**SYLLABUS OF B.E. SEM. VIII (MECHANICAL ENGINEERING) [C.B.C.S.]**

## 8ME01 OPERATION RESEARCH TECHNIQUES

**Course Learning Objectives (CLOs):**

1. To study operation research models and linear programming methods.
2. To understand transportation models and assignment models.
3. To study waiting line models and understands the concept of sequencing.
4. To study replacement models and simulation models.
5. To understand the concept network models, CPM and PERT analysis.

**Course Outcomes (CO):**

1. Understand the knowledge of OR and OR models.
2. Analyze the transportation problems and related issues.
3. Understand the concept network models, CPM and PERT analysis.
4. Understand the concept replacement models and solve the problem on simulation techniques.

**SECTION – A**

**UNIT I: Operations Research:** Introduction, characteristics, Phases, Limitations, Models and classification ofO.R.Models.
**Linear Programming:** Formulation, Standard Form, Graphical and simplex methods, Primal-Dualrelationship. **(8 H**

**UNIT II**: **Transportation Models: Introduction**, LP Formulation of transportation problems, Methods forfinding initial solution, MODI method.
**Assignment Models:** Introduction, Mathematical statement and solution methods of assign. Problems, variations of assignment Problems. **(6 Hrs)**

**UNIT III**: **Network Models:** Network construction, PERT analysis, CPManalysis, cost analysis & crashing the network, Updating resources smoothing and leveling. **(6 Hrs)**

**SECTION-B**

**UNITIV: Waiting line models:** Introduction, characteristics, classification, analysis of M/M/1 and M/M/s models.
**Sequencing:** processing of n jobs through two machines, n jobs through m machines, two jobs through mmachines**.** **(7 Hrs)**

**UNITV**: **Replacement models:** introduction, value of money, individual and group replacement policies.
` **Simulation:** introduction, Monte Carlo simulation, advantages and limitations, applications of simulation to queuing models, inventory models, maintenance models , etc. **(7 Hrs)**

**UNITVI**: **Dynamic programming**: introduction, characteristics, applications of dynamic programming to capital budgeting, production scheduling, travelling sales men, cargo loading problems, etc. **(6 Hrs)**

RECOMMENDED BOOKS:

**Text Books:**


1. Operations Research and Theory applications- II ed.J.K.Sharma;Macmilan Business Books
2. Operations Research; Prem kumar Gupta, D.S.Hira; S.Chand & Co. ltd.


**Reference Books:**


1. Introduction to Research Operation, 7th Edition; Hiller/Lieberman; Tata Mc-graw Hills.
2. Operations Research : An Introduction, 7th Edition, H.A.Taha; PHI.
3. Operations Research: Principles and practices; 2nd Edition, Ravindran,Philips, Solberg, John Willey & Sons.
4. Operations Research: Kapoor.


## 8ME02: I. C. ENGINES

**Course Learning Objectives (CLOs):**

1. To study basic of engines, Air standard cycles, Fuel air cycle, actual cycle and review of other losses in ICengines.
2. To study conventional fuels, requirement, properties, fuel additive and limitations of fossil fuels.
3. To study stages of combustion, factors influencing various stages, Detonation, Factors and effect ofdetonation, rating of fuel and combustion chambers.
4. To study delay period, diesel knock, cetane rating, requirements of combustion chamber and methods of generating turbulence.
5. To Evaluate performance of Engines by using heat balance sheet, excess air calculation and determinationof friction power, effect of supercharging.
6. To study Emission from Engines, EURO emission norms and Recent trends in Engines.

**Course Outcomes (COs):**

1. Remember fundamentals of I.C. engines, their types and cycle analysis.
2. Remember the knowledge of fuels and alternative fuels, study of fuel injection pump.
3. Remember the concept of combustion of CI engine.
4. Understand the concept of supercharging its objectives, advantages and limitations.

**SECTION-A**

**UNIT I**: **Introduction to IC Engines and cycle analysis:** Basic of I.C. Engines , Details of two stroke and four stroke engines, Air standard cycles, Fuel air cycle and actual cycle. Variation in specific heat, Dissociation and their effect on engine performance. Review of other losses in IC engines. **(7 Hrs)**

**UNIT II: Fuels and alternative fuels:** Conventional fuels for IC engines, requirement, properties, fuel additive, limitations of fossil fuels. Review of various alternative/non-conventional fuels. Studies of fuel injection systems: Fuel pump and their working, different types of fuel feed systems, studies of injector'snozzles, Bosch type fuel pump. **(8 Hrs)**

**UNIT III**: **Combustion SI Engine:** - Stages of combustion, factors influencing various stages, Normal and abnormal combustion, Detonation, Factors responsible for detonation. Effect of detonation. Octane rating of fuel, Requirement of combustion chambers for SI engines, important types, relative advantages and disadvantages and application. **(8 Hrs.)**

**SECTION- B**

**UNIT IV: Combustion in CI. Engines:** - Stages of combustion in CI Engines, Delay period, factor affecting delay period, diesel knock, cetanerating, Requirements of combustion chamber for CI Engines. Methods of generating turbulence in combustion chamber. Types of combustion chambers for CI Engines. **(8 Hours)**

