# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

(CBCS Curriculum for the Academic Year 2019-2020)

and

## Syllabi

## B.E. VII and VIII Semester

## of

## Four Year Degree Programme

## In

# Automobile Engineering

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on 25-06-2019)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad – 500 007**

**2019**

# SCHEME OF INSTRUCTION & EXAMINATION
## B.E. VII - Semester
## (AUTOMOBILE ENGINEERING)

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | **PC 701 AE** | Automotive Air Conditioning | 3 | 1 | - | 4 | 30 | 70 | 3 | 3 |
| 2 | **PC 702 AE** | Vehicle Maintenance | 3 | 1 | - | 4 | 30 | 70 | 3 | 3 |
| 3 | **PC 703 AE** | Metrology & Automobile Instrumentation | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | **PC 704 AE** | Vehicle Body Engineering | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | **HS 901 MB** | Managerial Economics and Accountancy | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 6 | | Open Elective-II | | | | | | | | |
| 7 | | Open Elective-III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 8 | **PC 751 AE** | Reconditioning Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 9 | **PC 752 AE** | Metrology & Automobile Instrumentation Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 10 | **PW 761 AE** | Project Work – I | - | - | 4 | 4 | 50 | - | - | 2 |
| 11 | **SI 762 AE** | Summer Internship | ` | - | - | - | 50 | - | - | 2 |
| | | | **21** | **02** | **08** | **31** | **360** | **590** | | **27** |

| **Open Elective – II** | | | **Open Elective – III** | | |
|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | S. No. | Course Code | Course Title |
| 1 | **OE 771 CE** | Green Building Technologies | 1 | **OE 781 CE** | Road Safety Engineering |
| 2 | **OE 772 CS** | Data Science Using R Programming | 2 | **OE 782 IT** | Software Engineering |
| 3 | **OE 773 EC** | Fundamentals of IoT | 3 | **OE 783 EC** | Principles of Electronic Communications |
| 4 | **OE 774 EE** | Non-Conventional Energy Sources | 4 | **OE 784 EE** | Illumination and Electric Traction systems |
| 5 | **OE 775 ME**** | Entrepreneurship | 5 | **OE 785 ME**** | Mechatronics |

PC: Professional Course PE: Professional Elective
L: Lectures T: Tutorials P: Practical D: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.

**Note-2:** * The students have to undergo a Summer Internship of four weeks' duration after VI semester and credits will be awarded in VII semester after evaluation.
** Subject is not offered to the students of Mechanical Engineering Department.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 701 AE** | **Automotive Air-Conditioning** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To have the knowledge on psychrometry, application of basics of thermodynamics and psychrometric chart.
- To understand the terminology related to air conditioning load calculations and design considerations for summer and winter air conditioning system.
- To know the different air conditioning system components along with their controllers and regulators
- To understand the different refrigerants along with their properties and ford automatically controlled air conditioner and heater system.
- To understand the duct system for controlling flow, automotive air conditioning maintenance, service and trouble shooting.

**Course Outcomes**

After completing this course, the student will be able to

1. Explain psychrometric processes using Psychrometric chart
2. Perform the load calculations for the given conditions
3. Demonstrate the working principle of the components of air-conditioning systems
4. Select the suitable refrigerant by analysing its properties
5. Design the duct system and maintain automobile air-conditioning.

**UNIT-I**

**Psychrometry:** Psychrometric properties, Psychrometric chart, construction, Representation of Psychrometric processes on the chart, Heat and Cooling with Humidification and Dehumidification, Adiabatic dehumidification, Adiabatic chemical dehumidification and mixing processes.

**UNIT-II**

**Cooling Load Calculations in Air Conditioning:** Concept of bypass factor, Sensible beat factor, Apparatus Dew Point, Room Sensible Heat Factor (RSHF), Gross Sensible Heat Factor (GSHF), Different heating and cooling loads, Problems.

**Design of Air Conditioning Systems**: All fresh air, Re-circulated air with bypassed air, Design of Summer, Winter and Year round air conditioning systems

**UNIT-III**

**Air-Conditioning Components:** Basic air conditioning system, Location of air conditioning components in a car, schematic layout of a refrigeration system. Compressor components, Condenser and high pressure service ports. Thermostatic expansion valve, Expansion valve calibration, Controlling evaporator temperature, evaporator pressure regulator, evaporator temperature regulator.

**UNIT-IV**

**Refrigerants:** Classification of refrigerants, coding of Refrigerants, desirable properties of refrigerants, substitute for CFC refrigerants, containers, handling refrigerants, tapping into the refrigerant container. Ambient conditions affecting system pressures.

**Heating System and Temperature Control:** Automotive heaters - Manually controlled air conditioner - Heater system - Ford automatically controlled air conditioner and heater systems - Automatic temperature control - Air conditioning protection.

**UNIT-V**

**Air Routing:** Objectives - Evaporator care air, flow through the Dash recirculating unit - Duct system - Controlling flow.

**Air Conditioning Service:** Air conditioner maintenance and service - Servicing heater system - Trouble shooting of air controlling system - Compressor service.

***Suggested Readings:***

1. William H Crouse and Donald L Anglin, "Automotive Air conditioning ", McGraw-Hill Inc., 1990.
2. Mitchell information Services, Inc., "Mitchell Automatic Heating and Air Conditioning Systems ", Prentice Hall Ind., 1989.
3. Paul Weiser, “Automotive Air Conditioning ", Reston Publishing Co Inc., 1990.
4. MacDonald, K.L., "Automotive Air Conditioning ", Theodore Audel series, 1978.

Goings. L.F., Automotive Air Conditioning ", American Technical services, 1974.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 702 AE** | **Vehicle Maintenance** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **Automotive Chassis and Components** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To study basic types of vehicle maintenance along with its importance.
- To understand the trouble diagnosis procedure for electrical and electronic systems in automobiles
- To know the dismantling and service procedure of drive line system
- To acquaint with various Trouble shooting, fault tracing practices available in automobile industry.
- To understand the maintenance procedure for air-conditioning in automobiles.

**Course Outcomes**

After completing this course, the student will be able to

1. Demonstrate the maintenance procedure for automotive Engine and prepare checklist
2. Illustrate the trouble diagnosis procedure for electrical systems like Battery, Starting Systems
3. Identify the trouble diagnosis procedure for steering and suspension system.
4. Illustrate trouble diagnosis procedure for lubrication and fuel delivery system etc.
5. Explain trouble diagnosis procedure for heating system of automobile.

**UNIT-I**

**Maintenance, Workshop Practices, Safety and Tools:** Maintenance – Need, importance, primary and secondary functions, policies - classification of maintenance work - vehicle insurance - basic problem diagnosis. Automotive service procedures – workshop operations – workshop manual - vehicle identification. Safety – Personnel, machines and equipment, vehicles, fire safety - First aid. Basic tools – special service tools – measuring instruments – condition checking of seals, gaskets and sealants. Scheduled maintenance services – service intervals - Towing and recovering.

**UNIT-II**

**Engine and Engine Subsystem Maintenance:** General Engine service- Dismantling of Engine components- Engine repair- working on the underside, front, top, ancillaries- Service of basic engine parts, cooling and lubricating system, fuel system, Intake and Exhaust system, electrical system - Electronic fuel injection and engine management. **S**ervice - fault diagnosis- servicing emission controls.

**UNIT-III**

**Transmission and Driveline Maintenance:** Clutch- general checks, adjustment and service- Dismantling, identifying, checking and reassembling transmission, - road testing- Removing and replacing propeller shaft, servicing of cross and yoke joint and constant velocity joints- Rear axle service points- removing axle shaft and bearings- servicing differential assemblies- fault diagnosis.

**UNIT-IV**

**Steering, Brake, Suspension and Wheel Maintenance:** Inspection, Maintenance and Service of Hydraulic brake, Drum brake, Disc brake, Parking brake. Bleeding of brakes. Inspection, Maintenance and Service of Mc person strut, coil spring, leaf spring, shock absorbers. Dismantling and assembly procedures. Wheel alignment and balance, removing and fitting of tyres, tyre wear and tyre rotation. Inspection, Maintenance and Service of steering linkage, steering column, Rack and pinion steering, Recirculating ball steering service- Worm type steering, power steering system.

**UNIT-V**

**Auto Electrical and Air Conditioning Maintenance:** Maintenance of batteries, starting system, charging system and body electrical -Fault diagnosis using Scan tools. Maintenance of air conditioning parts like compressor, condenser, expansion valve, evaporator - Replacement of hoses- Leak detection- AC Charging- Fault Diagnosis Vehicle body repair like panel beating, tinkering, soldering, polishing, painting.

