**PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018**
**(AUTONOMOUS)**
**B.E- MECHANICAL ENGINEERING**
**REGULATIONS 2016**
**CURRICULUM**
**(CHOICE BASED CREDIT SYSTEM)**
**(For the candidates admitted during the Academic Year 2017-2018)**
**SEMESTER I**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | BS | MA16101 | Matrices and Calculus | 3 | 2 | 0 | 4 |
| 2 | HS | EN16101 | Technical English I | 3 | 0 | 0 | 3 |
| 3 | BS | PH16101 | Engineering Physics | 3 | 0 | 0 | 3 |
| 4 | BS | CH16101 | Engineering Chemistry I | 3 | 0 | 0 | 3 |
| 5 | ES | ME16101 | Engineering Graphics | 3 | 2 | 0 | 4 |
| 6 | ES | EE16101 | Basic Electrical & Electronics Engineering | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | BS | PC16101 | Physics & Chemistry Laboratory I | 0 | 0 | 2 | 1 |
| 8 | ES | ME16103 | Computer Aided Drafting Laboratory | 0 | 0 | 2 | 1 |
| 9 | ES | GE16101 | Engineering Practices Laboratory | 0 | 0 | 4 | 2 |
| | | | **Total** | **18** | **4** | **8** | **24** |

**SEMESTER II**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | BS | MA16201 | Differential Equations and Complex Analysis | 3 | 2 | 0 | 4 |
| 2 | HS | EN16201 | Technical English II | 3 | 0 | 0 | 3 |
| 3 | BS | PH16202 | Applied Physics | 3 | 0 | 0 | 3 |
| 4 | BS | CH16201 | Engineering Chemistry II | 3 | 0 | 0 | 3 |
| 5 | ES | CS16201 | Computer Programming | 3 | 0 | 0 | 3 |
| 6 | ES | ME16201 | Engineering Mechanics | 3 | 2 | 0 | 4 |
| **Practical** | | | | | | | |
| 7 | BS | PC16201 | Physics & Chemistry Laboratory II | 0 | 0 | 2 | 1 |
| 8 | ES | CS16202 | Computer Programming Laboratory | 0 | 0 | 2 | 1 |
| 9 | HS | EN16202 | English Communication Skills Laboratory | 0 | 0 | 2 | 1 |
| | | | **Total** | **18** | **4** | **6** | **23** |

## SEMESTER III

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | BS | MA16301 | Transforms and Boundary Value Problems | 3 | 2 | 0 | 4 |
| 2 | PC | ME16301 | Engineering Thermodynamics | 3 | 2 | 0 | 4 |
| 3 | PC | ME16302 | Manufacturing Technology I | 3 | 0 | 0 | 3 |
| 4 | PC | ME16303 | Engineering Materials and Metallurgy | 3 | 0 | 0 | 3 |
| 5 | ES | ME16304 | Fluid Mechanics and Machinery | 3 | 0 | 0 | 3 |
| 6 | ES | EE16305 | Electrical Machines and Drives | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | ME16305 | Manufacturing Technology Laboratory I | 0 | 0 | 4 | 2 |
| 8 | ES | ME16306 | Fluid Mechanics and Machinery Laboratory | 0 | 0 | 4 | 2 |
| 9 | ES | EE16306 | Electrical Engineering Laboratory | 0 | 0 | 4 | 2 |
| | | | **Total** | **18** | **4** | **12** | **26** |

## SEMESTER IV

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | BS | MA16404 | Numerical Methods | 3 | 2 | 0 | 4 |
| 2 | PC | ME16401 | Thermal Engineering | 3 | 0 | 0 | 3 |
| 3 | PC | ME16402 | Kinematics of Machinery | 3 | 0 | 0 | 3 |
| 4 | PC | ME16403 | Manufacturing Technology II | 3 | 0 | 0 | 3 |
| 5 | ES | ME16404 | Strength of Materials | 3 | 2 | 0 | 4 |
| 6 | HS | CH16403 | Environmental Science and Engineering | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | ME16405 | Thermal Laboratory | 0 | 0 | 4 | 2 |
| 8 | PC | ME16406 | Manufacturing Technology Laboratory II | 0 | 0 | 4 | 2 |
| 9 | ES | ME16407 | Strength of Materials Laboratory | 0 | 0 | 4 | 2 |
| 10 | HS | EN16401 | Business English Course Laboratory | 0 | 0 | 2 | 1 |
| | | | **Total** | **18** | **4** | **14** | **27** |

**SEMESTER V**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | ME16501 | Design of Machine Elements | 3 | 0 | 0 | 3 |
| 2 | PC | ME16502 | Dynamics of Machinery | 3 | 2 | 0 | 4 |
| 3 | PC | ME16503 | Heat and Mass Transfer | 3 | 2 | 0 | 4 |
| 4 | PC | ME16504 | Hydraulic and Pneumatic systems | 3 | 0 | 0 | 3 |
| 5 | PC | ME16505 | Metrology and Measurements | 3 | 0 | 0 | 3 |
| 6 | PE | ME1615* | Programme Elective I | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | ME16506 | Dynamics Laboratory | 0 | 0 | 2 | 1 |
| 8 | PC | ME16507 | Metrology and Measurements Laboratory | 0 | 0 | 2 | 1 |
| 9 | PC | ME16508 | Heat Transfer Laboratory | 0 | 0 | 2 | 1 |
| 10 | EE | EN16501 | Career Development Laboratory I | 0 | 0 | 2 | 1 |
| | | | **Total** | **18** | **4** | **8** | **24** |

**SEMESTER VI**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | ME16601 | Industrial Robotics | 3 | 0 | 0 | 3 |
| 2 | PC | ME16602 | Power Plant Engineering | 3 | 0 | 0 | 3 |
| 3 | PC | ME16603 | Gas Dynamics and Jet Propulsion | 3 | 0 | 0 | 3 |
| 4 | PC | ME16604 | Design of Transmission Systems | 3 | 2 | 0 | 4 |
| 5 | PC | ME16605 | Finite Element Analysis | 3 | 2 | 0 | 4 |
| 6 | OE | ******* | Open Elective I | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | ME16606 | Simulation and Analysis Laboratory | 0 | 0 | 2 | 1 |
| 8 | PC | ME16607 | Computer Aided Design Laboratory | 0 | 0 | 2 | 1 |
| 9 | EE | ME16608 | Design and Fabrication Project | 0 | 0 | 2 | 1 |
| 10 | EE | EN16601 | Career Development Laboratory II | 0 | 0 | 2 | 1 |
| | | | **Total** | **18** | **4** | **8** | **24** |

## SEMESTER VII

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | ME16701 | Mechatronics | 3 | 0 | 0 | 3 |
| 2 | PC | ME16702 | Computer Integrated Manufacturing Systems | 3 | 0 | 0 | 3 |
| 3 | PC | ME16703 | Automobile Engineering | 3 | 0 | 0 | 3 |
| 4 | HS | BA16151 | Professional Ethics and Human Values | 3 | 0 | 0 | 3 |
| 5 | PE | ME1625* | Programme Elective II | 3 | 0 | 0 | 3 |
| 6 | OE | ******* | Open Elective II | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 7 | PC | ME16704 | Mechatronics Laboratory | 0 | 0 | 2 | 1 |
| 8 | PC | ME16705 | Computer Aided Manufacturing Laboratory | 0 | 0 | 2 | 1 |
| 9 | EE | ME16706 | Project Work (Phase I) | 0 | 0 | 4 | 2 |
| | | | **Total** | **18** | **0** | **8** | **22** |

## SEMESTER VIII

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| **Theory** | | | | | | | |
| 1 | PC | BA16253 | Total Quality Management | 3 | 0 | 0 | 3 |
| 2 | PE | ******* | Programme Elective III | 3 | 0 | 0 | 3 |
| 3 | PE | ******* | Programme Elective IV | 3 | 0 | 0 | 3 |
| **Practical** | | | | | | | |
| 4 | EE | ME16801 | Project Work (Phase II) | 0 | 0 | 12 | 6 |
| | | | **Total** | **9** | **0** | **12** | **15** |

## LIST OF ELECTIVES

## PROGRAMME ELECTIVE I

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE | ME16151 | Unconventional Machining Processes | 3 | 0 | 0 | 3 |
| 2 | PE | ME16152 | Rapid Prototyping | 3 | 0 | 0 | 3 |
| 3 | PE | ME16153 | Theory of Metal Forming | 3 | 0 | 0 | 3 |
| 4 | PE | ME16154 | Solar Energy System | 3 | 0 | 0 | 3 |
| 5 | PE | ME16155 | Foundry Technology | 3 | 0 | 0 | 3 |

**OPEN ELECTIVE I**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | OE | ME16901 | Renewable Energy Sources | 3 | 0 | 0 | 3 |
| 2 | OE | ME16902 | Quality Control and Reliability Engineering | 3 | 0 | 0 | 3 |
| 3 | OE | ME16903 | Industrial Psychology and work ethics | 3 | 0 | 0 | 3 |

**PROGRAMME ELECTIVE II**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE | ME16251 | Maintenance Engineering | 3 | 0 | 0 | 3 |
| 2 | PE | ME16252 | Non-Destructive Evaluation Techniques | 3 | 0 | 0 | 3 |
| 3 | PE | ME16253 | Design of Jigs, Fixtures and Press Tools | 3 | 0 | 0 | 3 |
| 4 | PE | ME16254 | Micro Electro Mechanical Systems | 3 | 0 | 0 | 3 |
| 5 | PE | ME16255 | CNC Technology | 3 | 0 | 0 | 3 |

**PROGRAMME ELECTIVE III**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE | ME16351 | Productivity Management and Re-Engineering | 3 | 0 | 0 | 3 |
| 2 | PE | ME16352 | Tool Design | 3 | 0 | 0 | 3 |
| 3 | PE | ME16353 | Welding Technology | 3 | 0 | 0 | 3 |
| 4 | PE | ME16354 | Composite Materials and Mechanics | 3 | 0 | 0 | 3 |
| 5 | PE | BA16451 | Entrepreneurship Development | 3 | 0 | 0 | 3 |

**PROGRAMME ELECTIVE IV**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | PE | ME16451 | Production Planning and Control | 3 | 0 | 0 | 3 |
| 2 | PE | ME16452 | Refrigeration and Air Conditioning | 3 | 0 | 0 | 3 |
| 3 | PE | ME16453 | Industrial Tribology | 3 | 0 | 0 | 3 |
| 4 | PE | ME16454 | Advanced I.C. Engines | 3 | 0 | 0 | 3 |
| 5 | PE | BA16352 | Engineering Economics | 3 | 0 | 0 | 3 |

**OPEN ELECTIVE II**

| S.No. | Category | Course Code | Course Title | L | T | P | C |
|---|---|---|---|---|---|---|---|
| 1 | OE | ME16904 | Energy Conservation and Management | 3 | 0 | 0 | 3 |
| 2 | OE | ME16905 | Safety Engineering and Environmental Systems | 3 | 0 | 0 | 3 |
| 3 | OE | ME16906 | Plant Layout and Material Handling | 3 | 0 | 0 | 3 |

**ME16701 MECHATRONICS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the structural and functional principles of sensors and transducers used for various physical and nonelectric quantities and how to use them to measure these quantities.
- describe the constructional and functional aspects of mechanical actuators and stepper and servo motors
- get a precise idea about the system structural models and working of controllers
- learn structure and processing of PLC
- gain knowledge about the elements and techniques involved in Mechatronic systems which are very much essential to understand the emerging field of automation.

