# 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

**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 |
| IN | 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 |

# 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 |

| No. | Code | Course | Pos | Contact Hours | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T* | P | C | |
| **Semester I** | | | | | | | | |
| 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 | 20ME301 | Thermodynamics | 1, 2, 4, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20ME302 | Material Science and Metallurgy | 1, 7, 12 | 3 | 0 | 0 | 3.0 | PC |
| 04 | 20ME303 | Mechanics of Solids | 2, 3, 12, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 05 | 20ME304 | Manufacturing Processes | 1, 6, 12 | 3 | 0 | 0 | 3.0 | PC |
| 06 | 20ME305 | Material Science and Metallurgy Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME306 | Mechanics of Solids Lab | 1, 4 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20ME307 | 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** | |

* Suggested hours for tutorial
[1] By default all courses are mapped to PO 12 as they are weakly contributing

| No. | Code | Course | Pos | Contact Hours | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | C | |
| **Semester IV** | | | | | | | | |
| 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** | |
| **Semester V** | | | | | | | | |
| 01 | 20ME501 | Dynamics of Machinery | 2, 3, 4,12, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 02 | 20ME502 | Design of Machine Elements I | 2, 3, 4,12, PSO 1 | 2 | 1 | 0 | 3.0 | PC |
| 03 | 20ME503 | Metal Cutting and Machine Tools | 1, 6, 12 | 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 | 0 | 0 | 3 | 1.5 | PC |
| 07 | 20ME507 | Metal Cutting and Machine Tools Lab | 1, 3, 4 | 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 | 15 | 02 | 14 | **21.5** | |
| **Semester VI** | | | | | | | | |
| 01 | 20ME601 | Mechanical Measurements and Metrology | 1, 6, 12 | 3 | 0 | 0 | 3.0 | PC |
| 02 | 20ME602 | Design of Machine Elements II | 2, 3, 4, PSO 1 | 3 | 1 | 0 | 3.0 | PC |
| 03 | 20ME603 | Heat Transfer | 1, 2, 3, 4, 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 | 0 | 0 | 3 | 1.5 | PC |
| 08 | 20ME608 | Heat Transfer Lab | 1, 3, 4, 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 | 16 | 02 | 15 | **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** | |

[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 Service | - | 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 | - | 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 |
| 40 | 20SHO02 | Design the Thinking | - | 3 | 0 | 0 | 3.0 | OE |
| Open Elective #3 | | | | | | | | |
| 41 | 20CEO03 | Disaster, Risk Mitigation and Management | - | 3 | 0 | 0 | 3.0 | OE |
| 42 | 20CS302 | Operating Systems | - | 3 | 0 | 0 | 3.0 | OE |
| 43 | 20AIO03 | Intelligent Robots and Drone Technology | - | 3 | 0 | 0 | 3.0 | OE |
| 44 | 20DSO03 | Introduction to Big Data | - | 3 | 0 | 0 | 3.0 | OE |
| 45 | 20ECO03 | Privacy and Security in IoT | - | 3 | 0 | 0 | 3.0 | OE |
| 46 | 20EEO03 | Low-cost Automation | - | 3 | 0 | 0 | 3.0 | OE |
| 47 | 20MEO03 | Industrial Automation | - | 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 | Design and Analysis of Engineering Materials | - | 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. Integrated Product Development

List of Minor with Specialization offered by Mechanical Engineering Program

1. Electromechanical Systems using Biomaterials and Surface Engineering

## BS 20BSX13 Numerical Methods and Transforms 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | DoK |
|---|---|---|---|---|
| | | PO1 | PO12 | |
| 20BSX13.1 | Calculate the approximate roots of the algebraic equations & Transcendental equations by different techniques | 3 | 1 | L1, L2, L3 |
| 20BSX13.2 | Make use of the concepts of interpolation to estimate the unknown functional values | 3 | 1 | L1, L2, L3 |
| 20BSX13.3 | Find approximate values of finite integrals using different numerical techniques and use different algorithms for approximating solutions of ordinary differential equation to its analytical computations | 3 | 1 | L1, L2, L3 |
| 20BSX13.4 | Apply the Laplace transform to solve ordinary differential equations with initial conditions | 3 | 1 | L1, L2, L3 |
| 20BSX13.5 | Solve engineering problems using Fourier Transforms | 3 | 1 | 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: Solutions of Algebraic and Transcendental Equations 11 + 1 Hour

Introduction – Bisection method – Secant method – Method of false position – Iteration method – Newton-Raphson method– Jacobi and Gauss-Seidel methods solving system of equations.

*Convergence of – Bisection method, Secant method, Method of false position Newton - Raphson Method*

### Unit II: Interpolation 11 + 1 Hour

Introduction –– Finite differences – Forward differences – Backward differences – Central differences – Relations between operators – Newton's forward and backward formulae for interpolation – Interpolation with unequal intervals – Lagrange's interpolation formula – Newton's divide difference formula.

*Errors in Polynomial Interpolation – Error Propagation in a Difference Table- Numerical differentiations*

### Unit III: Numerical integration and solution of ordinary differential equations 11 + 1 Hour

Numerical integration: Trapezoidal rule – Simpson's 1/3rd and 3/8th rule.
Solution of ordinary differential equations by Taylor's series – Picard's method of successive approximations – Euler's method – Runge-Kutta method.

*Runge-Kutta method (second order)*

### Unit IV: Laplace Transforms 11 + 1 Hour

Laplace Transforms of Standard Functions - Shifting Theorems –Transforms of Derivatives and Integrals – Multiplication by $t^n$ - $Dt^n$ – Division by t - Unit Step Function - Unit Impulse function - Laplace Transforms of Periodic Functions- Inverse Laplace Transforms - Convolution Theorem (Without Proof).
Applications: Solving Ordinary Differential Equation (Initial Value Problems) using Laplace Transforms.

*Unit Step Function -Unit Impulse function*

### Unit V: Fourier Transforms 11 + 1 Hour

Fourier Transforms: Fourier Integrals - Fourier Cosine and Sine Integrals - Fourier Transform- Sine and Cosine Transform - Properties - Inverse Fourier Transforms.

*Finite Fourier Sine Transforms, Finite Fourier Cosine Transforms, Inverse Finite Fourier Transforms.*

### Text Books

1. Grewal B. S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, 2018
2. Ramana B. V., "Higher Engineering Mathematics", Tata McGraw Hill Education, 2018

### Reference Books


1. Erwin Kreyszig, "Advanced Engineering Mathematics", 10th Edition, Wiley India, 2015
2. Bali N. P., "Engineering Mathematics", 22th Edition, Lakshmi Publications, 2018
3. Peter O' Neil," Advanced Engineering Mathematics",8th Edition, Cengage, 2017
4. Iyenger T. K. V, Prasad M. V. S. S. N, Ranganatham.S, KrishnaGandhi. B, "Engineering Mathematics II& III",S. Chand Publications, 2nd Edition, 2019


### Web References

1. https://nptel.ac.in/courses/122/102/122102009/
2. https://nptel.ac.in/courses/111/106/111106139/
3. https://nptel.ac.in/courses/111/102/111102129/

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 20 | 20 |
| L2 | 50 | 40 |
| L3 | 30 | 40 |
| Total (%) | 100 | 100 |

### L1: Remember

1. Identify the root lies between which values for $\mathbf{x^3 - 5x + 1 = 0}$
2. Prove that $(1+\Delta)(\mathbf{1 - \nabla})$=1
3. Find the First difference of the polynomial $x^4-12x^3+42x^2-30x+9$ with interval of differencing h = 2
4. Define unit step function
5. State Convolution theorem

### L2: Understand

1. Find a real root of xtanx+1=0 using false position method
2. Find a real root of the equation $xe^x$-cosx=0 using Newtons-Raphson method
3. Use Gauss backward interpolation formula to find f(32) given that f(25)=0.2707 f(30)=0.3027 ,f(35)=0.3386, f(40)=0.3794
4. Using Lagrange's formula find the value of f(1) given that

| x | -2 | -1 | 2 | 7 |
|---|---|---|---|---|
| y | -1 | 0 | 4 | 11 |

5. Find $\int_0^1 \frac{1}{1+x}$ dx by (i) Trapezoidal rule (ii) Simpsons $\frac{1}{3}$rd rule (iii) Simpsons $\frac{3}{8}$th rule

### L3: Apply

1. Using Newton Raphson method compute $\sqrt[3]{\mathbf{37}}$ correct to 4 decimal places
2. Find $\sqrt{\mathbf{12}}$ & $\frac{\mathbf{1}}{\sqrt{\mathbf{12}}}$ by the fixed point iteration method
3. The population of a nation in the decimal census was given below .Estimate the population in the year 1925 using appropriate interpolation formula

| Year x | 1891 | 1901 | 1911 | 1921 | 1931 |
|---|---|---|---|---|---|
| Population y | 46 | 66 | 81 | 93 | 101 |

4. Given that $Sin45^0$ =0.7077, $Sin50^0$ = 0.766, $Sin55^0$ =0.8192, $Sin60^0$ =0.866 find $Sin40^0$ using Newton's forward difference formula
5. Solve $y^1=y-x^2$, y(0)=1 using picard's method up to fourth approximation

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**Board of Studies (Mathematics)**

## PC 20ME301 Thermodynamics 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 | PO12 | PSO1 | |
| 20ME301.1 | Relate the fundamental concepts of thermodynamics and processes of thermodynamics | 3 | - | - | 1 | 1 | L2 |
| 20ME301.2 | Demonstrate the principle of first law of thermodynamics and energy transfer. | 3 | 2 | - | 1 | 1 | L2 |
| 20ME301.3 | Explain the second law of thermodynamics and functions, usage and the relations. | 3 | 2 | - | 1 | 1 | L2 |
| 20ME301.4 | Illustrate pure substance and diagrams of related properties and phase transformations | 3 | 2 | 1 | 1 | 1 | L2 |
| 20ME301.5 | Interpret the Ideal gas equation and perfect gas equation for studying the gas behaviour and its properties. | 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: Basic Concepts — 11 + 1 Hours

System, boundary, Surrounding, Universe, control volume, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process - Reversible, Quasi static & Irreversible Processes, cycle, Causes of Irreversibility. Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zero Law of Thermodynamics, Concept of Temperature, Principles of Thermometry, and Reference Points. Constant volume gas Thermometer, Scales of Temperature.

### Unit II: First law of Thermodynamics — 11 + 1 Hours

Joule's Experiments – First law of Thermodynamics, Corollaries, and First law applied to a Process, applied to a flow system, Energy balance for closed systems-Specific heats, Internal energy, Enthalpy and Specific heats of Solids, liquids and Ideal gases, Some steady flow energy equation applied to Nozzle, Turbine, Compressor and heat exchanger devices.