***Suggested Readings:***

1. Ed May, "Automotive Mechanics Volume One", McGraw Hill Publications, 2003
2. Ed May, "Automotive Mechanics Volume Two", McGraw Hill Publications, 2003
3. Vehicle Service Manuals of reputed manufacturers
4. Bosch Automotive Handbook, Sixth Edition, 2004

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 703 AE** | **Metrology and Automobile Instrumentation** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand limits, fits and tolerances and their applications. Linear and angular measurements and measuring instruments.
- To understand the design of limit gauges, evaluate roughness and its measurement.
- To understand basic measuring system, static and dynamic characteristics of instruments.
- To understand various principles to measure pressure, temperature, displacement, force, torque and vibrations.
- To understand seismic transducers and various gauges

**Course Outcomes**

By the end of this course, the students will be able to

1. Determine Limits & fits, I.S.O. system and the instruments used to measure these limits.
2. Accurate measurement of precision linear and angular measuring instruments.
3. Identify and measure form errors.
4. Demonstrate working principles of various instruments used for the measurement of strain, forces, pressure, temperature and vibrations.
5. Use seismic transducers and different gauges

**UNIT-I**

**Limits and Fits, ISO system**: Types of interchangeability Taylor's Principle or plain limit gauges, Use of Plug, Ring and Snap gauges. Indicating type limit gauges. Introduction_ Linear and Angular measurements – Slip gauges and End bars – Gauge material and manufacturing methods, Different types of Micrometers, Height gauges Tomlinson gauges. Precision polygon, Sine bar, Auto collimator

**UNIT-II**

**Comparators**: Dial indicator, Sigma and Mechanical comparator, free flow and back pressure type Pneumatic comparator. Application of set jet gauge heads. Optical projector, Chart, screen gauges and measuring methods, Micro Gauge Bridge Lines Tool Maker's Microscope applications. Measurement of Straightness and Flatness Roundness measurement with bench centres and talyrond, Coordinate Measuring Machine in complex geometries

**UNIT-III**

**Surface Roughness Measurements** –parameters as per ISO indices. Profilometer, Taylor Hobson Talysurf. Application of Thread metrology - 2 wire and 3 wire methods, Gear measurement - Gear tooth thickness, Parkinson gear tester, General geometric tests for testing machine tools – Lathe, drill and Mill.

**UNIT-IV**

**Elements of Instrumentation System**- Static and Dynamic characteristics, Types of errors. Displacement transducers LVDT Strain measurement -Wire and foil type resistance strain gauges. Rosette Gauges. Bonding procedure Lead resistance compensation. Adjacent arm and self-compensating gauges proving ring Strain gauge load cells, measurement of axial load and torsion by strain gauges. Piezo-electric load cell

**UNIT-V**

**Introduction to Seismic Transducers** -displacement and acceleration measurement, Pressure measurement -Bourdon pressure gauge, bulk modulus gauge, Pirani gauge, Temperature measurement by thermo couples.

Laws of thermo electricity Types of materials used in thermocouples Protection tubes. Extension wire Series and parallel circuit's ambient temperature compensation.

***Suggested Readings:***

1. I.C. Gupta – "Engineering metrology", Dhanpat Rai Publications, New Delhi.
2. Rega Rajendra, "Principles of Engineering Metrology", Jaico Publishing House, Mumbai.
3. RK Jain, "Engineering Metrology", Khanna Publications, 1996.
4. Doeblin,"Measurement Systems Application and Design", Tata McGraw Hill,5th ed., 2004.
5. Beckwith, Buck, Lienhard, Mechanical Measurements, Pearson Education India
6. P. Donald Echman, "Industrial Instrumentation", John Wiley and Sons, 1996.
7. Hume, "Engineering Metrology", Kalyani Publications, 1985.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 704 AE** | **Vehicle Body Engineering** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To identify all types of cars body details. Apply knowledge to identify different vehicles dimensions and engine location
- Explain the importance of aerodynamic effort, Apply the methods of reducing air resistance and wind tunnel testing
- To understand Load Distribution, Body design requirement and car body space nomenclature.
- To know Interior ergonomics and vehicle body safety
- To understand Noise and vibration, explain the types of materials used in automobiles, and Explain paint and painting process

**Course Outcomes**

After completing this course, the student will be able to

1. Identify all types of cars body details and to identify different vehicles dimensions and engine location
2. The importance of aerodynamic effort, Apply the methods of reducing air resistance and wind tunnel testing
3. Load Distribution, Body design requirement and car body space nomenclature.
4. To know Interior ergonomics and vehicle body safety
5. Noise and vibration in vehicle body, explain the types of materials used in automobiles, Apply skills for selection of materials for different components of automobile and explain paint and painting process

**UNIT-I**

**Car Body Details:** Saloon car, Hatch back car, convertible, racing car and sports car. Bus body details: Single Decker, Mini bus, Bus body layout. Floor height, Engine location, Entrance and exit position Seat and other commercial vehicle dimension

**UNIT-II**

**Aerodynamic Effect**: Pressure distribution on vehicle surface. Air resistance on vehicle, Wind tunnel testing. Flow visualization around vehicle. Methods of reducing air resistance. Effect of side force and wind thrust.

**UNIT-III**

**Load Distribution**: Types of load carrying structures -closed, integral, open, flat types. Calculation of loading cases- static, asymmetric, vertical loads. Load distribution, stress analysis of structure, body shell analysis.

**Body:** Body design requirement, car body space nomenclature. Body frame of passenger car and commercial vehicle. Different type of car door and window regulator, car roof, wind shield,

**UNIT-IV**

**Interior Ergonomics:** Introduction, seating dimensions, interior ergonomics, seat comfort, driver seat design, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, goods vehicle layout. Visibility, regulations, driver's visibility, methods of improving visibility.

**Safety:** Impact protection basics, physics of impact between deformable bodies, design for crash worthiness, occupant and cargo restraint, passive restraint systems, side impact analysis, bumper system.

**UNIT-V**

**Noise and Vibration:** Noise characteristics, sources of noise, noise level measurement techniques, body structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression.

**Body Materials**: Different types of ferrous and non-ferrous materials used in vehicle such as cast iron. Steel. Alloy steel, plastic, G.R.P Glass etc. and their properties

**Painting:** Corrosion and anticorrosion method, Paint and painting process

***Suggested Readings:***

1. Crouse W and Anglin D, Automotive Mechanics Tata McGrawHill, 10th edition, 2004
2. Jack E Rjavee, Automotive Technology- A system approach, Thomson Asia Pte Ltd, Singapore, 3rd Edition, 2004
3. K Sing, Automobile Engineering Vol-I Standard Publishers Distributor 2003
4. Body Engineering -Sydney F Page
5. Vehicle Body Engineering -Gilcs J Pawlowski,
6. Automotive Chassis -P.M. Heldt. Chilton & Co.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **HS 901 MB** | **Managerial Economics and Accountancy** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand responsibilities of a manager of a business undertaking.
- To analyse various factors influencing demand elasticity
- To Forecast & compute the future sales level.
- To determine Break Even Point (BEP) of an enterprise
- To understand the features, steps, merits, uses & limitations of Pay Back, ARR, NPV, PI & IRR methods of Capital Budgeting
- To understand the principles of accounting and prepare Journal, Ledger, Trial Balance, Manufacturing A/c, Trading A/c., Profit & Loss A/c. and Balance Sheet of an enterprise.

**Course Outcomes**

1. Determine the responsibilities of a manager of a business undertaking.
2. Assess various factors influencing demand elasticity
3. Able to Forecast & compute the future sales level.
4. Determine Break Even Point (BEP) of an enterprise Outline the features, steps, merits, uses & limitations of Pay Back, ARR, NPV, PI & IRR methods of Capital Budgeting
5. Understands the principles of accounting and prepare Journal, Ledger, Trial Balance, Manufacturing A/c, Trading A/c., Profit & Loss A/c. and Balance Sheet of an enterprise.

**UNIT-I**

Introduction to economics and its evolution: Managerial Economics its Scope, Importance and relation to other sciences, its usefulness to Engineers-Basic concepts of Managerial Economics.

**UNIT-II**

Demands: Analysis-concept of demand, determinants, law of demand, its assumptions, elasticity of demand, price, income and cross elasticity, demand forecasting-markets competitive structure, price- output determination under perfect competition and Monopoly.

**UNIT-III**

Theory of Production: Firm and industry-production function-input-output relations-laws of returns- internal and external economics of scale. Cost Analysis-Cost concepts-fixed and variable costs-explicitly and implicitly costs-out pocket of costs and imputed costs-opportunity cost-cost output relation- ship-break even analysis.

**UNIT-IV**

Capital management: Significance, determinates and estimation of fixed and working capital requirements, sources of capital. Introduction to capital budgeting, methods of payback and discounted cash flow methods with problems.

**UNIT-V**

Book-keeping: Principles and significance of double entry book keeping, journal, subsidiary books, ledger accounts, trial balance concepts and preparation of final accounts with simple adjustments- analysis and interpretation of financial statements through ratios.

***Suggested Readings:***

1. Varshney RL and KI Maheswari, Managerial Economics, Sultan Chand.
2. JC Pappas and EF Grigham, Managerial Economics.
3. Grawal T.S. Introduction to Accountancy.
4. Maheswari S.N. Introduction to Accountancy.
5. Panday I.M. Financial Management.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 771 CE** | **Green Building Technologies** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To impart knowledge of the principles behind the green building technologies.
- To know the importance of sustainable use of natural resources and energy.
- To understand the principles of effective energy and resources management in buildings.
- To bring awareness of the basic criteria in the green building rating systems.
- To understand the methodologies to reduce, recycle and reuse towards sustainability.

**Course Outcomes**

After completing this course, the student will be able to

1. Define a green building, along with its features, benefits and rating systems.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

**UNIT-I**

**Introduction to Green Buildings:** Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

**UNIT- II**

**Site selection and planning:** Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

**Water conservation and efficiency:** Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

**UNIT-III**

**Energy Efficiency:** Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy. Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

**UNIT-IV**

**Building materials:** Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials

**Waste Management:** Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

**UNIT-V**

**Indoor Environmental Quality for Occupant Comfort and Wellbeing:** Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

***Suggested Readings:***

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. *Alternative building materials and technologies* by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual*, Vol.1 and 2, TERI, New Delhi 2004.
6. Mike Montoya, *Green Building Fundamentals*, Pearson, USA, 2010.
7. Charles J. Kibert*, Sustainable Construction - Green Building Design and Delivery*, John Wiley & Sons, New York, 2008.
8. Regina Leffers*, Sustainable Construction and Design*, Pearson / Prentice Hall, USA, 2009.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 772 CS** | **Data Science Using R Programming** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn basics of R Programming environment: R language, R- studio and R packages
- To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting
- To learn Decision tree induction, association rule mining and text mining

**Course Outcomes**

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

1. Use various data structures and packages in R for data visualization and summarization
2. Use linear, non-linear regression models, and classification techniques for data analysis
3. Use clustering methods including K-means and CURE algorithm

**UNIT – I**

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

**UNIT II**

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

**UNIT III**

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression

**UNIT IV**

Introduction to R Programming, getting started with R: Installation of R software and using the interface, Variables and data types, R Objects, Vectors and lists, Operations: Arithmetic, Logical and Matrix operations, Data frames, functions, Control structures, Debugging and Simulation in R.