**UNIT I MECHATRONICS, SENSORS AND TRANSDUCERS 9**

Introduction to Mechatronics Systems – Measurement Systems – Control Systems. Sensors and Transducers -Performance Terminology – Potentiometer displacement sensor - Inductive displacement sensor - Hall effect sensor- Photoelectric sensor - Eddy current Proximity sensor. Tacho - generator- Strain gauge load cell, Orifice meter, Differential pressure liquid level detector, Resistant temperature detector, Photodiode and Photo transistor light sensors. Selection of Sensors.

**UNIT II ACTUATION SYSTEMS 9**

Pneumatic and Hydraulic Systems – Rotary Actuators. Mechanical Actuation Systems - Cams- Ratchet and pawl-Belt and Chain Drives. Stepper Motors - switching circuitries for stepper motor – AC & DC Servo motors. Mechanical Switches-Solid State Switches-Diode-SCR-TRIAC.

**UNIT III SYSTEM MODELS AND CONTROLLERS 9**

Building blocks of Mechanical, Fluid and Thermal Systems, Rotational – Electromechanical Systems-Hydraulic – Mechanical Systems. Continuous and discrete process Controllers – Control Mode – Two – Step mode - Proportional Mode – Derivative Mode – Integral Mode – PID Controllers- Digital Controllers – Velocity Control – Adaptive Control - Architecture of 8085 and 8051.

**UNIT IV PROGRAMMING LOGIC CONTROLLERS 9**

Programmable Logic Controllers – Basic Structure – Input / Output Processing –Programming – Mnemonics –Internal relays and counters – Shift Registers –Master and Jump Controls – Data Handling – Analogs Input / Output – Selection of a PLC.

**UNIT V DESIGN OF MECHATRONICS SYSTEM 9**

Stages in designing Mechatronics Systems – Traditional and Mechatronic Design – Possible Design Solutions. Case studies of Mechatronics systems- Pick and place Robot- Wireless surveillance balloon - Engine Management system- Automatic car park barrier.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- design components and systems to integrate computers, sensors and transducers in mechanical system to meet desired needs.
- have a strong foundation in actuators and fundamental operations of stepper and servo motors in the field of engineering and technology.
- design experiments to evaluate system performance with respect to specifications.
- integrate PLC with Mechanical, Electronic and computer engineering components in the design of mechatronics system.
- develop mechatronics systems for various engineering applications.

**TEXT BOOKS**


1. Bolton,W, "Mechatronics" , Pearson education, Sixth edition, 2015
2. Smaili.A and Mrad.F, "Mechatronics integrated technologies for intelligent machines", Oxford University Press, 2008.


**REFERENCES**


1. Rajput. R.K, "A Textbook of Mechatronics", S. Chand & Co, Fourth edition, 2014
2. Devadas Shetty and Richard A.Kolk, "Mechatronics systems design", PWS Publishing company, 2007.
3. Michael B. Histand and David G. Alciatore, "Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, Third Edition, 2006.
4. Dan Necsulesu, "Mechatronics", Pearson Education Asia, 2002 (Indian Reprint).
5. Bradley D. A., Dawson D., Buru N.C. and. Loader A.J, "Mechatronics", Chapman and Hall, 1993.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **CO2** | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **CO3** | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **CO4** | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 2 |
| **CO5** | 2 | - | 1 | - | - | - | - | - | - | - | - | - | 2 | 2 |

**ME16702 COMPUTER INTEGRATED MANUFACTURING SYSTEMS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the integration concept of CAD/CAM, Production planning and control under CIM.
- familiarize the principles of computer aided process planning, Inventory control, MRP and ERP.
- gain knowledge on the design of a manufacturing cell and the elements of cellular manufacturing system.
- learn about the components of Flexible Manufacturing System and AGVs.
- understand the basic concepts of robots, robot anatomy and its industrial applications.

**UNIT I INTRODUCTION 10**

Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control- Introduction to CAD/CAM – Concurrent Engineering-CIM concepts – Computerized elements of CIM system –Types of production – Manufacturing models and Metrics – Mathematical models of Production Performance – Manufacturing Control – Basic Elements of an Automated system – Levels of Automation – Lean production and Just-In-Time Production.

**UNIT II PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING 10**

Process planning – Computer aided process planning (CAPP) - Logical steps in computer aided process planning- Aggregate Production Planning and the Master Production Schedule - Material Requirement planning - Capacity Planning - Control Systems - Shop Floor Control - Inventory Control - Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP).

**UNIT III CELLULAR MANUFACTURING 9**

Group Technologies(GT), Part families - Parts Classification and coding - Opitz Part Coding System - Production flow Analysis - Cellular Manufacturing - Composite part concept - Machine cell design and Layout - Quantitative analysis in Cellular Manufacturing - Rank Order Clustering Method - Arranging Machines in a GT cell - Hollier Method – Simple Problems.

**UNIT I V FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS) 8**

Types of Flexibility - FMS – FMS Components - FMS Application & Benefits - FMS Planning and Control–Quantitative analysis in FMS - Automated Guided Vehicle System (AGVS) – AGVS Application– Vehicle Guidance technology -Vehicle Management & Safety.

**UNIT V INDUSTRIAL ROBOTICS 8**

Robot Anatomy and Related Attributes - Classification of Robots - Robot Control systems - End Effectors - Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot Applications - Robot Part Programming - Robot Accuracy and Repeatability.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe the importance and scope of CIM in fabrication/ manufacturing industries.
- prepare CAPP (Computer Aided Process Planning) for manufacturing processes.
- demonstrate implementation of cellular manufacturing system in industries.
- explain about FMS, AGVs and its applications.
- develop robots and its components for different applications.

**TEXT BOOKS**


1. Mikell.P.Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India, 2016.
2. Radhakrishnan P, Subramanyan S. and Raju V., "CAD/CAM/CIM", 2nd Edition, New Age International (P) Ltd, New Delhi, 2008.


**REFERENCES**


1. Gideon Halevi and Roland Weill, "Principles of Process Planning – A Logical Approach", London, 2012.
2. Singh. N, "Systems Approach to Computer-Integrated Design and Manufacturing", Wiley India Pvt Ltd., 2011.
3. Kant Vajpayee S, "Principles of Computer Integrated Manufacturing", Prentice Hall India, 2003.
4. James A. Rehg, "Introduction to Robotics in CIM Systems", Prentice Hall, 5th edition, 2002.
5. Rao. P. N Tewari & T.K. Kundra, "Computer Aided Manufacturing", Tata McGraw Hill Publishing Company, 2000.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO2** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO3** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO4** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO5** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |

**ME16703 AUTOMOBILE ENGINEERING 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the construction and working principles of various parts of an automobile
- have clear understanding of different auxiliary systems.
- gain knowledge about different types of transmission systems
- learn the concepts and working principles of steering, brakes and suspension systems
- acquire knowledge on alternate energy sources in automobiles.

**UNIT I VEHICLE STRUCTURE AND ENGINES 10**

Types of Automobiles, Vehicle Construction and different layouts, Chassis, Frame and Body, Vehicle Aerodynamics (various resistances and moments involved), IC engines – components - functions and materials, variable valve timing (VVT).

**UNIT II ENGINE AUXILIARY SYSTEMS 10**

Electronically controlled gasoline injection system for SI engines, Electronically controlled diesel injection system (Unit injector system, Rotary distributor type and CRDI system), Electronic ignition system (Transistorized coil ignition system, capacitive discharge ignition system), Turbo chargers (WGT, VGT), Engine Emission control by 3-Way catalytic convertor system, Emission norms (Euro and BS).

**UNIT III TRANSMISSION SYSTEMS 10**

Clutch – Types and Construction, Gear Boxes - Manual and Automatic, Gear Shift Mechanisms – Over Drive, Transfer Box, Fluid flywheel, Torque converter, Propeller shaft, Slip Joints, universal joints, Differential and Rear Axle, Hotchkiss Drive and Torque Tube Drive.

**UNIT IV STEERING, BRAKES AND SUSPENSION SYSTEMS 8**

Steering Geometry and Types of steering gear box – Power Steering, Types of Front Axle, Types of Suspension systems, pneumatic and hydraulic braking systems, Antilock braking system (ABS), Electronic brake force distribution (EBD) and traction control.

**UNIT V ALTERNATIVE ENERGY SOURCES 7**

Use of Natural Gas, Liquefied petroleum gas (LPG), Bio-diesel, Bio-ethanol, Gasohol and hydrogen in Automobiles – Engine modification required – performance, Combustion and Emission characteristics of SI and CI engines with these alternate fuels - Autonomous Vehicle - Electric and Hybrid vehicles, Fuel Cell.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

On successful completion of the course, the student will be able to,

- demonstrate knowledge on vehicle construction and IC Engine components
- describe the principle and working of CRDI, MPFI, electronic fuel injection system, ignition

system and 3-way catalytic converter system.

- differentiate between clutch, gear box, rear axle drives, fluid flywheel, and torque converter.
- demonstrate knowledge on parts like the wheels, tyres, steering gear box, suspension system-telescopic, and leaf spring.
- appraise the recent trends in automobile like alternate fuels in automobiles.

**TEXT BOOKS**


1. Kirpal Singh, "Automobile Engineering", Vol 1 & 2, Seventh Edition, Standard Publishers, New Delhi, 2014.
2. Jain K.K. and Asthana.R.B, "Automobile Engineering" Tata McGraw Hill Publishers, New Delhi, 2014.


**REFERENCES**


1. Martin W, Stockel and Martin T Stockle, "Automotive Mechanics Fundamentals," The Good heart –Will Cox Company Inc, USA, 2008.
2. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007.
3. Newton, Steeds and Garet, "Motor Vehicles", Butterworth Publishers, 2007.
4. Joseph Heitner, "Automotive Mechanics," Second Edition, East-West Press, 2004.
5. Heinz Heisler, "Advanced Engine Technology," SAE International Publications USA, 1998.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO2** | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO3** | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO4** | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO5** | 2 | - | - | - | 2 | - | - | - | - | - | - | 1 | 2 | 2 |

**BA16151 PROFESSIONAL ETHICS AND HUMAN VALUES 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the basic human values for a professional.
- discuss the significance of ethics in engineering and the theories related to it
- familiarize oneself with the role of engineer as responsible experimenters
- expose the students to their roles and responsibilities in assessing safety and reducing risks
- describe the global issues in ethics and role of engineers as manager and consultants.

**UNIT I HUMAN VALUES 10**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time –Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality.

**UNIT II ENGINEERING ETHICS 9**

Senses of „Engineering Ethics‟ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg‟s theory – Gilligan‟s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.

**UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9**

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – a Balanced Outlook on Law- the challenger case study.

**UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9**

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - the Three Mile Island and Chernobyl case studies Collegiality and loyalty -Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination

**UNIT V GLOBAL ISSUES 8**

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership – sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers(India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers(IETE), India,etc.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe the basic human values for a professional.
- understand the significance of ethics in engineering and the theories related to it.

- be familiar with the role of engineer as responsible experimenters.
- acquire knowledge about their roles and responsibilities in assessing safety and reducing risks.
- discuss the global issues in ethics and role of engineers as manager and consultants

**TEXT BOOKS**


1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics –Concepts and Cases", Thompson Learning, 2000.


**REFERENCES**


1. Charles B Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, 2008.
2. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective",Biztantra, New Delhi, 2004.
3. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, 2003.
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, 2003.
5. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, 2001.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16704 MECHATRONICS LABORATORY 0 0 2 1**

**COURSE OBJECTIVES**

To enable the students to

- acquire practical knowledge on working principles of hydraulic, electro pneumatic kit with Programmable Logic Controller (PLC)
- learn interfacing of servo controller for open and closed loop circuits
- know interfacing of Proportional, Integral and Derivative (PID) controller and stepper motor
- provide practical hands on experience with Assembly Language Programming using 8085 microprocessor

**LIST OF EXPERIMENTS**

1. Design of basic pneumatic circuits using Electro pneumatic trainer kits.
2. Simulation of Hydraulic and Pneumatic circuits using simulation software
3. Simulation of Electro Pneumatic and electro hydraulic circuits using simulation software
4. Circuits with multiple cylinder sequences in Electro pneumatic using PLC
5. Servo controller interfacing for open loop
6. Servo controller interfacing for closed loop
7. PID controller interfacing
8. Stepper motor interfacing with 8051 Micro controller(i) Full step resolution (ii) Half step resolution
9. Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division
10. Speed control circuit using basic hydraulic kit

**TOTAL PERIODS 30**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- simulate Hydraulic, Pneumatic and Electric circuits using software tool
- conduct experiments using servo controller
- apply speed control of stepper motor using PID
- understand and apply the fundamentals of assembly level programming of microprocessors and microcontroller


**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16705 COMPUTER AIDED MANUFACTURING LABORATORY 0 0 2 1**

**COURSE OBJECTIVES**

To enable the students to

- understand the basic concepts of computer numerical control (CNC) machine tool and CNC Programming.
- learn the different types of CNC Machine - Basic working principle, Axis movements, G & M code development programing and test run of programmed part.
- get practical knowledge on different cycles like canned cycle drilling, peck drilling, boring
- demonstrate CL Data and Post process generation using CAM packages

The Lab has Production model CNC lathe and CNC milling machines with CAM simulation Software (Edge CAM)

**Exercises**

**Manual Part Programming**

**Part Programming - CNC Turning Centre**

a. Simple Facing
b. Straight Turning
c. Contouring
d. Facing Cycle
    (i) Box Facing
    (ii) Taper Facing
    (iii) Multiple Facing
e. Turning Cycle
    (i) Box turning
    (ii) Taper turning
    (iii) Multiple turning
f. Pattern Repeating
g. Grooving cycle
h. Thread Cutting.
    (i) External Box threading
    (ii) Multiple Threading cycle
i. End face Peck Drilling Cycle.
j. Boring cycle
k. Parting off

**(i) Part Programming - CNC Machining Centre**

a. Linear and circular interpolation

b. Contouring

(i) Cutter diameter compensation

(ii) subprogram

c. Mirroring

d. Drilling

e. Pocketing

f. Rotation

g. Scaling

h. Canned Cycle - Drilling

i. Canned Cycle -Peck drilling

j. Canned Cycle -Boring

k. Tapping cycle

l. CL Data and Post process generation using CAM packages.

**TOTAL PERIODS 30**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- understand and use G and M codes and manual part programming.
- get exposure to modern control systems (Fanuc, Siemens etc).
- know the working principles and application of various CNC machines.
- apply CL Data and Post process generation using CAM packages

**CO-PO Mapping**

| **Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16706** **PROJECT WORK ( PHASE I)** **0 0 4 2**

**COURSE OBJECTIVES**

To enable the students to

- develop ability to identify problems to solve through project works.
- get exposure to literature review related to project problem and how to find the gap.
- get exposure to required design procedure, experimental setup, analysis package to solve the identified problem.
- Prepare project reports, practice to face viva- voce examination.

**GUIDELINES**

1. The students are expected to get formed into a team of convenient groups of not more than 4 members for a project.
2. Every project team shall have a guide who is the member of the faculty of the institution. Identification of student group and their faculty guide need to be completed within the first two Weaks from the day of the beginning of 7$^{th}$semester.
3. The group has to identify and select the problem to be addressed as their project work; work through literature survey and finalize a comprehensive aim and scope of their work.
4. 30% of the total work of the project work has to be completed by end of 7th semester.
5. A mini project report (of the phase-I) to this effect has to be submitted by each student group.
6. Three reviews and end semester review of the progress of the project work have to be conducted by a team of faculty (minimum 3 and a maximum of 5) along with their faculty guide as a member the review team.
7. The same team of faculty will evaluate the project phase-I report. This evaluation will form 50% of the internal assessment mark. The remaining 50% of the internal assessment mark will be given at the end of the 8$^{th}$ semester, at the time of completing the full project work.

**TOTAL PERIODS 60**

**COURSE OUTCOMES**

On completion of the project work, the students will be able to

- identify feasible problems to solve through project works
- Collect literature through research journals and identify the gap in selected area
- Devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project
- Prepare project report as per format and confidently face viva voce with proper PPT for presentation

**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO2** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |

## PROGRAMME ELECTIVE II

**ME16251 MAINTENANCE ENGINEERING 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- learn the principles of maintenance and planning activities required for maintenance.
- explore the fundamentals of maintenance policies and classification of maintenance.
- gain knowledge on condition monitoring.
- get in-depth knowledge of repair methods of machine elements and its maintenance.
- gain in-sight into repair methods for material handling equipment.

**UNIT I PRINCIPLE AND PRACTICES OF MAINTENANCE PLANNING 10**

Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.

**UNIT II MAINTENANCE POLICIES – PREVENTIVE MAINTENANCE 9**

Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.

**UNIT III CONDITION MONITORING 9**

Condition Monitoring – Cost comparison with and without CM – On-load testing and off-load testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis.

**UNIT IV REPAIR METHODS FOR BASIC MACHINE ELEMENTS 9**

Repair methods for beds, slideways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location.

**UNIT V REPAIR METHODS FOR MATERIAL HANDLING EQUIPMENT 8**

Repair methods for Material handling equipment - Equipment records – Job order systems - Use of computers in maintenance.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- have a comprehensive understanding of the basic principles of maintenance, planning principles of maintenance activity, importance of maintenance planning, factors availability of maintenance planning.
- have good grounding on different types of maintenance- comparison of merits of different

types of maintenance and also gain knowledge on preventive maintenance, maintenance schedules and repair cycle.

- acquire knowledge on monitoring techniques, cost of condition monitoring, wear debris analysis.
- demonstrate knowledge on material condition and methods used to repair the elements, sequential fault location.
- discuss technically the elements of computer maintenance, job order systems, and methods of material handling equipment.

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**TEXT BOOKS**


1. Srivastava S.K., "Industrial Maintenance Management", S.Chand and Co., 2002.
2. Bhattacharya S.N., "Installation, Servicing and Maintenance", S.Chand and Co., 2001.


**REFERENCES**


1. White E.N., "Maintenance Planning", I Documentation, Gower Press, 2005.
2. Garg M.R., "Industrial Maintenance", S. Chand & Co., 2010.
3. Davies, "Handbook of Condition Monitoring", Chapman &Hall, 1998.
4. Armstrong, "Condition Monitoring", BSIRSA, 1988.
5. Higgins L.R., "Maintenance Engineering Hand book", McGraw Hill, 5th Edition, 1988.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16252 NON - DESTRUCTIVE EVALUATION TECHNIQUES 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- learn the basic concepts on non - destructive testing and its limitations**.**
- gain knowledge of NDT methods like liquid penetrant and magnetic particle testing
- know the basic principles of eddy current and thermography testing.
- understand the principles of ultrasonic testing.
- familiarize the concepts involved in radiography techniques.

**UNIT I INTRODUCTION TO NON-DESTRUCTIVE TESTING 7**

Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects as well as material characterization; Comparison of advantages and limitations of different NDT methods; Visual inspection.

**UNIT II SURFACE NDT, LIQUID PENETRANT (PT), MAGNETIC PARTICLE TESTING (MT) 8**

PT: Physical Principles – procedure - testing methods - Applications and limitations; MT: Magnetization, principles - methods - Equipment‟s - evaluation of results.

**UNIT III THERMOGRAPHY AND EDDY CURRENT TESTING (ET) 10**

Thermography – principles - contact and non-contact methods - Active and Passive Thermography - Application in flaw detection; ET: Principles - permeability and conductivity-Testing for defects-material characterization and Sorting.

**UNIT IV ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) 10**

Principle - Transducers - transmission and pulse - echo method - straight beam and angle beam – Instrumentation - data representation - A-scan- B-scan-C-scan; Phased Array Ultrasound-Time of Flight-Diffraction.

**UNIT V RADIOGRAPHY (RT) 10**

Principle - interaction of X-Ray with matter-imaging - film and film less techniques - Computed Radiography -Computed Tomography.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe knowledge on various NDT techniques to carry out inspections in accordance with the established procedures.
- evaluate concepts involved in the liquid penetrant and magnetic testing methods.
- demonstrate knowledge on thermography and eddy current testing and its behavior.
- employ the functions of transducer and principle of ultrasonic testing at appropriate places.
- illustrate knowledge on radiography techniques and its elements.

**TEXT BOOKS**

1. Prakash Ravi., "Nondestructive Testing Techniques", New Age International Publishers. 1st Rev Edition., 2017.
2. Paul E Mix, "Introduction to Non-destructive Testing: a training guide, Wiley", 2nd edition New Jersey.,2005.

**REFERENCES**


1. Charles., J. Hellier., "Handbook of Non-destructive evaluation", 2nd edition McGraw Hill., New York, 2013.
2. J. Prasad and C. G. K. Nair., "Non-Destructive Test and Evaluation of Materials", Tata McGraw-Hill Education, 2nd edition 2011.
3. Baldev Raj., B. Venkataraman., O. J.Varde., Nerulikar., "Practical Magnetic Particle Testing", Narosa Publishing House.,2007.
4. B.P.C. Rao., "Practical Eddy Current Testing", Alpha Science International Limited, 2006.
5. B. Raj., T. Jayakumar and M. Thavasimuthu., "Practical Non-Destructive Testing", Alpha Science International Limited, 3rd edition, 2002.


**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 1 | 1 | 1 | 1 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO2** | 2 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO3** | 2 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO4** | 2 | 1 | 1 | 3 | 1 | - | - | - | - | - | - | 1 | 2 | 2 |
| **CO5** | 2 | 1 | 1 | 3 | 2 | - | - | - | - | - | - | 1 | 2 | 2 |

**ME16253 DESIGN OF JIGS, FIXTURES AND PRESS TOOLS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- study the functions of Jigs and Fixtures.
- gain proficiency in design and development of jigs.
- understand the principles, functions and design practices of Fixtures.
- gain the knowledge of press working terminologies and operations.
- become familiar with the design of dies for bending, forming and drawing operations.