### Unit III: Thermodynamic Laws — 11 + 1 Hours

Limitations of the First Law, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin, Planck and Clausius Statements and their Equivalence, Corollaries, PMM of Second kind, Carnot cycle and its specialties, Carnot's theorem, Thermodynamic scale of Temperature. Clausius Inequality, Entropy, Principle of Entropy Increase, Availability and Irreversibility (Basic definitions). Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

### Unit IV: Pure Substances — 11 + 1 Hours

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Moliere Charts, Phase Transformations. Triple point and critical point, properties during change of phase, Dryness Fraction, Clausius, Chaperon Equation, Property tables. Various Thermodynamic processes and energy Transfer, Steam Calorimetric.

### Unit V: Ideal Gas Constants — 11 + 1 Hours

Ideal Gas equation of state- Compressibility factor, Vander Waals equation of state- Beattie, Bridgeman equation of state-Benedict, Webb-Rubin equation of state, Viral equation of state, compressibility charts, variable specific heats. Mixtures of perfect Gases, Dalton's Law of partial pressure, Avogadro's Laws of additive volumes Equivalent Gas constant and Molecular Internal Energy, Enthalpy, Specific Heat and Entropy of Mixture of Perfect Gases and Vapour. Psychometric Properties, Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, Saturated Air, Vapour pressure, Degree of saturation, Adiabatic Saturation , Carrier's Equation, Psychometric chart.

### Text Books


1. Nag.P.K-Engineering Thermodynamics, 6thEdition , McGraw Hill- 2013
2. Sonntag, Borgnakke, Van Wylen,Fundamentals of Thermodynamics –6th Edition, Wiley-2015
3. Yunus A Cenegel, Michael A Boles, Thermodynamics, an Engineering Approach, 8th Edition-MCH- 2014
4. Dr. J.P.Holman Thermodynamics –, McGrawHill-6thEdition , McGraw Hill- 2013

## Reference Books

1. Prasanna Kumar, Thermodynamics, Pearson Publishers- 6thEdition , McGraw Hill- 2011
2. Jones & Dugan, Engineering Thermodynamics –PHI- 6thEdition, McGraw Hill- 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 | Internal Assessment #1(%) | Internal Assessment #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 types of thermodynamic systems?
2. Define quasi-static process.
3. What is second law of thermodynamics?
4. List the entropy categories with respect to thermodynamic relations.
5. Write the enthalpy functions of thermodynamics properties.
6. What are availability and irreversibility?
7. Define Carnot's theorem.
8. Describe the triple point and critical point.
9. What is ideal gas?
10. Define dry bulb temperature and wet bulb temperature.

### L2: Understand

1. Describe the concept of thermometry and its reference points
2. What are the differences between point function and path function?
3. Describe the corollaries of first law of thermodynamics
4. Demonstrate Kelvin Planck and Clausius statement with example
5. What do mean by the terms relative humidity and specific humidity?

### 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 the liquid. Find the density of the liquid at the mass flow rate of the liquid handled by the pump.
2. Illustrate First law applied to a flow system.
3. An engine cylinder has a piston of area 0.12sq.m and contains 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 gasby the piston.
4. Design P-V-T surfaces and T-S, h-s diagrams.
5. Find the enthalpy and entropy of a steam, When the pressure is 2 MPa and specific volume is 0.09 $m^3$ /kg

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**Board of Studies (ME)**

PC **20ME302 Material Science and Metallurgy** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | | | DoK |
|---|---|---|---|---|---|
| | | PO1 | PO7 | PO12 | |
| 20ME302.1 | Classify metals and alloys based on behaviour of bonds and properties. | 3 | 2 | 2 | L2 |
| 20ME302.2 | Illustrate the regions of stability of the phases occur in an alloy system. | 3 | 2 | 2 | L2 |
| 20ME302.3 | Compare cast irons and steels with respect to their properties and practical applications. | 3 | 2 | 2 | L2 |
| 20ME302.4 | Summarize the affect of various alloying elements on iron-iron carbide system, various heat treatment and strengthening processes. | 3 | 2 | 2 | L2 |
| 20ME302.5 | Make use of non-ferrous metals and alloys for practical applications. | 3 | 2 | 2 | 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: Structure of Metals And Constitution of Alloys** **12 Hours**

Bonds in Solids, Metallic bond, crystallization of metals, Packing Factor - SC, BCC, FCC& HCP-line density, plane density. Grain and grain boundaries, effect of grain boundaries on the Properties of metal / alloys – determination of grain size. Imperfections point, line, surface and volume- Slip and Twinning. Necessity of alloying, types of solid solutions, Hume Rotherys rules, intermediate alloy phases, and electron compounds

**Equilibrium Diagrams** : Experimental methods of construction of equilibrium diagrams, Isomorphism alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peristaltic reaction. Transformations in the solid state, allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe3

**UNIT –II: Ferrous Metals and Alloys:** **12 Hours**

Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroid graphite cast iron, Alloy cast irons. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels. Non-ferrous Metals and Alloys: Structure and properties of Copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

**UNIT – III: Heat Treatment of Alloys** **12 Hours**

Effect of alloying elements on Fe-Fe3C system, Annealing, normalizing, hardening, TTT diagrams, tempering, harden ability, surface - hardening methods, Age hardening treatment, Cryogenic treatment of alloys.

**UNIT – IV: Powder Metallurgy** **12 Hours**

Basic processes- Methods of producing metal powders- milling atomization Granulation-Reduction. Electrolytic Deposition. Compacting methods. Sintering methods of manufacturing sintered parts. Sintering Secondary operations. Sizing, coining, machining -Factors determining the use of powder metallurgy. Application of this process

**UNIT – V: Ceramic and Composite Materials:** **12 Hours**

Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, various methods of component manufacture of composites, particle reinforced materials, and fiber reinforced materials, metal ceramic mixtures, metal matrix composites and C – C composites. Nano materials, definition, properties and applications.

**Text Books:**

1. Sidney H. Avener – Introduction to Physical Metallurgy - McGrawHill- 6th Edition- 2015
2. Donald R.Askeland -Essential of Materials science and engineering – Cengage- 7th Edition- 2015
3. Dr. V.D.kodgire- Material Science and Metallurgy, Everest Publishing House- 4th Edition- 2015
4. Callister & Baalasubrahmanyam, Materials Science and engineering- Wiley Publications- 11th Edition- 2015

**References:**

1. Fischer – Material Science for Engineering students –Elsevier Publishers- 11th Edition-2010
2. Rahghavan.V-Material science and Engineering - PHI Publishers- 5th Edition- 2009
3. Yip-Wah Chung- Introduction to Material Science and Engineering –CRC Press- 8th Edition- 2012
4. Suryanarayana. A V K- Material Science and Metallurgy– B S Publications- 13th Edition- 2013
5. Jindal. U.C-Material Science and Metallurgy– Pearson Publications- 15th Edition-2016

**Web References:**

1. www.edinformatics.com/math_science/how_is_heat_transferred.htm
2. https://www.quora.com/Why-are-dimensionless-numbers-used-in-heat-transfer-and-fl
3. http://nptel.ac.in/courses/103103032/16
4. web.mit.edu/16.unified/www/FALL/thermodynamics/notes/node128.html
5. web.pdx.edu/~yongkang/main/class/Internal%20Flow.pdf

**Internal Assessment Pattern**

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

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

**L1: Remember**

1) Define elasticity and plasticity
2) Define Space Lattice.
3) What is the significance of liquids, solidus and solves lines in phase diagram?
4) Compare nodular cast iron and malleable cast iron.
5) When will you prefer annealing?
6) What are the properties of Titanium alloys?
7) List abrasive materials.

**L2: Understand**

1. Explain point defect, Line defect and plane defect. b) Mention the types of solid solutions with examples.
2. Draw iron-carbon equilibrium diagram and mark on it all salient temperatures, composition and phases involved.
3. a) Classify different types of cast iron. Why silicon is added to cast iron? Explain the effects of any four alloying elements on the properties of cast iron.
4. Explain the structure and properties of plain carbon steels.
5. a) Discuss different types of annealing processes. b) Define harden ability of a material and list the factors affecting harden ability.
6. a) What are the types of copper alloy, their composition, properties and applications? b) Enlist the properties of pure Aluminum and mention the composition, specific properties and applications of any one aluminum alloy.
7. a) What are Nano materials? What are their advantages? b) What is a Composite material? How it is classified? Explain briefly.

**L3: Apply**

1) Write equations for the following invariant reactions: eutectic, peristaltic, monotectic, eutectoid and peritectoid. How many degrees of freedom do exist at invariant reaction points in binary phase diagram
2) Explain different types of transformations in solid state? Illustrate with an example
3) Compare annealing and normalizing. When do you use them
4) Find the degrees of freedom in a binary system (C=2) at single phase, double phase, and triple phase region at atmospheric pressure conditions using phase rule
4) Explain thermal analysis method of construction of phase diagram
5) Explain the manufacture of fibre reinforced composites

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**Chairman**
**Board of Studies (ME)**

## PC 20ME303 Mechanics of Solids 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | DoK |
|---|---|---|---|---|---|---|
| | | PO2 | PO3 | PO12 | PSO 01 | |
| 20ME303.1 | Outline the concepts of stresses and strains of varying cross-sectional bodies | 3 | 3 | - | 1 | L1, L2 |
| 20ME303.2 | Solve the shear force and bending moment problems for beams of various supports and loads | 3 | 3 | 1 | 1 | L1, L2,L3 |
| 20ME303.3 | Identify shear stresses due to application of twisting moment | 3 | 3 | 1 | 1 | L1, L2,L3 |
| 20ME303.4 | Solve the slope and deflection for beams of various load and support arrangements | 3 | 3 | 2 | 1 | L1, L2,L3 |
| 20ME303.5 | Interpret the stress analysis on thin and thick cylinder shells. | 3 | 3 | 1 | 1 | 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: Simple Stresses & Strains** **11 + 1 Hour**

Elasticity and plasticity, Types of stresses & strains, Hooke's law, stress – strain diagram for mild steel, Working stress, Factor of safety, Lateral strain, Poisson's ratio & volumetric strain, Bars of varying section, composite bars, Temperature stresses, Complex Stresses, Stresses on an inclined plane under different axial and biaxial stress conditions, Principal planes and principal stresses, Mohr's circle, Relation between elastic constants, Strain energy, Resilience, Gradual, sudden, impact and shock loadings.

**Unit II: Shear Force And Bending Moment** **11 + 1 Hour**

Definition of beam, Types of beams, Concept of shear force and bending moment, S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads, Point of contra flexure, Relation between S.F., B.M and rate of loading at a section of a beam.

