DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction and Syllabus of M.E. (Mechanical)

Specialization:

CAD/CAM

Full time / Part time (2015-16)

UNIVERSITY COLLEGE OF ENGINEERING
(Autonomous)
Osmania University
Hyderabad – 500 007, Telangana, INDIA

Scheme of Instruction & Examination

M.E. (Mechanical Engineering) 4 Semesters (Full Time)

Sl. No	Subject	Hours per week		Duration (Hrs)	Max. Marks		Credits
		L/T	D/P		SEE	CIE	
Semester - I							
1.	Core	3	--	3	70	30	3
2.	Core	3	--	3	70	30	3
3.	Core / Elective	3	--	3	70	30	3
4.	Core / Elective	3	--	3	70	30	3
5.	Elective	3	--	3	70	30	3
6.	Elective	3	--	3	70	30	3
7.	Laboratory - I	--	2½	2½	--	50	2
8.	Seminar – I	--	2½	2½	--	50	2
	Total	**18**	**5**	**23**	**420**	**280**	**22**
Semester - II							
1.	Core	3	--	3	70	30	3
2.	Core	3	--	3	70	30	3
3.	Core / Elective	3	--	3	70	30	3
4.	Core / Elective	3	--	3	70	30	3
5.	Elective	3	--	3	70	30	3
6.	Elective	3	--	3	70	30	3
7.	Laboratory - II	--	2½	2½	--	50	2
8.	Seminar - II	--	2½	2½	--	50	2
	Total	**18**	**5**	**23**	**420**	**280**	**22**
Semester - III							
1.	Project+ Seminar*	--	4	4	--	**100****	**8**
Semester – IV							
1.	Dissertation	--	6	6	**200**		**16**

Note: Six core subjects, six elective subjects, two laboratory courses and two seminars should normally be completed by the end of semester II.

* *One project seminar presentation.*

** *50 marks to be awarded by guide and 50 marks to be awarded by viva-voice committee comprising Guide and two internal senior faculty members (subject experts)*

Scheme of Instruction & Examination

M.E. (Mechanical Engineering) 6 Semesters (Part Time)

Sl. No	Subject	Hours per week		Duration (Hrs)	Max. Marks		Credits
		L/T	D/P		SEE	CIE	
Semester - I							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I /Seminar - I	--	2½	2½	--	50	2
	Total	**9**	**2½**	**11½**	**210**	**140**	**11**
Semester - II							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I /Seminar - I	--	2½	2½	--	50	2
	Total	**9**	**2½**	**11½**	**210**	**140**	**11**
Semester - III							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I /Seminar - I	--	2½	2½	--	50	2
	Total	**9**	**2½**	**11½**	**210**	**140**	**11**
Semester - IV							
1.	Core	3	--	3	70	30	3
2.	Core / Elective	3	--	3	70	30	3
3.	Elective	3	--	3	70	30	3
4.	Lab. I /Seminar - I	--	2½	2½	--	50	2
	Total	**9**	**2½**	**11½**	**210**	**140**	**11**
Semester – V							
1.	Project+ Seminar*	--	4	4	--	**100****	**8**
Semester – VI							
1.	Dissertation	--	6	6	**200**		**16**

Note : Six core subjects, six elective subjects, two laboratory courses and two seminars should normally be completed by the end of semester IV.

* Project seminar presentation on the topic of Dissertation only

*** 50 marks to be awarded by guide and 50 marks to be awarded by viva-voice committee comprising Guide and two internal senior faculty members (subject experts)*

M. E. Mechanical Engineering (CAD/CAM)

Syllabus Ref. No. (Code)	Subject Title	Contact hrs Per week	Scheme of Examination		Credits
			CIE	SEE	
Core Subjects:					
ME2301	Automation	3	30	70	3
ME2401	Finite Element Techniques	3	30	70	3
ME2402	Computer Aided Modeling and Design	3	30	70	3
ME2403	Computer Integrated Manufacturing	3	30	70	3
ME2404	Failure Analysis and Design	3	30	70	3
ME2306	Computer Aided Mechanical Design and Analysis	3	30	70	3
Elective Subjects:					
ME2302	Control of Dynamic Systems	3	30	70	3
ME2303	Robotic Engineering	3	30	70	3
ME2308	Optimization Techniques	3	30	70	3
ME2309	Vibrations Analysis and Condition Monitoring	3	30	70	3
ME2001	Engineering Research Methodology	3	30	70	3
ME2311	Neural Networks and Fuzzy Logic	3	30	70	3
ME2312	Artificial Intelligence and Expert Systems	3	30	70	3
ME2107	Mechanics of Composite Materials	3	30	70	3
ME2109	Theory of Elasticity and Plasticity	3	30	70	3
ME2110	Experimental Techniques and Data Analysis	3	30	70	3
ME2601	Design for Manufacture	3	30	70	3
ME2405	Data Base Management Systems	3	30	70	3
ME2406	Fracture Mechanics	3	30	70	3
ME2505	Design of Press Tools	3	30	70	3
ME2506	Design of Dies	3	30	70	3
ME2206	Computational Fluid Dynamics	3	30	70	3
ME2112	Additive Manufacturing Technologies and Applications	3	30	70	3
ME2113	Flexible Manufacturing Systems	3	30	70	3
ME2111	Product Design and Process Planning	3	30	70	3
Departmental Requirements:					
ME2431	CAD/CAM Lab (Lab –I)	2	50	-	2
ME2032	Computation Lab (Lab –II)	2	50	-	2
ME2033	Seminar I	2	50	-	2
ME2034	Seminar II	2	50	-	2
ME2035	Project Seminar	6	150		12
ME2036	Dissertation	4	100	-	8

CIE : Continuous Internal Evaluation SEE : Semester End Examination

ME2301

AUTOMATION

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I
Introduction: Definition of automation, Types of production, Functions of Manufacturing, Organization and Information Processing in Manufacturing, Production concepts and Mathematical Models, Automation Strategies, Production Economics: Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break-Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT – II
Automation Production Lines**:** Automated Flow lines, Methods of Workpart Transport, Transfer Mechanism, Buffer Storage, Control Functions, Automation for Machining Operations, Design and Fabrication Considerations. *Analysis of Automated Flow Lines*: General Terminology and Analysis, Analysis of Transfer Lines Without Storage, Partial Automation, Automated Flow Lines with Storage Buffers, Computer Simulation of Automated Flow Lines.

UNIT – III
Assembly Systems and Line Balancing: The Assembly Process, Assembly Systems, Manual Assembly Lines, The Line Balancing Problem, Methods of Line Balancing, Computerized Line Balancing Methods, Other ways to improve the Line Balancing, Flexible Manual Assembly Lines. *Automated Assembly Systems:* Design for Automated Assembly, Types of Automated Assembly Systems, Part Feeding Devices, Analysis of Multi-station Assembly Machines, Analysis of a Single Station Assembly Machine.

UNIT –IV ***Automated Materials Handling:*** The material handling function, Types of Material Handling Equipment, Analysis for Material Handling Systems, Design of the System, Conveyor Systems, Automated Guided Vehicle Systems. *Automated Storage Systems:* Storage System Performance, Automated Storage/Retrieval Systems, Carousel Storage Systems, Work-in-process Storage, Interfacing Handling and Storage with Manufacturing.