**(Use of approved design data book is permitted)**

**UNIT I PURPOSE TYPES AND FUNCTIONS OF JIGS AND FIXTURES 8**

Tool design objectives - Production devices - Inspection devices - Materials used in Jigs and Fixtures -Types of jigs - Types of Fixtures - Mechanical actuation - pneumatic and hydraulic actuation - Analysis of clamping force – Tolerance and error analysis.

**UNIT II DESIGN AND DEVELOPMENT OF JIGS 9**

Drill bushes - plate latch, channel, box, post, angle plate, angular post, turnover, Pot jigs - Automatic drill jigs - Rack and pinion operated. Air operated Jigs components. Design and Development of Jigs for given components.

**UNIT III DESIGN AND DEVELOPMENT OF FIXTURES 9**

General principles of boring, lathe, milling and broaching fixtures - grinding, planning and shaping fixtures, assembly, inspection and welding fixtures - Modular fixtures. Design and development of fixtures for given component**.**

**UNIT IV PRESS WORKING TERMINOLOGIES AND ELEMENTS OF DIES AND STRIP LAY OUT 10**

Press working terminology - Presses and press accessories - Computation of capacities and tonnage requirements. Elements of progressive combination and compound dies: Die block - die shoe. Bolster Plate - punch plate – punch holder - guide pins and bushes - strippers - knockouts - stops - pilots - Selection of standarddie sets strip lay out – strip lay out calculations.

**UNIT V DESIGN AND DEVELOPMENT OF DIES 9**

Design and development of progressive and compound dies for blanking and piercing operations. Bending dies - Development of bending dies - forming and drawing dies - Development of drawing dies. Design considerations in forging, extrusion, casting and plastic dies.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe the selection of jigs and fixtures and design suitable actuation for fixtures.

- become proficient in different types of jigs for various products.
- implement in practice the principles of design and development of fixtures for different components
- internalize press working terminologies and operations.
- design the dies for bending, forming and drawing operations.

**TEXT BOOKS**

1. Joshi, P.H., "Jigs & Fixtures", Second Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi 2004.
2. Edward G Hoffman, "Jigs & Fixture Design", Thomson – Delmar Learning, Singapore 2004.

**REFERENCES**


1. K. Venkataraman., "Design of Jigs, Fixtures and Press Tools", John Wiley & Sons, 2015.
2. Hiram E Grant, "Jigs and Fixture" Tata McGraw-Hill, New Delhi, 2003.
3. "Fundamentals of Tool Design", CEEE Edition, ASTME, 1983.
4. Kempster, "Jigs & Fixtures Design", The English Language Book Society", 1978.
5. Design Data Handbook PSG College of Technology, Coimbatore.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |

**ME16254 MICRO ELECTRO MECHANICAL SYSTEMS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- gain knowledge on lithography techniques for Micro/Nano systems.
- understand different sensor packaging technologies.
- study the various types of techniques of mechanical transduction.
- familiarize with pressure sensors techniques and types.
- learn about various electronic devices of MEMS.

**UNIT I INTRODUCTION 8**

Introduction, Materials-substrates, Additive materials. Introduction to Micro fabrication - Silicon based MEMS processes – Fabrication techniques - Deposition, Lithography etching, Surface micro machining, Thick film screen-Printing and electroplating.

**UNIT II MECHANICAL SENSOR PACKAGING 8**

Introduction, Standard IC packages - ceramic, plastic and metal packages. Packaging process - Electrical Interconnects, Methods of die attachment, sealing techniques. MEMS mechanical sensor packaging.

**UNIT III MECHANICAL TRANSDUCTION TECHNIQUES 9**

Piezoresistive sensor materials, Piezo resistivity, Piezoelectricity, Capacitive Techniques, Optical techniques, Resonant techniques. Actuation techniques, Smart Sensors. MEMS Simulation and Design Tools - Behavioral modelling Simulation tools and Finite element simulation tools.

**UNIT IV PRESSURE SENSORS 12**

Introduction. Techniques for sensing. Physics of pressure sensing-Pressure sensor specifications. Dynamic Pressure sensing. Pressure sensor types. MEMS technology pressure sensors-Micro Machined Silicon diaphragms.

**UNIT V FORCE, TORQUE AND INERTIAL SENSORS 8**

Introduction - Silicon based devices - Optical devises - capacitive devices-Magnetic devices - Atomic force microscope and scanning probes - micro machined accelerometer - Micro Machined Gyroscope - Future inertial micro machined sensors

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe the fundamental working principles of micro fabrication techniques.
- get strong understanding of mechanical sensor packaging in MEMS.
- apply their knowledge about transduction techniques and MEMS simulation.
- become conversant with the working principles of sensing techniques.
- demonstrate knowledge on various electronic devices involved in MEMS.

**TEXT BOOKS**

1. Tai Ran Hsu, "MEMS & Micro systems Design and Manufacture" Tata McGraw Hill, New Delhi, 2002
2. Nadim Maluf and Kirt Williams,‟ An introduction to Micro electro mechanical System Engineering, Artech House, Inc. Boston 1991

**REFERENCES**


1. Thomas M.Adams and Richard A.Layton, "Introduction MEMS, Fabrication and Application," Springer 2012.
2. James J.Allen, "Micro Electro Mechanical System Design", CRC Press Publisher, 2010.
3. Chang Liu, "Foundations of MEMS", Pearson Education Inc., 2006.
4. Stephen Beeby, Graham Ensell, Michael Kraft and Neil White,‟ MEMS Mechanical sensors‟ Artech House, Inc. Boston 2003.
5. Julian w. Gardner, Vijay K. Varadan, Osama O. Awadelkarim, "Micro Sensors MEMS and Smart Devices", JohnWiley& Son LTD,2002.


**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO2** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO3** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO4** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO5** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |

**ME16255 CNC TECHNOLOGY 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the basic concepts of Computer Numerical Control (CNC) of machine tools.
- understand the various drives and controls, cutting tool materials and work holding devices for rotating and fixed work parts.
- To know the different M & G codes for create the CNC programme.
- To write the CNC programme with and without loops and other functions.
- To use the different inserts for the different tool holding device.

**UNIT I INTRODUCTION TO CNC MACHINE TOOLS 6**

Evolution of CNC Technology, principles, features, advantages, applications, CNC and DNC concept, classification of CNC Machines – turning centre, machining centre, grinding machine, EDM, types of control systems, CNC controllers, characteristics, interpolators– Computer Aided Inspection.

**UNIT II STRUCTURE OF CNC MACHINE TOOL 10**

CNC Machine building, structural details, configuration and design, guide ways – Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion –Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings.

**UNIT III DRIVES AND CONTROLS 9**

Spindle drives – DC shunt motor, 3 phase AC induction motor, feed drives – stepper motor, servo principle, DC and AC servomotors, Open loop and closed loop control, Axis measuring system – synchro, synchro-resolver, gratings, moiré fringe gratings, encoders, inductosysn, laser interferometer.

**UNIT IV CNC PROGRAMMING 11**

Coordinate system, structure of a part program, G & M Codes, tool length compensation, cutter radius and tool nose radius compensation, do loops, subroutines, canned cycles, mirror image, parametric programming, machining cycles, programming for machining centre and turning centre for well known controllers such as Fanuc, Heidenhain, Sinumerik etc., generation of CNC codes from CAM packages.

**UNIT V TOOLING AND WORK HOLDING DEVICES 9**

Introduction to cutting tool materials – Carbides, Ceramics, CBN, PCD–inserts classification- PMK, NSH, qualified, semi qualified and preset tooling, tooling system for Machining centre and Turning centre, work holding devices for rotating and fixed work parts, economics of CNC, maintenance of CNC machines.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- learn about classification of CNC Machines, types of control systems.
- learn about structural details, types of guide ways, rotary motion to a linear motion, torque transmission elements.
- learn about Spindle drives, DC and AC servomotors, Axis measuring system
- learn about programming for machining centre and turning centre for well known controllers
- write the variety of programme for different application.

**TEXT BOOKS**


1. Rao P.N., CAD/CAM, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.
2. Warren S.Seamers, "Computer Numeric Control", Fourth Edition – Thomson Delmar, 2002.


**REFERENCES**


1. James Madison, "CNC Machining Hand Book", Industrial Press Inc., 1996.
2. Ken Evans, John Polywka & Stanley Gabrel, "Programming of CNC Machines", Second Edition – Industrial Press Inc, New York, 2002
3. Peter Smid, "CNC Programming Hand book", Industrial Press Inc., 2000
4. Berry Leathan – Jones, "Introduction to Computer Numerical Control", Pitman, London, 1987.
5. Radhakrishnan P "Computer Numerical Control Machines", New Central Book Agency, 2002.


**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | 3 | - | - | 2 | - | - | - | 3 | 3 | - | 3 | 3 | 3 |
| **CO2** | 3 | 2 | - | - | 2 | - | - | - | 2 | 2 | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | - | - | 2 | - | - | - | 3 | 3 | - | 2 | 3 | 3 |
| **CO4** | 3 | 2 | - | - | 3 | - | - | - | 3 | 3 | - | 2 | 2 | 3 |
| **CO5** | 3 | 2 | - | - | 3 | - | - | - | 2 | 3 | - | 2 | 3 | 3 |

## OPEN ELECTIVE II

**ME16904 ENERGY CONSERVATION AND MANAGEMENT 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the basic principles of energy consumption and know how energy auditing is applied in engineering practice.
- gain knowledge on the analysis of various power generation systems involved in electrical systems.
- know the fundamentals of boilers and the factors to improve their efficiency.
- acquire knowledge for conserving energy from pumps, fans, refrigeration and air conditioning systems.
- learn the concepts of Energy resource management and utilize the available resources in optimal ways.

**UNIT I IMPORTANCE OF ENERGY CONSERVATION AND MANAGEMENT 8**

World, national Energy consumption – environmental aspects – Energy prices, policies – Energy auditing: methodology, analysis, energy accounting – Measurements – Thermal and Electrical.

**UNIT II ELECTRICAL SYSTEMS 12**

AC / DC current systems, Demand control, power factor correction, load management, Motor drives: motor efficiency testing, energy efficient motors, motor speed control – Lighting: lighting levels, efficientoptions, daylighting, timers, Energy efficient windows – electrical distribution systems – Transformers – Power quality – harmonic distortion

**UNIT III THERMAL SYSTEMS 10**

Boiler – efficiency testing, excess air control, Steam distribution & use – steam traps, condensate recovery, flash steam utilization, Thermal Insulation. Heat exchanger networking – concept of pinch, Target settling, problem table approach.

**UNIT IV ENERGY CONSERVATION 8**

Energy conservation in Pumps, Fans (flow control) and blowers, Compressed Air Systems, Refrigeration and air conditioning systems – Waste heat recovery recuperators, heat sheets, heat pipes heat pumps.

