**

Liquid Phase Sintering, Stages of Liquid Phase Sintering, Super solidus Sintering, Activated Sintering, Pressure Assisted Sintering.
*Microwave Sintering, Select Case Studies.*

### Unit V: Applications

**12 Hours**

Major applications in Aerospace, Nuclear and Automobile industries- Bearing Materials-types, Self lubrication and other types, Methods of production, Properties, Applications. Sintered Friction Materials-Clutches, Brake linings, Tool Materials- Cemented carbides, Oxide ceramics.

*Cermets- Dispersion strengthened materials.*

**Text Books**

1. Powder Metallugy Science, 2nd ed R.M. German.
2. Powder Metallurgy: Science, Technology and Materials by A. Upadhyaya, G.S. Upadhyaya,
3. ASM Handbook, Volume 7: Powder Metal Technologies & Applications (1998)
4. Introduction to Ceramics by Kingery W.D, Bowmen H. K., Uhlmann D.R

**Reference Text books**

1. ASM Handbook. Vol. 7, Powder Metallurgy, Metals Park, Ohio, USA, 1990.
2. Animesh Bose., Advances in Particulate Materials, Butterworth – Heinemann. New Delhi, 1995.
3. Erhard Klar., Powder Metallurgy Applications, Advantages and Limitations, American Society for Metals, Ohio, 1983.
4. Kempton. H Roll., Powder Metallurgy, Metallurgical Society of AMIE, 1988.
5. R.M. German, Powder Metallurgy and Particulate Materials Processing, Metal Powder Industries Federation, Princeton, NJ, 2005.

**Web References**

https://nptel.ac.in › content › syllabus

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write about introduction of powders metallurgy?
2. State the applications of powder metallurgy?
3. List the advantages and disadvantages?
4. Write about Effects of compacting?
5. DefineImportance of Sintering?
6. Write aboutvarious sintering processes

**L2: Understand**

1. Stages of Liquid Phase Sintering
2. Powder Production, Chemical Methods
3. Slip casting and slurry casting.
4. Comparing of pressure compaction- lubrication, single ended and double ended compaction

**L3: Apply**

1. Major applications in Aerospace, Nuclear and Automobile industries

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## H0 20MEH05 Advanced Manufacturing Methods 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH05.1 | Explain the working principle of Electron beam, laser beam and laser hybrid welding processes. | L2 |
| 20MEH05.2 | Summarize different types of composite material characteristics, types of micro & macro machining processes. | L2 |
| 20MEH05.3 | Compare the e-manufacturing & nano materials. | L2 |
| 20MEH05.4 | Describe the economical characteristics of manufacturing operations and methods | L3 |
| 20MEH05.5 | Utilize modern tools and techniques to effectively communication methods | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: 12 Hours

Surface treatment: Scope, Cleaners, MetH0ds of cleaning, Surface coating types, and ceramic and organic metH0ds of coating, economics of coating. Electro forming, Chemical vapour deposition, thermal spraying, Ion implantation, diffusion coating, *Diamond coating and cladding.*

### Unit II: 12 Hours

Non-Traditional Machining: Introduction, need ,AJM, Parametric Analysis, Process capabilities, USM –Mechanics of cutting, models, Parametric Analysis, WJM –principle, equipment ,process characteristics , performance, EDM – principles, equipment, generators, analysis of R-C circuits.
*MRR , Surface finish, WEDM.*

### Unit III: 12 Hours

Laser Beam Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Plasma Arc Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electron Beam Machining - Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications. Electro Chemical Machining – Principle of working, equipment, Material removal rate, Process parameters, performance characterization, Applications.
*Advanced machining techniques*

### Unit IV: 12 Hours

Processing of ceramics : Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, Drying , sintering, H0t compaction, Area of application.
*finishing of ceramics.*

### Unit V: 12 Hours

Fabrication of Microelectronic devices: Crystal growth and wafer preparation, Film Deposition oxidation, litH0graphy, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in microelectronics, surface mount technology, Integrated circuit economics. E-Manufacturing, nanotechnology.
*micromachining, High speed Machining*

### Text Books

1. Manufacturing Engineering and Technology, Kalpakijian, Adisson Wesley, 1995.
2. Process and Materials of Manufacturing, R. A. Lindburg, 4th edition, PHI 1990.
3. Foundation of MEMS/ Chang Liu/Pearson, 2012.
4. Advanced Machining Processes, V.K.Jain, Allied Publications.
5. Introduction to Manufacturing Processes, John A Schey, Mc Graw Hill.