UNIT – V ***Automated Inspection and Testing:*** Inspection and testing, Statistical Quality Control, Automated Inspection Principles and Methods, Sensor Technologies for Automated Inspection, Coordinate Measuring Machines, Other Contact Inspection Methods, Machine Vision, Other optical Inspection Methods. *Modeling Automated Manufacturing Systems:* Role of Performance Modeling, Performance Measures, Performance Modeling Tools: Simulation Models, Analytical Models. *The Future Automated Factory:* Trends in Manufacturing, The Future Automated Factory, Human Workers in the Future Automated Factory, The social impact.

Suggested Reading:
1. Mikell P.Grover, Automation, Production Systems and Computer Integrated Manufacturing, Pearson Education Asia.
2. C.Ray Asfahl, Robots and manufacturing Sutomation, John Wiley and Sons New York.
3. N.Viswanadham and Y.Narahari, Performance Modeling of Automated Manufacturing Syetms, Printice Hall India Pvt. Ltd.
4. Stephen J. Derby, Design of Automatic Machinary, Special Indian Edition, Marcel Decker, New York, Yesdee publishing Pvt. Ltd, Chennai

ME2401

FINITE ELEMENT TECHNIQUES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- *To understand the theory and application of the finite element method for analyzing structural systems.*
- *To learn Approximation theory for structural problems as the basis for finite element methods.*
- *To learn formulations for a variety of elements in one, two, and three dimensions.*
- *To understand modeling and analysis of structures using planar, solid, and plate elements.*

UNIT-I

Introduction: Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach : Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

UNIT-II

Analysis of trusses and frames: Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements. Convergence requirements and geometric isotropy.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors. Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Reading:

1. Tirupathi R Chandraputla and Ashok. D. Belegundu, *Introduction of Finite Element in Engineering,* Prentice Hall of India, 1997.
2. Rao S.S., *The Finite Element Methods in Engineering,* Pergamon Press, 1989.
3. Segerland. L.J., *Applied Finite Element Analysis,* Wiley Publication, 1984.
4. Reddy J.N., *An Introduction to Finite Element Methods,* Mc Graw Hill Company, 1984.

ME2402

COMPUTER AIDED MODELLING & DESIGN

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I
Introduction to CAD, Criteria for selection of CAD workstations, Shigle Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives. 2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, conlatenation. Graphics standards: GKS IGES, PDES.

UNIT-II
Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Conis. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

UNIT-III Surface Modeling: Surface entities, Surface Representation. Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cyliner. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

UNIT-IV Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG).

UNIT-V Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioural Modeling, Conceptual Design & Top Down Design. Capabilities of Modeling & Analysis Packages such as solid works, Unigraghics, Ansys, Hypermesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

Suggested Reading:
1. Ibrahim Zeid, CAD/CAM, Theory and Practice, Mc Graw Hill, 1998.
2. Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, 2nd Ed., Addison – Wesley, 2000.
3. Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
4. Hill Jr, F.S., Computer Graphics using open GL, Pearson Education, 2003.

ME2403

COMPUTER INTEGRATED MANUFACTURING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the need for CIM, evolution of CIM, fundamentals of CIM and the Concept of Concurrent Engineering.
- To know the role of database management of CIM and understand various types of CIM technologies and systems like DFMA, CAPP, MRP, Cellular Manufacturing, FMS etc.
- To understand the fundamental networking concepts that help in integrating all the important components of an enterprise and discuss the different types of CIM models developed by various industries. stand the new trends in manufacturing systems.

UNIT – I: Introduction to CIM

The meaning of Manufacturing, Types of Manufacturing; Basic Concepts of CIM: CIM Definition, Elements of CIM, CIM wheel, concept or technology, Evolution of CIM, Benefits of CIM, Needs of CIM: Hardware and software. Concurrent Engineering: Definition, Sequential Engineering Versus Concurrent Engineering, Benefits of Concurrent Engineering, Characteristics of concurrent Engineering, Framework for integration of Life-cycle phases in CE, Concurrent Engineering Techniques, Integrated Product Development(IPD), Product Life-Cycle Management (PLM), Collaborative Product Development.

UNIT – II: CIM database and database management systems

Introduction, Manufacturing Data: Types, sources; Database Terminology, Database requirements, Database models, Database Management System, DBMS Architecture, Query Language, Structural Query Language (SQL): Basic structure, Data definition Language (Create, Alter, Drop, Truncate, View), Data Manipulation Language (store, retrieve, update, delete). Illustration of Creating and Manipulating a Manufacturing Database. SQL as a Knowledge Base Query Language. Features of commercial DBMS: Oracle, MySQL, SQL Access, Sybase, DB2. Product Data Management (PDM), Advantages of PDM.

UNIT – III: CIM Technology and Systems

Product Design: Needs of the market, Design and Engineering, The design Process, Design for Manufacturability DFM, Design for Assembly (DFA), Design for Manufacturing and Assembly (DFMA), Computer-Aided Process Planning: Basic Steps in developing a process plan, Variant and Generative Process Planning, Feature Recognition in Computer-Aided Process Planning. Material Requirements Planning (MRP): Lot Sizing Techniques: Lot for Lot (LFL), Fixed Order Quantity (FOQ), Periodic Order Quantity (POQ), Economic Order Quantity (EOQ), Fixed Period Requirement (FPR). Manufacturing Resource Planning (MRP –II). Cellular Manufacturing: Design of Cellular Manufacturing Systems, Cell Formation Approaches: Machine–Component Group Analysis, Similarity Coefficients-Based Approaches. Evaluation of Cell Design. Flexible Manufacturing Systems: Physical Components of an FMS, Types of FMS layouts, Operational Problems of FMS. FMS benefits.

UNIT –IV: Enterprise Wide Integration in CIM and CIM Models

Introduction to Networking, Principles of Networking, Network Terminology, Types of Networks: LAN, MAN, WAN; Selection of Network Technology: Communication medium, Network Topology, Medium access control Methods, Signaling methods; Network Architectures and Protocols: OSI Model, MAP & TOP, TCP/IP, Network Interconnection and Devices, Network Performance. Framework for Enterprise-wide Integration.

CIM Models: ESPRIT-CIM OSA Model, NIST-AMRF Model, Siemens Model of CIM, Digital Equipment Corporation Model, IBM Concept of CIM.

UNIT – V: Future Trends in Manufacturing Systems

Lean Manufacturing: Definition, Principles of Lean Manufacturing, Characteristics of Lean Manufacturing, Value of Product, Continuous Improvement, Focus on Waste, Relationship of Waste

to Profit, Four Functions of Lean Production, Performance Measures, The Supply Chain, Benefits of Lean Manufacturing. Introduction to Agile and Web Based Manufacturing systems.