**UNIT V ENERGY MANAGEMENT AND ECONOMICS 7**

Energy resource management – Energy Management information systems – Computerized energy management – Energy economics – discount rate, payback period, internal rate of Return, life cycle costing – Financing energy conservation Project.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- carry out energy accounting and balancing.
- demonstrate knowledge on various motor drives and transformers.
- get strong grounding on basics of boilers and identify the various concepts/components/processes involved in thermal systems
- implement practices like cogeneration in industry and waste heat recovery techniques for energy conservation.
- apply the concepts of energy management and energy economics for energy savings in practical life.

**TEXT BOOKS**


1. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 2005.
2. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publications, Washington, 2002.


**REFERENCES**


1. W.C. turner, "Energy Management Hand book" Wiley, New York, 2009.
2. Albert Thumann, Handbook of Energy Audits, 6th Edition, The Fairmont Press,2007
3. W.R. Murphy and G. Mc KAY "Energy Management" Butterworths, London, 2007.
4. Dale R Patrick, Stephen W Fardo, "Energy Conservation Guidebook" 2nd Edition, CRC Press,2005
5. I.G.C. Dryden, "The Efficient Use of Energy" Butterworths, London, 2003.


**CO - PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | 3 | - | - | 2 | - | - | - | 3 | 3 | - | 3 | 3 | 3 |
| **CO2** | 3 | 2 | - | - | 2 | - | - | - | 2 | 2 | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | - | - | 2 | - | - | - | 3 | 3 | - | 2 | 3 | 3 |
| **CO4** | 3 | 2 | - | - | 3 | - | - | - | 3 | 3 | - | 2 | 2 | 3 |
| **CO5** | 3 | 2 | - | - | 3 | - | - | - | 2 | 3 | - | 2 | 3 | 3 |

**ME16905 SAFETY ENGINEERING AND ENVIRONMENTAL SYSTEMS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the fundamentals and significance of safety along with ohsas standards and safety auditing.
- identify electrical, chemical and mechanical works related hazards and gain knowledge on them.
- learn about safety working practices in workplaces and protective equipment.
- know about preventive measures for fire safety and safety aspects of building design.
- acquire knowledge on environment pollutants, radiation hazards, occupational diseases and learn about factories act-1948

**UNIT I INTRODUCTION TO SAFETY ENGINEERING & MANAGEMENT 9**

Safety Engineering: Fundamentals of safety-Significance, general instructions, awareness, hazard identification-safety planning and inspection, OHSAS standards-safety symbols.

Safety management: Introduction, classification of accidents-Principles of safety management, Management safety policy-safety auditing-stages in plant life and unsafe condition factor-Responsibilities of government, social organization and public authorities.

**UNIT II SAFETY WORKING PRACTICES 9**

Safe working environment-Fire safety instructions, Safety devices and tools, safety instructions in use of electricity,welding,hand tools, workshop and garages. Personal safety of human body parts- Protection of eye, Head, Respiratory system, hearing system, hand and foot, personal protective equipment.

**UNIT III ELECTRICAL.CHEMICAL AND MECHANICAL HAZARDS 9**

Electrical Hazards: Introduction to electrical safety, Electric shock situations, Electric shock phenomena, Prevention of shocks, electrical safety systems and training.

Chemical hazards: Industrial toxicology-Harmful effects-Dust explosions-Hazards due to flammable gas, Bulk fire and toxic release-control measures.

Mechanical hazards: Introduction-safety devices-portable ladders, ropes, chains, slings, flywheels, lifting equipment, Mechanical handling equipment, Pressure hazards, Management of hazards in work environment.

**UNIT IV FIRE SAFETY AND BUILDING DESIGN 9**

Fire hazards: Introduction - Classification of fire, various classes - Preventive measures, Fire extinguishers - Halon extinguishers, water fire extinguishers, Foam fire, Dry powder, Gas cartridge, $CO_2$ fire extinguishers - Methods of operation, Fire detectors and fire-fighting system - Maintenance.

Building Design: general requirements of building design in fire protection, walls and openings, roofs, Basements, Escape from building, electrical installations, fire-fighting in buildings, tips to prevent fire outbreaks.

**UNIT V ENVIRONMENTAL HAZARDS AND PREVENTION 9**

Introduction - Man and environment - degradation of environment: air, water, soil and noise - environmental management plans for power plants, environment impact assessment study, Environment standards.

Radiation hazards: Instruments for radiation detection and measurement. Devices for measuring radiation- Crystal dosimeters, Fonization chambers. The Geiger-Muller counter, Proportional counter- Personal monitoring devices-Controlling radiation exposure.

Occupational health: Health hazards at workplace, Occupational diseases-Need for occupational health care -Ergonomics-Role of occupational health service, Main provisions of Factory Act 1948.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- give priority to safety and gain good grounding in ohsas and safety auditing.
- become safety conscious and follow safe working practices and wear/use work related protective gadgets/tools
- differentiate among electrical, chemical and mechanical hazards and plan safety measures accordingly.
- get sensitized about fire accidents, how to act at fire emergencies and also follow safe aspects in building design.
- know technically about environment pollution, radiation and occupation hazards and take steps personally, officiallyand legally to act against these dangers.

**TEXT BOOKS**


1. Jain R. K and Sunil S. Rao, "Industrial Safety, Health and Environment Management Systems" Khanna Publishers, Fourth Edition, 2015.
2. Gupta K., "Industrial Safety & Environment", University Science Press, Second Edition, 2008.


**REFERENCES**


1. Deshmukh L. M., "Industrial Safety Management", Tata McGraw Hill, 2010.
2. Krishnan N.V., "Safety Management in Industry", Jaico Publishing House, Bombay, 1997.
3. Mahajan S. P., "Pollution control in process industries", Tata McGraw Hill Publishing Company, New Delhi, 1993.
4. William E. Clark, "Firefighting Principles &Practices", Fire Engineering Books and Videos, 2nd edition 1991.
5. Fordham Cooper, W., Electrical Safety Engineering, Butterworth and Company, London, 1986.

## CO - PO Mapping

| Mapping of Course Outcomes with Programme Outcomes:<br>**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | 3 | - | - | 2 | - | - | - | 3 | 3 | - | 3 | 3 | 3 |
| **CO2** | 3 | 2 | - | - | 2 | - | - | - | 2 | 2 | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | - | - | 2 | - | - | - | 3 | 3 | - | 2 | 3 | 3 |
| **CO4** | 3 | 2 | - | - | 3 | - | - | - | 3 | 3 | - | 2 | 2 | 3 |
| **CO5** | 3 | 2 | - | - | 3 | - | - | - | 2 | 3 | - | 2 | 3 | 3 |

**ME16906 PLANT LAYOUT AND MATERIAL HANDLING 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- study the basics of plant layout, physical facilities and the requirements.
- understand and apply the techniques needed to plan, analyze and design new or modify existing production/service facilities.
- familiarize with material handling principles and storage systems.
- gain knowledge on packaging techniques and the significance of packaging and ergonomics.
- learn to analyze the material handling and surveying techniques.

**UNIT I INTRODUCTION 9**

Plant location - factors to be considered - influence of location on plant layout - selection of plant site. Comparative study of rural and urban sites. Consideration in facilities planning and layout. Equipment required for plant Operation. Capacity, serviceability and flexibility and analysis in selection of equipment space, requirements, man power requirements. Selection site - Case study.

**UNIT II PLANT LAYOUT 9**

Plant layout - need for layout, types of layout, factors influencing product- process, fixed and combination layout-Comparison of layouts: tools and techniques for developing layout, process chart, flow diagram, string diagram, template and scale models - machine data. Layout planning procedure.
Visualization of layout revision and improving existing layout, assembly line balancing-Methods.

**UNIT III MATERIAL HANDLING 9**

Material handling - Importance and scope. Principles of material handling. Storage system performances. Planning operation and costing principles - types of material handling systems, factors influencing their choice. Design of AGVs.

**UNIT IV PACKAGING 9**

Industrial buildings and utilities - centralized electrical pneumatic water line systems. Types of building, lighting heating, air-conditioning and ventilation utilities. Planning and maintenance, waste handling statutory requirements. Packing and storage of materials - Importance of packaging layout for packaging - packaging machinery – Ergonomics.

**UNIT V ANALYSIS 9**

Analysis of material handling - Factors involved, motion analysis, flow analysis, graphic analysis, Network diagram. Number of AGVs determination, safety analysis, equipment cost analysis, analysis of operation material handling surveys.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- demonstrate knowledge on site selection criteria and equipment selection.
- gather thorough knowledge on all the types of plant layout and development.
- describe knowledgeably the principle and operations of material handling systems.
- gain strong grounding on the concepts of packaging.
- analyze the concepts involved in the material handling processes.

**TEXT BOOKS**


1. K.R Govindan "Plant Layout and Material Handling" Anuradha.2010
2. James, M. Apple., „Plant Layout and Material Handling", John Wiley & Sons, INC, 3rd Ed., 1977.


**REFERENCES**


1. Kanishka Bedi, "Production and Operations management", Oxford university press, 2nd Edition 2007.
2. Norman Gaither, G. Frazier, "Operations management" Thomson learning 9th edition, 2007.
3. Martand Telsang, "Industrial Engineering and Production Management", S. Chand and Company, 2000
4. James, M. Moore, „Plant Layout and Design", Macmillan Company, NY, 1963.
5. Muther, R., „Practical Plant Layout", Mc Graw Hill Book Company, NY, 1955.


**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |

**SEMESTER VIII**

**BA16253 TOTAL QUALITY MANAGEMENT 3 0 0 3**

**COURSE OBJECTIVES**

To enable students to

- describe the basic concepts in Quality Management, Customer orientation and retention.
- facilitate the understanding of Quality Management principles and process.
- discuss the techniques in Six Sigma, Bench marking and FMEA.
- understand the basic concepts in Quality Function Development and TPM.
- become familiar with Quality System, Quality Auditing in manufacturing.

**UNIT I INTRODUCTION 9**

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

**UNIT II TQM PRINCIPLES 9**

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering,Supplier selection, Supplier Rating.

**UNIT III TQM TOOLS AND TECHNIQUES I 9**

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

**UNIT IV TQM TOOLS AND TECHNIQUES II 9**

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) – Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

**UNIT V QUALITY SYSTEMS 9**

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 -ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- discuss the basic concepts in Quality Management, Customer orientation and retention.

- describe the principles and process of Quality Management.
- implement the quality control techniques in Six Sigma, Bench marking and FMEA.
- explain the basic concepts in Quality Function Development and TPM.
- understand the elements in Quality System, Quality Auditing in manufacturing.

**TEXT BOOKS**


1. Dale H. Besterfiled, "Total quality Management", Third Edition, Pearson Education Asia, Indian Reprint, 2006.
2. D.R Kiran, "Total quality Management", Butterworth-Heinemann, 2016.


**REFERENCES**


1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt.Ltd., 2006.
4. Dennis AuBuchon, Understanding the Concept of Quality, Pronoun, 2017.
5. Donna C. S. Summers, Quality, Pearson, 5th edition, 2009.