### Reference Books

1. Benedict G. F. – 'Non-Traditional Manufacturing Processes' – Marcell Dekker Inc., NY – 1987
2. Krar S. F. and Gill A. – 'Exploring Advanced Manufacturing Technologies' -Industrial Press – 2003

**Web Reference**

1. https://www.youtube.com/watch?v=6ysDAmtF_uU
2. https://www.youtube.com/watch?v=sDadl2KX55Y



**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample SH0rt and Long Answer Questions of Various Cognitive Levels**
**L1: Remember**

1. Explain Surface treatment
2. What is diffusion
3. H0t compaction
4. Explain Crystal growth and wafer preparation

**L2: Understand**

1. Explain Laser Beam Machining
2. Explain Processing of ceramics
3. Explain Fabrication of Microelectronic devices
4. Explain Non-Traditional Machining

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**Visakhapatnam-531173**

## HO 20MEH06 Rapid Prototyping 4 0 0 4

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

| Code | Course Outcomes | DoK |
|---|---|---|
| 20MEH06.1 | Demonstrate the Additive Manufacturing and Rapid Prototyping technologies. | L1,L2 |
| 20MEH06.2 | Illustrate different Rapid Prototyping techniques | L2 |
| 20MEH06.3 | Discuss fundamentals of Reverse Engineering. | L2 |
| 20MEH06.4 | Demonstrate the Rapid Tooling | L2 |
| 20MEH06.5 | Apply the Rapid Prototype technique for biomedical and aeronautical applications | L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

### Unit I: INTRODUCTION: 12 Hours

Prototyping fundamentals, historical development, fundamentals of rapid prototyping,advantages and limitations of rapid prototyping, commonly used terms, classification of RP process. LIQUID-BASED RAPID PROTOTYPING SYSTEMS: Stereo lithography Apparatus (SLA): models and specifications, process, working principle, photopolymers, photo polymerization, layering technology
*laser and laser scanning, applications, advantages and disadvantages*

### Unit II: SOLID-BASED RAPID PROTOTYPING SYSTEMS: 12 Hours

Laminated object manufacturing (LOM) - models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modeling (FDM) - models and specifications, process, working principle, applications,

*Solid based Systems advantages and disadvantages, case studies.*

### Unit III: POWDER BASED RAPID PROTOTYPING SYSTEMS 12 Hours

Selective laser sintering (SLS): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

*three dimensional printing (3DP): models and specifications, process, working principle, applications, advantages and disadvantages, case studies.*

### Unit IV: RAPID TOOLING: 12 Hours

Introduction to rapid tooling (RT), conventional tooling Vs RT, Need for RT. rapid tooling classification: indirect rapid tooling methods: spray metal deposition, RTV epoxy tools, Ceramic tools, investment casting, spin casting, die casting, sand casting, 3D Keltool process. Direct rapid tooling: direct AIM, LOM Tools, DTM Rapid Tool Process,

*EOS Direct Tool Process and Direct Metal Tooling using 3DP.*

**Unit V: RP APPLICATIONS:** **12 Hours**

Application in engineering, analysis and planning, aerospace industry, automotive industry, jewelry industry, coin industry, GIS application, arts and architecture. RP medical and bioengineering applications: planning and simulation of complex surgery, customized implants & prosthesis, design and production of medical devices.

*forensic science and anthropology, visualization of bimolecular.*

**Text Books**

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications.
2. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer.
3. Chua C. K., Leong K. F., and Lim C. S., "Rapid Prototyping: Principles and Applications", Second Edition, World Scientific Publishers (2003),.
4. Patri K. Venuvinod, Weiyin Ma "Rapid Prototyping: Laser-Based and Other Technologies" Springer , 2004

**Reference Books**

1. Wholers Report 2000 – Terry Wohlers, Wohlers Associates.
2. Rapid Prototyping & Manufacturing – Paul F.Jacobs, ASME Press.