**Unit III: Flexural Stresses & Shear Stresses** **11 + 1 Hour**

Flexural Stresses**:** Theory of simple bending, Assumptions, Derivation of bending equation: M/ I = f/y = E/R Neutral axis, Determination bending stresses, section modulus of rectangular and circular sections (Solid and Hollow), Angle and Channel sections, Design of simple beam sections.

Shear stresses**:** Derivation of formula, Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

**Unit IV: Deflection of Beams & Torsion** **11 + 1 Hour**

Deflection of beams: Bending into a circular arc, slope, deflection and radius of curvature, Differential equation for the elastic line of a beam, Double integration and Macaulay's methods, Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, U.D.L uniformly varying load. Mohr's theorems, Moment area method, application to simple cases including overhanging beams, Statically indeterminate Beams and solution methods.

Torsion: Introduction, Derivation, Torsion of Circular shafts, Pure Shear, Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

**Unit V: Thin and Thick Cylinders & Columns** **11 + 1 Hour**

Thin seamless cylindrical shells, Derivation of formula for longitudinal and circumferential stresses, hoop, longitudinal and Volumetric strains, changes in diameter, and volume of thin cylinders, Riveted boiler shells, Thin spherical shells. Wire wound thin cylinders. Lame's equation, cylinders subjected to inside & outside pressures, compound cylinders.

Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula

### Text Books


1. Bansal. R.K.- Strength of Materials, Laxmi Publications- 15th Edition- 2015
2. Popov, Prentice Hall- Solid Mechanics, Engle wood cliffs,New Jersey- 13th Edition-2017.
3. GH Ryder, Strength of materials, Mc Millan publishers India Ltd- 10th Edition-2011
4. Gere and Timoshenko, Mechanics of Materials- CBS Publishers- 12th Edition- 2014


### Reference Books


1. Ramamrutham.S, Strength of Materials, Dhanpat Rai Publications- 11th Edition-2017
2. Bhavikatti.S.S.- Mechanics of solids –New Age International Publications- 15th Edition-2018
3. Jindal, Strength of Materials, Umesh Publications- 9th Edition- 2010
4. Andrew Pytel and Ferdinond L. Singer Longman- Strength of Materials LSA Publication- 2013.

## Web References

1. https://drive.google.com/file/d/0BylKfvgX-GD6c2FFRF9GLTNNVTA/view
2. https://drive.google.com/file/d/1R-kxYKtjVB7g-Kiq60n1KrL-RpRDJUDB/edit

## Internal Assessment Pattern

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

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

**L1: Remember**

1. Define elasticity and plasticity
2. State the Hooke's Law?
3. Write the types of loads?
4. What are the General sign conventions for shear force and bending moment in general?
5. State the assumptions made in the theory of simple bending.

**L2: Understand**

1. What do you mean by "a bar of uniform strength"?
2. Distinguish the Impact and Shock loading?
3. Write a note on impact loads?
4. Express Poisson's ratio in terms of shear and Bulk module.
5. What is statically determinate beam? Give some examples

**L3: Apply**

1. Two vertical rods one of steel and other of copper are each rigidly fixed at the top and 50 cm apart. Diameters and lengths of each rod are 2 cm and 4m respectively. A cross bar fixed to the rods at the lower end carries a load of 5000 N such that the cross bar remains horizontal even after loading. Find the stresses in each rod and the position of the load on the bar. Take E for steel = $2x10^5$ N/mm$^2$ and E for copper = $1x10^5$N/mm$^2$.
2. A beam of length 6m is simply supported at its ends. It is loaded with a gradually varying load of 750 N/m from left end to 1500 N/m to the right end. Construct the SF and BM diagrams and find the magnitude and position of the maximum BM.
3. A beam of symmetrical section 30cm deep and I= 12000cm4, carries U.D.L. of 16kN/m. Calculate the maximum span of the beam if the maximum bending stress is not to exceed160N/mm2. With this span, calculate the maximum central load if the bending stress is not to exceed the limit given above.
4. A beam of uniform section, 10 meters long, is simply supported at the ends. It carries point loads of 110 KN and 60 KN at distances of 2m and 5m respectively from the left end. Calculate: The deflection under each load and maximum deflection. Given: E = $200x10^6$N/m$^2$and I = $118x10^{-4}$m$^4$.
5. A closed cylindrical vessel made of steel plates 4 mm thick with plane ends, carries fluid under a pressure of 3N/mm$^2$. The diameter of the cylinder is 25 cm and length is 75 cm, calculate the longitudinal and hoop stress in the cylinder wall and determine the change in the in diameter, length and volume of the cylinder. Take E= $2.1x10^5$ N/mm$^2$ and Poisson's ratios is 0.286.

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**Chairman**
**Board of Studies (ME)**

**PC** **20ME304 Manufacturing Processes** **3 0 0 3**

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

| Code | Course Outcomes | Mapping with POs | | | DoK |
|---|---|---|---|---|---|
| | | PO1 | PO6 | PO12 | |
| 20ME304.1 | Demonstrate the various casting methods for product making with their merits and demerits. | 2 | - | 1 | L1, L2 |
| 20ME304.2 | Choose the various materials joining process and associated defects with possible cause and cure | 2 | 1 | 1 | L1, L2, L3 |
| 20ME304.3 | Develop various metal forming process with its application | 2 | - | 2 | L1, L2, L3 |
| 20ME304.4 | Experiment with the various processes involved in sheet metal forming | 2 | - | 2 | L1, L2, L3 |
| 20ME304.5 | Make use of special manufacturing processes for customized applications | 2 | 2 | 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, DoK: Depth of Knowledge

**Unit I: Introduction to Casting** **12 Hours**

Steps involved in making a casting, Advantage of casting and its applications. Patterns and Pattern making, Types of patterns. Materials used for patterns, pattern allowances and their construction, Molding, molding methods, ingredients of molding sand, Molding materials, Properties of molding sand, Testing of molding sand. Types of molding, Hand molding. Machine molding. Core, different types of cores, materials, properties of core sand, core manufacturing.

**Unit II: Die Casting** **12 Hours**

Principles of Gating, Gating ratio and design of Gating systems. Risers, Types, function and design, casting design considerations. Methods of melting and types of furnaces, cupola, electric arc, resistance and induction furnace. Solidification of castings-Solidification of pure metals and alloys-Short & long freezing range alloys. Fettling. Casting defects. Basic principles and applications of special casting processes - Centrifugal casting, True, semi and centrifuging, Die casting, Investment casting and shell molding.

**Unit-III: Welding** **12 Hours**

Welding : Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, Submerged arc welding, TIG & MIG welding. Electro slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermal welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, Weld ability of metals, welding defects, causes and remedies, destructive and nondestructive testing of welds.

**Unit-IV: Plastic Deformation** **12 Hours**

Plastic deformation in metals and alloys-recovery, re-crystallization and grain growth. Hot working and Cold working strain hardening and Annealing. Bulk forming processes: Forging, Types of Forging, Smith forging, Drop Forging, Roll forging, Forging hammers, Rotary forging, forging defects. Rolling, fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

**Unit-V: Sheet Metal Forgings** **12 Hours**

Sheet metal forming, Blanking and piercing, Forces and power requirement in these operations, Deep drawing, Stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools. High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

**Text Books:**

1. Kalpakjian S and Steven R Schmid, Manufacturing Processes for Engineering Materials –- Pearson Publications- 15th Edition-2015
2. Rao. P.N, Manufacturing Technology -Vol I-TMH- 13th Edition-2014
3. Ghosh.A & A.K.Malik – Manufacturing Science –East West Press Pvt. Ltd- 10th Edition-2011
4. Lindberg, Process and materials of manufacture- - PHI- 12th Edition-2017

**Reference Books:**

1. Jain.R.K- Production Technology- Khanna- Tata McGrawHill- 10th Edition-2011
2. Sharma.P.C-Production Technology- S. Chand- 13th Edition-2013
3. Shaun.H.S.- Manufacturing Processes- Pearson- 12th Edition-2012
4. Kaushish.P.S.- Manufacturing Processes- PHI Publishers Distributors Pvt.Ltds- 5th Edition-2015

**Web References:**

1. https://www.thomasnet.com/articles/custom-manufacturing-fabricating/types-of-casting-processes/
2. http://www.velhightech.com/Documents/ME8451%20Manufacturing%20Technology%20II.pdf
3. https://www.sciencedirect.com/topics/materials-science/plastic-deformation
4. https://www.machinemfg.com/sheet-metal-fabrication-technological-process

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #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 out the steps involved in solving a problem.
2. List any four types of patterns.
3. What are the Steps involved in making a casting?
4. Give the reasons of welding processes.
5. Explain steps involved in a casting process with a neat sketch.
6. What is the high energy rate forming processes ?
7. Define Casting.
8. Explain type of patterns and also explain any three patterns with a neat sketch.
9. Explain injection molding and Blow molding.
10. What is the difference between the solidification of pure me als and metal alloys

**L2: Understand**

1. Explain the two types of crucible furnaces with diagrams?
2. What is the difference between the solidification of pure me als and metal alloys?
3. Explain briefly the Investment casting and Die casting?
4. How do you classify the welding processes?
5. What is meant by penetration? Explain its relevance to welding.

**L3: Apply**

1. Explain the two types of crucible furnaces with diagrams?
2. What is the difference between the solidification of pure me als and metal alloys?
3. Explain briefly the Investment casting and Die casting?
4. How do you classify the welding processes?
5. What is meant by penetration? Explain its relevance to welding
6. Briefly describe the oxy-acetylene welding equipment?