**UNIT V**: **Performance testing of IC Engines:** Evaluation of various performance parameters of IC Engines including heat balance, sheet and excess air calculation. Methods of determination of friction power. Supercharging : Basic principles, objectives, arrangements for super charging, advantages and limitations of super charging. **(8 Hours)**

**UNIT VI**: **Emission from IC Engines:** review, their effect on human health, cause of formation and approaches to control this pollutants. Study of BIS, EURO emission norms, IC Engines: Recent trends: Microprocessor based engines, management multi-point fuel injection engines, common rail direct injections engines, variable valve timing engines. **(8 Hours)**

BOOKS RECOMMENDED:

**Text Books:**

1. Internal combustion Engines - M.L.Mathur & Sharma Dhanpatrai &Sons.
2. Internal combustion Engines – V.Ganeshan, Tata Mcgraw Hills.

**ReferenceBooks:**

1. Internal combustion Engines Fundaments- John B. Heywood, Mcgraw Hills
2. Internal combustion Engines & Air Pollution- Obert E.F.Intext Educational.

## 8ME03 PROFESSIONAL ELECTIVE – III
## (i) ENERGY CONSERVATION & MANAGEMENT

**Course Learning Objectives:**

Students are expected to learn the importance and the need for conserving the Energy and apply the knowledge gain through methodologies and the management techniques in the energy conservation.

**Course Outcome:**

After learning the course the students should be able:

1. To understand the basic knowledge of different terms & principles of energy conservation, audit and management.
2. To Evaluate the energy saving & conservation in different mechanical utilities
3. To understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical system.
4. To prepare energy audit report for different energy conservation instances.

**SECTION – A**

**Unit-I: Energy Scenario and importance of energy conservation:**

Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy

conservation and its importance, energy strategy for the future. Energy Conservation Act 2001 and related policies: Schemes of Bureau of Energy Efficiency (BEE), State Designated Agencies, Electricity Act 2003. Clean Development Mechanism (CDM). **(7-Hrs)**

**Unit-II: Thermal Systems: Boilers and Industrial furnaces:** Energy conservation opportunities in Boilers, efficiency testing, excess air control, performance evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Steam distribution & use – steam traps, condensate recovery, flash steam utilization. Electrical, Induction furnaces- Energy saving measures. **(7-Hrs)**

**Unit-III: Thermal Systems: Fans, Blowers and HVAC:**
Energy conservation in Pumps, Fans (flow control) and blowers, Pumps and Pumping systems - Classification, Performance, Factors affecting pump performance, efficiency. Compressed Air Systems, Performance monitoring and compressed air-distribution system. Factors affecting cooling tower performance and Energy saving opportunities. Refrigeration and air conditioning systems – Waste heat recovery recuperates, heat sheets, heat pipes, heat pumps. Energy conservation methods.
**(7-Hrs)**

**SECTION - B**

**Unit-IV: Electrical Systems:**
AC / DC current systems, Demand control, power factor correction, load management, Motor drives: motor efficiency testing, energy efficient motors, motor speed control, electrical distribution systems – Transformers – Power quality – harmonic distortion. Reduction of losses – Power factor. Lighting: lighting levels, efficient options. **(7-Hrs)**

**Unit-V: Energy auditing:**
Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering. **(7Hrs)**

**Unit-VI: Energy Management and Economics:**
Energy resource management – Energy Management information systems (EMIS) – Energy Monitoring and Targeting: Defining monitoring & targeting, elements of monitoring & targeting.
Energy economics – discount rate, payback period, internal rate of Return, life cycle costing – Financing energy conservation Projects. **(7-Hrs)**

BOOKS RECOMMENDED:

**Text Books:**


1. L.C. Witte, P.S. Schmidt, D.R. Brown, Industrial Energy Management and Utilisation, Hemisphere Publ, Washington, 1988.
2. O. Callaghn, P.W. Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. IDryden, I.G.C. The Efficient Use of Energy, Butterworths, London, 1982.


**Reference Books:**


1. Turner, W.C. Energy Management Hand Book, Wiley, New York, 1982.
2. 4Murphy, W.R. and Mc KAY, G. Energy Management, Butterworths, London 1987.
3. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press .
4. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press.
5. Trivedi, P.R, Jolka K.R., Energy Management, Commonwealth Publication, New Delhi,1997.


## (ii) PODUCTION PLANNING AND CONTROL

**Course Learning Objectives (CLOs);**

1. To understand the importance of production planning and control, its functions, advantages.
2. To apply the skills of calculating for sales forecasts using various forecasting methods.
3. To remember concept of machine capacity, loading of machines and man machine activity charts.
4. To study the concept of inventory control & various cases of inventory system and modern techniques/philosophies of management like CIM, JIT, MRP-I and MRP-II.

**Course Outcomes (COs):**

1. Understand the importance of production planning and control, its functions, advantages.
2. Apply the skills of calculating for sales forecasts using various forecasting methods.
3. Remember concept of machine capacity, loading of machines and man machine activity charts.
4. Understand concept of inventory control & various cases of inventory system and modern techniques/philosophies of management like CIM, JIT, MRP-I and MRP-II.