Suggested Reading:

1. S.Kant Vajpayee: Principles of Computer Integrated Manufacturing, Printice-Hall India.
2. Nanua Singh: Systems Approach to Computer Integrated Design and Manufacturing- John Wiley.
3. P.Radhakrishnan, S.Subramanyam: CAD/CAM/CIM, New Age International
4. Alavudeen, Venkateshwaran: Computer Integrated Manufacturing, Printice-Hall India

ME2404

FAILURE ANALYSIS AND DESIGN

Instructions 3 periods/week Duration of university Examination: 3 hours
Credits 3 SEE: 70 Marks CIE: 30 Marks

Objectives:

- To explain the importance of Good design and various factors affecting it
- To explain the importance of Ergonomics and Aesthetics in good design.
- To understand the importance of various scientific methods available to solve problems arising from product initiation state to product delivery state.
- To understand the phenomenon & importance of Fracture, its determination by various methods also understand the effect of fatigue on crack propagation.

UNIT - I

DESIGN FUNDAMENTALS Importance of design- The design process-Considerations of Good Design – Morphology of Design –Organization for design– Computer Aided Engineering –Concurrent Engineering – Product and process cycles –Market Identification – Competition Bench marking. Identification of customer needs- customer requirements- Product Design Specifications- Human Factors in Design – Ergonomics and Aesthetics.

UNIT- II

DESIGN METHODS Creativity and Problem Solving –Creativity methods-Theory of Inventive Problem Solving(TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design – Evaluation methods-Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Design for Reliability –Introduction to Robust Design-Failure mode Effect Analysis.

UNIT - III

FRACTURE MECHANICS: Introduction, Modes of fracture failure Griffith Analysis, Energy release rate, Energy release rate of DCB specimen; Stress Intensity Factor: SIF‘s for edge and centre line crack, Fracture toughness, Elastic plastic analysis through J-integral method: Relevance and scope, Definition of J-integral, Path independence, stress strain relation, Strain Energy Release Rate Vs J-integral. Failure analysis and determination of stress patterns from plastic Flow observations – Dynamic loading– Fracture types in tension

UNIT – IV

APPLICATIONS OF FRACTURE MECHANICS Introduction –Through cracks emanating from holes – Corner cracks at holes – Cracks approaching holes-Combined loading-Fatigue crack growth binder-Mixed mode loading-Fracture toughness of weld metals-Service failure analysis

UNIT – V

FATIGUE CRACK PROPOGATION— Mechanism of fatigue crack initiation, propagation and growth, Fatigue data representation, Factors influencing Fatigue strength, Fatigue life prediction, prevention of fatigue failures, corrosion fatigue. Cumulative fatigue damage

Suggested Reading:

1. Dieter, George E., —Engineering Design - A Materials and Processing Approach‖, McGraw Hill, International Editions, Singapore, 2000.
2. Pahl, G, and Beitz, W.,‖ Engineering Design‖, Springer – Verlag, NY. 1984.
3. David Broek, ‖Elementary Engineering Fracture Mechanics —, Fifthoff and Noerdhoff International Publisher, 1978.
4. Prashant Kumar, —Elements of Fracture Mechanics‖, Wheeler Publishing, 1999
5. S T. Rolfe and J M Barsom, Fracture and Fatgue control in structure, Prentice Hall
6. KRY Simha, Fracture Mechanics for Modern Engineering Design, University Press

ME2306

COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To develop students knowledge and understanding of Bending of Plates.
- To understand the basics of designing pressure vessels against internal and external pressure loads. To understand the effect of thermal stress on pressure vessel
- To understand the phenomenon of buckling in pressure vessels and usage of various methods available to prevent buckling of pressure vessels.
- To understand the importance of numerical methods in solving multi degree freedom dynamic analysis problems.

To understand various numerical methods available for solving eigen values problems

UNIT-I

Stresses in flat plates: Introduction, Bending of plate in one direction, Bending of plate in two perpendicular directions, Thermal stresses in plates, Bending of circular plates of constant thickness, Bending of uniformly loaded plates of constant thickness.

UNIT-II

Design of pressure Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cyliners, autofrettage of thick cylinders, thermal stresses and their significance. Stress concentration at a variable thickness, thickness transistion in a cylindrical vessel, about a circular hole, elliptical openings, reinforcement design

UNIT-III

Buckling in vessels: Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

UNIT-IV

Eigen Value Problems: Properties of Eigen values and Eigen Vectors, Torsional, Longitudinal vibration, lateral vibration, Sturm sequence. Subspace iteration and Lanczo‘s method, Component mode synthesis, Eigen value problems applied to stepped beams and bars.

UNIT-V

Dynamic Analysis: Direct integration method, Central difference method, Wilson-θ method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability.

Suggested Reading:

1. John, V. Harvey, Pressure Vessel Design: Nuclear and Chemical Applications, Affiliated East West Press Pvt. Ltd., 1969.
2. V. Rammurti, Computer Aided Mechanical Design and Analysis, Tata Mc Graw Hill-1992.
3. Abdel-Rehman Ragab & Salah Edin Bayoumi, Engineering Solid Mechanics, CRC Press, 1998
3**.** Annaratone**,** Donatello,Pressure Vessel Design, springer verlag, 2007
4.Henry bednar, Pressure vessel Design handbook, Krieger Pub Co; 2 edition.
5.Chandrasekhra, Theory of Plates, University Press, 2001

ME2302

CONTROL OF DYNAMIC SYSTEMS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:
The goal of the course is to introduce students to the fundamentals of feedback control system theory and analytical design methods, and to apply the methods to the design of real-world systems.

- To introduce the concepts of control systems and develop the ability of formulating mathematical models and designing feedback control systems.
- To provide students with the necessary tools to analyze feedback (linear) controls systems
- an ability to analyze, design, simulate, and experimentally validate linear and non linear control systems while taking into account practical limitations of operations.
- an understanding of negative and positive feedback systems and their application to circuit analysis and control system design
- an understanding of frequency compensation and its application to linear and nonlinear control system design

UNIT-I
Mathematical Modeling of physical systems, 1st, 2nd order and higher order systems, transient, steady state analysis, steady state errors, Performance Indices.

UNIT-II
Poles, zeros, zero and pole placements, Routh‟s criteria, Root locus Technique, Bode plots, Nyquist criterion, Compensation circuits.

UNIT-III
State space method, state transition matrix, canonical forms, Diagonalisation, solutions of homogeneous and non homogenous equations, zero and pole placement using state space techniques, controllability and observability, state controllability matrix, state observability matrix.

UNIT-IV
Non-Linear Systems Phase plane analysis: Phase portraits, Singular points characterization. Analysis of non-linear systems using phase plane techniques, Existence of limit cycles.

UNIT-V
Stability Analysis Concept of stability, Stability in the sense of Lyapunov and absolute stability, autonomous systems, the invariance principle, linear systems and linearization, non autonomous systems, linear time varying systems and linearization.