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**Board of Studies (ME)**

## PC 20ME305 Material Science and Metallurgy 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 | PO10 |
| 20ME306.1 | Microstructures of various materials | 3 | 2 | 2 |
| 20ME306.2 | Heat treatment procedures for variety of engineering materials and their importance in materials behavior | 3 | 2 | 2 |
| 20ME306.3 | Determine the Particle size and shape | 3 | 2 | 2 |
| 20ME306.4 | Grain size measurements of various materials | 3 | 2 | 2 |
| 20ME306.5 | Crystal size and precise lattice parameters of various material by X-ray diffraction | 3 | 2 | 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. Preparation and study of the Micro Structure of pure metals like Iron, Cu and Al.
2. Preparation and study of the Microstructure of Mild steels, low carbon steels, high – C steels.
3. Study of the Micro Structures of Cast Irons.
4. Study of the Micro Structures of Non-Ferrous alloys.
5. Study of the Micro structures of Heat treated steels.
6. Harden-ability of steels by Jominy End Quench Test.
7. To find out the hardness of various treated and untreated steels.
8. Study of the Heat treatment of aluminum alloy (Al - 4.5%Cu)
9. Selection of etchants for various Ferrous and Non-ferrous alloys
10. Micro structural observation of weld
    - Carbon steel • Stainless steel • Aluminium alloy •Dissimilar joints

**Add on List of Experiments for MMS LAB**

11. Particulate processing (Sieve analysis) Determination of
    a) Metal powder size and shape b) Apparent density and tap density
12. Determination of grain size of low carbon steels (or) Grain size measurements
13. Determination of crystal size and precise lattice parameters of various materials by X-ray diffraction

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**Board of Studies (ME)**

## PC 20ME306 Mechanics of Solids 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 | PO10 |
| 20ME306.1 | Find the stiffness and rigidity modulus of spring | 3 | 2 | 2 |
| 20ME306.2 | Evaluate the strength of various engineering materials through destructive tests | 3 | 2 | 2 |
| 20ME306.3 | Calculate young's modulus of wood/steel materials | 3 | 2 | 2 |
| 20ME306.4 | Measure the deformations in various beam members | 3 | 2 | 2 |
| 20ME306.5 | Compare the compressive strength of wood/Concrete/Brick materials along and across the grains | 3 | 2 | 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. Find the spring index and modulus of rigidity of the spring material by conducting compression and tensile tests.
2. Estimate the young's modulus of the given cantilever beam material (Steel)
3. Evaluate the young's modulus of the given simple supported beam material
4. Find the shear strength on a given specimen under double shear apparatus
5. Compare the compressive strength of the wood/Concrete/Brick (along and across the grains)
6. Calculate the Rockwell's hardness number for given material
7. Calculate the Brinell's hardness number for given material
8. Determine the impact strength of given materials using IZOD Impact testing machine
9. Determine the impact strength of given materials using CHARPY Impact testing machine
10. Compute the modulus of rigidity and shear strength of the given sample
11. Verify the Maxwell's Reciprocal theorem on beams.
12. Determine the Modulus of Elasticity (E) of wood by conducting bending test

### References

1. Lab Manual for Mechanics Of Solids, Department of Mechanical Engineering, NSRIT

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**Board of Studies (ME)**

## PC 20ME307 Manufacturing Processes Lab 0 0 3 1.5

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

| Code | Course Outcomes | Mapping with POs | | | |
|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 |
| 20ME307.1 | Test the properties of molding | 1 | 2 | 1 | 1 |
| 20ME307.2 | Fabricate joints using gas welding and arc welding | 1 | 2 | 1 | 1 |
| 20ME307.3 | Perform injection molding studies on plastics. | 1 | 2 | 2 | 1 |
| 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. To Make on Taper Section under Pattern Making
2. To Make on I-Section under Pattern Making
3. To Make on Stepped Cone Pulley
4. To Make on lap Joint under Arc Welding
5. To Make on Butt Joint under Arc Welding
6. To Make on Spot welding under Arc Welding
7. To Make on Taper Section under Casting Making
8. To Make on Taper Section under Casting Making
9. To Make on Stepped cone pulley under Casting Making
10. To Make on Injection Molding.

### References

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

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## SC 20MES01 Computer Aided Modelling 1 0 2 2

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

| Code | Course Outcomes | Mapping with POs | | | |
|---|---|---|---|---|---|
| | | PO1 | PO5 | PO10 | PSO1 |
| 20MESO1.1 | Recollect the various part designs with 2D and 3D tools | 3 | 2 | 2 | 1 |
| 20MES01.2 | Elucidate 3D tools and various assemblies with different approaches | 3 | 2 | 2 | 1 |
| 20MES01.3 | Develop automotive parts and assemblies with various sheet metal parameters and constraints. | 3 | 3 | 2 | 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

**Unit I: Part Design** **09 Hours**

Importance of 3d modelling and views associated with 3d models, Conversion of Sketches to 3d models by Material Add and Remove, Associating views and drawing sketch to obtain the final 3d models, Make use of reference elements like point, Line, Plane, Sketch based features like Extrude, Revolve, Sweep, Multi section solids, Dress up features like Fillets, Chamfers, Patterns, Transformation features like Move, Copy, Rotate, Mirror, Symmetry, Adding materials properties for 3d models, Using dynamic sectioning features and output features, Draft analysis for created models and measure the inertia and weight, Following proper tree structure for creating the products, Boolean operations.

**Unit II: Assembly** **09 Hours**

Clear explanation over Top down & Bottom up assemblies, creating individual parts and making them Assemble by using any of the Assembly pattern, Inserting parts and giving constraints between parts, Sub assemblies creations, Creating views of the final assembly on drafting sheet, Creating front view side view and top view & Isometric view of Assembly, Creating dimensions, part numbers, Bill of materials, Title block creation and Broken, auxiliary views creation, About Shape Design in automobile industries, Introduction to types of Surfaces in a automobile parts, A B & C Surfaces in automotive parts, Plastic Features in automobile vehicles, Premastering of products

**Unit III: Generative Sheet Metal Design** **09 Hours**

Sheet metal parameters and application in industries, Creating sheet metal walls and flanges, Bending for the created sheets, Views management and Sheet metal properties, Advanced sheet metal operations, Sheet metal cutting & Stamping operations, Rolled surfaces for sheet, Drafting the folded and Unfold views, Sheet metal features in automotive vehicles

### Experiments List

1. Show 2D tools and toolbars in interface with view tool bar, operation tool bar, specification tree
2. Demonstrate 3D tools and toolbars in interface with sketch based, dress up, transformation, annotation features.
3. Identify materials for different part designs
4. Explain graphic property tools and toolbar in part design
5. What is assembly design bottom up approach?
6. Demonstrate space analysis, constraints and move properties in assembly design
7. Experiment with product structure tools by considering any mechanical component or assembly
8. Translate DMU kinematics to DMC generic animation
9. Construct an part by using sheet metal parameters with elaborate demonstration in specification tree
10. Make use of sheet metal formation in BIW concept

### Internal Assessment Pattern

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

### Sample Questions of Various Cognitive Levels

### L1: Remember

1. Show 2D tools and toolbars in interface with view tool bar, operation tool bar, specification tree.
2. What is assembly design bottom up approach?

**L2: Understand**

1. Demonstrate 3D tools and toolbars in interface with sketch based, dress up, transformation, annotation features.
2. Explain graphic property tools and toolbar in part design.
3. Demonstrate space analysis, constraints and move properties in assembly design.
4. Translate DMU kinematics to DMC generic animation.

**L3: Apply**

1. Identify materials for different part designs.
2. Experiment with product structure tools by considering any mechanical component or assembly.
3. Construct an part by using sheet metal parameters with elaborate demonstration in specification tree
4. Make use of sheet metal formation in BIW concept. Make use of sheet metal formation in BIW concept.

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## MC 20MCX02 Constitution of India 2 0 0 0

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

| Code | Course Outcomes | Mapping with POs | | | DoK |
|---|---|---|---|---|---|
| | | PO1 | PO2 | PO12 | |
| 20MCX02.1 | Summerizing the basic features and modalities about Indian Constitution | 3 | 3 | 1 | L1 |
| 20MCX02.2 | Identify the Indian Federalism and Panchayath Raj systems in Indian Constitution | 3 | 3 | 1 | L1 |
| 20MCX02.3 | Identify the Legislature and Judiciary systems in Indian Constitution | 3 | 3 | 1 | L2 |
| 20MCX02.4 | Interpreting the political system that exists in India | 3 | 3 | 1 | L1, L2 |
| 20MCX02.5 | Categorising the contemporary issues in global politics and Election commission in India | 3 | 3 | 1 | 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 Constitution 10 Hours

Meaning of the Indian Constitution, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947, Indian Constitution and its Salient Features, The role of B. R. Ambedkar in the making of the Indian Constitution,The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional,The Historical Perspectives of the Constitutional Amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency and Local Self Government – Constitutional Scheme in India.

### Unit II: Indian Federalism 10 Hours

Meaning and Definition of Federalism, Structure and Features of Indian Federalism, Difference between Indian and Federation of other States, Difference between Federal and Unitary Features, Critical Evaluation of the Indian Federal System, Decentralisation of Powers, Centre-State Relations, 73rd Amendment, Panchayath Raj Institutions.

### Unit III: Union Government 10 Hours

Powers of Indian Parliament, Functions of Rajya Sabha and Lok Sabha, Powers and Functions of the President, Powers and Functions of the Prime Minister. Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Lok Pal and Lok Ayukta, The Lokpal and Lokayuktas Act 2013.

### Unit IV: Challenges to Indian Political System 10 Hours

Caste: A General Overview of the Indian Scenario,The Caste Issues in the Pre Independence Period, Gandhi Ambedkar Debate and the Poona Pact.The Politics of Caste in the Post Independence Period, Mandal Commission Reservation Policy in Government Jobs.The History of Communalism in India, The Concept of Terrorism and its Emergence in the Global Phenomenon since the End of Cold War.

### Unit V: India's External Relations and Election Commission 10 Hours

Cold War and Post Cold War Era, Foreign Policy, Indian and its Neighbours, India's Extended Neighbourhood in West Asia and South East Asia. India's Relations with the United States and Russia, India and the World Organisations, India in the 21st Century. Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission, Functions of Commissions for the welfare of SC/ST/OBC and women.