**Unit I: - INTRODUCTION:**

**SECTION–A**

Objectives and Advantages of PPC, Production procedure, functions of PPC, production consumptions cycle, centralized & decentralized PPC, Pre-requisite of PPC. **(7-Hrs)**

**Unit II: - PRODUCTION FOR CASTING:-**

Introduction, definition and importance of forecasts, Qualitative model: Delphi techniques, Quantitative Models: - Simple moving average, weighted moving average, simple experimental smoothing.

Forecasting error and selection of forecasting model. Types of forecaster: Constant, linear cycle forecaster, Verification and controlling, the moving range chart, Average MR, out of control conditions. **(8-Hrs)**

**Unit III: PRODUCTION PLANNING** : - The production order, Procedure for formulating Production order, masier Program, Basic problems in production planning, Quantities in batch production, criteria for batch, size determination, minimum cost batch size, production range, Maximum profit Batch size, Maximum return, Rateofreturn, Economic Batch size. **(7-Hrs)**

**SECTION–B**

**Unit IV: MACHINE OUTPUT:**

Machine output, multi machine supervision by one operator, Machine interference, Ashcroft labels, average number of consecutive servicing task, the Ashcraft Number. **(7-Hrs)**

**Unit V: ANALYTICAL STRUCTURE OF INVENTORY: -** Definition of inventory, Types of inventory and the classification, structure of inventory problems and its analysis, the relevant cost, objectives of carrying inventories, selective inventory analysis. Static Model: - General characteristic, incremental analysis, opportunity cost, cost of risk, decision criteria under uncertainty. **(7-Hrs)**

**Unit VI: A) DYNAMIC MODEL:-CERTAINITY CASE; -** General characteristic, optimum lot size model winconstant demand, quantity discounts. Risk Case: - General characteristics, P-system and Q-system.

B) Material Requirement planning (MRP) :- Introduction to MRP, Manufacturing Resource Planning (MRP-IT), just in time (JIT), comparison of MRP, MRP-II, Entrepreneurship Resource Planning (ERP). **(8 Hrs)**

BOOKS RECOMMENDED:

**Text Books:**


1. Elements of Production Planning and Control by Simuel Eilon –Universal Publishing Corporation ltd. Mumbai
2. Production Control – John E.Biegal- Prentice Hall of India.
3. Inventory Control, Theory & Practice- Start & Miller.


**Reference Books:**


1. Production Planning and control and Management: - K.C.Jain &L.N.Agrawal.
2. Production & Operation Mgmt.;- E.E.Adam, Jr.R.J.Ether, Prentics Hallof India.
3. Industrial Engineering and Production Management- M.Mahajan-Dhanpat Rai.

## (iii) PRODUCT DESIGN & DEVELOPMENT

**Course Learning Objectives:**
This course aims at introducing the students to the basic concepts of engineering design and product development with focus on the front-end processes. At the end of this course the student is expected to demonstrate an understanding of the overview of all the product development processes and knowledge of concept generation and selection tools.

**Course Outcomes:**
After successfully completion of this course students will be able to:

1. Manage the development of an idea from concept through to production.
2. Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.
3. Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
4. Demonstrate, apply, explain, and recognize basic engineering, mechanical, and technical principles for decision making
5. Use sustainable materials and manufacturing processes & Carry out cost and benefit analysis through various cost models.

### SECTION-A

**UNIT I: Introduction to product design:** The morphology of design, Primary design phases & flowcharting, Role of allowance, Process capability and tolerance in detailed design and assembly, detailed design phase. **(6-Hrs)**

**UNIT II: Product design practices:**
Product strategies, time to market, analysis of the product, the Three S's, standardization, Renard series, Simplification, Designer and his role, Basic design consideration, Procedures and problems faced by industrial designer, Role of aesthetics in product design, functional design practice. **(6-Hrs)**

**UNIT III: Product design consideration:**
Principal stress trajectories, balanced design, criteria and objectives of design, material toughness: resilience, designing for uniform strength, tension vis-à-vis compression.
Pure struts and pure columns, mapping of principal stresses, buckling and instability, theory of long columns, hollow columns, plastic design, practical ideas for material saving in design, ribs, corrugation, laminated, membranes.
**(6-Hrs)**

### SECTION-B

**UNIT IV Design for production:**
Producibility requirement, forging design, pressed component design, casting design, design for machining ease, the role of process engineer, ease of location and clamping, die casting and special casting, design of powder metallurgical parts, expanded metal and wire forms.
Introduction, properties & classification of plastics, phenol formaldehyde and urea formaldehyde resin products, compression moulding, transfer molding, injection molding, high-pressure laminates, forming and drawing of plastic sheets, design of plastic parts, natural & artificial rubber, engineering properties of rubber, Glass & ceramics. Plastic bush bearings, gears & fasteners in plastic, Design recommendation for rubber parts, Distortion in rubber, dimensional effects and tolerances, design factors for ceramics and glass parts, Wood. **(6-Hrs)**

**UNIT V: Optimization & Economics in Design:**
Siddal's classification of design approach, Optimization by differential calculus, Language multipliers, linear programming, geometric programming, Johnson's method of optimum design. Product value, design for safety, reliability and environmental considerations, manufacturing operations in relation to design, economic analysis, profit & competitiveness, break-even analysis, economics of a new product design. **(6-Hrs)**

**UNIT VI: Human engineering, value engineering & role of computer in product design:**
**Human being** vas applicator of forces, Anthropometry, design of controls& displays, man/machine information exchange, workplace layout from ergonomic consideration, noise, heating and ventilating, lighting.