Suggested Reading:
1 K. Ogata, “Modern Control Engineering”, Pearson India, 3rd Edition.
2 Norman Nise,”Control System Engineering”, Prentice Hall India, Fourth Edition
3 Anand Kumar, “Control System Theory”, Prentice Hall India.
4 M.Vidyasagar, "Nonlinear systems analysis", Second Edition, Prentice Hall, 1993
5 H.Khalil, "Nonlinear Systems", Macmillan Publishing Company, NY, 1992.
6 A. Isidori, “Nonlinear Control Systems” 3rd edition, Springer Verlag, London, 1995.
7 B. Brogliato, R. Lozano, B. Maschke, O. Egeland, "Dissipative Systems Analysis and Control", Springer Verlag, London, 2nd edition, 2007.

ME2303

ROBOTIC ENGINEERING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

The goal of the Robotics course is to familiarize the students with the concepts and techniques in robot manipulator control, enough to evaluate, chose, and incorporate robots in engineering systems

Objectives:

- To develop the student's knowledge in various robot structures and their workspace.
- To develop student's skills in performing spatial transformations associated with rigid body motions.
- To develop student's skills in perform kinematics analysis of robot systems.
- To provide the student with knowledge of the singularity issues associated with the operation of robotic systems.
- To provide the student with some knowledge and analysis skills associated with trajectory planning.

To provide the student with some knowledge and skills associated with robot control

UNIT-I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT-II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation,representation of absolute position and orientation in terms of joint parameters, direct kinematics.

UNIT-III

Inverse Kinematics, inverse orientation, inverse locations, Singularities, Jacobian, Trajectory Planning: joint interpolation, task space interpolation, executing user specified tasks.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangian and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, Computed torque control, force control, hybrid control.

UNIT-V

Sensors and controllers: Internal and external sensors, position, velocity and acceleration sensors, proximity sensors, force sensors, laser range finder. Robot vision: image processing fundamentals for robotic applications, image acquisition and preprocessing. Segmentation and region characterization object recognition by image matching and based on features

Suggested Readings:

1. Nagrath and Mittal, "Robotics and Control", Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, "Robot Dynamics and Control", John Wiley and sons, 2008.
3. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
4.Harry Asada & Slottine "Robot Analysis& Control" , Wiley Publications, 2014
5. S K Saha, "introduction to Robotics ", 2nd edition, TMH, 2013

ME2308

OPTIMISATION TECHNIQUES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I
Simulation: Introduction, Types of Simulation, Simulation Models, Monte Carlo Simulation, Random Number, Pseudo Random Number, Mid-Square Method of generating Random Numbers, Application & Limitation, Application of Simulation to Inventory Control and Queuing Problem

UNIT – II
Decision Theory: Introduction, Decision, Decision Making & Decision Theory, Types of Decisions, decision making process, Types of Decision making Environment: **Decision making under certainty** –Expected Monetary Value (EMV), Expected Opportunity Loss (EOL) Criterion & Expected Value of Perfect Information (EVPI) Criterion **Decision making under risk**- Criterion of Pessimism or Manimax, Criterion of Optimism or Maximin, Minimax Regret Criterion, Criterion of Realism & Criterion of Rationality **Decision making under uncertainty** and **Decision tree analysis**: Introduction, Procedure of Constructing Decision Trees & Solution through Decision Tree Analysis.

UNIT – III Integer Programming: Introduction, Types of Integer Programming Problems, Gomory‟s Cutting Plane method. Branch and Bound method for all Integer Programming Problems & Mixed Integer Programming Problems

UNIT – IV Dynamic Programming: Introduction- Bellman‟s principle of optimality-Application of dynamic programming-Linear programming problem-Capital budgeting problem

UNIT – V Classical Optimization: Introduction; Unconstrained problems of maxima and minima, constrained problems of maxima and minima; Constraints in the form of equations – Lagrangian method; Constraints in the form of inequalities -Kuhn-tucker conditions.

Suggested Reading:
1. S.S.Rao, Optimization Theory and Applications, NAI Publishers, Hyderabad, 1995.
2. S.D.Sharma, Operations Research, Kedarnath and Co. Publishers, Meerut, 2004.
3. V. K. Kapoor, Operations Research, S. Chand, New Delhi, 2004.
4. Hamdy A.Taha, Operations Research, Pearson Education, New York, 2001.
5. Bronson-Schaum Series, Operations Research, McGraw Hill, Singapore, 1983.
6. David Goldberg, Genetic Algorithms, S Chand Publications, 2006.

ME2309

VIBRATION ANALYSIS AND CONDITION MONITORING

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives

- Fully understand importance of vibrations in mechanical design of machine parts that operate under vibratory conditions.
- Able to write differential equation of motion of vibratory system and understand free and forced modes of vibration
- Able to obtain linear vibratory models of dynamic systems of varying complexity (SDOF,MDOF)\
- Able to understand the various condition monitoring techniques available in the literature.
- Able to understand the various devices available to record interpret and understand the vibration data.

UNIT-I

Causes and effects of vibration. Vibrations of Single Degree of freedom systems. Free, Damped and Forced vibrations

UNIT-II

Two Degree of freedom systems. Bending vibrations of two degree of freedom systems, Steady state and transient characteristics of vibration, vibration absorber and vibration isolation.

UNIT-III

Multi degree of freedom systems: Dunkerley method, Rayleigh method, stodola method and holzers method. Modal analysis.

UNIT-IV

Introduction to Condition Monitoring, Failure types, investigation and occurrences. Causes of failure, Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers. Condition Monitoring through vibration analysis. Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards.

UNIT-V

Contaminant analysis, SOAP and other contaminant monitoring techniques.
Special vibration measuring techniques - Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, Shaft –orbit & position analysis.

Suggested Readings:

1. Rao S .S Mechanical Vibrations , 5th Edition, Prentice Hall, 2011
2. V.P.Singh, Mechanical vibrations, Dhanpat Rai Publications, 2015
3. Collacott, R.A., *Mechanical Fault Diagnosis and Condition Monitoring,* Chapman & Hall, London, 1982.
4. John S. Mitchell, *Introduction to Machinery Analysis and Monitoring,* Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
5. J S Rao, Vibration condition monitoring of machines, CRC Press, 2000
6. Nakra, B.C. Yadava, G.S. and Thuested, L., *Vibration Measurement and Analysis,* National Productivity Council, New Delhi, 1989.

ME2001

ENGINEERING RESEARCH METHODOLOGY

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To learn the research types, methodology and formulation.
- To know the sources of literature, survey, review and quality journals.
- To understand the research design for collection of research data.
- To understand the research data analysis, writing of research report and grant proposal.

Unit - I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

Unit - II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

Unit - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

Unit - IV

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

Unit - V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.

ME2311

NEURAL NETWORKS AND FUZZY LOGIC

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

Concepts of fuzzy sets: Introduction – Crisps sets, notation of fuzzy sets, basic concepts of fuzzy sets, operation, fuzzy compliment, union, intersection, Binary relation, Equivalence and similarity relations, belief and plausibility measures, probability measures, computability, relations, ordering morphisms, possibility and necessary measures. Uncertainty and information: Types of uncertainty, measures of dissonance, measures of confusion, measures of nonspecificity, uncertainty and information. Complexity, Principle of uncertainity.

UNIT-II

Adaptive fuzzy systems: Neural and Fuzzy intelligence, Fuzziness as multivalent, fuzziness in probabilistic world, randomness verses ambiguity.