### Text Books


1. Austin G., "Working of a Democratic Constitution of India", Oxford University Press, New Delhi, 2004
2. Basu D. D., "An Introduction to the Constitution of India", Prentice Hall, New Delhi, 2005
3. Chandhoke N. and Priyadarshini, "Contemporary India: Economy, Society, Politics", Oxford University Press, New Delhi, 2009
4. Jayal N. G. and Maheta P. B., Oxford Companion to Indian Politics", Oxford University Press, New Delhi, 2010
5. Vanaik A. and Bharghava R. "Understanding Contemporary India: Critical Perspectives", Orient Blackswan, New Delhi, 2010

## Reference Books

1. Noorani A. G., “Constitution Questions in India: The President, Parliament and the States”, Oxford University Press, New Delhi, 2000
2. Chakravarthy B. and Pandey K. P., “Indian Government and Politics”, Sage Publications, New Delhi, 2006
3. Bajpai. Kanti and Pant V. Harsh, “India’s Foreign Policy: A Reader”, Oxford University Press, New Delhi, 2013
4. Laxmikanth M., “Indian Polity for Civil Services Examinations”, Tata McGraw Hill, New Delhi, 2016
5. Singh M. P. and Saxena R., “Indian Politics: Contemporary Issues and Concerns”, PHI Learning, New Delhi, 2008

## Web References

1. https://en.wikipedia.org/wiki/Federalism.in.India
2. https://legislative.gov.in/constitution-of-india
3. https://en.wikipedia.org/wiki/Foreign_relations_of_India
4. https://en.wikipedia.org/wiki/Government_of_India

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## HS 20HSX03Managerial Economics and Financial Analysis 3 0 0 3

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

| Code | Course Outcomes | Mapping with POs | | DoK |
|---|---|---|---|---|
| | | PO11 | PO12 | |
| 20HSX03.1 | Understand the theoretical concepts of managerial economics to make decisions for business problems | 3 | 1 | L1,L2 |
| 20HSX03.2 | Gain adequate theoretical knowledge on microeconomics concepts to perform successful business operations | 3 | 1 | L1,L2 |
| 20HSX03.3 | Understand the basic accounting principles to prepare final Accounts | 3 | 1 | L1,L2 |
| 20HSX03.4 | Apply Financial planning techniques to make successful longterm investment decisions. | 3 | 1 | L3,L4 |
| 20HSX03.5 | Apply accounting concepts to analyze financial strength of business | 3 | 1 | 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

**UnitI: Introduction to Managerial Economics and Demand Analysis9 Hours**

Definition of Managerial Economics –Scope of Managerial Economics and its Relationship with other Subjects – Concept of Demand, Types of Demand, Determinants of Demand- Demand Schedule, Demand Curve, Law of Demand and its Limitations- Elasticity of Demand, Types of Elasticity of Demand and Measurement- Demand Forecasting and Methods of Forecasting.

*Role of Managerial Economist, Law of Supply*

**Unit II: Production and Cost Analysis 9 Hours**

Theory of Production: Meaning and Factors of Production, Production Function with One Variable Input (Law of Variable Proportion), With Two Variable Inputs (Law of Returns to Scale) Theory of Cost: Different Cost Concepts and Different Relations between Cost and Output in Short Run and Long Run. Managerial uses of Revenue and Cost Concepts Break-Even Point). Pricing Strategies.

*Economies of Scale and Diseconomies of Scale*

**Unit III: Introduction to Final Accounts 9Hours**

Financial Accounting- Concepts and Conventions – Double Entry System – Preparation of Journal, Ledger and Trial Balance – Preparation of Final Accounts: Trading, Profit and Loss Account and Balance Sheet.

*Branches of Accounting*

**Unit IV: Introduction to CapitalPlanning 9 Hours**

Cocept of Capital – Types of Capital - Capital Budgeting -: Meaning of Capital-Capitalization-Meaning of Capital Budgeting-Time Value of Money- Methods of Appraising Project Profitability - Traditional Methods and Modern Methods.

*Concept of Working Capital*

**Unit V: Financial Analysis through ratios 9 Hours**

Computation, Analysis and Interpretation of Liquidity Ratios (CurrentRatio and Quick Ratio), Activity Ratios (Inventory Turnover Ratio and Debtor Turnover Ratio), Capital StructureRatios (Debt - Equity Ratio, Interest Coverage Ratio) and Profitability Ratios (Gross Profit Ratio, Net ProfitRatio,Operating Ratio, P/E Ratio and EPS).

*Cash Flow Statement and Funds Flow Statement (Theory Only)*

**Text Books**

1. AppaRao N., Vijay Kumar P., “Managerial Economics and Financial Analysis”, Cengage Publications, New Delhi, 2011
2. Siddiqui S. A. and Siddiqui A. S., “Managerial Economics and Financial Analysis”, New Age International Publishers, 2012
3. Kuberudu B. and Ramana T. V., “Managerial Economics and Financial Analysis”, Himalaya Publishing House, 2014
4. Aryasri A. R., “Managerial Economics and Financial Analysis”, Tata Mcgraw Hill, 2011

### Reference Books


1. Maheswari V., "Managerial Economics", Sultan Chand,2014
2. Suma Damodaran, " Managerial Economics", Oxford, 2011
3. Vanitha Agarwal, " Managerial Economics", Pearson Publications, 2011
4. Sanjay Dhameja, "Financial Accounting for Managers", Pearson Publications, 2011
5. Maheswari V., "Financial Accounting", Vikas Publications, 2012
6. Dominick Salvatore,"Managerial Economics: Principles and World Wide Application", 7th Edition, Oxford University Press, 2012


### Web References

1. https://btechgeeks.com/mefa-notes/#google_vignette
2. https://www.smartzworld.com/notes/managerial-economics-and-financial-analysis-pdf-notes-mefa
3. https://www.scribd.com/document/259129127/Mefa-course-plan
4. https://www.coursera.org/browse/business/entrepreneurship

### Internal Assessment Pattern

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 40 | 40 |
| L2 | 20 | 20 |
| L3 | 20 | 20 |
| L4 | 20 | 20 |
| Total (%) | 100 | 100 |

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

### L1: Remember

1. What is Managerial Economics?
2. What is meant by Elasticity of demand? How do you measure it?
3. Define different product curves
4. Define Accounting
5. Define Partnership

### L2: Understand

1. Explain the role of a Managerial Economist in a Business firm
2. Explain the concept cross elasticity of demand. Illustrate your answer with suitable examples
3. Explain the formation of a Joint Stock Company
4. Distinguish between a partnership and a joint stock company
5. Explain accounting principles

### L3: Apply

1. Journalise the following transactions
   2013 Jan 1st ABC Firm commenced business with Rs.40000
   Jan 2nd Deposited into bank Rs.30000
   Jan 3rd Bought goods worth Rs.48000 from Kamala
   Jan 4th Sold goods worth Rs.60000
2. Calculate Net Profit Ration from the following data
   Sales returns Rs.100000 Administration expences Rs.10000
   Gross Profit Rs.40000 Selling expences Rs.10000
   Income from investment Rs.5000 Loss on account of fire Rs.3000
3. From the following particulars findout
   Selling price Rs.200 per unit
   Variable cost Rs.100 per unit
   Total fixed cost Rs.96000
   i) Break even units and values
   ii) Sales to earn a profit Rs.20000

4. The following are the Ratios related to XYZ Limited company.
   Inventory holding period 2 months
   Gross profit ration 25 %
   Gross profit for the current year announced Rs.200000
   Closing stock is excess of Rs 40000 over opening stock. Findout
   A) Sales
   B) Cost of goods sold
   C) Closing stock
   D) Opening stock

**L4: Analyze**

1. A Project cost is Rs.144000. The average annual cash inflows are likely to be Rs.45000 for a period of 5 Years calucalte IRR for the project
2. The cost of project is Rs.50000 The annual cash iunflows for the next 4 years are Rs.25000 what is the PBP for the project
3. A firm is considering two different investment options A & B detailes of both the options are given below (Rs,in Lakhs)

| | **Investment cost** | **Inflow 1** | **Inflow 2** | **Inflow 3** |
|---|---|---|---|---|
| **Option A** | (25) | 10 | 10 | 12 |
| **Option B** | (40) | 15 | 20 | 24 |

4. ARR method (ARR on original investment)
   Inintial investment Rs.1200000

| Year | Cashinflows (Rs) | |
|---|---|---|
| | Project A | Project B |
| 1 | 600000 | 500000 |
| 2 | 500000 | 300000 |
| 3 | 200000 | 200000 |
| 4 | - | 300000 |

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**Board of Studies (MBA)**

## ES 20CS403 Python Programming 3 0 0 3

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

| Code | Course Outcomes | Mapping with POs | | DoK |
|---|---|---|---|---|
| | | PO1 | PO12 | |
| 20CS403.1 | Illustrate the use of basic concepts of Python Programming | 3 | 1 | L1, L2 |
| 20CS403.2 | Demonstrate the use of control Structures and Data Structures in Python | 3 | 1 | L1, L2 |
| 20CS403.3 | Build programs using functions for resolving simple problems | 3 | 1 | L1, L2 |
| 20CS403.4 | Explain the usage of Object oriented concepts and files | 3 | 1 | L1, L2 |
| 20CS403.5 | Apply mathematical libraries for analyzing data sets with GUI | 3 | 1 | 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 + 3 Hours

Introduction to Python, Program Development Cycle, Input, Processing, and Output, Displaying Output with the Print Function, Comments, Variables, Keywords, Reading Input from the Keyboard, Performing Calculations

Operators: Arithmetic Operators, Comparison (Relational) Operators, Bitwise Operators, Logical Operators, Assignment Operators, Membership Operators, Identity Operators, Type Conversions, Expressions, More about Data Output.

*More about Data Output*

### Unit II: Control Statements, Data Structures and Strings 9 + 3 Hours

Control Statements: If, if-Else, For, While, Break, Continue, Pass

Data Structures: List, Tuples, Sets, Dictionaries, Sequences, List Comprehension

Strings: String Formatting, Accessing Character and Substring in Strings, Data Encryption, Strings and Number Systems, String Methods

*More about While, Continue*

### Unit III: Functions and Modules 9 + 3 Hours

Functions: Defining Simple Functions, Functions as Abstraction Mechanisms, Problem Solving with Top - Down Design, Design with Recursive Functions, Case Study Gathering Information from a File System, Managing a Program's Namespace, Higher Order Function.

Modules: Creating Modules, Import Statement, From. Import Statement, Name Spacing, Builtin Modules - Os, Random, Math, Cmath, Pprint, Json, Request, Date, Regex.

Packages: Introduction to PIP, Installing Packages using PIP.

*More Programs using Functions*

### Unit IV: File Operations and OOPs 9 + 3 Hours

File Operations: Reading Config Files In Python, Writing Log Files In Python, Understanding Read Functions, Read(), Readline() and Readlines(), Understanding Write Functions, Write() and Writelines(), Manipulating File Pointer using Seek, Programming using File Operations.

Object Oriented Programming: Concept of Class, Object and Instances, Constructor, Class Attributes and Destructors, Real Time use of Class in Live Projects, Inheritance, Overlapping and Overloading Operators, Adding and Retrieving Dynamic Attributes of Classes, Programming using OOPs Support.

Design with Classes: Objects and Classes, Data Modeling Examples, Case Study on ATM, Structuring Classes with Inheritance and Polymorphism.

*Case Study on Library*

### Unit V 9 + 3 Hours

Graphical User Interfaces: The Behavior of Terminal Based Programs and GUI -Based, Programs, Coding Simple GUI-Based Programs, Other Useful GUI Resources. Programming: Introduction to Programming Concepts with Scratch.

Mathematical Libraries: NumPy, SciPy, Sympy, Pandas, StatsModels, Matplotlib and Gnuplot.