**Introduction to value**, maximum value, normal degree of value, importance of value, creativity, steps to problem solving and value analysis, value analysis tests, value engineering idea generation check-list, cost reduction through value engineering, material and process selection in value engineering.

**Introduction to product cycle & CAD/CAM**, role of computers in manufacturing and design, creation of a manufacturing database, CIM, communication networks, GT, production flow analysis, MRP, FMS, JIT. **(7-Hrs)**

BOOKS RECOMMENDED:

**Text Books:**


1. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development ", 4th Edition, 2009, Tata McGraw-Hill Education, ISBN-10-007-14679-9.

2. Clive L. Dym, Patrick Little, "Engineering Design: A Project-based Introduction", 3rd Edition, John Wiley & Sons, 2009, ISBN 978-0-470-22596-7


**Reference Books:**


1. George E.Dieter, Linda C.Schmidt, "Engineering Design", McGraw-Hill International Edition, 4th Edition, 2009, ISBN 978-007-127189-9.

2. Kevin Otto, Kristin Wood, "Product Design", Indian Reprint 2004, Pearson Education, ISBN 9788177588217.

3. Yousef Haik, T. M. M. Shahin, "Engineering Design Process", 2nd Edition Reprint, Cengage Learning, 2010, ISBN 0495668141.


## (iv) ARTIFICIAL INTELLIGENCE

**Course Learning Objectives (CLOs):**

1. To understand the basic concepts of Artificial Intelligence.
2. To understand the basic concepts of Expert System.
3. To study the methods of knowledge representation.
4. To understand the Expert system Tools, knowledge base editors, procedure oriented methods, object-oriented methods, logic-based methods, access-oriented methods.
5. To study the methods of Building an expert system.
6. To understand the concept of Fuzzy Engineering & applications of fuzzy expert systems for design of industrial controllers.

**Course Outcomes (COs):**

1. Understand the concept of knowledge and knowledge base.
2. Apply the skills of development of expert system for industrial problems.
3. Remember the design pre-requisites and design procedure of expert system.
4. Understand the concept of fuzzy logic and will try to implement in project work.

**SECTION – A**

**Unit-I : Introduction to Artificial Intelligence (AI):** Overview of AI, definition and importance of knowledge based systems, representation of knowledge, knowledge organization, knowledge manipulation, acquisition of knowledge **(6 Hours)**

**Unit II: Introduction to Expert Systems** - Features of expert systems, knowledge engineering, basis expert system terminology, human experts and artificial experts, algorithmic and heuristic methods, difference between conventional programs and expert systems, Architecture of expert systems. **(8 Hrs.)**

**Unit III : Knowledge Representation** – Rule based methods, rule execution, forward chaining and backward changing, knowledge representation using semantic nets, structure of semantic nets, Frame-based methods **. (8 Hours)**

**SECTION – B**

**Unit IV : Expert system Tools –** Types of tools for expert system building, system building aids, support facilities, debugging aids, I/O facilities, explanation facilities, knowledge base editors, stages in the development of expert system tools, procedure oriented methods, object-oriented methods, logic-based methods, access-oriented methods. **(7 Hours)**

**Unit V : Building an expert system** – Development phased in expert system building, development constraints, reliability, maintainability, examples of expert systems, difficulties in development of expert systems**. (7 Hours)**

**Unit VI: Fuzzy Engineering** - Fuzzy logic, fuzzy expert systems, fuzzysets, membership functions, fuzzy rules for approximate reasoning, fuzzy inference generation, deffufication, development of rules matrix, applications of fuzzy expert systems for design of industrial controllers. **(7 Hours)**

**RECOMMENDED BOOKS:**

**Text Books:**

1. A guide to Expert Systems by Donald a. Waterman, Pearson
2. Introduction to Artificial intelligence & Expert Systems by DanW. Peterson, PHI
3. Fuzzy Logic by John Yen, Reza Langari, Pearson

**ReferenceBooks:**

1) Expert Systems – Theory & Practice, By Ermine, Jean Louis, PHI.
2) Expert systems in Engineering , By D.T.Pham.JFS Pub.
3) Expert system application by Sumit Vadera,Sigma press
4) Artificial Intelligence by Winston P.H.,Pearson.