UNIT-III

Fuzzy association memories: Fuzzy and neural function estimates, FAN mapping, neural verses fuzzy representation of structural knowledge, FAM as mapping, Fuzzy hebb FAM's Bidirectional FAM theorem, Super imposition FAM Rules, FA System architecture.

UNIT-IV

Introduction to Neural networks: Knowledge base information processing, general view of knowledge based algorithm, neural information processing, Hybrid intelligence, and artificial neurons.

UNIT-V

Characteristics of artificial Neural Networks: Single Neural Networks, Multi Layer Neural Networks, Training of ANN – objective, supervise training, unsupervised training, overview of training. Neural networks Paradigms: Perception meculloch and Pitts Model, back propagation algorithm and deviation, stopping criterion, Hopfield nets, Boldman's machine algorithm, Neural networks applications.

Suggested Reading:

1. Bart, Kosko, *Neural Networks and Fuzzy Systems,* Prentice Hall of India, 1994.
2. Limin Fu, *Neural Networks in Computer Intelligence,* McGraw Hill, 1995.
3. George J Klir and Tina A. Folger, *Fuzzy Sets Uncertainity an Information,* Prentice Hall of India, New Delhi, 2000.
4. James A Freeman, *Simulating Neural Networks,* Adison Publication, 1995.

ME2312

ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I
Artificial Intelligence: Definition, Study of AI techniques, problems and Problems space, AI characteristics, Heuristics. Problem solving Methods: Forward and backward reasoning, problem trees, problem graph, hill climbing, search method, problem reduction, constraint satisfaction, means and analysis, game playing, mini max algorithms, alphabetic heuristics.
UNIT-II
Computer Vision: Perception, early processing, representation and recognition of scenes, Guzman‟s algorithms of spurting objects in a scene, Waltz algorithm.
UNIT-III
Neural Language understanding problems, syntactic analysis, semantic analysis, augmented transition networks.
UNIT-IV
Knowledge representation (Logic): Representing facts in logic predicate logic, resolution, unification, question answering, mathematical theorem proving. Knowledge representation (Structured): Declarative representation, Semantic nets, procedural representation.
UNIT-V Learning: Learning as induction, failure drive learning, learning by teaching, learning through examples (Winston‟s program) skill acquisition.
Suggested Reading:

1. Elaine Rich, *Artificial Intelligence,* Mc Graw Hill, 1985. 2. Nilson, *Principles of Artificial Intelligence.* 3. Winston, *The Psychology of Computer*.
2. Nilson, *Principles of Artificial Intelligence.* 3. Winston, *The Psychology of Computer*.
3. Winston, *The Psychology of Computer*.

ME2107

MECHANICS OF COMPOSITE MATERIALS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composites carbon fibre composites.

UNIT-II

Micromechanics of Composites: Mechanical properties-Prediction of Elastic constant, micromechanical approach, Halpin-Tsai equations, Transverse stresses. Thermal properties-Hygrothermal stresses, mechanics of load transfer from matrix to fibre.

UNIT-III

Macromechanics of Composites: Elastic constants of a lamina, relations between engineering constants and reduced stiffness and compliances, variation of lamina properties with orientation, analysis of laminated composites, stresses and strains with orientation, inter-laminar stresses and edge effects. Simplified composite beam solutions. Bending of laminated beams.

UNIT-IV

Strength, fracture, fatigue and design: Tensile and compressive strength of unidirectional fibre composites,

Fracture modes in composites: Single and multiple fracture, de-bonding, fibre pullout and de-lamination failure, fatigue of laminate composites. Effect of variability of fibre strength.

Strength of an orthotropic lamina: Max stress theory, max strain criteria, maximum work (Tsai-Hill) criterion, quadratic interaction criteria. Designing with composite materials.

UNIT-V

Analysis of plates and stress: Plate equilibrium equations, Bending of composite plates, Levy and Navier solution for plates of composite materials. Analysis of composite cylindrical shells under axially symmetric loads.

Suggested Reading:

1. Jones, R.M., *Mechanics of Composite Materials, Mc Graw Hill Co., 1967.*
2. Calcote, L.R., *The Analysis of Laminated Composite Structures,* Van Nostrand, 1969.
3. Whitney, I.M. Daniel, R.B. Pipes, *Experimental Mechanics of Fibre Reinforced Composite Materials,* Prentice Hall, 1984.
4. Hyer, M.W., *Stress Analysis of Fibre Reinforced Composite Materials,* Mc Graw Hill Co., 1998. 5. Carl. T. Herakovich, *Mechanics of Fibrous Composites,* John Wiley Sons Inc., 1998.

ME2109

THEORY OF ELASTICITY AND PLASTICITY

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

Basic Concepts of Stress: Definition, State of Stress at a point, Stress tensor, invariants of stress tensor, principle stresses, stress ellipsoid, derivation for maximum shear stress and planes of maximum shear stress, octahedral shear stress, Deviatoric and Hydrostatic components of stress, Invariance of Deviatoric stress tensor, plane stress.

UNIT-II

Basic concepts of Strain: Deformation tensor, Strain tensor and rotation tensor; invariants of strain tensor, principle strains, derivation for maximum shear strain and planes of maximum shear strain, octahedral shear strain, Deviatoric and Hydrostatic components of strain tensor, Invariance of Deviatoric strain tensor, plane strain.

UNIT-III

Generalized Hooke's Law: Stress-strain relationships for an isotropic body for three dimensional stress space, for plane stress and plane strain conditions, differential equations of equilibrium, compatibility equations, Material (D) matrix for Orthotropic Materials.

UNIT-IV

True stress and true strain, von-Mise‟s and Tresca yield criteria, Haigh–Westergard stress space representation of von - Mise‟s and Tresca yield criteria, effective stress and effective strain, St. Venants theory of plastic flow, Prandtle–Reuss and Levy–Mise‟s constitutive equations of plastic flow, Strain hardening and work hardening theories, work of plastic deformation.

UNIT-V

Analysis methods: Slab method, Slip line field method, uniform deformation energy method, upper and lower bound solutions. Application of Slab method to forging, wire drawing, extrusion and rolling processes.

Suggested Readings:

1. Timoshenko and Goodieer, *Theory of Elasticity*, Mcgraw Hill Publications 3rd Edition,
2. Madleson, *Theory of Plasticity,*
3. J. Chakrabarty, *Theory of Plasticity, 2nd* edition, McGraw Hill Publications 1998 4. George E Dieter, *Mechanical Metallurgy,* McGraw Hill Publications 1988

ME2110

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the working principle of instruments used for cutting forces measurement and temperature measurement.
- To have knowledge of various precision measuring instruments for metallurgical studies.
- To understand the basic concept of experiment design for collection of data
- To learn the data analysis, optimization of experimental methods for better data.

Unit - I

Measurement of Cutting Forces: Strain gauge and piezoelectric transducers and their characteristics. Dynamometer construction, Bridge circuits. Instrumentation and calibration. Displacement and strain measurements by photoelasticity. Holography, interferometer, Moir techniques, strain gauge rosettes.