*Other Useful GUI Resources*

## Text Books

1. Kenneth A. Lambert, " Fundamentals of Python First Programs", 1st Edition, Cengage Learning, Inc., 2017
2. Vamsi Kurama, "Python Programming: A Modern Approach", 1st Edition, Pearson Education, 2018
3. Mark Lutz, "Learning Python", 1st Edition, Orielly, 2019

## Reference Books

1. Gowrishankar S., Veena A., "Introduction to Python Programming", CRC Press, 2019
2. Daniel Liang Y., "Introduction to Programming Using Python", 1st Edition, Pearson, 2012
3. Allen Downey, "Think Python", 2nd Edition, Green Tea Press, 2017
4. Chun W., "Core Python Programming", 2nd Edition, Pearson, 2006

## Web References

1. https://www.tutorialspoint.com/python3/python_tutorial.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 Levels

## L1: Remember

1. What is the difference between list and tuples in Python?
2. What are the key features of Python?
3. What type of language is python?
4. How is Python an interpreted language?
5. What is pep 8?

## L2: Understand

1. Give a comparison between lists, tuples, dictionaries and sets
2. Explain about methods in Lists of Python with appropriate examples
3. Explain the operators in python with appropriate examples
4. Explain how to implement inheritance in Python
5. Explain modules and Packages

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**Chairman**
**Board of Studies (ME)**

## PC 20ME403 Kinematics of machinery 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | DoK |
|---|---|---|---|---|---|---|
| | | PO2 | PO3 | PO12 | PS01 | |
| 20ME403.1 | Identify different principles and inversions of planar mechanisms. | 1 | 1 | 1 | 1 | L3 |
| 20ME403.2 | Model lower pair mechanisms | 1 | 1 | 1 | 1 | L3 |
| 20ME403.3 | Illustrate velocity and acceleration diagrams in plane motion of a body. | 2 | 1 | 1 | 1 | L2 |
| 20ME403.4 | Choose cam, follower profiles with various motion-displacement principles. | 2 | 2 | 1 | 1 | L3 |
| 20ME403.5 | Build the higher pairs mechanisms | 2 | 1 | 1 | 1 | 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: Mechanisms** **11 + 1 Hour**

Mechanisms: Elements or Links, classification, rigid Link, flexible and fluid link. Types of kinematic pairs, sliding, turning, rolling, screw and spherical pairs, lower and higher pairs, closed and open pairs, constrained motion, completely, partially or successfully constrained and incompletely constrained. Grubbers criterion , Grashoff's law , Degrees of freedom, Kutzbach criterion for planar mechanisms, Mechanism and machines, classification of machines, kinematic chain, inversion of mechanism, inversion of mechanism, inversions of quadric cycle, chain, single and double slider crank chains.

*Problems on Degrees of freedom and inversion mechanisms*

**UNIT – II: Lower pair Mechanism** **11 + 1 Hour**

Lower Pair Mechanism: Exact and approximate copiers and generated types, Peaucellier, Hart and Scott Russell, Grasshopper, Watt T. Chebicheff and Robert Mechanisms and straight line motion, Pantograph. Conditions for correct steering, Davis Steering gear, Ackerman's steering gear, velocity ratio; Hooke's Joint: Single and double, universal coupling, application, problems.

*Problems on steering gear mechanism.*

**UNIT – III: Plane motion of body** **11 + 1 Hour**

Kinematics: Velocity and acceleration, motion of a link in machine. Determination of Velocity and acceleration diagrams. Graphical method. Application of relative velocity method four bar chain. Velocity and acceleration analysis of for a given mechanism, Kleins construction, Coriolis acceleration.

Plane motion of body: Instantaneous centre of rotation, centroids and axodes, relative motion between two bodies, three centres in line theorem. Graphical determination of instantaneous centre, diagrams for simple mechanisms and determination of angular velocity of points and links.

*Determination of Coriolis component of acceleration.*

**UNIT – IV: Cams, follower and belt drives** **11 + 1 Hour**

Cams: Definitions of cam and followers, their uses. Types of followers and cams. Terminology, types of follower motion: Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases. Analysis of motion of followers: Roller follower – circular cam with straight, concave and convex flanks.

Power Transmissions : Introduction, Belt and rope drives, selection of belt drive- types of belt drives, belts, materials used for belt and rope drives, velocity ratio of belt drives, slip of belt, creep of belt, tensions for flat belt drive, angle of contact, centrifugal tension, maximum tension of belt, Chains- length, angular speed ratio, classification of chains.

*Maximum velocity and acceleration, displacement analysis.*

**UNIT – V: Gears** **11 + 1 Hour**

Gears: Higher pairs, friction wheels and toothed gears–types, law of gearing, condition for constant velocity ratio for transmission of motion, Form of teeth: cycloid and involutes profiles. Velocity of sliding, phenomena of interferences. Methods of interference. Condition for minimum number of teeth to avoid interference, expressions for arc of contact and path of contact. Introduction to Helical, Bevel and worm gearing.

Introduction to gear Trains, Train value, types, simple and reverted wheel train. Epicyclical gear Train. Methods of finding train value or velocity ratio. Epicyclical gear trains.

*Selection of gear box-Differential gear for an automobile*.

**Text Books:**

1. Jagadeesh lal, Theory of Mechanisms & Machines by, Metropolitan Pvt. Ltd- 15th Edition-2015
2. Thomas Bevan, Theory of Machines, CBS Publishers- 13th Edition-2014
3. Rattan S.S, Theory of Machines, TMH Publishers- 10th Edition-2011
4. Vickers, Theory of machines and Machinery, Oxford- 12th Edition-2017

**References:**

1. Sadhu Singh, Theory of Machines, Pearsons Education Publications- 10th Edition-2011
2. Ghosh.A & Malik.A.K, Theory of Mechanisms and machines, East West Press Pvt. Ltd- 13th Edition-2013
3. Ashok G. Ambekar, Mechanism and Machine Theory, PHI Publishers- 12th Edition-2012
4. J.J Uicker, G.R.Pennock & J.E.Shigley, Theory of machines and Mechanisms, Oxford publishers- 5th Edition-2015

**Web References:**

1. https://nptel.ac.in/courses/112/104/112104121/
2. https://nptel.ac.in/courses/112/105/112105268/

**Internal Assessment Pattern**

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

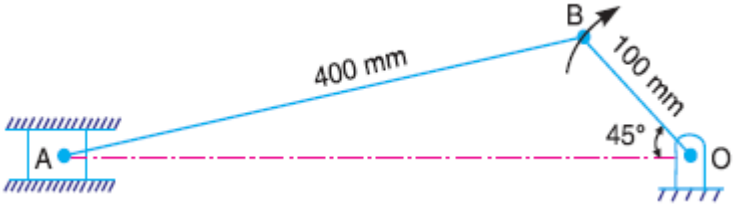
**Sample Questions of Various Cognitive Levels**

**L1: Remember**

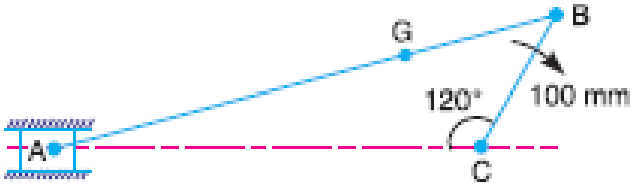
1. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centers is 240 mm and the length of the driving crank is 120 mm. Find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting stroke to the return stroke. If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever.
2. What is Kutzback's criterion for degree of freedom of plane mechanisms? In what way is Gruber's criterion different from it?
3. Explain double slider crank chain mechanism and its inversion with neat diagrams.
4. How to determine coriolis acceleration component and which cases it occurs?

**L2: Understand**

1. Explain with a neat sketch, Pantograph mechanism. State its applications.
2. Draw a neat sketch of the Scott Russell's mechanism, and explain its working. How this mechanism can be modified to produce Grasshopper mechanism
3. Locate all the instantaneous centres of the slider crank mechanism as shown in Figure. the lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB.




4. An engine mechanism, the crank CB = 100 mm and the Connecting rod BA = 300 mm with centre of gravity G, 100 mm from B. In the position shown, the crankshaft has a speed of 75 rad/s and an angular acceleration of 1200 rad/s$^2$. Find: 1. Velocity of G and angular velocity of AB, and 2. acceleration of G and angular acceleration of AB.



5. PQRS is a four bar chain with link PS fixed. The lengths of the links are PQ is 62.5 mm ; QR = 175 mm ; RS = 112.5 mm ; and PS = 200 mm. The crank PQ rotates at 10 rad/Sec clockwise. Draw the velocity and acceleration diagram when angle QPS = 60° and Q and R lie on the same side of PS. Find the angular velocity and angular acceleration of links QR and RS.
6. Use the following data in drawing the profile of a cam in which a knife-edged follower is raised with uniform acceleration and deceleration and is lowered with simple harmonic motion: Least radius of cam = 60 mm; Lift of follower = 45 mm; Angle of ascent = 60 degrees; Angle of dwell between ascent and descent = 40 degrees; Angle of descent = 75 degrees If the cam rotates at 180 rpm, determine the maximum velocity and acceleration during ascent and descent.
7. A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed is to be designed to give a roller follower, at the end of a valve rod, motion described below :
   1. To raise the valve through 50 mm during 120° rotation of the cam ;
   2. To keep the valve fully raised through next 30°;
   3. To lower the valve during next 60°; and
   4. To keep the valve closed during rest of the revolution i.e. 150°, The diameter of the roller is 20 mm and the diameter of the cam shaft is 25 mm. Draw the profile of the cam when (a) the line of stroke of the valve rod passes through the axis of the cam shaft, and (b) the line of the stroke is offset 15 mm from the axis of the cam shaft. The displacement of the valve, while being raised and lowered, is to take place with simple harmonic motion. Determine the maximum acceleration of the valve rod when the cam shaft rotates at 100 r.p.m. Draw the displacement, the velocity and the acceleration diagrams for one complete revolution of the cam.

**L3: Apply**

1. Shaft rotating at 200 rpm drives another shaft at 300 rpm and transmits 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The distance between the shafts is 4m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt, if it is 1. An open belt drive and 2. A cross belt drive. Take μ = 0.3.
2. A pinion with 24 involutes teeth of 150 mm pitch circle diameter drives a rack. The addendum of the pinion and rack is 6 mm. What is the least pressure angle which can be used if interference is to be avoided? Using this pressure angle, find the length of arc of contact and the number of teeth in contact.
3. Derive an expression for length of path of contact, length of arc contact and contact ratio for a pair of involutes gears in contact.
4. Derive an equation to determine the length of path of contact by a pair of mating spur gear.
5. Locate all the instantaneous centers of the slider crank mechanism as shown in Figure. The lengths of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: 1. Velocity of the slider A, and 2. Angular velocity of the connecting rod AB.