## 8ME04 PROFESSIONAL ELECTIVE – IV
## (i) REFRIGERATION & AIR CONDITIOING

**Course Learning Objectives (CLOs):**

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Comparative study of different refrigerants with respect to properties, applications and environmental issues. Study the numbering system of Refrigerants and its classification.
3. Identify the basic components of a refrigeration cycle. Study of various refrigeration cycles and evaluate performance using P-H chart, Mollier charts and/ or refrigerant property tables. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
4. Understand the basic air conditioning processes on psychometric charts, calculate cooling load for its applications in comfort and industrial air conditioning. Operate and analyze the refrigeration and air conditioning systems.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

**Course Outcomes:**

1. Understand the fundamental basics of simple vapour compression system, types of refrigerant used in refrigeration system.
2. Understand the multistage pressure system, its types and elementary treatment of refrigeration system.
3. Apply the knowledge of refrigeration system and its controls, defrosting.
4. Apply the concept air conditioning system as winter, summer air conditioning system applications and its related issues.

**SECTION – A**

**Unit I** : **Introduction to automotive air conditioning**- Vapour compression system:- Analysis of simple vapour compression system. Use of pressure enthalpy. Temperature entropy charts. Effect of operating conditions such as evaporation and condesion pressure, superheating and sub cooling Actual vapour compression system, Refrigerants :- classification: primary & secondary refrigerants, desirable properties of refrigerants; merits& demerits of commonly used refrigerants such as Ammonia R-12, R-22 and their selections and ecofriendly refrigeration 134 a, HFC. **(8- Hours)**

**Unit II**: **Multi stage pressure systems**- multistage compression: choice of intermediate pressure, complete multi- stage compressions. Multi evaporator systems; single compression individual expansion value, single compression multi expansion valve, individual compressor multi expansion valves, cascade systems, its applications to cryogenics Air liquefaction processes- Linde- Hampson (No numerical treatment to air liquefaction system) **(7- Hours)**

**Unit III: Refrigeration systems components & controls**:- brief study of refrigerants compressor, condensers, evaporators, expansion valves, drier, fillers, selection criteria for the components of vapours compression systems Flow controls,

temperature controls, pressure controls and safety devices. Defrosting systems, testing & charging of refrigeration systems, leak detection. (No analytical treatment is expected) **(7-Hours)**

**SECTION – B**

**Unit IV: Psychometric properties** of mois air psychrometric chart, concept of thermodynamic wet –bulb temperature, representations of Psychromeric process on Psychromeric charts, mixing of air, evaporate cooling, air washers. Human comfort:- metabolism of human body, factors influencing comfort, concept of effective temperature, optimum effective temperature & comfort charts. **(7 Hours)**

**Unit V: Classification of air conditioning systems & applications**. Unitary system package, window type & split type air conditioning. Central system:-System components, types:- direct expansion system, all water system & all air system. Water, summers & year round air conditioning. Transmission & distribution. Types of supply air ducts, consideration for selection & location of outlet, distribution partners of outlet, location of return air opening &introduction to duct design.
(*No numerical treatment is expected*). **(7 Hours)**

**Unit VI:** Load calculation & applied Psychromety-basic consideration at heat gains/losses sensible & latent, heat due to occupancy lightening, appliances, products, process, air conditioning systems, safety factor cooling load estimates, heating load estimates. Sensible heat factor by pass factor, apparatus dew point, effective sensible heat factor. **(7 Hours)**

BOOKS RECOMMENDED:

**Text Books:**

1. Refrigeration & air conditioning; C.P.Arora; Tata Mcgraw HillPublication.
2. Refrigeration & air conditioning; Arora, Domkundwar; Dhanpat Rai Publication.

**Reference Books:**

**1.** Principles of Refrigeration; J.Dossat; Pearson Education, Asiapublication
**2.** Refrigeration & air conditioning- P.L.Balaney
**3.** Refrigeration & air conditioning- Manohar Prasad.

## (ii) FINITE ELEMENT ANALYSIS

**Course Learning Objectives (CLOS):**

1. To study the concept of FEM and various methods in it.
2. To understand the knowledge of application of MatrixAlgebra & Gausian Elimination.
3. To study the finite element modeling approaches and understands the concept of boundary conditions.
4. To study 2D problems for Constant strain triangle, temperature effects, problem modeling and boundary conditions.
5. To study the concept of heat transfer and fluid flow.

**Course Outcomes:**

1. Apply the knowledge of principal of FEA, its types, governing equation, fundamental concept of solid mechanics.
2. Remember the mathematical understanding required for FEA and finite difference techniques.
3. Understand the knowledge of application of FEA such as related to stress on beams, three dimensional frames, heat transfer.
4. Apply the knowledge of FEA in project work.