**UNIT V**

Classification: performance measures, Logistic regression implementation in R, K-Nearest neighbours (KNN), K-Nearest neighbours implementation in R, Clustering: K-Means Algorithm, K-Means implementation in R.

***Suggested Readings:***

1. Nina Zumel, Practical Data Science with R, Manning Publications, 2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly, 2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing, 2016.
5. Rafael A Irizarry, Introduction to Data Science, Lean Publishing,2016.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 773 EC** | **Fundamentals of IoT** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Discuss fundamentals of IoT and its applications and requisite infrastructure Describe Internet principles and communication technologies relevant to IoT Discuss hardware and software aspects of designing an IoT system
- Describe concepts of cloud computing and Data Analytics
- Discuss business models and manufacturing strategies of IoT products

**Course Outcomes**

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

1. Understand the various applications of IoT and other enabling technologies. Comprehend various protocols and communication technologies used in IoT
2. Design simple IoT systems with requisite hardware and C programming software Understand the relevance of cloud computing and data analytics to IoT
3. Comprehend the business model of IoT from developing a prototype to launching a product

**UNIT - I**

**Introduction to Internet of Things:** IOT vision, Strategic research and innovation directions, IoT Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues.

**UNIT – II**

**Internet Principles and communication technology:** Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source.

**UNIT – III**

**Prototyping and programming for IoT:** Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling.

Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND, OR, XOR, NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for Arduino board.

**UNIT – IV**

**Cloud computing and Data analytics:** Introduction to Cloud storage models -SAAS, PAAS, IAAS. Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform.

Introduction to Data Analytics for IoT - Apache Hadoop- Map reduce job execution workflow.

**UNIT – V**

**IoT Product Manufacturing - From prototype to reality:** Business model for IoT product manufacturing, Business models canvas, Funding an IoT Start-up, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues.

***Suggested Readings:***

1. *Internet of Things* - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of embedded software: where C meets assembly by Daneil W lewies, Pearson.
4. *Internet of things* -A hands on Approach, Arshdeep Bahga, Universities press.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 774 EE** | **Non-Conventional Energy Sources** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

To impart the knowledge of basics of different non-conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature

**Course Outcomes**

On completion of course the student will be able to:

1. Understand the different nonconventional sources and the power generation techniques to generate electrical power.
2. Understand the Solar energy power development and different applications.
3. Understand different wind energy power generation techniques and applications.
4. Design a prescribed engineering sub-system
5. Recognize the need and ability to engage in lifelong learning for further developments in this field.

**UNIT-I**

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells-Polarization - Conversion efficiency and Applications of Fuel Cells.

**UNIT-II**

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

**UNIT-III**

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

**UNIT- IV**

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-Thermal Energy - Types of Geo-Thermal Energy Systems - Applications of Geo-Thermal Energy.

**UNIT-V**

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

***Suggested Readings:***

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M. El-Wakil, Power *Plant Technology.* McGraw Hill, 1984.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 775 ME** | **Entrepreneurship** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioural aspects of entrepreneurs and time management

**Course Outcomes**

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

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

**UNIT-I**

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

**UNIT-II**

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

**UNIT-III**

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

**UNIT-IV**

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

**UNIT-V**

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

***Suggested Readings:***

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 781 CE** | **Road Safety Engineering** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **0** | **0** | **0** | **30** | **70** | **3** |

**Course Objectives**

- Introduction to various factors considered for road safety and management
- Explain the road safety appurtenances and design elements
- Discuss the various traffic management techniques

**Course Outcomes**

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

1. Prepare accident investigation reports and database
2. Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
3. Manage traffic including incident management

**UNIT – I**

**Road Accidents:** Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

**UNIT – II**

**Safety in Road Design:** Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & Driver characteristics influencing road safety.

**UNIT – III**

**Road Signs and Traffic Signals:** Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design, pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

**UNIT – IV**

**Traffic Management Techniques:** Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, One-way streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

**UNIT – V**

**Incident Management:** Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management

programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc. and manmade disasters like sabotage, terrorism etc.

***Suggested Readings:***

1. Guidelines on Design and Installation of Road Traffic Signals, IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali and N.B. Lal.
4. Hand Book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 782 CS** | **Software Engineering** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases, methodologies and practices of software development
- To understand importance of software modelling using UML
- To understand the importance of testing in software development and study various testing strategies and software quality metrics.

**Course Outcomes**

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

1. Acquire knowledge about different software development processes and their usability in different problem domains.
2. Understand the process of requirements collection, analysing, and modelling requirements for effective understanding and communication with stakeholders.
3. Design and develop the architecture of real world problems towards developing a blueprint for implementation.
4. Use the UML language to design various models during software development life cycle.
5. Understand the concepts of software quality, testing and maintenance.

**UNIT-I**

**The software Problem:** Cost, Schedule and Quality, Scale and change, Software Processes: - Process and project, Component Software Processes, Software Development Process Models, Project management Process.

**UNIT-II**

**Software Requirements Analysis and Specification**: Value of a good SRS, Requirements Process, Requirements Specification, Functional Specification with Use Cases, Other approaches for analysis. Software Architecture: Role of Software Architecture Views, Component and connector view, Architectural styles for C & C view, Documenting Architecture Design, Evaluating Architectures.

**UNIT-III**

**Planning a Software Project**: Effort Estimation, Project Schedule and staffing, Quality Planning, Risk Management Planning, Project Monitoring Plan, Detailed Scheduling. Design: Design concepts, Function oriented Design, Object Oriented Design, Detailed Design, Verification, Metrics.

**UNIT-IV**

**Coding and Unit Testing**: Programming Principles and Guidelines, incrementally developing code, managing evolving code, unit testing, code inspection, Metrics. Testing: Testing Concepts, Testing Process, Black Box testing, White box testing, Metrics.

**UNIT-V**

**Maintenance and Re-engineering**: Software Maintenance, supportability, Reengineering, Business process Reengineering, Software reengineering, Reverse engineering; Restructuring, Forward engineering, Economics of Reengineering. Software Process Improvement: Introduction, SPI process, CMMI, PCMM, Other SPI Frameworks, SPI return on investment, SPI Trends.

***Suggested Readings:***

1. Pankaj Jalote, "Software Engineering- A Precise Approach", Wiley India, 2010.
2. Roger. S. Pressman, "Software Engineering - A Practitioner's Approach", 7th Edition, McGraw Hill Higher Education, 2010.
3. Deepak Jain, "Software Engineering", Oxford University Press, 2008.
4. Rajib Mall, "Fundamentals of Software Engineering", 4th Edition, PHI Learning, 2014.
5. Ian Sommerville, "Software Engineering", 10th Edition, Addison Wesley, 2015.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 783 EC** | **Principles of Electronic Communications** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | **Credits** |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Provide an introduction to fundamental concepts in the understanding of communications systems.
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer.
- Provide an introduction to the evolution of wireless systems and current wireless technologies.

**Course Outcomes**

1. Understand the working of analog and digital communication systems
2. Understand the OSI network model and the working of data transmission
3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.

**UNIT – I**

**Introduction to communication systems:** Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.
**Signal Transmission Concepts:** Baseband transmission and Broadband transmission,
**Communication Parameters:** Transmitted power, Channel bandwidth and Noise, Need for modulation
**Signal Radiation and Propagation:** Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

**UNIT – II**

**Analog and Digital Communications:** Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation.

**UNIT – III**

**Data Communication and Networking:** Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP.

**UNIT – IV**

**Telecommunication Systems:** Telephones, Telephone system, Paging systems, Internet Telephony.
**Optical Communications:** Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

**UNIT – V**

**Wireless Communications:** Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks.

***Suggested Readings:***

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill, 2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH, 2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill, 1999.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 784 EE** | **Illumination and Electric Traction Systems** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system

**Course Outcomes**

On successful completion of course, students will be able to:

1. Design the resistive and inductive heating and calculate the requirements of heating power for an industrial need
2. Analyse the type of motor control required and select the type and rating of motor.
3. Understand and Design illumination for different application
4. Understand the traction and use of DC machines
5. Analyse the traction mechanics to arrive at a rating of drive.

**UNIT-I**

**Industrial Heating:** Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

**UNIT-II**

**Schematic Utilization and Connection Diagrams for Motor Control:** Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

**UNIT-III**

**Illumination:** Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

**UNIT-IV**

**Electric Traction:** System of Electric Traction — Transmission of drive — Systems of track electrification — Traction mechanics — Speed time curves — Tractive effort — Power of Traction motor — Specific energy consumption — Mechanics of train movement— Coefficient of adhesion.

**Traction Motors:** Desirable characteristics, DC series motors, AC series motors 3-phase induction motors, DC motor series & parallel control, Energy saving.