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## PC 20ME404 Fluid Mechanics & Hydraulic Machines 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | DoK |
|---|---|---|---|---|---|---|
| | | PO2 | PO3 | PO12 | PS01 | |
| 20ME404.1 | Classify the properties of fluid and study of fluid in static condition | 1 | 1 | 1 | 1 | L2 |
| 20ME404.2 | Interpret the dynamics of fluids and boundary layer conditions | 1 | 1 | 1 | 1 | L2 |
| 20ME404.3 | Demonstrate natural and forced convention using dimensional analysis | 2 | 1 | 1 | 1 | L2 |
| 20ME404.4 | Select the appropriate pump based on its working principle and operation | 2 | 2 | 1 | 1 | L3 |
| 20ME404.5 | Identify the performance and construction of various types of flow in turbines. | 2 | 1 | 1 | 1 | 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: Fluid Properties and Flow Characteristics** **11 + 1 Hours**

Units and dimensions- Properties of fluids- mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity and Measurement of pressures. Flow characteristics, application of continuity equation, energy equation and momentum equation. Total Pressure and Centre pressure for Plane Surface. Buoyancy and Floating-buoyancy centre of buoyancy, Meta centre, Meta centric height, Condition of Equilibrium of floating and submerged bodies.
*Oscillation of a floating Body*

**Unit II: Flow through Circular Conduits** **11 + 1 Hours**

Types of Fluid motion -Rate of flow, Continuity equation, Velocity and acceleration, Potential function and Vortex flow. Equation of motion-Euler's equation of motion, Bernoulli's equation, applications of Bernoulli's equation .Concept of control volume, energy equation and momentum equation .Hydraulic and energy gradient. Laminar flow through circular conduits and circular annuli Boundary layer concepts – types of boundary layer thickness. Darcy Weisbach equation, friction factor-minor losses. Flow through pipes in series and parallel.
*Free Liquid Jets, Orifice and Mouth piece*

**Unit III: Dimensional Analysis** **11 + 1 Hours**

Need for dimensional analysis, methods of dimensional analysis. Similitude, types of similitude, Dimensionless parameters, application of dimensionless parameters – Model analysis.
*Undistorted and distorted models*

**Unit IV: Pumps** **11 + 1 Hours**

Impact of jets - Theory of roto-dynamic machines, various efficiencies, velocity components at entry and exit of the rotor, velocity triangles. Centrifugal pumps, working principle, work done by the impeller, performance curves. Reciprocating pump, working principle, Rotary pumps, classification.
*Jet Propulsion of ships*

**Unit V: Turbines** **11 + 1 Hours**

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

**Text Books:**

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.
2. Bansal.R.K "Fluid Mechanics and Hydraulic Mchinary", 6th Edition, Laxmi Publications, 2005.
3. Y.A.Cengel,J.M.Cimbala "Fluid Mechanics-Fundamental and Applications", 6th Edition, McGrawHill.
4. Dixon "Fluid Mechanics", 7th Edition ,Elesvier

**Reference Books:**

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, "Fluid Mechanics and Machinery",Eurasia *Publishing,* 2011
4. Streeter, V. L. and Wylie E. B., "Fluid Mechanics", McGraw Hill Publishing Co. 2010

**Web References:**

1. https://www.nptel.ac.in/courses/112/104/112104118/
2. http://nptel.ac.in/courses/Webcourse-contents/IITKANPUR/machine/ui/Course_home-7.htm
3. http://nptel.ac.in/courses/112105182/9
4. http://www.slideshare.net/ArchieSecorata/fluid-mechanicsfundamentalsandapplications-by-cengel-cimbala-3rd-c2014-txtbk

**Internal Assessment Pattern**

| Cognitive Level | Internal Assessment #1 (%) | Internal Assessment #2 (%) |
|---|---|---|
| L1 | 60 | - |
| L2 | 40 | 40 |
| L3 | - | 60 |
| L4 | - | - |
| Total (%) | 100 | 100 |

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

**L1: Remember**

1. Define Surface tension on a liquid droplet.
2. Define buoyancy.
3. Define dimensional analysis.
4. Define momentum thickness.

**L 2: Understand**

1. A U-tube is made of two capillaries of diameter 1mm and 1.5mm respectively. The tube is kept vertically and partially filled with water of surface tension 0.0736 N/m and zero contact angle. Calculate the difference in the levels of the menisci caused by the capillary
2. State Darcy-Weisbach equation OR What is the expression for head loss due to friction?
3. List the repeating variables used in Buckingham π theorem
4. Explain in detail about Specific speed of turbine & Type
5. Briefly explain about Cavitations in centrifugal pumps

**L 3: Applying**

**1.** A centrifugal pump with an impeller diameter of 0.4m runs at 1450rpm. The angle at outlet of the backward curved vane is 25° with tangent. The flow velocity remains constant at 3m/s. If the manometric efficiency is 84%. Determine the fraction of the kinetic energy at outlet recovered as static head.

**2.** A reaction turbine at 450 rpm, head 120 m, diameter at inlet 120 cm, flow area 0.4 m2 has angles made by absolute and relative velocities at inlet 20° and 60° respectively. Find volume flow rate, H.P and Efficiency.

3. Derive expression for the force exerted by the jet of water on a series of moving radial curved vanes mounted on a wheel. Also find the maximum efficiency.

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## PC 20ME405 IC Engines and Gas Turbines 3 1 0 3

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

| Code | Course Outcomes | Mapping with POs | | | | DoK |
|---|---|---|---|---|---|---|
| | | PO2 | PO3 | PO12 | PSO2 | |
| 20ME405.1 | Interpret the effect of various operating parameters in engine performance. | 3 | 1 | 1 | 1 | L2 |
| 20ME405.2 | Experiment with fuel metering and fuel supply for different IC engines | 3 | 1 | 1 | 1 | L3 |
| 20ME405.3 | Organize performance analysis of IC engines with normal and abnormal combustion phenomena. | 3 | 2 | 1 | 1 | L3 |
| 20ME405.4 | Contrast the effects of conventional and non conventional fuels for IC engines. | 3 | 2 | 1 | 1 | L2 |
| 20ME405.5 | Develop the performance characteristics of gas turbines | 3 | 1 | 1 | 1 | 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 : Air standard Cycles & Actual Cycles and Analysis** **11 + 1 Hours**

Introduction of air standard cycles Otto, diesel and dual cycles, its comparison. Comparison of Air Standard and Actual Cycles, Introduction to IC Engines, Time Loss Factor, Heat Loss Factor, Exhaust & Blow down-Loss due to Gas exchange process, Volumetric Efficiency. Loss due to Rubbing Friction, Actual and Fuel-Air Cycles of CI Engines

**Unit – II : Combustion in S.I. and C.I. Engines** **11 + 1 Hours**

Classification of SI & CI engines ,Working principles, Valve and Port Timing Diagrams, Importance of flame speed and effect of engine variables –pre-ignition and knocking – combustion chamber –requirements, types. Four stages of combustion in SI & CI Engines – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence – nozzles used – fuel requirements and fuel rating – anti knock additives

**Unit – III : I.C. Engines, Measurement, Testing and Performance** **11 + 1 Hours**

Engine systems – Fuel, Carburettor, Fuel Injection System, Ignition, Cooling and Lubrication, principle of winkle engine, principles of supercharging and turbo charging. Normal Combustion and abnormal combustion, Types of Abnormal combustion, Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart.

**Unit – IV : Conventional and Non- Conventional Fuels** **11 + 1 Hours**

Different fossil fuels and their limitations, Engine requirements, different alternative liquid and gaseous fuels. Use of gaseous fuels like, befouls biogas, LPG, hydrogen, natural gas, producer gas etc. in SI/CI engines. Comparisons of performance and emission characteristics using conventional and non conventional fuels.

**Unit –V : Gas Turbines , Jet Propulsions & Rockets** **11 + 1 Hours**

Brayton cycle, Simple gas turbine plant – ideal cycle, essential components – parameters of performance – actual cycle – regeneration, inter cooling and reheating –closed cycle type gas turbines, merits and demerits, types of combustion chambers. Jet propulsions, Principle of operation –classification of jet propulsive engines – working principles with schematic diagrams and representation on t-s diagram - thrust, thrust power and propulsion efficiency – turbo jet engines, thermodynamic cycle, performance evaluation (Definitions and Simple Problems). Rockets working principle – classification – propellant type – thrust, propulsive efficiency – specific impulse – solid and liquid propellant rocket engines (only Theoretical concepts

**Text Books:**


1. Heywood J.B, I.C. Engines Fundamentals,10th Edition, TMH Publications, 2015
2. Ganesan. V, I.C. Engines, 15th Edition, TMH Publications., 2017
3. Pathak G.K. & DK Chevan, I.C. Engines, 9th Edition, Standard Publications, 2011
4. Rajput R.K, Thermal Engineering, 10th Edition, TMH Publications, 2015


**References:**


1. Fergnson & Wiley, I.C. Engines, 7th Edition, Cengage Publications, 2012
2. Teylor, The I.C. Engine in theory and Practice, Vol.I, 2018
3. Ramadhas A.S., Alternative Fuels for Transportation, 10th Edition, S. Chand Publications, 2019

**Web References:**

1. https://books.google.co.in/books/about/Internal_Combustion_Engines.html
2. https://www.expresslibrary.mheducation.com/product/ic-engines50044944

**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 Levels**

**L1: Remember**

1. Define the phenomenon Knocking in spark ignited engines?
2. What are assumptions made in air standard cycles?
3. What is meant by delay period?
4. Define Volumetric efficiency?
5. Define Mean effective pressure?
6. What is meant by abnormal combustion?
7. What do you mean by performance of IC engine?
8. List out the main parts of a CI & SI engine?

**L2: Understand**

1. Explain its importance for calculation o f volumetric efficiency in the performance test?.
2. List the different methods used for finding friction power and indicated power of an engine ,Explain in detail.?
3. Explain normal and abnormal combustions in SI engine?
4. Explain the phenomenon of knock in SI engine. Discuss the effect of engine variables on knock?
5. Discuss about Exhaust Blow down and Loss due to Gas exchange process.
6. What is ignition lag? Explain the factors effecting ignition lag?