**SECTION-A**

**Unit I : Introduction :** Application, Advantages, Steps of FEM, Stress and Equilibrium, Boundary conditions, Strain Displacement Relations, Stress-strain Relations, Von mises stress, Temperature effect, Potential Energy & Equilibrium, Gelerkin's Method, stiffness (Displacement) Method. **(7Hrs)**

**Unit II**: **MatrixAlgebra & Gausian Elimination :** Matrix Multiplication,Transposition, Diagonal Matrix, Symetric Matrix, Upper Triangular Matrix, Determinant of Matrix, Matrix Inversion Eligen values & Elgenvectors, Gaussian elimination. **(7 Hrs)**

**Unit III** : **ID Problems :** Finite Element modeling, coordinate Shapefunction, The potential Energy approah, The Galerkin'sApproach, assemblies of the global stiffness matrix and loacvectors, Properties of stiffness Matrix, Treatment of boundaryconditions, quadratic Shape Functions, Temperature Effects. **(7 Hrs)**

**SECTION – B**

**Unit IV** : **2D Problems for CST :** Constant strain triangle, isoperimetric Representation , potential Energy energy approach, element stiffness, galaerkin's approach, temperature effects, problem modeling and boundary conditions. **(7 Hrs)**

**Unit V: Development of equations:** Truss equations, derivation of thestiffness, matrix for a bar element in local coordinate, global stiffness matrix, beam equation. Beam stiffness, example assemblage of beamstiffness matrix, plain stress & plain stressstiffness equations, basic concept of plain stress and plain strain, derivation of the CST stiffness matrix and equations Treatment of body and surface forces. **(7 Hrs)**

**Unit VI: Heat Transfer:** Derivation of the basic differential equations, Heat transfer with conduction, radiation, ID Formulation usingvariational method.

**Fluid Flow:** Derivation of the basic differential equations, Id Finite Element formulation, Computer Implementation (prepossessing, post processing, input data file, mesh generation) **(7 Hrs)**

**BOOKS RECOMMENDED:**

**Text Books :**


1. Introduction to Finite Element Engineering – T.R.Chandrupatla,Belegunda; PHI
2. A First course in Finite Element Method- Darya Logon, ThompsonLearning (TL Publisher)


**Reference Books:**


1. The Finite Element Method in Engineering- S.S.Rao, Elsveir Pub., 4th Edition.
2. Fundamentals of Finite Element Method analysis – D.V.Huttan, TataMc-graw Hill
3. Concept & Applications of Finite Element Analysis – Robert D.Cook
4. Finite & Boundary Element Method in Engineering – O.P.Gupta
5. An Introduction to Finite Element Method- J.N.Reddy, Tata Mc-graw Hill, 2nd Edition, 2005.


## (iii) ROBOTICS & INDUSTRIAL APPLICATIONS

**Course Learning Objectives :**

1. To understand basics of robotics, evolution of robots and their role in industrial automation.
2. To study the Robot's anatomy, joints types, wrist construction, robot standard configurations and their work spaces..
3. To study the construction and working of different types of end Effectors.
4. To study various robot drives, robot motion control and its levels.
5. To understand various methods of teaching and programming the robots.
6. To study principle of working and applications of different types of robot sensors.
7. To study robot kinematics viz. forward, reverse and homogeneous transformation.
8. To study different applications of robots in manufacturing and to understand importance of robot features for a particular application.
9. To study different Quantitative methods to perform economic evaluation of robot project.

**Course Outcomes:**

1. Understand the concept of robotics, its history.
2. Remember robot anatomy and various configurations for different industrial applications.
3. Understand the concept of kinematic analysis of robots.
4. Remember the concept robot programming, its methods and programming languages.

**SECTION – A**

**Unit I : Fundamentals of Robotics-** Introduction, Automation & Robotics- robot applications robotic systems, robot anatomy and robot configurations, Joint types used in robots, robot wrists, joint notation schemes, work value for various robot

anatomies, robot Specifications. **(8 Hrs.)**

**Unit II : Robots end-effectors**-classification of end-effectors, mechanical grippers, hooking or Lifting grippers, grippers for molten metal ,plastics, vacuum cups, magnetic grippers Electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. Design consideration in gripper, gripper analysis. **(7 Hrs.)**

**Unit III: Robot drives & control**-pneumatic power drives, hydraulic systems, electric drives, robot controllers- servo and non-servo systems, motion control of robots, point to point and continuous path control, teaching of robots, robot programming methods. **(7 Hrs.)**

**SECTION – B**

**Unit IV: Robot Sensors:** Features, Contact type sensors:- wrist force sensor, binary & analog touch sensor,

Artificial skins, force, torque, encoders, position, velocity sensors, Non-contact type sensors;- vision sensor, proximity, range sensors, safety measures in robot. **(7 Hrs.)**

**Unit V: Robot Kinematics-** Forward & reverse kinematics, forward and reverse transformation of two DOF & three DOF 2-D manipulator, homogeneous transformations. **(6-Hrs)**

**Unit VI: Quantitative Techniques for economic performance of robots-** Robot investment coats, robot operating expenses. Methods of economic evaluation, method of pay-back period, return on investment method, discounted cash flow method. VAL Command: robot programming in Val & RAIL. **(7 Hrs.)**

**RECOMMENDED BOOKS:**

**Text Books:**


1) Robotics Technology & Flexible Automation by S.R Deb, Tata McGraw Hill.
2) Industrial Robotics by M.P.Groover, McGraw Hill.


**Reference Books:**


1. Robotics for Engineering, Korean Yoram, McGraw Hill.
2. Robots & Manufacturing automation by Asfahal, C.Ray, John Wiley.
3. Robotic Engineering by Richard D.Klafter, PHI.