**UNIT-V**

**Train Lighting:** Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo.

**Batteries:** Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

***Suggested Readings:***

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L. Theraja, A Text Book of Electrical Technology, S. Chand & Company Ltd, Vol —I.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 785 ME** | **Mechatronics** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student has to understand the

- How to identify, formulate, and solve engineering problems
- The design a system, component, or process to meet desired needs within realistic constraints
- The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
- The use of drive mechanisms and fluid power systems
- The use of industrial electronic devices
- The demonstrate the design of modern CNC machines, and Mechatronics elements

**Course Outcomes**

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

1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

**UNIT-I**

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

**UNIT-II**

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

**UNIT-III**

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits

**UNIT-IV**

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response

**UNIT-V**

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

***Suggested Readings:***

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 751 AE** | **Reconditioning Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- To understand the concepts and working principles of various automotive components

**Course Outcomes**

After completing this course, the student will be able to

1. To understand the concept of cylinder reboring and study its parameters
2. To understand the working of leaf spring
3. To understand the flip and its calibration
4. To study the concept of wheel alignment and related concept like caster camber, king pin inclination and toe in toe out
5. To know how to check the off set of chassis frame
6. To learn the concept of brake bleeding
7. To know the concept of wheel balancing
8. To understand valves working and of its parameters

**List of experiments**

1. Measurement of cylinder bore parameters.
2. Cylinder Re-boring
3. Cylinder honing
4. Valve grinding, valve lapping.
5. Calibration of fuel injection pump.
6. Wheel Alignment-Testing of camber, caster, kingpin inclination, toe-in and toe out.
7. Chassis alignment testing
8. Break adjustment
9. Break bleeding
10. Wheel Balancing
11. Measurement of valve parameters
12. Fuel Injector Testing

**Note:** Minimum ten experiments should be conducted in the semester

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 752 AE** | **Metrology and Automobile Instrumentation Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- To have knowledge of various precision measuring instruments.

**Course Outcomes**

After completing this course, the student will be able to

1. Select and apply the knowledge of measuring tools for external, internal and angular measurements for promoting the qualitative production management.
2. Adopt the principles of optical measurements in measurement of screw and gear profiles.
3. Choose and practice the appropriate methods of force measuring devices principles for required situation.
4. Demonstrate the need of machine alignment test for qualitative production.
5. Practice calibration principles for maintaining the required precision of instruments / tools.
6. Select and practice the methods of temperature measurement.
7. Select cutting tool materials and tool geometries along with appropriate cutting conditions for different work materials and grind the cutting tools to the required geometry.

**List of experiments**

1. Measurement with inside, outside and depth micrometers.
2. Measurement with height gauges, height masters, etc.
3. Measurement of Linear and Angular dimensions with Tool Makers Microscope – Flat specimens, plain, cylindrical specimens with centres and threaded components.
4. Measurement with - Dial Indicator / Electrical Comparator / Mechanical Comparator / Dial
5. Bore Gauges, etc.
6. Measurement of angles with Sine Bar, Bevel protractor and Precision level, Block level, etc.
7. Measurement of roundness errors with bench centres.
8. Geometrical tests on Lathe machine.
9. Measurement of flatness errors (surface plate) with precision level.
10. Measurement with optical projector.
11. Checking machined components with plug gauges, adjustable snap gauges, indicating gauges, etc.
12. Force measurement with strain gauge type load cell / proving ring / piezoelectric load cell etc. Temperature measurement with thermocouples.

**Note:** Minimum ten experiments should be conducted in the semester

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PW 761 AE** | **Project Work - I** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **4** | **50** | **-** | **2** |

**Course Objectives**

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

**Course Outcomes**

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

**Each group will be required to:**

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **SI 762 AE** | **Summer Internship** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **-** | **50** | **-** | **2** |

**Course Objectives**

- Produce an accurate record of work performed during the Internship/Co-op
- Apply engineering knowledge to a problem in industry
- Produce a technical report
- Discuss work in a team environment, if relevant to the project
- Conduct herself/himself responsibly, safely, and ethically in a professional environment

**Course Outcomes**

After completing this course, the student will be able to

1. Able to design/develop a small and simple product in hardware or software.
2. Able to complete the task or realize a prespecified target, with limited scope, rather than taking up a complex task and leave it.
3. Able to learn to find alternate viable solutions for a given problem and evaluate these alternatives with reference to prespecified criteria.
4. Able to implement the selected solution and document the same.

Summer Internship is introduced as part of the curricula of encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organisations/Computer Industry/Software Companies/R&D Organization for a period of 4-6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship

- Overview of company/project
- Safety training
- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of sessionals are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (25 Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will co-ordinate the overall activity of Industry Attachment Program.

**Note:** Students have to undergo summer internship of 4-6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. VIII - SEMESTER
## (AUTOMOBILE ENGINEERING)

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | | Professional Elective – II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | | Professional Elective – III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | | Professional Elective – IV | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | | Professional Elective – V | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 5 | **PW 961 AE** | Project Work – II | - | - | 16 | 16 | 50 | 100 | - | 8 |
| | | | **12** | **-** | **16** | **28** | **170** | **380** | | **20** |

| **Professional Elective – II** | | | **Professional Elective – III** | | |
|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | S. No. | Course Code | Course Title |
| 1 | **PE 821 AE** | Vehicle Dynamics | 1 | **PE 826 AE** | Transport Management |
| 2 | **PE 822 AE** | Modern Machining and Forming Methods | 2 | **PE 827 AE** | Non-Conventional Energy Sources |
| 3 | **PE 823 AE** | Advanced Composite Materials | 3 | **PE 827 ME** | Robotic Engineering |
| 4 | **PE 824 AE** | Autotronics | 4 | **PE 833 ME** | Machine Tool Engineering and Design |
| **Professional Elective – IV** | | | **Professional Elective – V** | | |
| 1 | **PE 824 ME** | Non-Destructive Testing | 1 | **PE 841 ME** | Energy Conservation and Management |
| 2 | **PE 831 AE** | Automotive Pollution & Control | 2 | **PE 842 ME** | Advanced Propulsion and Space Science |
| 3 | **PE 832 ME** | Additive Manufacturing Technology | 3 | **PE 843 ME** | Waste Heat Recovery and Co-Generation |
| 4 | **PE 834 ME** | Entrepreneurship Development | 4 | **PE 844 ME** | Aerodynamic Design of Thermal Turbines |

PC: Professional Course PE: Professional Elective
L: Lectures T: Tutorials P: Practical D: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 821 AE** | **Vehicle Dynamics** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **Engineering Physics, Engineering Mechanics, Dynamics of Machines and Mechanical Vibrations** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student will understand

- Identify the difference between static loads and dynamic loads on vehicle and vibration responses.
- Identification of various vibration measuring instruments and methods of measuring them.
- Review the performance of a vehicle in braking and acceleration
- Assess different road loads on vehicle
- Provide ride and handling concepts of a vehicle

**Course Outcomes**

After completing this course, students will be able to:

1. Calculate static loads and dynamic loads on vehicle, vibrational frequencies
2. Evaluate different braking and acceleration forces
3. Estimate different road loads of a vehicle
4. Identify difference between ride and handling of a vehicle

**UNIT-I**

**Fundamentals of Vibration:** Introduction, classification of vibration: free and forced vibration, undamped and damped vibration, response of damped and undamped systems under harmonic force, analysis of single degree and two degree of freedom systems, torsional vibration, determination of natural frequencies.

**UNIT-II**

**Vehicle Vibrations:** Vehicle vibration with single degree of freedom free vibration, forced vibration, vibration due to road roughness, vibration due to engine unbalance, transmissibility of engine mounting vibration with two degree of freedom, free vibration, compensated suspension systems forced vibration.

**UNIT-III**

**Different types of Tyres** – Materials used: Tyre construction, physics of tyre traction on dry and wet surface, tyre traction on dry and wet surface, tyre forces and moments, SAE recommended terminologies of tyre road interaction.

**UNIT-IV**

**Numerical Methods for Multi Degree of Freedom Systems**: Methods, influence coefficient. Maxwell's reciprocal theorem. Dunkerley's equation, orthogonality principle, method of matrix iteration – method of determination of all the natural frequencies using sweeping matrix and orthogonality principle, Holzer's method for systems with free, fixed free and fixed ends.

**UNIT-V**

Vibration measuring instruments – Accelerometers and vibrometers, whirling of shafts with and without air damping, discussion of speeds above and below critical speeds.

***Suggested Readings:***

1. Vehicle Dynamics - by J S Rao V. Dukkipati
2. Theory of Vibration with applications - by William J Thomson
3. Theory & Problems of Mechanical Vibration – by William W. Seto, McGraw Hill
4. Problems in Automobile Mechanics – by N.K. Giri, Khanna Pub.
5. Mechanics of Pneumatic Tyre – by S.K. Clark, Prentice Hall.
6. Mechanical Vibration – by Church- Wylie international

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 822 AE** | **Modern Machining and Forming Methods** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student has to understand the

- To understand the working principle of Ultra Sonic Machining and Abrasive Jet Machining
- To familiarize with Electro Discharge Machining
- To get thorough knowledge on Laser Beam Machining Electro Beam Machining
- To understand the principles of Rubber Pad Forming and Electro Hydraulic Forming
- To understand the working of different components of Stretch Forming, Tube Spinning, Hydrostatic Forming and Water Hammer Forming.

**Course Outcomes**

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

1. Demonstrate Ultrasonic Machining and Abrasive Jet Machining.
2. Explain the working principle Electro Discharge Machining
3. Apply Rubber Pad Forming and Electro Hydraulic Forming methods in automobiles
4. Demonstrate Rubber Pad Forming and Electro Hydraulic Forming
5. Distinguish between Stretch Forming, Tube Spinning, Hydrostatic Forming and Water Hammer Forming processes and select the suitable them for the required applications.

**UNIT-I**

**Ultra Sonic Machining (USM):** Introduction, process description, abrasive slurry, Abrasive materials and their characteristics. Functions of liquid medium in slurry, Types of Transducers, effect of process parameters, applications and limitations. Abrasive Jet Machining (AJM): Principle of operation, process details, process variables and their effect on M RR and accuracy.