**Web Reference**

https://www.youtube.com/watch?v=KJj8CfnC0Ek

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 40 | 30 |
| L2 | 40 | 30 |
| L3 | 20 | 40 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What is Stereo lithography
2. What is Laminated object manufacturing
3. What is Selective laser sintering

**L2: Understand**

1. Explain Application in engineering
2. Explain indirect rapid tooling methods

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**20CEM01 Air Pollution** **3 0 0 3**

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

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20CEM01.1 | Identify different types of pollution and their sources | | L1,L2 |
| 20CEM01.2 | Identify the meteorological components | | L1,L2 |
| 20CEM01.3 | Outline the impact on local and global effects of air pollution on human, materials, properties and vegetation | - | L1,L2 |
| 20CEM01.4 | Explain various types of air pollution control equipment and their working principles | | L1,L2 |
| 20CEM01.5 | Understand sampling methods and monitoring of air pollution | | L1,L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Definition of air pollution, Sources and causes of air pollution, Types and classification of air pollution - Natural contaminants,Particulate, Gases and Vapors, Primary and secondary air pollutants

**Unit II: Meteorology** **9 Hours**

General atmospheric circulation, Atmospheric stability, Effect of meteorology on Plume dispersion, Inversion, Wind profiles andstack plume patterns

**Unit III: Effects of Air Pollution** **9 Hours**

Effects of air pollution on human beings, plants and animals and properties. Global effects-Green house effect, Ozone depletion,heat island, dust storms, Automobile pollution sources and control, Photochemical smog

**Unit IV: Air Pollution Control** **9 Hours**

Particulate matter and gaseous pollutants - Settling chambers, Cyclone separators, Scrubbers, Filters & Electrostatic precipitator

**Unit V: Air Quality Sampling and Monitoring** **9 Hours**

Sampling of particulate and gaseous pollutants (Stack, Ambient & indoor air pollution), Monitoring and analysis of air pollutants

**Text Books**

1. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, "Environmental Engineering", Mc Graw Hill, International Edition, 2017
2. Rao M. N., Rao H. V. N., "Air Pollution", 1st Edition, Mc Graw Hill, 2004

**Reference Books**

1. Martin, Crawford, "Air Pollution Control Theory", Tata McGraw Hill, New Delhi, 1986
2. Bulkeley, H., "Cities and Climate Change", Routledge, London, 2013
3. Rao C. S., "Environmental Pollution Control Engineering," Wiley Eastern Limited, New Delhi, 1992
4. Gurjar, B. R., Molina, L., Ojha, C. S. P., "Air Pollution: Health and Environmental Impacts", CRC Press, 2010

**Web References**

1. http://www.epa.gov
2. http://www.indiaenvironmentportal.org.in
3. http://nptel.iitm.ac.in
4. http://www.filtersource.com
5. https://dgserver.dgsnd.gov

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Mention various sources of air pollution.
2. Define Atmospheric stability
3. Write a note on Ozone depletion
4. What are Filters & Electrostatic precipitators?

**L2: Understand**

1. What are Primary and secondary air pollutants?
2. Write the effect of effect of meteorology on Plume dispersion
3. Explain briefly about effects of air pollution on human beings, plants and animals and properties

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**20CSM01 E-Commerce** **3 0 0 3.0**

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

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20CSM01.1 | Explain the role of new internet economy in E-Commerce | | L1,L2 |
| 20CSM01.2 | Explain the architecture of World Wide Web | | L1,L2 |
| 20CSM01.3 | Describe the E-Commerce process models and E-Payment System | - | L1,L2 |
| 20CSM01.4 | Illustrate the network models in customization and internal commerce | | L1,L2 |
| 20CSM01.5 | Explain the E-commerce models in advertising and marketing of business | | L1,L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I:Introduction** **9 hours**

Electronic Commerce- Architectural Frame work, anatomy of E-commerce applications, E-Commerce consumer applications, E-commerce organization applications

*E-Commerce and media convergence*

**Unit II: World Wide Web & Network security** **9 hours**

Client-Server Network security, World Wide Web(WWW) as the architecture, Web background: Hypertext Publishing, Technologybehind the web, Security and the web

*Emerging Client-Server Security Threats*

**Unit III: E-Payment Systems** **9 hours**

Consumer Oriented Electronic Commerce- Mercantile Process models, E-Payment systems- Digital Token-Based, smart cards, credit cards, risk and E-Payment systems.

*Designing E-Payment Systems*

**Unit IV:EDI Implementation and Intraorganizational E-Commerce** **9 hours**

Standardization and EDI, EDI Software implementation, Value added networks, Intra organizational E-Commerce- Workflow Automation and Coordination, Customization and Internal Commerce, Supply chain management (SCM).