## (iv) RAPID PROTOTYPING

**Course Learning Objectives (CLOS):**

1. Understand the fundamentals of Rapid Prototyping Techniques.
2. Understand the methodology for processing of RP Cad models.
3. Selection of appropriate RP fabrication techniques for the prototyping.
4. Study of prototyping techniques for Reverse engineering.
5. To acquire the necessary knowledge regarding RP software's

**Course Outcomes (CO):**

1. **Create** and develop overall awareness for design of Rapid prototype.
2. **Apply** fundamentals of RP techniques.
3. **Design and develop** the RP Tooling's for using suitable rapid prototyping technique.
4. **Synthesis** of RP techniques for reverse engineering.

**SECTION-A**

**Unit-I: Introduction to Product Design**: Design definitions; Brief history of Industrial designs. Industrial Design chronology, stages in Product development. Cost associated in various stages of Product development.
**Prototyping**: What is Prototype?, Types of Prototype, Principles of Prototyping, Prototyping Technologies. **(7-Hrs)**

**Unit-II: Basics of Rapid Prototyping:** Rapid Prototyping: Working Principles and types of Rapid Prototyping machines. Input devices, Contact and non-contact type digitizers such as Coordinate measuring machines, Laser and White light scanners. **Fields of Application of RP**: Industrial, medical, etc. **(7-**

**Hrs)**

**Unit-III.RP Process:** Photo polymerization (Stereo lithography (SL), Micro-stereo lithography), Powder Bed Fusion (Selective laser Sintering (SLS), Electron Beam melting (EBM)), Extrusion-Based RP Systems (Fused Deposition Modeling (FDM)), 3D Printing, Sheet Lamination (Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC)), Beam Deposition (Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD)). **(8-Hrs)**

**SECTION-B**

**Unit-IV: Physics of RP Process:**
Process Physics, Tooling, Process Analysis, Material and technological aspects, Applications, limitations and comparison of various rapid manufacturing processes. Classification of RP Methods.

**Pre and Post processing:** Pre-processing for RP, Post-processing of RP parts, Errors in RP parts, Part building errors in FDM, STL,LOM, SLS Parts. **(6 Hrs.)**

**Unit-V: Rapid Tooling**: What is Rapid tooling?, Types of Rapid tooling's. Benefits of Rapid tooling.
Silicon rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM. Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling**.** **(6 Hrs.)**

**Unit-VI: Overview of RP Software**: STL files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools. . **(6-Hrs)**

**BOOKS RECOMMENDED:**

**Text Books:**

1. Rapid Prototyping by Amitabha Ghosh , affiliated East –west press pvt. ltd., New Delhi.
2. Rapid Prototyping by Adithan M. Edition 2018, Atlantic Publishers & distributer pvt.ltd.
3. Additive Manufacturing by C.P.Paul & A.N. Jinoop McGraw Hill 1st Edition 2021
4. Product Design & Development by Karl T.Ulrich & Steven D. Eppinger.,Tata McGraw Hill Publishing.
5. Rapid Prototyping Data Formats by V.V. Prathibha Bharathi. Notion press publishing.


**Reference Books:**

1. CAD & Rapid Prototyping for product design, Dauglas Bryden, Laurence King Publishing.
2. Rapid Prototyping (Principle and Application), Rafiq Noorani by Wiley Publishing.


## 8ME05 I.C. ENGINES - LAB.

**Course Learning Objectives (CLOs):**
1. To study basic of engines, Air standard cycles ,Fuel air cycle, actual cycle and review of other losses in IC engines.
2. To Evaluate performance of Engines by using heat balance sheet, excess air calculation and determination of friction power, effect of supercharging.
3. To study Emission from Engines, EURO emission norms and Recent trends in Engines.

**Course Outcomes (COs):**
1. Remember fundamentals of I.C. engines, their types and cycle analysis.
2. Apply the knowledge of a multi-cylinder petrol engine.
3. Evaluate performance of Engines by using heat balance sheet
4. Study of fuel injection pump and injectors.

**List of Experiments (Any Six):**

**Any six** of the following practical should be performed and Performance test on a single cylinder diesel engine.

1. Performance test on a single cylinder petrol engine.
2. Evaluation of the heat balance for single cylinder diesel engine.
3. Performance test on a multi-cylinder petrol engine.
4. Mors test on multi-cylinder petrol engine.

5. Trial on petrol/ diesel engine to plot p-0 and p-V diagram.
6. Measurement of exhaust gas emission from S.I.engine
7. Measurement of smoke density of CI engine exhaust.
8. Study of Bosch type single plunger fuel pump.
9. Study of various types of fuel injectors and nozzles.