**CO-PO Mapping**

| COs | Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO2** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO3** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO4** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO5** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |

**ME16801** **PROJECT WORK (PHASE II)** **0 0 12 6**

**COURSE OBJECTIVES**

To enable the students to

- get trained in preparing project reports and how to face reviews and viva voce examinations.
- develop ability to identify problems to solve through project works.
- acquire knowledge on literature review related to project problem and how to find the gap.
- gain exposure to required design procedure, experimental setup, analysis package to solve the identified problem.

**GUIDELINES**

1. The students are expected to get formed into a team of convenient groups of not more than 4 members on a project.
2. Two mid semester review and another end semester review for the progress of the project work have to be conducted by a team of faculty along with their faculty guide as a member the review team.
3. Progress of project work has to be monitored by the project guide and committee periodically.
4. Attendance for review is mandatory. If a student fails to attend review for some valid reasons, one more chance may be given.
5. The project report should be submitted by the students around the first Weak of April.

**TOTAL PERIODS 180**

**COURSE OUTCOMES**

On completion of the project work, the students will be able to

- to take up any challenging practical problems and find solution by formulating proper methodology.
- collect literature through research journals and identify the gap in selected area
- devise the methodology to find solution through gathering complete knowledge on materials/design procedure/analysis and optimisation techniques/ availability of experimental setup/ company permission and other documentation procedures to execute the project.
- prepare project report as per format and confidently face viva voce with proper PPT for presentation


**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO2** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO3** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO4** | 3 | - | 2 | - | - | - | - | - | 3 | 3 | 3 | 2 | 2 | 2 |

## PROGRAMME ELECTIVE III

**ME16351 PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the concepts of productivity improvement techniques.
- learn the systems used for productivity measurement and evaluation process.
- know about how the planning and implementation of innovative concepts are carried out.
- familiarize modern practices in Re-engineering process
- acquire ideas of new tools like process improvement models along with BPR and IT

**UNIT I INTRODUCTION 3**

Basic concept and meaning of Productivity – Significance of Productivity – Factors affecting Productivity -Productivity cycle, Scope of Productivity, Engineering and Management.

**UNIT II PRODUCTIVITY MEASUREMENT AND EVALUATION 9**

Productivity measurement in International, National and Industrial level – Total Productivity Model – Productivity measurement in Manufacturing and Service sectors – Performance Objective Productivity(PO) model – Need for Productivity Evaluation – Evaluation Methodology.

**UNIT III PRODUCTIVITY PLANNING AND IMPLEMENTATION 9**

Need for Productivity Planning – Short term and long term productivity planning – Productivity Material improvement approaches, Principles - Productivity Improvement techniques – Technology based, Employee based, Product based techniques – Managerial aspects of Productivity Implementation.

Schedule, Productivity audit and control.

**UNIT IV RE-ENGINEERING PROCESS 15**

Definition, Fundamentals of process reengineering – Principles, Methodology and guidelines for Organization Transformation, DSMCQ and PMP organization Transformation models – Process Improvement Models like PMI, Edosomwan, LMICIP and NPRDC Models.

**UNIT V BPR TOOLS AND IMPLEMENTATION 9**

Analytical and Process Tools and Techniques - Role of Information and Communication Technology in BPR – Requirements and steps in BPR Implementation – Case studies.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- internalize concepts of productivity management.
- describe the differences among small, medium and large measurements of productivity and evaluation process.

- aggregate the salient characteristics of productivity measurement models.
- design new concepts on Business Process and Re-engineering.
- develop ability to improve productivity with new tools using latest techniques like IT.

**TEXT BOOKS**


1. Seiichi Nakajima, "Introduction to TPM", Productivity Press, Chennai, 2004.
2. Gopalakrishnan, P. and Banerji, A.K., "Maintenance and Spare Parts, Management", Prentice – Hall of India Pvt. Ltd., 2002.


**REFERENCES**


1. Phusavat. K, Fankham-ai K, Haapasalo. H, & Lin. B, "Productivity Management in an Organization", 2011.
2. Edosomwan, J.A. "Organizational Transformation and Process re- Engineering", British Cataloging in publications, 2006.
3. Premvrat, Sardana, G.D. and Sahay, B.S. "Productivity Management - A systems approach", Narosa Publications, New Delhi, 2002.
4. Prokopenko. J, "Productivity Management, A Practical Handbook", International LabourOrganisation, 2000.
5. Sumanth, D.J."Productivity Engineering and Management", TMH, New Delhi, 2000.


**CO - PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | 2 | 2 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 2 | 3 | 2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16352 TOOL DESIGN 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- study various types of cutting tools.
- understand the functions and design principles of cutting tools.
- gain proficiency in the development of die design for different types of dies.
- understand the functions and design principles of Jigs, fixtures.
- gain the knowledge on numerically controlled machine tools.

**UNIT I TOOLING MATERIALS 9**

Broad Classification of Tools - Cutting tools, Dies, Holding and Measuring tools Introduction – Properties of Materials – Ferrous Tooling Materials – Tool steels – Cast Iron – Mild, or low-carbon Steel – Non-metallic Tooling Materials – Nonferrous Tooling Materials – Metal cutting Tools – Single-point cutting tools – Milling cutters – Drills and Drilling– Reamer classification – Taps – Tap classification- the selection of carbide cutting tools – Determining the insert thickness for carbide tools.

**UNIT II DESIGN OF CUTTING TOOLS 9**

Single Point and multi-pint cutting tools. Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. **Tools**: Classification and Specification, nomenclature, Design of drills, milling cutters, broaches, taps etc.

**Design of Form Tools:** Flat and circular form tools, their design and application.

**UNIT III DESIGN OF DIES 9**

Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion and Rolling; Design of Dies for Sheet metal: Blanking and Piercing, Bending and Deep-drawing; Design of Dies used for Casting and Molding, microstructure injection molding for MEMs, multi-color injection molding, Powder Metallurgy die design.

**UNIT IV FORGING DIE DESIGN 9**

Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies, Forging design factors – Draft, fillet & Corner radius, parting line, shrinkage & die wear, mismatch, finish allowances, webs & ribs Preliminary forging operation- fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging – determination of stock size in closed & open die forging. Tools for flash trimming & hole piercing, materials & manufacture of forging dies.

**UNIT V TOOL DESIGN FOR NUMERICALLY CONTROLLED MACHINE TOOLS 9**

Introduction – The need for numerical control – A basic explanation of numeric control – Numerical control systems in use today – Fixture design for numerically controlled machine tools – Cutting tools for numerical control – Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool pre-setting – Introduction – General explanation of the Brown and sharp machine – tooling for Automatic screw machines.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- describe knowledge on tools used for different processes, materials used for tool-making and their specific advantages
- gain good grounding on single-point, multi-point cutting tools and design of form-tools along with specifications, nomenclature and designing aspects
- have knowledge for designing of dies for various processes like wire-drawing, forging, rolling, sheet metal, blanking, piercing, casting, moulding and powder metallurgy
- possess knowledge to design Jigs and Fixtures for various processes like drilling, milling and indexing
- demonstrate knowledge for tool design for Numerically controlled machine tools involving tool holding, tool changing and tool setting methods

**TEXT BOOKS**


1. Cyrll Donaldson, George H.LeCain, V.C. Goold, "Tool Design", Tata McGraw Hill Publishing Company Ltd., 2000.
2. Pollack, H.W. Tool Design, Reston Publishing Company, Inc. 1966.



**REFERENCES**


1. Nicholas Lisitsyn, "Machine Tool Design", 2000.
2. Prakash Hiralal Joshi, "Tooling data", Wheeler Publishing, 2000.
3. Donaldson. C, "Tool Design", Tata McGraw-Hill, 1986.
4. "Fundamentals of Tool Design", CEEE Edition, ASTME, 1983.
5. Kempster, M.H.A. "Principles of Jig and Tool Design", English University Press Ltd.1968.


**CO - PO Mapping**

Mapping of Course Outcomes with Programme Outcomes:

**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak**

| COs | Programme Outcomes(POs) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | - | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO3** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO4** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |
| **CO5** | 3 | 2 | 2 | - | - | - | - | - | - | - | - | 2 | 3 | 2 |

**ME16353 WELDING TECHNOLOGY 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand welding techniques and principles of gas and arc welding
- learn the concepts of resistance welding and various resistance welding processes.
- gain knowledge of solid state welding process for engineering applications
- acquire knowledge on special welding processes.
- understand the standards and codes for design and testing of weldments.

**UNIT I GAS AND ARC WELDING PROCESSES 9**

Fundamental principles – Air Acetylene welding, Oxyacetylene welding, Carbon arc welding, Shielded metal arc welding, Submerged arc welding, TIG & MIG welding, Plasma arc welding and Electro slag welding processes –safety aspects in welding – advantages, limitations and applications - Selection of welding rod for different application.

**UNIT II RESISTANCE WELDING PROCESSES 9**

Spot welding, Seam welding, Projection welding, Resistance Butt welding, Flash Butt welding, Percussion welding and High frequency resistance welding processes – advantages, limitations and applications.

**UNIT III SOLID STATE WELDING PROCESSES 9**

Cold welding, Diffusion bonding, Explosive welding, Ultrasonic welding, Friction welding, Forge welding, Roll

welding and Hot pressure welding processes – advantages, limitations and applications.

**UNIT IV OTHER WELDING PROCESSES 9**

Thermit welding, Atomic hydrogen welding, Electron beam welding, Laser Beam welding, Friction stir welding, Under Water welding, Welding automation in aerospace, nuclear and surface transport vehicles.

**UNIT V DESIGN OF WELD JOINTS, WELDABILITY AND TESTING OF WELDMENTS 9**

Various weld joint designs – Weldability of Aluminium, Copper, and Stainless steels. Destructive and non-destructive testing of weldments – brief introduction to welding codes & standards (ASME / ASTM / AWS)

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- gain knowledge on gas and arc welding processes
- describe knowledge on resistance welding processes

- identify solid state welding processes and their correct usage.
- demonstrate sound theoretical knowledge on various welding processes.
- design weldments with proper welding codes and standards

**TEXT BOOKS**


1. Parmer R.S., "Welding Engineering and Technology", 1st edition, Khanna Publishers, New Delhi, 2008.
2. Little R.L., "Welding and welding Technology", Tata McGraw Hill Publishing Co., Ltd., New Delhi, 34th reprint, 2008.


**REFERENCES**


1. K.S.Yadav. "Advanced Welding Technology", Standard Book Huse Publishers, 2017
2. Martin Thaddeus. "Welding: A Practical guide to joining metal", The Crowood Press Ltd, 2010.
3. O.P.Khanna, "Welding Technology", Dhanpat Rai and sons,2008.
4. Nadkarni S.V. "Modern Arc Welding Technology", 1st edition, Oxford IBH Publishers, 2005.
5. AWS- Welding Hand Book. "Welding Process" 8th Edition. Vol- 2.


**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 2 | - | 1 | - | - | - | - | - | - | - | - | 2 | 2 | 2 |

**ME16354 COMPOSITE MATERIALS AND MECHANICS 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- learn the Classification of Composite materials, Reinforcement type of Fibres.
- learn the Different types of Flat Plate Laminate Constitute Equations.
- learn about the Stress-strain relationship for anisotropic and orthotropic materials.
- learn the Fatigue, S-N curves, Fatigue behaviors of CMCs, Introduction to structures.
- To understand concept of various analysis on laminated plates.