*EDI Envelope for Message Transport*

**Unit V: Advertising and Marketing on the Internet** **9 hours**

Corporate Digital Library- Document Library, digital document types, corporate data warehouses, Advertising and marketing-Information based marketing, Advertising on Internet, online marketing process, market research.

*Charting the Online Marketing Process*

**Text Books**

1. Ravi Kalakota and Andrew B. Whinston., "Frontiers of electronic commerce", First Edition, Pearson Education ,2011
2. Jaiswal S.," E-Commerce", Second Edition,Galgotia,2010

**Reference Books**

1. Dave Chaffey., "E-business & E- commerece management- strategy, implementation and Practice", Fifth edition, Pearson Education, 2015.
2. Kenneth C, "E-Commerce: Business.Technology.Society", First Edition, Pearson Education, 2008

**Web References**

1. https://www.techopedia.com/definition/18226/corporate-data-warehouse-cdw
2. http://ecmrce.blogspot.com
3. http://data.conferenceworld.in

**Internal Assessment Pattern**

| CognitiveLevel | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. Write any four important E-Commerce organization Applications
2. Write about any four requirements of EDI
3. Write short notes on Risks in E-Payment systems
4. Write short notes on Market research
5. What are the factors for design of electronic payment system?

**L2: Understand**

1. How enterprise resource planning and supply chain management software differs in their goals and implementations
2. How product or service customization is adopted in intraorganizational commerce?
3. Explain Merchantile's model from the Merchant's perceptive
4. Explain in detail about E-Payment systems
5. Discuss about mercantile transaction using credit cards

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MI 20MEM01 Biomaterials **3 0 0 3**

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

| Code | Course Outcomes | Mapping withPOs | DoK |
|---|---|---|---|
| 20MEM01.1 | Classify various biomaterials | | L1,L2 |
| 20MEM01.2 | Identify the Metallic implant materials | | L1,L2, L3 |
| 20MEM01.3 | Describe the failure modes of implant materials | - | L1,L2 |
| 20MEM01.4 | Apply Ceramic implant materials | | L1,L2, L3 |
| 20MEM01.5 | Develop the Biocompatibility & Toxicological properties in of biomaterials | | L1,L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective POs
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create,DoK: Depth of Knowledge

**Unit I: Introduction** **09 Hours**

Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra- vascular system). Surface properties of materials.

*physical properties of materials, mechanical properties.*

**Unit II: Metallic implant materials** **09 Hours**

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacementimplant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants.

*Vascular implants, Heart valve implants-Tailor made composite in medium.*

**Unit III: Polymeric implant materials** **09 Hours**

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers).Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems.

*Synthetic polymeric membranes and their biological applications.*

**Unit IV: Ceramic implant materials** **09 Hours**

Definition of bio ceramics. Common types of bio-ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).
Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out).

*Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.*

**Unit V: Biocompatibility & Toxicological screening of biomaterials** **09 Hours**

Definition of biocompatibility, blood compatibility and tissue compatibility. Toxicity tests: acute and chronic toxicity studies (in situimplantation, tissue culture, haemolysis, thrombogenic potential test, systemic toxicity, intracutaneous irritation test), sensitization.

*carcinogenicity, mutagenicity and special tests.*

**Text Books**


1. Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
2. Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
3. J B Park, Biomaterials – Science and Engineering, Plenum Press, 1984.
4. Comprehensive structural interity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, ElsevierAcademic Press, 2003.


**Reference Text books**


1. Biomaterials Science: An introduction to Materials in Medicine, Edited by Ratner, Hoffman, Schoet and Lemons, Second Edition: Elsevier Academic Press, 2004.


**Web References**

1. https://nptel.ac.in/content/syllabus_pdf/113104009.pdf
2. RBM603 BIOMATERIALS Syllabus free download
3. UP Technical University BE BM Syllabus
4. RBM603 Syllabus, BM Unit-wise Syllabus – BE 6th Semester

**Internal Assessment Pattern**

| CognitiveLevel | InternalAssessment#1(%) | InternalAssessment#2(%) |
|---|---|---|
| L1 | 10 | 10 |
| L2 | 30 | 30 |
| L3 | 60 | 60 |
| Total(%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. Write about classification of biomaterials?
2. State the applications of biomaterials?
3. List the advantages and disadvantages biomaterials?
4. Write about Effects of physiological fluid on the properties of biomaterials?
5. Define Importance of stress-corrosion cracking?