**L3: Apply**

1. Determine the process of evaluating indicated power of an IC engine?
2. Compare actual cycle and air standard cycle of SI engine?
3. 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 cm, Length of the indicator diagram= 55 mm, Spring constant= 3.5 bar/cm. Find the indicated power of the engine.
4. Discuss the various methods for measurement of brake power?
5. Does the flame front exist in a C.I. engine? Explain
6. A test on a single-cylinder, four-stroke oil engine having a bore of 15 cm and stroke 30 cm gave the following results; speed 300 rpm; brake torque 200 Nm; indicated mean effective pressure 7 bar; fuel consumption 2.4 kg/h; cooling water flow 5 kg/min; cooling water temperature rise 350C; air-fuel ratio 22; exhaust gas temperature 4100C; barometer pressure 1 bar; room temperature 200C. The fuel has a calorific value of 42 MJ/kg and contains 15% by weight of hydrogen. Take latent heat of vaporization as 2250 kJ/kg. Determine: (i) The indicated thermal efficiency. (ii) The volumetric efficiency based on atmospheric conditions. Draw up a heat balance in terms of kJ/min. Take Cp for dry exhaust gas = 1 kJ/kgK and super-heated steam Cp = 2.1 kJ/kgK; R = 0.287kJ/kgK.?

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## PC 20ME406 Fluid Mechanics and Hydraulic 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 | PO2 | PO4 |
| 20ME406.1 | Find the forces of water jet striking on various types of vanes | 3 | 2 | 2 |
| 20ME406.2 | Evaluate the performance Pelton Wheel | 3 | 2 | 2 |
| 20ME406.3 | Evaluate the performance Francis Turbine | 3 | 2 | 2 |
| 20ME406.4 | Evaluate the performance Kaplan Turbine | 3 | 2 | 2 |
| 20ME406.5 | Evaluate the performance Single Stage Centrifugal Pump | 3 | 2 | 2 |
| 20ME406.6 | Evaluate the performance on Multi Stage Centrifugal Pump | 3 | 2 | 2 |
| 20ME406.7 | Evaluate the performance Reciprocating Pump | 3 | 2 | 2 |
| 20ME406.8 | Compare the accuracy of Venturimeter | 3 | 2 | 2 |
| 20ME406.9 | Compare the accuracy of Orifice | 3 | 2 | 2 |
| 20ME406.10 | Find the Friction Factor of given pipe. | 3 | 2 | 2 |
| 20ME406.11 | Find the Loss of Head Factor of given pipe. | 3 | 2 | 2 |
| 20ME406.12 | Calculate the Coefficient of Discharge of Flow Meter | 3 | 2 | 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. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.

### References

1. Lab Manual for Fluid mechanics and hydraulic machinery, Department of ME

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## PC 20ME407 Thermal Engineering 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 | PS02 |
| 20ME405.1 | Interpret the effect of various operating parameters in engine performance. | 3 | 1 | 1 |
| 20ME405.2 | Experiment with fuel metering and fuel supply for different IC engines | 3 | 1 | 1 |
| 20ME405.3 | Organize performance analysis of IC engines with normal and abnormal combustion phenomena. | 3 | 2 | 1 |
| 20ME405.4 | Contrast the effects of conventional and non conventional fuels for IC engines. | 3 | 2 | 1 |
| 20ME405.5 | Develop the performance characteristics of gas turbines | 3 | 1 | 1 |
| 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. I.C. Engines valve and port timing diagrams
2. Testing of Fuels – Viscosity, flash point, fire point, carbon residue, calorific value.
3. I.C. Engine performance test and Exhaust emission measurements (4 -stroke High Speed diesel engine)
4. I.C. Engine performance test and Exhaust emission measurements (4 -stroke Low Speed diesel engine)
5. Evaluation of friction power by conducting Morse test on 4-stroke multi cylinder engine.
6. Determination of Friction Power by retardation test on IC engine.
7. I.C. Engine heat balance at different loads and show the heat distribution curve.
8. Economical speed test of an IC engine.
9. Estimation of steam quality by throttling and separating calorimeter
10. Performance test on reciprocating air compressor unit.
11. Dis-assembly / assembly of different parts of two wheelers. 3 wheelers & 4 wheelers. Tractor & Heavy duty engines covering 2-stroke and 4 stroke, SI and CI engines.

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## ES 20CS407 Python Programming Lab 0 0 3 1.5

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

| Code | Course Outcomes | Mapping with POs | |
|---|---|---|---|
| | | PO1 | PO12 |
| 20CS403.1 | Illustrate the use of basic concepts of Python Programming | 3 | 1 |
| 20CS403.2 | Demonstrate the use of control Structures and Data Structures in Python | 3 | 1 |
| 20CS403.3 | Build programs using functions for resolving simple problems | 3 | 1 |
| 20CS403.4 | Explain the usage of Object oriented concepts and files | 3 | 1 |
| 20CS403.5 | Apply mathematical libraries for analyzing data sets with GUI | 3 | 1 |
| 1. Weakly Contributing \| 2. Moderately Contributing \| 3. Strongly Contributing, for the attainment of respective Pos | | | |

### List of Experiments

1. a. Write a program that asks the user for a weight in kilograms and converts it to pounds
   b. Write a program to find total and average of 3 numbers
   c. Write a program that uses a for loop to print the numbers 8, 11, 14, 17, 20, . . . , 83, 86, 89
2. a. Write a program that should print out the user's name the specified number of times
   b. Use for loop to print a triangle like the one below. Allow the user to specify how high the triangle should be

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   c. Generate a random number between 1 and 10. Ask the user to guess the number and print a message based on whether they get it right or not
3. a. Write a program that asks the user for two numbers and prints Close if the numbers are within .001 of each other and Not close otherwise
   b. Write a program that asks the user to enter a word and prints out whether that word contains any vowels
   c. Write a program that asks the user to enter two strings of the same length. If they are not, the program should print an appropriate message and exit
4. a. Write a program that asks the user for a large integer and inserts commas into it according to the standard American convention for commas in large numbers
   b. Write a program that asks the user for an algebraic expression and then inserts multiplication symbols where appropriate
5. Write a program that generates a list of 20 random numbers between 1 and 100.
   Print the list.
   a. Print the average of the elements in the list.
   b. Print the largest and smallest values in the list.
   c. Print the second largest and second smallest entries in the list
   d. Print how many even numbers are in the list
6. a. Write a program that asks the user for an integer and creates a list that consists of the factors of that integer
   b. Write a program that generates 100 random integers that are either 0 or 1. Then find the longest run of zeros, the largest number of zeros in a row
   c. Write a program that removes any repeated items from a list so that each item appears at most once. For instance, the list [1,1,2,3,4,3,0,0] would become [1,2,3,4,0]
7. a. Write a function called sum_digits that is given an integer num and returns the sum of the digits of numbers
   b. Write a function called first_diff that is given two strings and returns the first location in which the strings differ. If the strings are identical, it should return -1
   c. Write a function called number_of_factors that takes an integer and returns how many factors the number has
   d. Write a function called is_sorted that is given a list and returns True if the list is sorted and False otherwise
8. a. Write a function called root that is given a number x and an integer n and returns x1/n. In the function definition, set the default value of n to 2
   b. Write a function called primes that is given a number n and returns a list of the first n primes. Let the default value of n be 100

c. Write a function called merge that takes two already sorted lists of possibly different lengths, and merges Them into a single sorted list: i. Do this using the sort method ii. Do this without using the sort method

9. a. Write a program that reads a file consisting of email addresses, each on its own line. Your program should Print out a string consisting of those email addresses separated by semicolons.
   b. Write a program that reads a list of temperatures from a file called temps.txt, converts those temperatures to Fahrenheit, and writes the results to a file called ftemps.txt.
10. Write programs to demonstrate the usage of class
11. Write programs to demonstrate the usage of GUI
12. Write programs to demonstrate the usage Mat Plot lib library

## References

1. Lab Manual for " Python Programming ", Department of Computer Science Engineering, NSRIT

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SC **20MES02 Computer Numerical Control Programming** **1 0 2 2**

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

| Code | Course Outcomes | Mapping with POs | | | | | DoK |
|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO4 | P05 | PO10 | |
| 20MESO1.1 | Delineate the operation sequence and route sheet for given mechanical parts. | 3 | 1 | 1 | 1 | 1 | L1 |
| 20MES01.2 | Exemplify the selection criteria for CNC machines by describing principle, operation, procedural steps for different tooling. | 3 | 1 | 2 | 1 | 1 | L2 |
| 20MES01.3 | Load the part program with interface software application for automatic part programming. | 3 | 2 | 2 | 2 | 3 | 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: Fundamentals of process planning** **09 Hours**

Process planning, Structure of process plan, Factors influencing process plan, Sequence of operation of process plan, CAM, NC,CNC and DNC, Selection criteria for CNC machines, Adoptive Control, Classifications of CNC Machine, Modes of operation of CNC, Working of: Machine Structure, Sideways, Spindle drive, Axis drive, Recirculation ball screw Feedback devices (transducers, encoders), Automatic tool changer (ATC), Automatic pallet changer (APC), CNC axis and motion nomenclature, CNC tooling – tool pre setting, qualified tool, tool holders and inserts

**Unit II: G and M Codes** **09 Hours**

Axes Identification in CNC turning and Machining centres, Machine zero, home position, work piece zero, program zero, CNC part programming: Programming format and Structure of part program, ISO G and M codes for turning and milling-meaning and applications of important codes.

**Unit III: CNC Part Programming** **12 Hours**

Compensations: Tool length compensation, Pitch error compensation, Tool radius compensation, Simple part programming for turning using ISO format having straight turning, taper turning (linear interpolation) and convex/concave turning (circular interpolation), Simple part programming for milling using ISO format, Importance, types, applications and format for: Canned cycles, Macro, Do loops, Subroutine, Mirror image, CNC turning and milling part programming using canned cycles, Do loops and Subroutine, CAD CAM integration: Concept Steps involved in CAD/CAM integration, CAM software.

**Experiments List**

1. What is the operation sequence for given drawing
2. How to prepare route sheet for given drawing
3. Demonstrate CAM, NC, CNC and DNC and differentiate them.
4. Choose the selection criteria for CNC machines
5. Show working principle of CNC system with sketches.
6. Identify different modes of operations of CNC machine.
7. Explain different tooling used in CNC systems.
8. Develop part programs for given component on turning and milling machine.
9. Make use of various positions of machine and parts.
10. Utilize the program using canned cycles, Do loops and Subroutine

**Internal Assessment Pattern**

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

**Sample Questions of Various Cognitive Levels**

**L1: Remember**

1. What is the operation sequence for given mechanical component
2. How to prepare route sheet for given mechanical component
3. Choose the selection criteria for CNC machines for given mechanical component.
4. Show working principle of CNC system with sketches.

**L2: Understand**

1. Demonstrate CAM, NC, CNC and DNC and differentiate them.
2. Explain different tooling used in CNC systems.

**L3: Apply**

1. Identify different modes of operations of CNC machine.
2. Develop part programs for given component on turning and milling machine.
3. Make use of various positions of machine and parts.
4. Utilize the program using canned cycles, Do loops and Subroutine

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