**UNIT I INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS & MANUFACTURING 12**

Definition –Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic andAramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke‟s Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Typical Commercial material properties, Rule of Mixtures. Generally Orthotropic Lamina –Transformation Matrix, Transformed Stiffness. Manufacturing: Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes.

**UNIT II FLAT PLATE LAMINATE CONSTITUTE EQUATIONS 10**

Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses within Laminates.

**UNIT III LAMINA STRENGTH ANALYSIS 5**

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill‟s Criterion for Anisotropic materials. Tsai-Hill‟s Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure.

**UNIT IV THERMAL ANALYSIS 8**

Assumption of Constant C.T.E‟s. Modification of Hooke‟s Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E‟s. C.T.E‟s for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E laminates, Thermally Quasi- Isotropic Laminates.

**UNIT V ANALYSIS OF LAMINATED FLAT PLATES 10**

Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- learn about the classification of composite materials based on structure, based on matrix. advantages of composites, application of composites, functional requirements of
- learn about reinforcement types, fibers particulate and whisker reinforcements, and its properties.
- learn about the polymer matrix composites: preparation of molding compounds and pre-pregs,hand lay up method, autoclave method, filament winding method, compression molding, reaction injection molding.
- learn about the stress-strain relationship for anisotropic and orthotropic materials - rule of mixtures, invariant properties of orthotropic laminates, strength of an orthotropic lamina, failure criteria of orthotropic lamina.
- learn about the equilibrium equations of motion, energy formulations, static bending analysis, buckling analysis.

**REFERENCES**


1. Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994, SecondEdition - CRC press in progress.
2. Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw- Hill, 1998


**CO - PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes: **(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO2** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO3** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO4** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |
| **CO5** | 3 | - | - | - | 2 | - | 1 | - | - | - | - | 2 | 3 | 2 |

**BA16451 ENTREPRENEURSHIP DEVELOPMENT 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- acquire the knowledge about competencies required for an entrepreneur.
- impart knowledge in motivation techniques in entrepreneurship
- discuss the various factors that has to be considered while preparing a business plan.
- understand the various sources of finance and accounting for business
- describe the role of government and other agencies in promoting entrepreneurship.

**UNIT I ENTREPRENEURSHIP 9**

Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur, Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

**UNIT II MOTIVATION 9**

Major Motives Influencing an Entrepreneur – Achievement Motivation Training, - Self Rating, Business Game, Thematic Appreciation Test – Stress Management, Entrepreneurship - Development Programs – Need, Objectives.

**UNIT III BUSINESS 9**

Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation - Steps involved in setting up a Business – identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

**UNIT IV FINANCING AND ACCOUNTING 9**

Need– Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis – Taxation – Income Tax, Excise Duty – Sales Tax.

**UNIT V SUPPORT TO ENTREPRENEURS 9**

Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Business Incubators - Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- acquire skills necessary to become an entrepreneur
- exhibit the skills required to manage small business

- analyze and develop a business plan.
- identify the various factors to be considered for launching a small business.
- comprehend the support rendered by government and other agencies in entrepreneurship development

**TEXT BOOKS**

1. Donald F Kuratko, "Entrepreneurship – Theory, Process and Practice", 9th Edition, Cengage Learning, 2014.
2. S.S. Khanka "Entrepreneurial Development" S. Chand & Co. Ltd. Ram Nagar New Delhi.2013.

**REFERENCES**

1. Hisrich R D and Peters M P, "Entrepreneurship" 8th Edition Tata McGraw-Hill, 2013.
2. Rajeev Roy, "Entrepreneurship" 2nd Edition, Oxford University Press, 2011.
3. S. Anil Kumar, "Entrepreneurship Development", New Age international, 2008.
4. EDII "Faulty and External Experts – A Hand Book for New Entrepreneurs Publishers: "Entrepreneurship Development" Institute of India, Ahmadabad, 2006.
5. Mathew J Manimala," Entrepreneurship theory at cross roads: paradigms and praxis" 2nd edition Dream tech, 2005.

**CO - PO Mapping**

| **Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 1 | - | - | - | - | 2 | - | 1 | - | - | 2 | 2 | 2 | 3 |
| **CO2** | 1 | - | - | - | - | 2 | - | 1 | - | - | 2 | 2 | 2 | 3 |
| **CO3** | 1 | - | - | - | - | 2 | - | 1 | - | - | 2 | 2 | 2 | 3 |
| **CO4** | 1 | - | - | - | - | 2 | - | 1 | - | - | 2 | 2 | 2 | 3 |
| **CO5** | 1 | - | - | - | - | 2 | - | 1 | - | - | 2 | 2 | 2 | 3 |

## PROGRAMME ELECTIVE IV

**ME16451 PRODUCTION PLANNING AND CONTROL 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the concepts of production planning, product development and design and break-even analysis
- become familiar with basic procedure, selection, work measurement involved in work study
- gain knowledge on value analysis, product planning, routing, batch production and balancing analysis of process capabilities of product planning and process planning.
- learn methods of scheduling, material requirement planning, kanban, dispatching process and techniques for aligning completion time of production scheduling
- study concepts like inventory control, bin system, abc analysis, just in time system and other recent trends in production planning and control

**UNIT I INTRODUCTION 9**

Objectives and benefits of planning and control - Functions of production control - steps in production planning and control - Types of production – job - batch and continuous - Product development and design - Marketing aspect - Functional aspect -Operational aspect - Durability and dependability aspect aesthetic aspect. Profit consideration - Standardization, Simplification &Specialization - Break even analysis - Economics of a new design.

**UNIT II WORK STUDY 9**

Method study - basic procedure – Selection - Recording of process - Critical analysis, Development - Implementation - Micro motion and memo motion study – work measurement - Techniques of work measurement - Time study - Steps - Production study - Work sampling - Synthesis from standard data - Predetermined motion time standards.

**UNIT III PRODUCT PLANNING AND PROCESS PLANNING 9**

Product planning - Extending the original product information-Value analysis - Problems in lack of product Planning- Process planning and routing – Pre-requisite information needed for process planning-Steps in process planning- Quantity determination in batch production-Machine capacity, balancing-Analysis of process capabilities in a multi-product system.

**UNIT IV PRODUCTION SCHEDULING 9**

Production Control Systems - Loading and scheduling - Master Scheduling-Scheduling rules - Gantt charts-Perpetual loading - Basic scheduling problems - Line of balance – Flow production scheduling-Batch production scheduling - Product sequencing – Production Control systems - Periodic batch control - Material requirement planning kanban – Dispatching - Progress reporting and expediting - Manufacturing lead time - Techniques for aligning completion times and due dates

**UNIT V INVENTORY CONTROL AND RECENT TRENDS IN PRODUCTION PLANNING AND CONTROL** **9**

Inventory control - Purpose of holding stock - Effect of demand on inventories - Ordering procedures. Two bin System - Ordering cycle system - Determination of Economic order quantity and economic lot size - ABC analysis-Recorder procedure - Introduction to computer integrated production planning systems - elements of JUST IN TIME SYSTEMS - Fundamentals of MRP II and ERP.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

- internalize the concepts of production control, product development, break even analysis and economics of new design.
- thoroughly understand production components like selection, recording procedure, work measurement, time study and predetermined motion time standards.
- demonstrate knowledge on product planning, value analysis, planning and routing, batch production and balancing, analysis of multi product system
- be conversant with production control, scheduling, product sequencing, material requirement planning, kanban, dispatching and manufacturing lead time and techniques of scheduling
- implement techniques of inventory control, ordering procedure, two bin system, ABC analysis and elements of Just in Time systems.

**TEXT BOOKS**


1. James.B.Dilworth, ”Operations management – Design, Planning and Control for manufacturing and services” Mcgraw Hill International edition 2005.
2. MartandTelsang, “Industrial Engineering and Production Management”, S. Chand and Company, First edition, 2000.


**REFERENCES**


1. Kanishka Bedi, “Production and Operations management”, Oxford university press, 2nd Edition 2007.
2. Norman Gaither, G. Frazier, “Operations management” Thomson learning 9th edition, 2007.
3. Jain. K.C & L.N. Aggarwal, “Production Planning Control and Industrial Management”, Khanna Publishers, 2002.
4. Samson Eilon, “Elements of production planning and control”, Universal Book Corpn.2001.
5. Elwood S.Buffa, and Rakesh K. Sarin, “Modern Production / Operations Management”, 8th Ed. John
   Wiley and Sons, 2000.

**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO2** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO3** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO4** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |
| **CO5** | 2 | - | - | - | 2 | - | - | 2 | - | - | - | 1 | 1 | 1 |

**ME16452 REFRIGERATION AND AIR CONDITIONING 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- get familiar with the basic principles and concepts of refrigeration applied in the engineering practice.
- understand the fundamentals of refrigeration system components, properties of refrigerants and applications of refrigeration systems.
- learn about Psychrometric processes and its properties.
- gain knowledge on different air conditioning systems.
- study the cooling load calculations in various systems.

**UNIT I REFRIGERATION CYCLE 9**

Review of thermodynamic principles of refrigeration. Air cycle refrigeration system. Vapour compression refrigeration cycle - use of P-H charts - multistage and multiple evaporator systems - cascade system - COP comparison. Vapor absorption refrigeration system. Ammonia water and Lithium - Bromide water systems. Steam jet refrigeration system.

**UNIT II REFRIGERATION SYSTEM COMPONENTS AND REFRIGERANTS 9**

Compressors: Types – based on operation and based on arrangement. Condensers: Types-air cooled, water cooled and evaporative condensers. Evaporators: Flooded and dry expansion types. Expansion devices: Capillary tube, Automatic expansion valve, Thermostatic expansion valve. Refrigerants: Properties and Selection. Eco friendly refrigerants: Ozone Depletion Potential (ODP) and Global Warming Potential (GWP).

**UNIT III PSYCHROMETRIC PROCESSES 9**

Review of fundamental properties of psychrometry, Psychrometric chart, Psychrometry properties calculation, Psychrometric processes, Bypass factor, Apparatus Dew Point (ADP) temperature, numerical problems.

**UNIT IV AIR CONDITIONING SYSTEMS 9**

Air conditioning – definition, standards of temperature, humidity and air motion, components of air conditioning system. Summer, winter and year-round air conditioners, Window, Split air conditioners, Central air conditioner systems. Air distribution system. Thermal insulation of air conditioning systems- applications.

**UNIT V COOLING LOAD CALCULATIONS 9**

Types of load - design of space cooling load - heat transmission through building. Solar radiation - infiltration - internal heat sources (sensible and latent) - outside air and fresh air load - estimation of total load - Domestic, commercial and industrial systems - central air conditioning systems.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- use with understanding the basic concepts and terms involved in refrigeration and Air-Conditioning systems like refrigerants, refrigeration cycle, compressor, COP etc.
- describe knowledge on different types of compressors and different types of refrigerants
- demonstrate thorough understanding of Psychrometric chart and its usage
- be conversant with Air-conditioning systems for car, stores and public buildings
- learn Cooling load calculations for different types of Air-Conditioning requirements like domestic, commercial and industrial systems

**TEXT BOOKS**


1. R.K.Rajput, "Refrigeration and Air-Conditioning" , S.K. Kataria& Sons, 3rd Edition:2015.
2. R.S. Khurmi ,"Refrigeration and Air-conditioning" S.Chand, Dec 2006.