**L2: Understand**

1. Surface properties of materials
2. Comparison of properties of some common biomaterials
3. Corrosion behavior and the importance of passive films for tissue adhesion
4. Visco elastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity

**L3: Apply**

1. Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions

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**20EEM01 Basic Control Systems** 3 0 0 3

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

| Code | Course Outcomes | Mapping with PO's | DoK |
|---|---|---|---|
| 20EEM01.1 | Determine time response specifications of second order systems | | L1-L2 |
| 20EEM01.2 | Determine error Constants for different types of input signals | | L1-L2 |
| 20EEM01.3 | Understand various levels of illuminosity produced by differentilluminating sources. | | L1-L3 |
| 20EEM01.4 | Design different lighting systems by taking inputs and constraints in view for different layouts. | | L1-L3 |
| 20EEM01.5 | Understand the speed/time characteristics of different types oftraction motors. | | L1-L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create, DoK:Depth of Knowledge

**Unit I: Introduction to Control Systems** **09 Hours**

Classification of control systems, open loop and closed loop control systems and their differences, Feedback characteristics, transfer function of linear system, differential equations of electrical networks, translational and rotational mechanical systems

*Differences between Closed loop and Open Loop Control Systems*

**Unit II: Time Response Analysis** **09 Hours**

Standard test signals time response of first and second order systems time domain specifications, steady state errors and error constants

*Definitions of Time domain Specifications*

**Unit III: Stability** **09 Hours**

The concept of stability, Routh's stability criteria – Limitations of Routh's stability, effect of addition of poles and zeros, introduction to root locus.

*Basics of Routh's Criteria*

**Unit IV: Frequency response** **09 Hours**

Introduction to frequency domain specifications, basics of bode plot, Phase margin, Gain Margin. Introduction to Polar plots, its phase margin and gain margin. Introduction to Nyquist stability criteria

*Definitions of Frequency domain Specifications*

**Unit V: State Space Analysis** **09 Hours**

Concepts of state, state variables and state model, state space representation of transfer function, diagonalization, solving the time invariant state equations, State Transition Matrix and its Properties, concepts of controllability and observability.

*Basics of Matrix operations*

**Text Books**

1. I.J.Nagarath and M.Gopal, "Control Systems Engineering", Newage International Publications, 5th Edition, 2014.
2. Kotsuhiko Ogata, Modern Control Engineering, Prentice Hall of India, 5th edition, 2014

**Reference Books**

1. S.Palani, "Control Systems Engineering", Tata Mc Graw Hill Publications, 3rd Edition, 2012.

**Web References**

1. https://nptel.ac.in/courses/107/106/107106081/
2. https://www.tutorialspoint.com/control_systems/control_systems_introduction.htm

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1(%) | Internal Assessment #2(%) |
|---|---|---|
| L1 | 30 | 30 |
| L2 | 40 | 30 |
| L3 | 30 | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

1. What are the various standard test signals?
2. Define concept of observability.
3. What is state transition matrix? Write its properties.

**L2: Understand**

1. Explain how Routh Hurwitz criterion can be used to determine the absolute stability of a system
2. Explain about feedback characteristics.
3. Describe the effect of addition of poles and zeros.

**L3: Apply**

1. The characteristic polynomial of a system is.$s^5+2s^6+3s^5+s^4+5s^3+2s^2+s+7=0$. Determine the the stability of thesystem using Routh's stability criteria.
2. Determine range of K for stability of unit feedback system whose open loop transfer function is G(s) = K/s(s+1)(s+2).
3. For a system having G(s) = 25/s(s+10) and units negative feedback, find its time response specifications.

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Board of Studies (EEE)

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**20ECM01 Semiconductor Devices and Circuits** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20ECM01.1 | Classify different types of semiconductors with energy band diagrams | - | L1, L2 |
| 20ECM01.2 | Explain the operation and characteristics of PN junction diode and special diodes | | L1, L2 |
| 20ECM01.3 | Classify and Analyze different types of rectifiers | | L1, L2, L3 |
| 20ECM01.4 | Demonstrate the flow of current in different configurations of the transistor & the concept of DC biasing and transistor stabilization | | L1, L2, L3 |
| 20ECM01.5 | Analyze and Design the small signal low frequency amplifiers | | L1, L2, L3 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos
L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit I: Semiconductor Physics** **09 Hours**

Atomic structure, Neil Bohr's atomic theory, definition of conductors, insulators and semiconductors, energy level diagrams. Semiconductors: Classification and types, intrinsic and extrinsic, P-type and N-type semiconductors, majority and minority carriers, recombination, effect of temperature.