Unit - II

Temperature Measurement: Circuits and instrumentation for different transducers viz, bimetallic, expanding fluid, electrical resistance, thermister, thermocouples, pyrometers. Flow Measurement: Transducers for flow measurements of Non-compressible and compressible fluids. Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schlieren photography. Interferometer.

Unit - III

Metallurgical Studies: Optical and electron microscopy, X-Ray diffraction, Bragg‟s Law and its application for studying crystal structure and residual stresses. Electron spectroscopy, electron microprobe. Surface Measurements: Micro hardness, roughness, accuracy of dimensions and forms. 3 -D co-ordinate measuring machines.

Unit - IV

Experiment design & data analysis: Statistical methods, Randomized block design, Latin and orthogonal squares, factorial design. Replication and randomization. Data Analysis: Deterministic and random data, uncertainty analysis, tests for significance: Chi -square, student's t-test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time Series analysis, Autocorrelation and autoregressive modeling.

Unit - V

Taguchi Methods: Experiment design and planning with Orthogonal arrays and linear graphs. Additive cause effect model. Optimization of response level. Identification of Design and noise factors. Performance evaluation and Optimization by signal to noise ratios. Concept of loss function and its application.

Suggested Reading:

1. Holman, J.P.: Experimental Methods for Engineers, McGraw Hill Int., New York.
2. Venkatesh, V.C., and Chandrasekharan, Experimental Methods in Metal Cutting, Prentice Hall of India, Delhi.
3. Davis, O.V.; The Design and Analysis of Industrial Experiments, Longman, London.
4. Box and Jenkins; Time Series analysis, Forecasting and control, Holden Day, Sanfrancisco.
5. Dove and Adams, Experimental stress analysis and motion measurement, Prentice Hall of India, Delhi.
6. Tapan P. Bagchi, Taguchi Methods Explained, Prentice Hall of India, Delhi.

ME2601

DESIGN FOR MANUFACTURE

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization. Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

UNIT-II

Metallic Components Design: Metal extrusion, metal stamping, fine blanking, four slide parts, spring and wire forms, spun metal parts, cold headed parts, extruded parts, tube and section bends, rolled formed parts, power metal parts, forging electro forming parts, specialized forming methods, turned parts, machined round holes, drilled parts, milled parts.

UNIT-III

Metallic Components Design: Planned shaped and slotted parts, screw threaded contoured and internal ground parts, center less ground, electrical discharged, rolled furnished parts, electro chemical and advanced machine parts. Sand cast, die cast, investment cast and other cast products.

UNIT-IV

Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics. Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly.

UNIT-V

Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements. **Case Studies:** Identification of economical design and redesign for manufacture.

Suggested Reading:

1. James G. Bralla, —*Hand book of product design for manufacturing*‖ McGraw Hill Co., 1986
2. K.G. Swift —*Knowledge based design for Manufacture*‖, Kogan page Limited, 1987.

ME2405

DATA BASE MANAGEMENT SYSTEMS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I
Introduction and E.R. Model: Purpose of database systems, Data abstraction Data models, data independent DDL, DML, DBA. Entities and entity sets. Relationships and relationship sets Mapping constraints, Primary Keys E-R diagrams, reducing E-R Diagram to tables.

UNIT-II
Relational model and relational database design: Structure of relational database, former query languages, commercial query languages. Modifying the database views. Pitfalls in relational database design and normalization.

UNIT-III
Network data model and hierarchical data model: data structure diagram, the DBTCCODASYL. Model data retrieval Update and set processing facility, Three structure diagram, data retrieval and update facility, virtual records.

UNIT-IV
File and System Structure, Indexing and Hashing: Physical storage media – file organization, buffer management, Mapping relations, networks and hierarchies to files – Index – sequential files. Bi-tree indexed files.

UNIT-V
Distributed database, security and integrity: Design, transparency and autonomy, query processing, recovery, concurrency control, deadlock handling and coordinator selection. Security and integrity, near database application**.**

Suggested Reading:
1. Korth, H.F. Silbenhatz, A., *Database Concepts,* Mc Graw Hill, 1986.
2. Gio Wiederhold, *Database Design,* Mc Graw Hill, 1983.
3. Jefferey O Ullman, *Principles of database systems.*
4. C.J. Date, *An Introduction to database systems,* Addison Wisely, 1980.
5. Trembley and Soreson, *An Introduction to Data structures with applications,* Mc Graw Hills.

ME2406

FRACTURE MECHANICS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT-I

Introduction: Crack in a Structure – Griffth Criterion – Cleavage fracture – Ductile fracture – Fatigue Cracking. Service failure analysis.

UNIT-II

Elastic Crack: Elastic Crack tip stress field – Solution to crack problems. Effect of finite size stress intensity factor – Special cases – Irwin plastic zone correction. Actual shape of plastic zone – Plane stress – Plane strain.

UNIT-III

Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice. Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

UNIT-IV

Elastic Plastic Fracture Mechanics: Elastic plastic fracture concept – Crack tip opening displacement – J-integral technique; Determination of J-using FEM.

UNIT-V

Application of Fracture Mechanics: Fracture design – Selection of materials – fatigue crack growth rate curve – Stress intensity factor range – Use of crack growth law.

Suggested Reading:

1. David Broek – Elementary Engineering Fracture Mechanics: Sifth off an Noordhoff Internal Publishers – 1978.
2. John M. Barson and Stanely T. Rolfe: Fracture and Fatigue Control in Structures – Prentice Hall, Inc. USA 1987.
3. Jean Cemative and Jean Louis Chboche Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1987.

ME2505

DESIGN OF PRESS TOOLS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I

Classification of presses – Specification of Presses – Safety Devices in Presses – Principles of loading and unloading equipment – Various press tool operations – Selection of types of presses – Theory of shearing – Clearance concept – Location of clearance for regular and irregular shapes – Analysis of forces – Force, power & energy – Stock strip terms – Layouts – Economic utilization – Dimensioning of punches and die openings with tolerance.

UNIT – II

Classification of dies viz. shearing, bending, drawing & forming – Terminology of press tool elements – Design considerations of various elements viz. die plates, stock guides, strippers & types – Shedders – Stops - function and types – Pilots - function and types – Punches types – Punches mounted in punch holder – Calculation of spring, rubber, ejector – Shear and its application – Types of shear (cutting with inclined edges) – Alignment system design of press tools.

UNIT – III

Design of dies – Simple piercing/blanking – Inverted die – Compound die – Progressive dies – Rules for developing stock – Strip layouts for progressive dies – Types of progressive dies viz. blank through, slug cur-off and shear cut off – Load centre – Necessity – Analytical and graphical method to determine load centre (i.e. centre of pressure) – Miscellaneous dies – Shaving, Horn, Cam actuated and precision lamination dies – Fine blanking dies – Principles - design considerations.

UNIT – IV

Bending dies – Theory of bending – Blank development – Spring back effect – Spring back factor – Methods of correction to overcome spring back – both practical and theoretical – Types of bending dies viz. V, U and L – Pressure pad dies – Forces in bending – Construction and working principles – Press brake Tooling – Curling – Flanging – Principles of stretch forming – Stretch forming dies.