Equation for MRR Advantage, disadvantages and applications. Water Jet Machining (WJM): Schematic diagram, equipment used, advantages and applications.

**UNIT-II**

**Electro Discharge Machining (EDM):** Process description with schematic diagram, process parameters, functions and characteristics of dielectrics medium, dielectric fluids, over cut and side taper' Flushing, Mechanism of metal removal, crater volume, types of power supply circuits, mathematical analysis of metal removal rate (MRR), characteristics of spark eroded surfaces, advantages, disadvantages and applications.

**Wire EDM:** Process description and application. Electro-Chemical Machining (ECM): Schematic of the process parameters, function and characteristics of electrolyte, chemistry of the process, Equation for specific MRR and electrode feed rate, advantages, limitations and applications, Rotary Machining, Hot machining, high speed machining, description of each process, process parameters, advantages and applications.

**UNIT-III**

**LASER Beam Machining (LBM):** Principle of LASER Beam production, materials used, thermal analysis of process, process parameters, equations for power density and machining rate, advantages, limitations and applications.

**Plasma Arc Machining (PAM):** Introduction, equipment used, process description and parameters, types of plasma arc: Transferred arc and non-transferred arc and process applications.

**Electron Beam Machining (EBM):** Schematic of the process, process parameters, principal of production of Electron Beam, equipment used, Advantages, disadvantages and applications. ION Etching: Process description and applications.

**UNIT-IV**

**Rubber Pad Forming:** Principal of the process, process details and its types: Guerin, wheel on, Marforming and Hydro Forming processes and applications.

**Electro-Hydraulic Forming (EHF):** Schematic of the process description and its applications.

**High Energy Rate Forming (HERF):** HERF hammers, principal of explosive forming, Explosive materials, types of explosive forming, standoff operation and contact operation, the pressure pulse, Gas bubble and the process applications.

**UNIT-V**

**Stretch Forming:** Introduction types of stretch forming: stretch draw forming, rotary stretch forming or stretch wrapping, compression forming, radial draw forming. Stretch forming equipment and accessories, accuracy and surface finish, process variables and limitations.

**Tube Spinning:** Introduction, methods of tube spinning, Backward spinning, forward spinning, machines and tools used. Machine variables, speeds and feeds, effect of tube spinning on work mortal properties and applications.

**Hydrostatic Forming:** Process principle, description and applications.

**Water Hammer Forming (WHF):** Schematic diagram of the process, principle of operation, process variables, work materials, process limitations and applications.

***Suggested Readings:***

1. P.C. Pandey and H.S Shah, Modern Machining Process", Tata Mc Graw Hill publishing Ltd., New Delhi, 1980.
2. A. Bhatacharya, New Technology", The Institution of Engineers (India), 1984.
3. Davies and Austin, Developments in High Speed Metal Forming", The Machinery Publishing Co. Ltd., 1985.
4. Production Technology: -HMT.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 823 ME** | **Advanced Composite Materials** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

The objectives of this course are to:

- Discuss the basic structure of composites
- Define Elastic constants and Hygro-thermal stresses
- identify stress-strain relations in composites
- Describe the behaviour and Design with composites
- Demonstrate the basic equations of plate bending

**Course Outcomes**

On completion of the course the student will be able to:

1. demonstrate knowledge of composites and their structure
2. predict the Elastic constants and Hygrothermal stresses
3. analyse the stress - strain relationship in composites
4. summarise and apply the Design procedure and the failure criteria.
5. formulate Plate bending equations for various Boundary conditions of composite plates.

**UNIT-I**

Introduction: Definition and classification of Composites (PMC, MMC, CMC), FRP Composites, Fiber Reinforcements: Fiber Types and its properties, Fiber Forms, Matrix materials and its properties: Thermoset Matrices, Thermoplastic Matrices, Applications of Composite Materials.

**UNIT-II**

**Manufacturing Processes:** Hand-Lay-up, Prepreg Lay-up, Bag Moulding, Autoclave processing, Compression Moulding, Resin Transfer Moulding, Pultrusion, Filament Winding, Gel time test for resins, Curing Cycle.

**Measurement of Basic Composite Properties:** Fiber and matrix tests, Tensile test, Compressive test, in-plane shear test, interlaminar shear test, flexure test.

**UNIT-III**

**Micromechanics of Composites:** Basic Concepts: Volume and Mass fraction, Heterogeneous, Anisotropic, Orthotropic, Transversely Isotropic and Isotropic Materials.

Mechanical Properties: Prediction of Elastic constants, micromechanical approach, Stress Partitioning Parameter, Halpin-Tsai equations.

Thermal Properties: Thermal Expansion, Moisture Expansion, Transport Properties.

**UNIT-IV**

**Macromechanics of Composites:** Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, Classification of Laminated composites, analysis of laminated composites, stresses and strain with orientation, Interlaminar stresses and edge effects.

**UNIT-V**

**Strength of Orthotropic Lamina:** Tensile and compressive strength of unidirectional fiber composites, fracture modes in composites, delamination failure, Maximum stress theory, Maximum Strain theory, Tsai-Hill Criterion, Tsai-Wu Criterion.

**Laminate Strength:** First Ply Failure, Fiber Failure, Truncated- Maximum- Strain Criterion.

***Suggested Readings:***

1. Ronald F. Gibson, "Principles of Composite Materials Mechanics", McGraw-Hill, Inc, 1994.
2. Krishna, K, Chewla, "Composite Materials", Springer-Verilog, 1987.
3. Carl. T. Herakovich, "Mechanics of Fibrous Composites", John Wiley Sons Inc., 1998.
4. Ever J. Barbero, "Introduction to Composite Materials Design", Taylor & Francis, 1999.
5. Jones, R.M., Mechanics of Composite Materials", McGraw-Hill Co., 1967

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 824 AE** | **Autotronics** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student has to understand the

- To justify the need of Autotronic Systems and explain the construction of various electronically components.
- To Understand Electronic ignition systems and electronic fuel control.
- To know Engine management system
- To know the chassis electrical systems and Electromagnetic interference suppression
- To know Electronics for comfort, safety and security

**Course Outcomes**

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

1. On completion of the course the student must be able to understand and realize, the concepts of
2. The need of Autotronic and various electronically components.
3. Electronic ignition systems and electronic fuel control.
4. Engine management system
5. Chassis electrical systems and Electromagnetic interference suppression
6. Electronics for comfort, safety and security

**UNIT - I**

**Introduction**: Need for electronics in automotive control systems, structure of vehicle electronics systems, common features of vehicle systems, measurement system, sensors and actuators.

**Introduction to Electronics:** Electronic components, diodes, transistors, electronic circuits, analog circuits, digital circuits, integrated circuits, microprocessor systems, systems approach to control and instrumentation.

**UNIT - II**

**Electronic ignition systems:** Types of ignition systems, conventional ignition system, CDI, programmed ignition system, distributor-less ignition system, direct ignition.

**Electronic fuel control**: Electronic control of carburetion, petrol injection system, single and multi-point injection system, components, flow diagram, diesel fuel injection.

**UNIT - III**

**Engine Management System**: Combined ignition and fuel management system, exhaust emission control, digital control techniques, complete vehicle control systems, artificial intelligence and engine management.

**UNIT - IV**

**Chassis Electrical Systems**: Anti-lock brakes, active suspension, traction control, electronic control of automatic transmission.

**Electromagnetic Interference Suppression:** Electromagnetic compatibility Electronic dash board instruments - On-board diagnosis system. Security and warning system

**UNIT-V**

**Electronics for Comfort, Safety and Security**: Electric seats, mirrors and sun-roof operation, central looking and electric windows, cruise control, In Car Entertainment (ICE) and communications, adaptive noise control, airbags and seatbelt tensioners, obstacle avoidance radar, security systems - engine immobilizer, ICAT.

***Suggested Readings:***

1. Automotive electrical and electronic systems: Tom Denton, 3rd edition, SAE International.
2. Automotive electronics: Eric Chowanietz, Newnes, 1995.
3. Understanding automotive electronics, William B Ribbens, Butterworth-Heinemann.
4. Electrics Automotive Electronics, Robert Bosch.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 826 AE** | **Transport Management** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Students will understand

- To understand the concept of personal Management and selection process.
- To Understand the Transport organization structure and passenger transport operation and understand the bus Scheduling and Fare Structure.
- To Understand goods transport operation**,** Scheduling of goods transport, Advance Techniques in Traffic Management and Forms of ownership
- To understand the Motor Vehicle Act, insurance, and constructional regulations
- To understand the vehicle Maintenance system in transport industry Causes for uneven tyre wear and maintenance procedure for better fuel economy.

**Course Outcomes**

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

1. understand and realize, the concepts of personal Management and selection process
2. Prepare organization structure and passenger transport operations.
3. Implement Motor Vehicle Act, insurance, and constructional regulations
4. Motor Vehicle Act, insurance, and constructional regulations
5. Perform maintenance of the vehicle.

**UNIT – I**

**Introduction Personnel Management:** Objectives and functions of personnel management, psychology, sociology and their relevance to organization, personality problems. Selection process: job description, employment tests, interviewing, introduction to training objectives, advantages, methods of training, training procedure, psychological tests.

**UNIT – II**

**Transport Systems**: Introduction to various transport systems

**Passenger Transport Operation:** Structure of passenger transport organizations- Typical depot layouts. Scheduling and Fare Structure: Principal features of operating costs for transport vehicles with examples of estimating the costs. Fare structure and method of drawing up of a fare table, various types of fare collecting methods. Basic factors of bus scheduling. Problems on bus scheduling.