*Fermi Level, Charge Densities in Semiconductors*

**Unit II: Semiconductor Diodes and Special Diodes** **09 Hours**

Formation of depletion region, barrier potential, reverse breakdowns, PN junction as diode, symbol, biasing modes, V-I characteristics, diode current equation, effect of temperature on diode current, ideal diode. Special Diodes: Zener diode, Photo Diode, LED - Working, characteristics and applications.

*Diode Switching times, Varactor diode, Tunnel Diode*

**Unit III: Rectifiers and Filters** **09 Hours**

Half wave Rectifier, Full wave rectifier, Bridge Rectifier - Operation, Input and output wave forms. Filters: Inductor filter, Capacitor filter, π filter, Comparison of various filter circuits in terms of ripple factors.

*LC filter, Multi section π filter*

**Unit IV: Transistors and Biasing Techniques** **09 Hours**

Junction transistor, Transistor current components, Transistor configurations, Transistor as an amplifier, characteristics of transistor in CB and CE configurations. Need for biasing, operating point, Load line analysis, fixed bias and self bias, Stabilization against variations in VBE, Ic, and β, Stability factor, Thermistor and Sensistor bias compensation techniques, Thermal runaway.

*Ebers-Moll model of a transistor, Punch through/reach through, Thermal stability*

**Unit V: Small Signal Low Frequency Transistor Amplifier Models** **09 Hours**

**BJT:** Two port network, Transistor hybrid model, Determination of h-parameters, Generalized analysis of transistor amplifier model using h-parameters, Exact and approximate analysis of CB and CE amplifiers, Comparison of transistor amplifiers.

*Effects of emitter bypass capacitor (Ce) on low frequency response*

**Textbooks**


1. Lal Kishore K., "Electronic Devices and Circuits", 4th Edition, Bright Sky Publications, 2016
2. Millman J. and Christos C. Halkias, "Electronic Devices and Circuits", 4th Edition, Tata Mc-Graw Hill, 2010
3. David A. Bell, "Electronic Devices and Circuits", 5th Edition, Oxford University Press, 2009
4. Boylestad R. L. and Louis Nashelsky, "Electronic Devices and Circuits", 10th Edition, Pearson Publications,2009

**Reference Books**


1. Salivahanan S., Suresh Kumar and Vallavaraj N. A., "Electronic Devices and Circuits", 2nd Edition, Tata Mc-Graw Hill, 2012
2. Donald A. Neamen, "Electronic Circuit Analysis and Design", 3rd Edition, Tata McGraw Hill, 2010
3. Millman J. and Halkias C., "Integrated Electronics", 2nd Edition, Tata Mc-Graw Hill, 2009
4. Singh B. P. and Rekha, "Electronic Devices and Integrated Circuits", 3rd Edition, Pearson publications, 2009
5. Mittal G. K., "Electronic Devices and Circuits", 3rd Edition, Khannan Publishers, 2008


**Web Resources**

1. www.elprocus.com/p-n-junction-diode-theory-and-working/
2. http://fourier.eng.hmc.edu/e84/lectures/ch4/node3.html
3. http://nptel.ac.in/courses/117103063/11

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 35 |
| L2 | 40 | 35 |
| L3 | 20 | 30 |
| Total (%) | 100 | 100 |

Sample Short and Long Answer Questions of Various Cognitive Levels

**L1: Remember**

1. Define Semiconductor
2. What is ideal diode?
3. List any three applications of Zener diode
4. What is rectifier?
5. Define ripple factor
6. What is BJT?
7. What is thermal runaway?
8. Define stability

**L2: Understand**

1. Describe the formation of P type semiconductor
2. Draw and explain V-I characteristics of PN junction diode
3. Describe the construction and operation of Photo diode
4. With neat circuit diagram describe the operation of bridge rectifier
5. Explain, why Zener diode is used in reverse bias with the help of characteristics
6. Draw and explain the input and output Characteristics of Common base configuration
7. With neat sketches explain the V-I characteristics of NPN transistor in common emitter configuration
8. Write a short note on Thermal Runaway
9. Explain thermister compensation technique