UNIT – V

Drawing and forming: Definition of drawing, redrawing, reverse redraw – Theory of drawing for metal flow in cylindrical shells – Blank development – Algebraic - centre of gravity, segment area and layout method – Severity of draw – Reduction – Strain factor – Draw force calculation – Draw die edge radius consideration – Blank holder – Stages in draw dies – Calculations – Drawing of rectangular components – Blank development – Draw beeds – Ironing – Defects in draw – Modern metal forming techniques viz. rubber pad forming, explosive forming, magnetic pulse forming, roll forming – Awareness of various software for sheet metal operations, both for analysis and design.

Suggested Reading:

1. Fundamentals of Tool Design – ASTME, Prentice Hall, New Delhi, 1987
2. Die Design Handbook – AISME, Mc Graw Hills, Newyork, 1965
3. Eary & Reed, Shear Working of Metals, Prentice Hall, New Delhi, 1969
4. Basic Die Making & Advance Die Making – D. Eugene Ostergaard, Mc Graw Hill
5. Tool Design by Cyril Donaldson – Tata Mc Graw Hill, New Delhi.

ME2506

DESIGN OF DIES

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

UNIT – I
Definition of Plastics – Development – Types of Plastics viz. thermo plastic and thermosetting plastics – Types plastic materials for both and their application – Methods of processes - a birds eye view – Mould terminology – Construction – Mold cavities, cores – Bolsters types – Standard mold base – Ejection system and techniques – Feed system design – sprue, runner and gate – Efficiency of runner – Functions of gate – Types of gate, application – Mold cooling.

UNIT – II
Design of moulds: for external undercuts (Splits) – Side core & cavities – Methods of actuating – Moulds for internal undercuts – Moulds for threaded components – Multi day light moulds – Under feed moulds – Details – Runner less moulds – Design approach and process variables for transfer moulds and compression moulds.

UNIT – III
Design of dies for metal casting - Various casting processes – Die casting dies – Terminology applicable to process viz. hot chamber, cold chamber (horizonal and vertical) process – Terminology applicable to dies – Alignment of metal flow in hot chamber, horizontal cold chamber and vertical cold chamber machines – Modification for casting deep core or with limitations of stroke – Design for various elements – Effect of off-centre cavity Layout – Necessity of balancing – Types of dies viz. single cavity, multi cavity, combination and unit die – Runner, gate calculations – Various parameters influencing the Runner gate design - Ejection mechanism – Ejection elements and various locations – Die locking mechanism – Types of alloys – Trimming – Types of trim dies.

UNIT – IV
Bulk metal forming tools – Forging dies – Definition – Influence of temperature and external pressure – Glossary words applicable in forming dies – Types of forging dies, open die forming closed die forging – Methods of open die forging – Allowance and tolerances applicable to closed die forging – Factors to be considered – Forging equipment – Layout of forge shop

UNIT – V
Design of finisher impression – Preparation of forging drawing – Design of fuller – Types of fuller – Design of blocker and consideration – Design of edger or rolling impression – Design of bender – Planning layout of multi impression dies – procedure – Flash land, gutter – Importance – Calculations – Capacity calculations for hammers & presses – Trimming dies - Push through and compound – Upsetting – Rules for simple upsetting – Press forging or reduce roll forging concepts – Forward and backward extrusion.

Suggested Reading:

1. Rusinoff S.E. Forging & forming Metals, Taraporewala, 1952
2. Dochlar H.H., Die Casting Dies, Mc Graw Hill, 1951
3. I.S. Standards, BSI, New Delhi
4. Pye R.G.W., Injection Mould Design, Longman Scientific & Technical Publishers, London, 1989

ME2206

COMPUTATIONAL FLUID DYNAMICS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- **To convert the conservation equations of fluid flow in differential form into algebraic equations and apply numerical methods to obtain solutions.**
- **To learn the finite difference method.**
- **To learn finite volume method and solution methodology for fluid flow problems.**

UNIT-I
Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Differential equations for steady and unsteady state heat conduction. Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixing length model, K- turbulence Model.

UNIT-II
Classification of PDEs – Elliptic, parabolic and hyperbolic euqations. Initial and boundary value problems. Concepts of Finite difference methods – forward, backward and central difference. Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT-III
Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV
Finite difference solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs – Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function – Vorticity method & MAC method.

UNIT- V
Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

Suggested Reading:
1. Pradip Niyogi, Chakrabartty SK, Laha M.K., „Introduction to Computational Fluid Dynamics‟, Pearson Education, 2005.
2. Muralidhar K, Sundararajan T, „Computational Fluid flow and Heat transfer‟, Narosa Publishing House, 2003.
3. Chung, T J, „Computational Fluid Dynamics‟, Cambridge University Press, 2002.
4. John D Anderson, „Computational Fluid Dynamics‟, Mc Graw Hill, Inc., 1995.
5. Patankar, S.V, „Numerical Heat transfer and Fluid flow‟, Hemisphere Publishing Company, New York, 1980.

ME2112

ADDITIVE MANUFACTURING TECHNOLOGIES AND APPLICATIONS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To understand the fundamentals for additive manufacturing and how it is different and discuss about various types of liquid based, solid based and powder based AM technologies.
- To understand the various types of Pre-processing, processing, post-processing errors in AM. Also to know the various types of data formats and software's used in AM.
- To know the various applications of AM in design analysis, aerospace, automotive, biomedical and other fields

UNIT – I

Introduction: Prototyping fundamentals: Need for time compression in product development, Need for Additive Manufacturing, Historical development, Fundamentals of Additive Manufacturing, AM Process Chain, Advantages and Limitations of AM, Commonly used Terms, Classification of AM process, Fundamental Automated Processes: Distinction between AM and CNC, other related technologies.

UNIT – II

Liquid-based AM 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. Polyjet: Process, Principle, working principle, Applications, Advantages and Disadvantages, Case studies. Microfabrication.

Solid-based AM Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Multi-Jet Modelling (MJM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT – III

Powder Based AM Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Laser Engineered Net Shaping (LENS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Electron Beam Melting (EBM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies

Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification: Indirect Rapid Tooling Methods: Arc Spray Metal Deposition, Investment Casting, Sand Casting, 3D Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP.

UNIT – IV

AM Data Formats: Reengineering for Digital Representation, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Mesh Refining by Sub division Techniques.

AM Software's: Need for AM software, Features of various AM software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor, SurgiGuide, 3-matic, Simplant, MeshLab.

UNIT –V

AM Applications: Application – Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customised Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visulization of Biomolecules. Web Based Rapid Prototyping Systems

Suggested Reading:

1. Rapid prototyping: Principles and Applications - Chua C.K., Leong K.F. and LIM C.S, World Scientific publications , Third Edition, 2010.

2. Rapid Manufacturing – D.T. Pham and S.S. Dimov, Springer , 2001

3. Wholers Report 2000 – Terry Wohlers, Wohlers Associates, 2000

4. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.