***It shall consist of viva-voce based on term work and syllabus.**

## 8ME06 PROFESSIONAL ELECTIVES –IV

## (i) REFRIGERATION & AIR CONDITIONING-LAB.

**Course Learning Objectives (CLOs):**

1. Illustrate the fundamental principles and applications of refrigeration and air conditioning system Learning the fundamental principles and different methods of refrigeration and air conditioning.
2. Identify the basic components of a refrigeration cycle. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems
3. Study of various types of refrigeration systems for various applications like ice plant, water cooler etc.
4. Understand the basic air conditioning processes.
5. Study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

**Course Outcomes (CO):**

1. Understand the fundamental basics of simple vapour compression system, types of refrigerant used in refrigeration system.
2. Apply the knowledge of different applications of refrigeration systems.
3. Apply the knowledge of refrigeration system and its controls, defrosting.
4. Apply the concept air conditioning system.

**List of Practical's:-**

Any **six** of the following should be conducted and a report thereof should be submitted.

1. Trial on Vapour compression system.
2. Trial on Air-conditioning system.
3. Study of Electrolux system.
4. Study of Water cooler.
5. Study of window Air conditioner.
6. Study of household refrigerator.
7. Study of desert cooler.
8. Study of cold storage plant.
9. Testing and changing of refrigeration system.
10. Study of defrosting system.
11. Study/trial of ice plant.
12. Study of various refrigeration and air-conditioning controls.

***Practical Examination: shall consist of viva-voce based on term work report and syllabus.**

## (ii) FINITE ELEMENT ANALYSIS-LAB.

**Course Learning Objectives (CLOS):**

To understand the knowledge of application of Matrix Algebra & Gausian Elimination.

1. Design of finite element modeling approaches and understand the concept of boundary conditions.
2. Formulation of 2D problems for Constant strain triangle, temperature effects, problem modeling and boundary conditions.
3. Understand concept FEA applied for heat transfer and fluid flow.

**Course Outcomes:**

1. Apply the knowledge of principal of FEA, its types, governing equation, fundamental concept of solidmechanics.
2. Remember the mathematical understanding required for FEA and finite difference techniques.
3. Application of FEA such as related to stress on beams, three dimensional frames.
4. Apply the knowledge of FEA in heat transfer and fluid flow.

**List of Practical's (Any-5):**

1. Study of a FEA modeling & FEA packages.
2. Stress Analysis of bars having
i) Constant cross section area
ii) Tapered cross section area
iii) Stepped bar.
3. Stress Analysis of beam (Simply supported or Cantilever) carrying point load and uniformly distributed load.
4. Solve any one 2D problem on CST element.
5. Solve any one problem on truss element.
6. Solve any one problem on axi-symmetric element
7. Solve any one problem on steady state heat condition.

***Practical Examination:** shall consist of viva-voce based on term work report and syllabus.

## (iii) ROBOTICS & INDUSTRIAL APPLICATIONS-LAB.

**Course Learning Objectives:**

1) To understand the basic concepts associated with the robot functioning and applications of Robots.
2) To study about the robot motion analysis of robot.
3) To study about the drives and control system used in Robots.
4) To understand the concepts of end effectors, sensors and vision system used in robots
5) To learn about robot programming.

**Course Outcomes:**

After successfully completion of this course students will be able to:
1) To know about fundamental knowledge about the robot
2) To know about robot motion analysis.
3) To know about drives and control system used in robots.
4) To know about end effectors, sensors and vision system.
5) To know about robot programming methods and languages.

**List of Practical's : (Any-5)**

1. Study of components of a real Robot & its DH Parameters.
2. Demonstration of Robot with 2DOF,3DOF,4DOF,etc.
3. Study of positioning and orientation of Robot arm.
4. Programming of the Robot for Industrial Application (actual trial on robot, if available or trial on simulation software).
5. Robotic Control Experiment demonstration using available hardware or software.
6. Integration of assorted sensors (IR, Potentiometer, staring gadges, etc.) micro controllers & ROS (Robot Operating System) in a Robotic system.
7. Industrial Robot application (Any one Mini project)
8. Study of Robot Simulation Software (on any one application).

***Practical Examination shall consist of viva voce based on above term work.**

## (iv) RAPID PROTOTYPING - LAB.

**Course Learning Objectives (CLOS):**

1- Study the fundamentals of Rapid Prototyping Techniques.
2- Understand the use of techniques for processing of Cad models for RP. 3- Use of suitable RP fabrication techniques for prototyping.
4-Use of prototyping techniques for reverse engineering.
5- To get the introduction regarding RP software.

**Course Outcomes (CO):**

1- Create and develop overall awareness for design of Rapid prototype. 2-
Apply fundamentals of RP techniques.
3- Selection of appropriate tooling for rapid prototyping process.4-
Synthesis of RP techniques for reverse engineering.

**List of Practical (Any-5):**

1-To create a 3-D model of a machine component for RP
2- Generation of a Process Plan for fabrication of a product on the basis of CAD Model.
3- Fabrication of part on available RP setup.
4- Post processing of fabricated Additive Manufactured product/prototype.
5- Inspection of fabricated product/prototype for dimensional accuracy and defects.
6- 6- Post processing of CAD model and generation of .stl file using suitable software.
7- Study of principles of various pixel generation techniques and forms of raw materials in RP.

***Practical Examination:**-shall consist of viva-voce based on term work report and syllabus.