**UNIT – III**

**Goods Transport Operation:** Structure of goods transport organizations- Scheduling of goods transport- Management Information System (MIS) in passenger / goods transport operation- Storage & transportation of petroleum products- Advance Techniques in Traffic Management- Traffic navigation- Global positioning system. Forms of ownership and advantages of motor transport.

**UNIT – IV**

**Motor Vehicle Act**: Traffic signs, fitness certificate, registration requirements, permit insurance, constructional regulations, description of vehicle-tankers, tippers, delivery vans, recovery vans, Power wagons and fire fighting vehicles. Spread over, running time, test for competence to drive. Training for drivers & conductors

**UNIT – V**

**Maintenance:** Preventive maintenance system in transport industry, tyre maintenance procedures. Causes for uneven tyre wear; remedies, maintenance procedure for better fuel economy, Design of bus depot layout.

***Suggested Readings:***

1. John Duke, Fleet Management, McGraw-Hill Co, USA, 1984.
2. Government Motor Vehicle Act, Eastern Book Company, Lucknow, 1989.
3. Kitchin.L.D., Bus Operation, Illiffee and Sons Co., London, III edition, 1992.
4. The motor vehicle Act 1939.
5. Ejaz Ahemad, Ashok law house, India, 1989.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 827 AE** | **Non-Conventional Energy Sources** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand the concepts and applications of non-conventional energy sources.
- To learn the principles of power generation - solar, wind, biomass, waste heat recovery
- To know the terminology used in solar technology and understand Solar engines
- To know the sources of geothermal energy and its applications.

To understand the working principles of Wave, tidal and OTEC systems.

**Course Outcomes**

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

1. Select any Non-Conventional Energy Source equipment and apply concept of heat transfer and obtain the results.
2. Apply solar energy in solar engines
3. Able to design a wind mill.
4. Apply geothermal energy for different applications
5. Able to design a solar collector for different applications.

**UNIT-I**

Statistics on conventional energy sources and supply in developing countries, Definition-Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES-Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

**UNIT-II**

Solar Energy-Energy available form Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency, Principle of Natural and Forced convection, Solar Engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

**UNIT-III**

Wind energy conversion, General formula -Lift and Drag- Basis of wind energy conversion -Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors- Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators- working principle.

**UNIT-IV**

Nature of Geothermal sources, Definition and classification of resources, Utilization for electric generation and direct heating, Well Head power generating units, Basic features- Atmospheric exhaust and condensing, exhaust types of conventional steam turbines.

Pyrolysis of Biomass to produce solid, liquid and gaseous fuels, Biomass gasification, Constructional details of gasifier, usage of biogas for chulhas, various types of chulhas for rural energy needs.

**UNIT-V**

Wave, Tidal and OTEC energy- Difference between tidal and wave power generation, Principles of tidal and wave power generation, OTEC power plants, Operational of small cycle experimental facility, Design of 5 Mw OTEC pro-commercial plant, Economics of OTEC, Environmental impacts of OTEC. Status of multiple product OTEC systems.

***Suggested Readings:***

1. Ashok V Desai, *Non-Conventional Energy,* Wiley Eastern Ltd, New Delhi, 2003
2. Mittal K M, *Non-Conventional Energy Systems,* Wheeler Publishing Co. Ltd, New Delhi, 2003.
3. Ramesh R & Kumar K U, *Renewable Energy Technologies,* Narosa Publishing House, New Delhi, 2004
4. Wakil MM, *Power Plant Technology,* Mc Graw Hill Book Co, New Delhi, 2004.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 827 ME** | **Robotic Engineering** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Students will understand

- The configuration, work envelop and motion controls and applications
- Familiarities with the kinematics of robots.
- Robot end effectors and their design.
- Familiarities with the dynamics of robots.
- Robot Programming methods & Languages of robot.
- Various Sensors and drives and their applications in robots

**Course Outcomes**

At the end of the course, the students will be

1. Equipped with robot anatomy, work volume and robot applications
2. Familiarized with the kinematic motions of robot
3. Having good knowledge about robot end effectors and their design concepts
4. Familiarized with the robot dynamics
5. Equipped with the Programming methods & drives used in robots
6. Equipped with the principles of various Sensors and their applications in robots.

**UNIT-I**

**Robots**: History and evolution of robots, Laws of Robotics, basic configuration, degree of freedom, work envelope, motion control methods, Application in industry, material handling, loading & unloading, processing, welding & painting applications, assembly and inspection, Robot specification requirements

**UNIT-II**

**Rotation matrix**: Homogenous transformation matrix, Denavit-Hartenberg convention, Euler angles, RPY representation, Direct and inverse kinematics for industrial robots for position and orientation, Redundancy

**UNIT-III**

**Manipulator Jacobian**: Joint, End effector velocity, direct and inverse velocity analysis, Trajectory Planning, interpolation, cubic polynomial, linear segments with parabolic blending, static force and moment transformation, solvability, stiffness, singularities

**UNIT-IV**

**Robot dynamics**: Lagrangian formulation, link inertia tensor and manipulator inertia tensor, Newton-Euler formulation for RR & RP manipulators, Control: Individual joint, computed torque

**UNIT-V**

**End effectors**: position and velocity measurement, Sensors: Proximity and range, tactile, force and torque, Drives for Robots: Electrical, Hydraulic and Pneumatic, Robot vision: Introduction to technique, image acquisition and processing, introduction to robot programming languages.

***Suggested Readings:***

1. Spong and Vidyasagar, *Robot Dynamics and Control*, John Wile and Sons, 1990
2. R.K. Mittal, I.J. Nagrath, *Robotics and control*, Tata McGraw-Hill Publishing Company Ltd. 2003
3. Groover, *Industrial Robotics*, McGraw-Hill Publishing Company Ltd. 2003

4. Asada and Siotine, *Robot analysis and Intelligence*, Wiley Interscience, 1986
5. K.S. Fu GonZalezRC., lEEc.S.G., *Robotics, Control Sensing Vision and Intelligence*, McGraw Hill, Int. Ed., 1987
6. Richard S. Paul, *Robot Manipulators: Mathematics, Programming, and Control*, MIT Press (MA)

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 833 ME** | **Machine Tool Engineering and Design** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Students will understand

- Types of tools for heavy machining processes
- Design elements in sheet metal operation
- Use of jigs and fixtures for automation in industries

**Course Outcomes**

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

1. Understand basic motions involved in a machine tool.
2. Design machine tool structures
3. Design and analyse systems for specified speeds and feeds
4. Understand control strategies for machine tool operations
5. Apply appropriate quality tests for quality assurance

**UNIT-I**

Classification of Machine Tools: General purpose, Special purpose, Automatic, Semi-Automatic machine tools, Transfer lines. Kinematics of Machine Tools: Shaping of geometrical and real surfaces, Developing and designing of kinematics schemes of machine tools, Kinematic structures of lathe, drilling, milling, relieving lathe, grinding, gear shaping and gear hobbing machining. Kinematic design and speed and feed boxes. Productivity loss. Stepped and stepless regulation.

**UNIT-II**

Strength and Rigidity of Machine Tool Structures: Basic principles of design for strength. Different types of structures. General design procedures. Effect of materials and shape factors on the rigidity of structure, overall compliance of machine tool. Design of beds, bases columns, tables, cross rails for various machines. Effect of wear of guide ways on the performance. Various types of guide ways, their relative advantages. Materials for machine tool components including plastic guide ways (PTFE).

**UNIT-III**

Analysis of Spindles, Bearing and Power Screws: Design of spindles subjected to combined bending and torsion. Layout of bearings. Pre-loading. Anti-friction slide ways. Rolling contact, hydrodynamic, hydrostatic, aerostatics and magnetic bearings, their relative performance. Power Screws, Recirculating ball screws. Hydrodynamic design of journal bearings.

**UNIT-IV**

Machine Tool Vibrations: Effect of vibration on machine tool; Forced vibrations. Machine tool chatter. Self-excited vibration and dynamic stability single and two-degree freedom analysis. Comply coefficient. Elimination of vibration. Vibration analysis of machine tool structures.

**UNIT-V**

Hydraulic Systems: General principles, hydraulic fluid power lines. Properties of hydraulic fluid. Various positive displacement pumps, their characteristics and operation. Design of hydraulic tanks and other systems. Various valves used in hydraulic systems. Design and application of various hydraulic circuits. One position and multi-position scheme. Single and multi-pump screws. Electrical analogy. Pneumatic circuits.

Hydro copying system. Evaluation of machine tools with regard to accuracies, sound and vibration. Machine tool testing.

***Suggested Readings:***

1. Sen and Bhattacharya, Principles of Machine Tools, New Central Book Agency, Calcutta, 1975.
2. S.K. Basu, Design of Machine Tools, Allied Publishers, India, 1961.
3. Acharkan, Machine Tool Design (vol. 1,2 & 3), MIR Publishers, Moscow, 1973.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 824 ME** | **Non-Destructive Testing** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student has to understand the

- Need, basic concepts and technologies of Non-Destructive Testing (NDT)
- Security precautions from Radiography, protection from radiation and measurement of radiation received by personnel.
- Technology of acoustic emission (AE), the associated instrumentation and applications
- Technologies like neutron radiography; laser induced ultrasonics, surface analysis and thermography
- Merits and demerits of the different NDT Technologies
- Latest research and developments in NDT

**Course Outcomes**

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

1. the knowledge of different NDT techniques.
2. clear understanding of liquid penetrant inspection and magnetic particle inspection.
3. view and interpret radiographs, utilize the various principles of radiography for different components of different shapes.
4. the knowledge of acoustic emission for NDT and the instrumentation used for NDT.
5. the ability to analyse and prepare a technical report.
6. the knowledge of latest research, developments and trends in NDT.