**L3: Apply**

1. Show that the efficiency of half wave rectifier is 40.6%
2. Show that the efficiency of full wave rectifier is 81.2%
3. Obtain an expression of stability factor for fixed bias
4. With suitable expressions explain self bias of BJT
5. Obtain the expressions for voltage gain and current gain of small signal low frequency common emitter amplifier

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**20AIM01 Fundamentals of Neural Networks** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20AIM01.1 | Describe the concepts of artificial neural networks | - | L1, L2 |
| 20AIM01.2 | Compare functions of biological and artificial neural networks | | L1, L2 |
| 20AIM01.3 | Explain the architecture and functioning of Single Layer feed forward networks | | L1, L2 |
| 20AIM01.4 | Describe architecture and functioning of Multi-layer networks | | L1, L2 |
| 20AIM01.5 | Explain associative memory networks | | L1, L2 |

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create. DoK: Depth of Knowledge

**Unit 1: Introduction to Neural Networks** **9 hours**

Introduction - Humans and Computers - Organization of the Brain – Biological Neuron - Biological and Artificial Neuron Models - Characteristics of ANN - McCulloch-Pitts Model - Historical Developments - Potential Applications of ANN

**Unit 2: Essentials of ANN** **9 hours**

Artificial Neuron Model - Operations of Artificial Neuron - Types of Neuron Activation Function - ANN Architectures - Classification Taxonomy of ANN – Connectivity - Learning Strategy (Supervised, Unsupervised, Reinforcement) - Learning Rules

**Unit 3: Single Layer Feedforward Networks** **9 hours**

Introduction - Perceptron Models: Discrete - Continuous and Multi-Category - Training Algorithms: Discrete and ContinuousPerceptron Networks – Limitations of the Perceptron Model

**Unit 4: Multi - Layer Feedforward Networks** **9 hours**

Generalized Delta Rule - Derivation of Backpropagation (BP) Training - Summary of Backpropagation Algorithm - Kolmogorov Theorem, Learning Difficulties and Improvements

**Unit 5: Associative Memory Networks** **9 hours**

Paradigms of Associative Memory - Pattern Mathematics - Hebbian Learning - General Concepts of Associative Memory - Bidirectional Associative Memory (BAM) Architecture - BAM Training Algorithms: Storage and Recall Algorithm - BAM Energy Function

**Text Books**

1. S. N. Sivanandam, S. Sumathi, S. N. Deepa, "Introduction to Neural Networks Using MATLAB 6.0", Tata McGraw-HillCompanies, 2006
2. Simon Haykin, "Neural Networks: A Comprehensive Foundation", Second Edition, Pearson Education, Asia
3. James A. Freeman, David M. Skapura, "Neural Networks: Algorithms, Applications, and Programming Techniques", Addison-Wesley Publishing Company

**Reference Books**

1. B. YagnaNarayana, "Artificial Neural Networks", Prentice Hall India, 2013
2. Satish Kumar, "Neural Networks: A classroom approach", Tata McGraw Hill, 2004.
3. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education

**Web Resources**

1. https://www.tutorialspoint.com/artificial_neural_network/index.html

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 50 | 50 |
| L2 | 50 | 50 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive Levels**

**L1: Remember**

5. Define Neural Computing
6. Define ANN and Neural Computing
7. List any 4 design parameters in the design of Artificial Neural Network
8. What kinds of transfer functions can be used in each layer?
9. Define Pattern Association
10. What is Adaline Model?
11. What are the types of Learning?
12. What is simple artificial neuron?
13. List any 4 applications of Artificial Neural Network
14. Define Delta Learning rule

**L2: Understand**

4. Describe on the process of assigning and updating weights in a artificial neural network
5. What are the design steps to be followed for using ANN for your problem?
6. Describe least square algorithm with example
7. Why XOR Problem cannot be solved by a single layer perceptron? Write an alternative solution for it
8. Explain Back Propagation Network with necessary diagrams and equations
9. Write the differences between Hetero Associative Memories and Interpolative Associative Memories

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**20DSO03 Introduction to R Programming** 3 0 0 3.0

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

| Code | Course Outcomes | Mapping with POs | DoK |
|---|---|---|---|
| 20DSO03.1 | Understand the basic concepts of R programming | | L1, L2 |
| 20DSO03.2 | Understand about Scalars and Vectors | | L1, L2, |
| 20DSO03.3 | Implement Lists and data Frames | | L1, L2, L3 |
| 20DSO03.4 | Implement Tables and Statistical Distributions | | L1, L2 , L3 |
| 20DSO03.5 | Implement Functions in R programming | | L1, L2 |