ME2113

FLEXIBLE MANUFACTURING SYSTEMS

Instructions 3 periods/week ***Duration of university Examination: 3 hours***
Credits 3 ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To learn the evolution of flexible manufacturing systems, layouts human resources involvement.
- To know the manufacturing driving force, design scheduling of jobs, classification and coding technique.
- To familiarize with design models for processing and quality assurance, automated manufacturing and measuring systems.
- To understand the working of automated movement, storage systems, tool management, fault detection and relationship with workstations.

Unit - I

Evolution of Manufacturing Systems: FMS definition and description, General FMS considerations, Manufacturing cells, Cellular versus Flexible Manufacturing. Systems Planning: Objective, introduction planning, preparation guidelines, the project team, supplier selection, system description and sizing, facility preparation planning, FMS layouts. Human resources: staff considerations, team work, communication and involvement, the supervisor's role, personnel selection, job classifications, employee training.

Unit - II

Manufacturing Driving Force: Definition, description and characteristics. Just in-time manufacturing, definition and description, benefits and relationship to FMS, implementation cornerstones, quality and quantity application principles. Single manufacture Cell–design scheduling of jobs on single manufacturing cells. Group Technology: Concepts, classification and coding, benefits and relationship to FMS, design of group technology using rank order clustering technique.

Unit - III

FMS Design – Using Bottleneck, Extended bottleneck models, Processing and Quality Assurance: Turning centres, Machining centre, construction and operations performed, axes, programming, and format information, work-holding and work-changing equipment, automated features and capabilities, cleaning and deburring – station types and operation description, importance to automated manufacturing, coordinate measuring machines, types, construction and general function, operation cycle description, importance to flexible cells and systems.

Unit - IV

Automated movement and storage systems –AGVs, Robots, automated storage and retrieval systems, storage space design, queuing carousels and automatic work changers, coolant and chip Disposal and recovery systems, auxiliary support equipment, cutting tools and tool Management – introduction, getting control of cutting tools, Tool Management, tool strategies, data transfer, tool monitoring and fault detection, guidelines, work holding considerations, General fixturing, Modular fixturing. FMS and the relationship with workstations – Manual, automated and transfer lines design aspects.

Unit - V

FMS: computer Hardware, Software, Communications networks and Nanotechnology – general functions, and manufacturing usages, hardware configuration, programmable logic controllers, cell controllers, communications networks. FMS implementation.

Suggested Reading:

1. Parrish, D.J., „Flexible Manufacturing ", - Butter Worths – Heinemann, Oxford, 1993.
2. Groover, M.P., „Automation, Production Systems and CIM", - Prentice Hall India, 1989.
3. Kusiak, A., „Intelligent Manufacturing Systems ", - Prentice Hall, 1990.
4. Considine,D.M., & Considine,G.D., „Standard Handbook of Industrial Automation",- Chapman & Hall, 1986
5. Ranky, P.G., „Design and Operation of FMS", - IFS Publishers, UK, 1988

ME2111

PRODUCT DESIGN AND PROCESS PLANNING

Instructions ***3 periods/week*** ***Duration of university Examination: 3 hours***
Credits ***3*** ***SEE: 70 Marks*** ***CIE: 30 Marks***

Objectives:

- To learn the essential factors with innovative ideas to develop successive right product.
- To know the product reliability, copyrights, value Engineering in product design and cost estimation of product.
- To understand the various machining processes, improving tolerances methods, selection of materials and their importance.
- To understand the modern approaches, ergonomics considerations in product design, integration of design, manufacturing and production control.

Unit - I

Product design and process design functions, selection of a right product, essential factors of product design, Morphology of design, sources of new ideas for products, evaluation of new product ideas. Product innovation procedure-Flow chart. Qualifications of product design Engineer. Criteria for success/failure of a product. Value of appearance, colours and Laws of appearance.

Unit - II

Product reliability, Mortality Curve, Reliability systems, Manufacturing reliability and quality control. Patents: Definitions, classes of patents, applying for patents. Trademarks and copyrights. Cost and quality sensitivity of products, Elements of cost of a product, costing methods, cost reduction and cost control activities. Economic analysis, Break even analysis Charts. Value engineering in product design, creativity aspects and techniques. Procedures of value analysis – cost reduction, material and process selection.

Unit - III

Various manufacturing processes, degree of accuracy and finish obtainable, process capability studies. Methods of improving tolerances. Basic product design rules for Casting, Forging, Machining, Sheet metal and Welding. Physical properties of engineering materials and their importance on products. Selection of plastics, rubber and ceramics for product design.

Unit - IV

Industrial ergonomics: Man- machine considerations, ease of maintenance. Ergonomic considerations in product design-Anthropometry, Design of controls, man-machine information exchange. Process sheet detail and their importance, Advanced techniques for higher productivity. Just -in -time and Kanban System. Modern approaches to product design; quality function development, Rapid prototyping.

Unit - V

Role of computer in product design and management of manufacturing, creation of manufacturing data base, Computer Integrated Manufacturing, communication network, production flow analysis, Group Technology, Computer Aided product design and process
Planning. Integrating product design, manufacture and production control.

Suggested Reading:

1. Niebel, B.W., and Draper, A.B., Product design and process Engineering, Mc Graw Hill Kogalkusha Ltd., Tokyo, 1974.
2. Chitale, A.K, and Gupta, R.C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Mahajan, M. Industrial Engineering and Production Management, Dhanpath Rai & Co., 2000.

ME2431

CAD/CAM LABORATORY

Instruction 3 periods/week CIE 50 Marks
CREDITS 2

List of Exercises: CAD

1. Understanding of various CAD commands and creating simple objects
2. Understanding of holes, cuts and model tree relations
3. Creation shafts, rounds, chamfers and slots
4. Sketch Tools & Datum planes
5. Creation of objects by revolved features, patterns and copies, sweeps and blends
6. Creation of engineering drawing details such as dimensioning, sectional views, adding esthetics
7. Assembling of part models using constraints
8. Assembly operations - part modifications, adding another assembly features – display.

List of Exercises: CAM

1. Understanding of CNC Machines and CNC Programming and Creation of
2. 2-D contour Pockets, Slots 2. Drills and Facing, 2-D high Speed blend
3. Surface Roughing for Bottle die
4. Surface finishing for Phone die
5. Manufacturing of Crane Hook
6. Manufacturing of Connecting Rod
7. Manufacturing of Turbine Blade
8. 3-D Machining using ball nose cutters

ME2032

COMPUTATION LABORATORY

Instruction 3 periods/week CIE 50 Marks
CREDITS 2

List of Experiments:

1. Introduction to Finite Element Analysis Software.
2. Static analysis of a corner bracket.
3. Statically indeterminate reaction force analysis.
4. Determination of Beam stresses and Deflection.
5. Bending analysis of a Tee-shaped beam.
6. Analysis of cylindrical shell under pressure.
7. Bending of a circular plate using axisymmetric shell element.
8. Stress analysis in a long cylinder.
9. Solidification of a casting.
10. Transient Heat transfer in an infinite slab.
11. Transient Thermal stress in a cylinder.
12. Vibration analysis of a Simply supported beam.
13. Natural frequency of a motor generator.
14. Thermal – structural contact of two bodies.
15. Drop test of a container (Explicit Dynamics).