**UNIT-I**

**Liquid penetrate inspection:** Principles of penetrate inspection, characteristics of a penetrate, water washable system, post emulsification system, solvent removable system, surface preparation and cleaning, penetrate application, development, advantages limitations, and applications. Magnetic particle instruction: Principle, magnetization methods, continuous and residual methods, sensitivities, demagnetization, magnetic particles, applications advantages and limitations.

**UNIT-II**

**Eddy current testing:** Principle, lift-off factor, and edge effect, skin effect, inspection frequency, coil arrangements, inspection probes, types of circuit, reference pieces, phase analysis, display methods and applications.

**UNIT-III**

**Ultrasonic testing:** Generation of ultra sound, characteristics of an ultrasonic beam, sound wavesat interfaces, sound attenuation, display systems, probe construction, type of display, inspection techniques, identification of defects, Immersion testing, sensitivity and calibration. Reference standards. Surface condition, Applications.

**UNIT-IV**

**Radiography:** Principle and uses of radiography, limitation principle, radiation sources, production of X-Rays, x-ray spectra, attenuation of radiation, radiographic equivalence, shadow formation enlargement and distortion, radio graphic film and paper, Xeroradiography, fluoroscopy, exposure factors, radiographic screens, identification markers and image quality indicators, inspection of simple shapes, inspection of complex shapes, viewing and interpretation of radiographs, radiation hazard, protection against radiation, measurement of radiation received by personnel.

**UNIT-V**

**Acoustic Emission:** Physical Principles, Sources of emission, instrumentation and applications, Other NDT Techniques: Neuron radiography, Laser induced ultrasonics, surface analysis, and thermography.

***Suggested Readings:***

1. Barry Hull & Vernon John, *Non-Destructive Testing*, 1988.
2. H J Frissell (Editorial Coordinator), Non-*Destructive Evaluation and quality control*, ASM Handbook-International Publication USA, 1989.
3. Dove and Adams, *Experimental Stress analysis and Motion Measurement*, Prentice Hall of India, Delhi
4. *Non-Destructive Examination and Quality Control*, ASM International, Vol.17, 9$^{th}$edition (1989)
5. J. Prasad and C. G. K. Nair, *Non-Destructive Test and Evaluation of Materials*, Tata McGraw-Hill Education, 2nd edition (2011).
6. B. Raj, T. Jayakumar and M. Thavasimuthu, Practical *Non Destructive Testing*, Alpha Science International Limited, 3 rd. edition (2002).
7. T. Rangachari, J. Prasad and B.N.S. Murthy, *Treatise on non-destructive testing and evaluation*, Navbharath Enterprises, Vol.3, (1983).

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 831 AE** | **Automotive Pollution and Control** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To know different pollutants from automobiles and their effect on health and environment.
- To understand the mechanism of pollutants formation in SI and CI Engines
- To understand the effect of engine design and operating variables of the engine to control emissions.

To understand the test procedure of pollution measuring devices

**Course Outcomes**

1. Analyse the sources of pollutants and operational effects on pollutants
2. Explain the mechanism of pollutants formation in SI and CI Engines.
3. Explain the methods to control emissions
4. Explain the test procedure of different emission measuring devices

**UNIT – I**

**Introduction:** Vehicle population assessment in metropolitan cities and contribution to pollution, effects on human health and environment, global warming, types of emission, transient operational effects on pollution.

**UNIT – II**

**Pollutant Formation in SI Engines:** Pollutant formation in SI Engines, mechanism of HC and CO formation in four-stroke and two-stroke SI engines, NOx formation in SI engines, effects of design and operating variables on emission formation, control of evaporative emission. Two-stroke engine pollution.

**UNIT – III**

**Pollutant Formation in CI Engines:** Pollutant formation in CI engines, smoke and particulate emissions in CI engines, effects of design and operating variables on CI engine emissions. NOx formation and control. Noise pollution from automobiles, measurement and standards.

**UNIT – IV**

**Control of Emissions from SI and CI Engines:** Design of engine, optimum selection of operating variables for control of emissions, EGR, Thermal reactors, secondary air injection, catalytic converters, catalysts, fuel modifications, fuel cells, Two-stroke engine pollution control.

**UNIT – V**

**Measurement Techniques Emission Standards and Test Procedure:** Orsat Apparatus, NDIR, FID, Chemiluminescent analysers, Gas Chromatograph, smoke meters, emission standards, driving cycles – USA, Japan, Euro and India. Test procedures – ECE, FTP Tests. SHED Test – chassis dynamometers, dilution tunnels

***Suggested Readings:***

1. Paul Degobert – Automobiles and Pollution – SAE International ISBN-1-56091-563-3, 1991.
2. Ganesan, V- “Internal Combustion Engines”- Tata McGraw-Hill Co.- 2003.
3. SAE Transactions- “Vehicle Emission”- 1982 (3 volumes).
4. Obert.E.F.- “Internal Combustion Engines”- 1988
5. Marco Nute- “Emissions from two stroke engines, SAE Publication – 1998

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 832 ME** | **Additive Manufacturing Technology** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Students will understand

- the importance of RPT
- Apply various liquid and solid based RPT Systems
- Apply various powder based RPT systems and rapid tooling
- Recognize various STL formats and slicing methods and tessellation
- Application of RPT in Engineering, Jewellery and Bio medical etc.

**Course Outcomes**

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

1. understand the developments of RPT and its terminology, Advantages and limitations of RPT
2. understand mechanism involved in stereo lithography apparatus system, and terminated object manufacturing, fused deposition modelling and their applications.
3. understand mechanism in selective laser interims and its application. Understand the importance of Rapid tooling
4. recognize various types of file format and slicing methods in RP and various software available to convert 3D models.
5. apply RPT in various fields of Engineering

**UNIT-I**

**Introduction:** Prototyping fundamentals, Historical development, fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, commonly used terms, classification of RP process, Rapid prototyping process chain: Fundamental Automated processes, process chain.

**UNIT-II**

**Liquid based rapid prototyping systems:** Stereo lithography apparatus (SLA): Models and specifications, process, working principle, photopolymers, photo polymerization, layering technology, laser and laser scanning, applications, advantages and disadvantages, case studies. Solid ground curing (SGC): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

**Solid based rapid prototyping systems:** Laminated object manufacturing (LOM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Fused deposition modelling (FDM): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies.

**UNIT-III**

**Powder Based Rapid Prototyping Systems:** Selective laser sintering (SLS): Models and specifications, process, working principle, applications, advantages and disadvantages, case studies. Three dimensional printing (3DP): Models and specification, process, working principle, applications, advantages and disadvantages, case studies.

**Rapid Tooling:** Introduction to Rapid Tooling (RT), Conventional Tooling VsRt, need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, investment casting, spin casting, diecsting, sand casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

**UNIT-IV**

**Rapid Prototyping Data Formats:** STL Format, STL File Problems, Consequence of Building Valid and invalid tressellated models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats.

**Rapid Prototyping Software's:** Features of various RP software's like Magics, Mimics, Solid View, view expert, 3 D view, velocity 2, Rhino, STL view 3 data expert and 3 D doctor

**UNIT-V**

**RP Applications:** Application – Material Relationship, application in design, application in engineering, Analysis and planning, aerospace industry, automatic industry, Jewellery industry, coin industry, GIS application, Arts and Architecture.

**RP Medical and Bioengineering Application:** Planning and simulation of complex surgery, customized implant and prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules.

***Suggested Readings:***

1. Chua C.K., Leong K.F. and LIM C.S Rapid prototyping: Principles an Applications, World Scientific publications, 3rd Ed., 2010
2. D.T. Pham and S.S. Dimov, "Rapid Manufacturing", Springer, 2001
3. Terry Wohlers, "Wholers Report 2000", Wohlers Associates, 2000
4. Paul F. Jacobs, "Rapid Prototyping and Manufacturing"–, ASME Press, 1996
5. Ian Gibson, Davin Rosen, Brent Stucker "Additive Manufacturing Technologies, Springer, 2nd Ed, 2014

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 834 ME** | **Entrepreneurship Development** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioral aspects of entrepreneurs and time management

**Course Outcomes**

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

**UNIT-I**

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

**UNIT-II**

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

**UNIT-III**

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

**UNIT-IV**

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

**UNIT-V**

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

***Suggested Readings:***

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997.
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 841 ME** | **Energy Conservation and Management** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn about energy conservation
- To understand sources of loss of power in energy conversion
- To understand Procedure for Comprehensive Energy Conservation Planning
- To understand Industrial energy conservation methods

**Course Outcomes**

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

1. Understand different forms of energy
2. Calculate the amount of heat energy available
3. Understand the industry energy conservation modelling
4. Understand methodology for forecasting industrial energy supply and demand.

**UNIT-I**

Definition, Principles of Energy Conservation - Maximum Thermodynamic efficiency. Maximum Cost - effectiveness in energy use. Various forms of energy - Heat Mechanical. Electrical energy and Chemical energy. Identification of potential sources of energy losses - Transportation, operation and conversion from one from to another.

**UNIT-II**

Heat energy and storage - Media of transport of heat energy - steam, oil and flue gases. Calculation of steam quality. Calculation of amount of heat energy available. Recuperators. Constructional details, Selection of materials to store heat energy. Concept of power. Modes of mechanical energy transport - Gears, pulleys, belts, shafts etc., Calculation of power. Sources of loss of power in energy conversion into electricity, potential energy (i.e., pumps).