**REFERENCES**


1. Manohar Prasad, "Refrigeration and Air Conditioning", Wiley Eastern Ltd., 2010.
2. Ramesh Arora," Refrigeration and Air-conditioning", Prentice Hall of India, 2010.
3. Domkundwar, Arrora and Domkundwar, "Refrigeration and Air Conditioning", Dhanpat Rai and co,2009.
4. W.F.Stocker and J.W.Jones, "Refrigeration and Air Conditioning", McGraw-Hill, 2009.
5. Arora. C.P., "Refrigeration and Air Conditioning", Tata McGraw-Hill New Delhi, 2008.


**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | 3 | 3 | 2 | - | - | 3 | - | - | - | - | 2 | 3 | 2 |
| **CO2** | 3 | 2 | 2 | 2 | 2 | - | 3 | - | - | - | - | 2 | 3 | 3 |
| **CO3** | 3 | 3 | 3 | 2 | 2 | - | 3 | - | - | - | - | 2 | 3 | 2 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | - | 3 | - | - | - | - | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 3 | 2 | 2 | - | 3 | - | - | - | - | 2 | 3 | 3 |

**ME16453 INDUSTRIAL TRIBOLOGY 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- acquire knowledge on various terminology involved in Tribology
- become familiar with the basic principles of Wear Mechanism
- learn about various properties and types of lubricants
- study the fundamental concepts of film lubrication theory
- familiarize with the concept of surface engineering and bearing materials

**UNIT I SURFACES AND FRICTION 9**

Topography of Engineering surfaces- Contact between surfaces - Sources of sliding Friction – Adhesion – Ploughing - Energy dissipation mechanisms Friction Characteristics of metals - Friction of non-metals. Friction of lamellar solids - friction of Ceramic materials and polymers - Rolling Friction - Source of Rolling Friction – Stick slip motion - Measurement of Friction.

**UNIT II WEAR 9**

Types of wear - Simple theory of Sliding Wear Mechanism of sliding wear of metals – Abrasive wear – Materials for Adhesive and Abrasive wear situations - Corrosive wear - Surface Fatigue wear situations - Brittle Fracture - wear - Wear of Ceramics and Polymers - Wear Measurements.

**UNIT III LUBRICANTS AND LUBRICATION TYPES 9**

Types and properties of Lubricants - Testing methods – Concepts of Hydrodynamic, Hydrostatic, Elasto -hydrodynamic, and Boundary Lubrication. Thin film and thick film lubrication – Methods of lubrication – Semi solid and Solid Lubrication.

**UNIT IV FILM LUBRICATION THEORY 9**

Fluid film in simple shear - Viscous flow between very close parallel plates - Shear stress variation Reynolds Equation for film Lubrication - High speed unloaded journal bearings – Loaded journal bearings – Reaction torque on the bearings - Virtual Co-efficient of friction – The Sommerfelddiagram. **UNIT V**

**SURFACE ENGINEERING AND MATERIALS FOR BEARINGS 9**

Surface modifications - Transformation Hardening, surface fusion - Thermo chemical processes – Surface coatings - Plating and anodizing - Fusion Processes - Vapour Phase processes - Materials for rolling Element bearings - Materials for fluid film bearings - Materials for marginally lubricated and dry bearings.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of the course, the students will be able to

- understand the significance of tribology and how it affects the life of machine components
- identify different types of wear, wear behavior of different types of materials.

- select suitable lubricants, know their properties and different methods of lubrication.
- describe technically film lubrication theory, bearings and the governing equations of lubrication
- use modification techniques to resist wear and design components.

**TEXT BOOKS**


1. Sushil Kumar Srivatsava, "Tribology in Industry", S. Chand &Co, 2010.
2. Basu S.K. et. Al., "Fundamentals of Tribology" PHI Learning Private Limited, 2009.


**REFERENCES**


1. Michael M Khonsari and E Richard Booser, "Applied Tribology: Bearing Design and Lubrication (Tribology in Practice Series)" ,2017.
2. M.M. Khonsari&E.R.Booser, " Applied Tribology", John Willey & Sons, New York,2001
3. M.J.Neale (Editor), "Tribology Handbook ", Newnes. Butter worth, Heinemann, U.K., 1995.
4. A. Cameron, "Basic Lubrication theory ", Longman, U.K.., 1981.
5. E.P. Bowden and Tabor D., "Friction and Lubrication ", Heinemann Educational Books Ltd., 1974.


**CO - PO Mapping**

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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 1 | 2 | 3 | - | - | - | - | 1 | - | - | - | 2 | 2 | 3 |
| **CO2** | 1 | 2 | 3 | - | - | - | - | 1 | - | - | - | 2 | 2 | 3 |
| **CO3** | 1 | 2 | 3 | - | - | - | - | 1 | - | - | - | 2 | 2 | 3 |
| **CO4** | 1 | 2 | 3 | - | - | - | - | 1 | - | - | - | 2 | 2 | 3 |
| **CO5** | 1 | 2 | 3 | - | - | - | - | 1 | - | - | - | 2 | 2 | 3 |

**ME16454 ADVANCED I.C ENGINES 3 0 0 3**

**COURSE OBJECTIVES**

To enable the students to

- understand the underlying principles of operation of Spark Ignition Engines and its components.
- get educated about the principles and operation of Compression Ignition Engines and its components.
- gain knowledge on pollutant formation and control methods.
- acquire knowledge on various alternate fuels available to replace non-renewable energy.
- update knowledge on recent trends and developments in IC engines.

**UNIT I SPARK IGNITION ENGINES 9**

Mixture requirements – Fuel injection systems – Mono point, Multipoint & Direct injection - Stages of combustion – Normal and Abnormal combustion – Knock - Factors affecting knock – Combustion chambers.

**UNIT II COMPRESSION IGNITION ENGINES 9**

Diesel Fuel Injection Systems - Stages of combustion – Knocking – Factors affecting knock – Direct and Indirect injection systems – Combustion chambers – Fuel Spray behaviour – Spray structure and spray penetration– Air motion.

**UNIT III POLLUTANT FORMATION AND CONTROL 9**

Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement – Emission norms and Driving cycles.

**UNIT IV ALTERNATIVE FUELS 9**

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel - Properties, Suitability, Merits and Demerits - Engine Modifications.

**UNIT V RECENT TRENDS 9**

Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers –Common Rail Direct Injection Systems - Hybrid Electric Vehicles – NOx Adsorbers - Onboard Diagnostics.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon completion of this course, the students will be able to

- describe knowledge on the operations of Spark Ignition Engine and its components.
- discuss in detail the operations of Compression Ignition Engine and its components.
- understand about pollutants developed from various fuel sources and apply controlling techniques.

- demonstrate knowledge on alternate fuels and engine design modifications required to use them
- keep trend with the latest developments in I.C engines like rail direct injection systems, On-board diagnostics and hybrid vehicles.

**TEXT BOOKS**


1. Ganesan.V, "Internal Combustion Engines", II Edition, TMH, 2002.
2. Ramalingam. K.K., "Internal Combustion Engine Fundamentals", Scitech Publications, 2002.


**REFERENCES**


1. Kirpal Singh "Automobile Engineering", Standard Publishers, New Delhi, 2009.
2. Mathur. R.B. and R.P. Sharma, "Internal Combustion Engines"., Dhanpat Rai & Sons 2007.
3. Ed May, "Automotive Mechanics", Tata McGraw-Hill,2003.
4. Eric Chowenitz, "Automobile Electronics", SAE Publications, 1995.
5. Duffy Smith, "Auto Fuel Systems", The Good Heart Willcox Company, Inc., 1987.


**CO - PO Mapping**

| **Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 2 | 1 | - | - | - | 2 | 2 | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 2 | 2 | - | - | - | 2 | 2 | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 2 | 2 | - | - | - | 2 | 2 | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 2 | 3 | - | - | - | 2 | 3 | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 2 | 3 | - | - | - | 2 | 3 | - | - | - | - | 2 | 2 | 2 |

**BA16352 ENGINEERING ECONOMICS 3 0 0 3**

**COURSE OBJECTIVES**

To enable students to

- understand the fundamental economic concepts applicable to engineering and to learn the techniques of economics.
- learn the applications on time value of money in value engineering
- impart knowledge on cash flow analysis
- acquire knowledge on maintenance and replacement analysis
- inculcate knowledge on depreciation and its methods

**UNIT I INTRODUCTION TO ECONOMICS 9**

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics – Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis - V ratio, Elementary economic Analysis – Material selection for product Design selection for a product, Process planning.

**UNIT II VALUE ENGINEERING 9**

Make or buy decision, Value engineering – Function, aims, Value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor- equal payment series capital recovery factor - Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.

**UNIT III CASH FLOW 9**

Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the methods.

**UNIT IV REPLACEMENT AND MAINTENANCE ANALYSIS 9**

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with Return and concept of challenger and defender, Simple probabilistic model for items which fail completely.

**UNIT V DEPRECIATION** **9**

Depreciation- Introduction, Straight line method of depreciation, declining balance method of Depreciation -Sum of the years digits method of depreciation, sinking fund method of depreciation/Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction, Examples, Inflation adjusted decisions – procedure to adjust inflation, Examples on comparison of alternatives and determination of economic life of asset.

**TOTAL PERIODS 45**

**COURSE OUTCOMES**

Upon the completion of the course, the students will be able to

- apply the fundamental economic concepts applicable to engineering and to learn the techniques of economics
- understand the applications on time value of money in value engineering
- familiar on cash flow analysis
- understand the maintenance and replacement analysis
- apply the depreciation methods

**TEXT BOOKS**


1. Ronald A. Chadderton, "Purposeful Engineering Economics", Springer; 2015.
2. Panneer Selvam, R, "Engineering Economics", Prentice Hall of India Ltd, New Delhi, 2001.


**REFERENCES**


1. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
2. Chan S.Park, "Contemporary Engineering Economics", Prentice Hall of India, 2011.
3. Degarmo, E.P., Sullivan, W.G and Canada, J.R, "Engineering Economy", Macmillan, New York, 2011.
4. Donald.G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press, Texas, 2010.
6. Chan S. Park, "Advanced engineering economics", John Wiley & Sons, 1990.

**CO-PO Mapping**

| Mapping of Course Outcomes with Programme Outcomes:<br>**(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COs** | **Programme Outcomes(POs)** | | | | | | | | | | | | | |
| | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO 10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO1** | 3 | 2 | 1 | - | - | - | | - | - | - | - | 2 | 2 | 2 |
| **CO2** | 3 | 2 | 1 | - | - | - | | - | - | - | - | 2 | 2 | 2 |
| **CO3** | 3 | 2 | 1 | - | - | - | | - | - | - | - | 2 | 2 | 2 |
| **CO4** | 3 | 2 | 1 | - | - | - | | - | - | - | - | 2 | 2 | 2 |
| **CO5** | 3 | 2 | 1 | - | - | - | | - | - | - | - | 2 | 2 | 2 |