1. Weakly Contributing | 2. Moderately Contributing | 3. Strongly Contributing, for the attainment of respective Pos

L1: Remember | L2: Understand | L3: Apply | L4: Analyze | L5: Evaluate | L6: Create DoK: Depth of Knowledge

**Unit I: Introduction** **9 Hours**

Overview of R, R data types and objects, reading and writing data, sub setting R Objects, Essentials of the R Language, Installing R, Running R, Packages in R, Calculations, Complex numbers in R, Rounding, Arithmetic, Modulo and integer quotients, Variable names and assignment, Operators, Integers, Factors, Logical operations

*Variable Scope & Default Arguments*

**Unit II: Control Structures And Vectors** **9 Hours**

Control structures, functions, scoping rules, dates and times, Introduction to Functions, preview of Some Important R Data Structures, Vectors, Character Strings, Matrices, Lists, Data Frames, Classes

Vectors: Generating sequences, Vectors and subscripts, Extracting elements of a vector using subscripts, Working with logical subscripts, Scalars, Vectors, Arrays, and Matrices, Adding and Deleting Vector Elements, Obtaining the Length of a Vector, Matrices and Arrays as Vectors Vector Arithmetic and Logical Operations, Vector Indexing, Common Vector Operations

*Higher-Dimensional Arrays*

**Unit III: Lists** **9 Hours**

Lists: Creating Lists, General List Operations, List Indexing Adding and Deleting List Elements, Getting the Size of a List, Extended Example: Text Concordance Accessing List Components and Values Applying Functions to Lists, Data Frames, Creating Data Frames, Accessing Data Frames, Other Matrix-Like Operations

Merging Data Frames

**Unit IV: Factors and Tables** **9 Hours**

Factors and Levels, Common Functions Used with Factors, Working with Tables, Matrix/Array-Like Operations on Tables

, Extracting a Sub table, Finding the Largest Cells in a Table, Math Functions, Calculating a Probability, Cumulative Sums and Products, Minima and Maxima, Calculus, Functions for Statistical Distributions

*Aaggregate () Function, Set Operations*

**Unit V: Functions** **9 Hours**

Scripts to Functions, Making the Script, Transforming the Script, Using the Function, Reduce the number of Lines, Adding more Arguments, Dots, Using Functions as Arguments, Crossing the Boarders, Choices with If-Else Statements, vectorizing Choices, Looping Through Values

*Coping and Scoping of Functions*

**Text Books**

1. Norman Matloff, " The Art of R Programming- A Tour of Statistical Software Design ", 2011
2. Roger D. Peng, " R Programming for Data Science " , 2012

**Reference Books**

1. Garrett Grolemund, Hadley Wickham, "Hands-On Programming with R: Write Your Own Functions andSimulations", 1st Edition, 2014
2. Andrie de Vries, Joris Meys, "R For Dummies", 2nd Edition, 2015

**Web References**

1. https://swayam.gov.in/nd1_noc19_ma33/preview
2. https://data-flair.training/blogs/object-oriented-programming-in-r/
3. http://www.r-tutor.com/elementary-statistics
4. https://www.tutorialspoint.com/r/

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 30 | 20 |
| L2 | 30 | 40 |
| L3 | 40 | 40 |
| Total (%) | 100 | 100 |

**Sample Short and Long Answer Questions of Various Cognitive LevelsL1: Remember**

1. Write about vectors in R
2. Write any three type conversions in R
3. What is a data structure in R?
4. Write any two Boolean operators in R
5. Write any two linear vector algebra operations

**L2: Understand**

1. Explain the importance of data frame
2. How to apply same functions to all rows and columns of a matrix? Explain with example
3. Explain about Finding Stationary Distributions of Markov Chains
4. Describe R functions for Reading a Matrix or Data Frame from a File
5. Explain different matrix operation function in R

**L3: Apply**

1. Implement binary search tree with R
2. Write R script to create a line graph
3. Create a R language code to generate first n terms of a Fibonacci series
4. Apply R program to implement quicksort
5. Apply R code to the function by using if else commandf(x) = x if
   x<1/2
   = (1-x) if 1/2<x<1
   = 0 otherwise

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