**UNIT-III**

Chemical energy - combustion of fuels - petrol, diesel and coal. Loss due to quality of fuel, conversion into other form of energy - boilers, I.C. engines. Calculation related to losses. Electrical energy - Working principle of motors and generators. Calculation of efficiency of generators. Losses during transmission and energy conversion - into mechanical energy, thermal energy. Calculation of effecting parameters.

**UNIT-IV**

Procedure for Comprehensive Energy Conservation Planning (CECP) -Specifying targets, identifying energy in-efficient facilities. Synthesize evaluation and optimization of alternative conservation measures in view of organization costs. Flow chart of organization's functions. Collection of accountable data. Application of CECP method. An example.

**UNIT-V**

Industrial energy conservation modeling - Methodology - Definition of production system - A primary copper production system, Model construction - Mathematical Programming. Market penetration, Structure of energy conservation model. Data preparation - coefficients needed in a model, Unit production cost and unit energy requirements. Model exercise, verification and validation. Methodology for forecasting Industrial Energy Supply and Demand.

***Suggested Readings:***

1. Gottschalk C.M., "Industrial Energy Conservation", John Wiley & Sons, 1996.
2. Chaturvedi P., and Joshi S., "Strategy for Energy Conservation in India", Concept Publishing Co., New Delhi, 1997.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 842 ME** | **Advanced Propulsion and Space Science** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn about gas dynamic concepts of rocket propulsion system
- To learn rocket engine system.
- To learn celestial sphere and its parameters
- To learn about Satellites & Remote Sensing

**Course Outcomes**

Student will be able to

1. Classify different rocket propulsion systems and understand the concept of gas dynamics
2. understand the working principle of rocket engine system
3. understand celestial sphere and its parameters

**UNIT-I**

Advanced Gas Dynamics: Normal shock waves, pitot tubes, moving shock waves, oblique shock waves, reflected shock waves, conical shock waves, hypersonic flow, Newtonian theory, high temperature flows, low density flows.

**UNIT-II**

Advanced Propulsion: Rocket engines - Operation and performance of rocket engines, design and operating parameters - total impulse, thrust, energy and efficiencies, Typical performance values, overview of monopropellant, bipropellant liquid, solid and hybrid rocket propulsion systems, combined cycle propulsion, Electric / Ion propulsion.

**UNIT-III**

Rocket Technology: Flight mechanics, application thrust profiles. Acceleration -staging of rockets, feed systems, injectors and expansion nozzles, typical nozzle designs (cone, bell, plug). Rocket heat transfer and ablative cooling. Testing and Instrumentation. Nuclear thermal rockets, pulsed detonation engines, Solar sails.

**UNIT-IV**

Celestial Sphere: Spherical trigonometry, celestial coordinate systems, Astronomical triangle, Time-Sidereal, apparent and mean solar time. Equation of Time.

Two Body Problem: Formulation, relative motion and solution, Kepler's equation, motions of rockets and artificial satellites, transfer orbits, minimum energy interplanetary transfer orbits, use of parking orbits, Perturbations of artificial satellites due to atmospheric drag and flattening of earth.

**UNIT-V**

Nuclear Processes in the Sun, Solar wind, interaction of solar Wind and Earth's magnetic field, Van Allen radiation belts.

Satellites & Remote Sensing: Orbits, earth segment, space segment, earth station, satellite subsystems, working details of communication and navigational satellites - components, operation and maintenance, meteorological satellites. Principles of remote sensing.

***Suggested Readings:***

1. Shapiro, "The dynamics and thermodynamics of compressible flow", 1953.

2. Thomas, D. Daman, "Introduction to space: The Science of space flight", Orbit book Co., 3rd ed., Malabar, FL, 2001.
3. K.D. Abhyankar, "Astrophysics of the solar systems", University Press (India) Ltd., 1999.
4. Timothy Pratt and Charles, W. Bostian, "Satellite Communications", John Wiley, 1986.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 843 ME** | **Waste Heat Recovery and Co-Generation** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn concepts of waste heat recovery
- To learn the applications of heat exchangers & recuperators in heat recovery
- To understand cogeneration methods

**Course Outcomes**

Student will be

1. Understand the concept of waste heat recovery
2. Distinguish heat exchangers and recuperators
3. Acquire knowledge about various cogeneration methods

**UNIT-I**

Definition, Sources, Quantity and quality of waste heat. Technologies for waste heat recovery and utilization. Need of storage systems for waste heat.

Utilization of Waste Heat - Continuous and Intermittent. Energy requirements of industry. Various forms of waste heat available.

**UNIT-II**

Overview of heat exchangers. Gas to gas. Gas to liquid and liquid to liquid heat exchangers. Calculation of effectiveness and design of heat exchanger for number of tubes. Pressure drop considerations LMTD and effectiveness -NTU methods.

**UNIT-III**

First and Second law of thermodynamics, and its effect on design of recuperators. Recuperators-Ceramic, metallic and reradiant recuperators, high temperature recuperators. Concept of porosity, Peclet number superficial velocity, pressure drop, and selection of material for heat storage and recovery.

**UNIT-IV**

Cogeneration - Definition, Two basic cogeneration concepts, thermodynamic advantage, Cogeneration efficiency, potential benefits and costs of cogeneration. Cogeneration-Over view, Industrial application of cogeneration.

**UNIT-V**

Source of waste heat and methods of utilization. Application of Cogeneration to a steam power plant. Identifying the possibilities of extracting energy to run a gas turbine. Integration of Steam turbine and Gas turbine - Power calculations, various types and their applications towards power generation. Quality of steam and its effect on performance. Legislation - Power plant and Industrial fuel use act (FUA) Potential nationwide benefits of Cogeneration, Impact of Cogeneration on fuel use patterns. Legislative, Environment and Institutional Constraints for use of waste heat.

***Suggested Readings:***

1. Donald Q. Kern, "Process Heat Transfer", McGraw Hill International Editions, Chemical Engineering Series, 1965.
2. Wylen V. and Sonntag, "Fundamentals of Classical Thermodynamics" - SI Version, Wiley Eastern Ltd., 1993.
3. David Hu S., "Handbook of Industrial Energy Conservation", Van Nostrand Reinhold Co., 1983.

| Course Code | Course Title | | | | | | Core/Elective |
|---|---|---|---|---|---|---|---|
| **PE 844 ME** | **Aerodynamic Design of Thermal Turbines** | | | | | | **Elective** |
| Prerequisite | Contact Hours Per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To learn design concepts of thermal turbines
- To understand the analysis of flow past a turbine cascade
- To understand turbine blade design methods

**Course Outcomes**

The student will be able to

4. explain the concepts of thermal turbines
5. analyze the flow past a turbine cascade
6. design the turbine blade

**UNIT-I**

**Introduction:** Definition of a turbine stage. Enthalpy - Entropy diagram for a Turbine stage. Definition of Euler work, specific work and isentropic work. Euler's turbine equation and Energy transfer equation. Definitions of shape No, stage efficiency, stage reaction, work done factor, utilization factor and coupling power.

Concepts of ID, 2D and 3D flows; Vortices; Circulation; Potential and Viscous flow theories. Definitions of subsonic, transonic and supersonic flows. Single Aerofoil theory and its limitations. Boundary layer parameters and flow separation.

**UNIT-II**

**Aerodynamics of turbine cascades:** Definition of a cascade. Classification of turbine Cascades. Blade and cascade geometric parameters. Blade and cascade angles and relationships. Flow parameters and their significance. Cascade flow model for turbines. Wake flow NACA and other cascade blade data specification methods.

**1D Analysis:** Cascade aerofoil blade forces. Force coefficients Lift and Drag Coefficients. Equations for blade forces with cascade blade parameters and angles. Stagnation pressure loss for a turbine cascade. Cascade efficiency.

**UNIT-III**

**1D and 2D Blade Design Methods:**

**1D methods:** Pitch-line design method. Velocity diagrams at hub, tip and mean radii. Definition of mean flow terms. Kulta condition and Zweifel's criterion for axial turbine cascade design. Problems on axial turbine stage cascades.

**2D methods:** Concepts of singularities, simple relations. Schlichting Method - equations for induced velocity,

Camber line and thickness distribution for an arbitrary aerofoil shape - Direct and indirect design problems. Channel flow approach - Stanitz I and I approximation methods.

**UNIT-IV**

**3D Blading Design Methods:**

**Radial Equilibrium theory:** Fundamental equation and approaches for the vortex design of axial turbine cascades; Simple problems on Radial equilibrium theory.

**Actuator Disc theory:** Concept and application to simple design problems on axial flow turbine cascades.

**UNIT-V**

**Performance Evaluation:**

Dimensionless groups and performance maps for axial turbines. Distribution of static pressure over blade profile losses in turbine cascades. Profile, Annulus, Secondary, Tip clearance and over all loss estimation - Soderberg and Ainley - Malhieson methods. Loss model for a turbine
cascade.

Description of wind tunnel test rig for experimental investigations of turbine cascades. Types of pressure probes, Hotwire anemometer, LDV principles and their calibration techniques. Concepts of flow visualization and its significance.

***Suggested Readings:***

1. J.P. Gostelow, " Cascade Aerodynamics" -, Pergamoa Press, USA.
2. S.M. Yahya, " Fans, Turbines and Compressors", Tata Mc-Graw Hill Pub; Delhi.
3. S.L. Dixon, "Fluid Mechanics and Thermodynamics of Turbomachinary" Pergamon Press, USA.
4. Gopalakrishnan G, Prithvi Raj D, "A treatise on Turboniachincs?', Scitech Publications. Chennai, 2002

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PW 961 AE** | **Project Work - II** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **16** | **50** | **100** | **8** |

**Course Objectives**

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

**Course Outcomes**

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

**Note:** Three periods of contact load will be assigned to each project guide.