DEPARTMENT OF MECHANICAL ENGINEERING

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

Specialization:

AUTOMATION & ROBOTICS

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	--	3	3	--	50	2
8.	Seminar - I	--	3	3	--	50	2
	Total	**18**	**6**	**24**	**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	--	3	3	--	50	2
8.	Seminar - II	--	3	3	--	50	2
	Total	**18**	**6**	**24**	**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	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**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	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**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. II / Seminar - II	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**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. II / Seminar - II	--	3	3	--	50	2
	Total	**9**	**3**	**12**	**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 (AUTOMATION & ROBOTICS)

Syllabus Ref. No. (Code)	Subject Title	Contact hrs Per week	Scheme of Examination		Credits
			CIE	SEE	
Core Subjects:					
ME2301	Automation	3	30	70	3
ME2302	Control of Dynamic Systems	3	30	70	3
ME2303	Robotic Engineering	3	30	70	3
ME2304	Advanced Kinematics	3	30	70	3
ME2305	Fluid Power Systems	3	30	70	3
ME2306	Computer Aided Mechanical Design and Analysis	3	30	70	3
Elective Subjects:					
ME2307	Microcontrollers and Applications	3	30	70	3
ME2401	Finite Element Techniques	3	30	70	3
ME2402	Computer Aided Modeling and Design	3	30	70	3
ME2308	Optimization Techniques	3	30	70	3
ME2309	Vibrations Analysis and Condition Monitoring	3	30	70	3
ME2310	Under Actuated Robotics	3	30	70	3
ME2311	Neural Networks and Fuzzy Logic	3	30	70	3
ME2312	Artificial Intelligence and Expert Systems	3	30	70	3
ME2313	Advanced Solid Mechanics	3	30	70	3
ME2107	Mechanics of Composite Materials	3	30	70	3
ME2403	Computer Integrated Manufacturing	3	30	70	3
ME2110	Experimental Techniques and Data Analysis	3	30	70	3
ME2111	Product Design and Process Planning	3	30	70	3
ME2112	Additive Manufacturing Technologies and Applications	3	30	70	3
ME2001	Engineering Research Methodology	3	30	70	3
ME2211	Rotor Dynamics	3	30	70	3
ME2216	Numerical Methods	3	30	70	3
Departmental Requirements:					
ME2331	Automation & Robotics Lab (Lab – I)	2	50	-	2
ME2332	Computation Lab (Lab –II)	2	50	-	2
ME2033	Seminar I	2	50	-	2
ME2034	Seminar II	2	50	-	2
ME2035	Project Seminar	4	100	-	8
ME2036	Dissertation	6	150		12

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

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

ME2304

ADVANCED KINEMATICS

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

Objectives

- This course builds on the basic understanding of topics learnt in the fundamental courses in kinematics and dynamics.
- principles of kinematic synthesis, analysis and dynamics to planer mechanisms
- Provides an in-depth understanding of selected advanced topics in the area of three dimensional kinematics, Robotics and flexible body dynamics.
- This course is intended to aid students in their research as well as in the application of the methods to mechanical systems in practice.

UNIT-I

Kinemtic Analysis of plane mechanism: Analytical method of kinematic analysis of four bar mechanism. Acceleration analysis of complex mechanisms by auxiliary point method, good man"s indirect method.

UNIT-II

Kinematic synthesis of linkages: Number synthesis, associated linkage or equivalent linkage concept, dimensional synthesis by analytical and graphical methods.

UNIT-III

Kinematic analysis of four link RGGR spatial mechanism, D-H parameters, Transformations matrix method for position velocity and acceleration analysis of special mechanisms.

UNIT-IV

Cams: Analysis of follower motions, analytical cam design.

UNIT-V

Kinematic analysis of two-degree freedom of Robot arm.

Suggested Reading:

1. Amitabh Ghosh and Ashok Kumar Mallik, Theory of mechanism and Machines, Affiliated East-West Press Pvt. Ltd., New Delhi, 1998.
2. Artur, G. Erdman and George. N. Sandor., Mechanism design: Analysis and Synthesis, Vol-1 Prentice Hall of India, 1984.
3. Joseph Edward. Shigley and J. Joseph Uicker, Theory of Mechanisms and Machines, Mc.Graw-Hill Company, 1995.

ME2305

FLUID POWER SYSTEMS

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

Objectives

- The course will develop the students' knowledge and understanding of hydraulic and pneumatic devices and systems.
- The students should be able to understand the principles of operation and the design details of hydraulic pumps, motors, valves, actuators, and systems.
- The student should be able to analyze both the steady-state and the dynamic performance of individual hydraulic components and systems.
- The student should also be able to relate the theory with the practical applications of these principles

UNIT - I

Advantages and Disadvantages of Fluid control, Types of Hydraulic Fluids, physical, chemical and thermal properties of hydraulic fluids, selection of hydraulic fluid, fluid flow fundamentals. Hydraulic Pumps and Motors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters

UNIT - II

Hydraulic Control Valves- Valve configurations, general valve analysis, critical center, open center, three way spool valve analysis and Flapper valve analysis, pressure control valves, single and two stage pressure control valves, flow control valves, introduction to electro hydraulic valves.

UNIT - III

Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlled piston, pump controlled motor, pressure transients in power elements.

UNIT - IV

Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Pneumatic servo mechanisms, pneumatic servo, ram equations, load sensitivity, method of stabilization, stabilization using auxiliary tanks. Some practical aspects of servo testing and design

UNIT - V

Control of pressure and speed in Hydraulic and Pneumatic Systems, Fluidics:proportional amplifier, bistable amplifier, vortex amplifier, turbulence amplifier, impact modulator, Boolean algebra, fluid logics,manipulation of logic expressions, special circuits and sequential circuits.

Suggested Reading:

1 Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley & Sons, 1967.
2 D McCloy & H R Martin,” The control of fluid power” Longman publications.1980
3 Anthony Esposito, “Fluid power with applications”, Prentice Hall, 7th Edition, 2002.
4 Arthur Akers, Max Gassman, Richard Smith, “Hydraulic Power System Analysis”, Taylor and Francis Group, 2006.
5 John Pippenger & Tyler Hicks, “Industrial Hydraulics”, 3rd edition McGraw Hill , 1979
6.A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.

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

ME2307

MICRO-CONTROLLERS AND ITS APPLICATIONS

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

UNIT-I

Binary data representation: decimal system, binary system, octal system, hexadecimal system, binary coded decimal system, decimal conversion, decimal to Hexadecimal, binary addition and subtraction, binary multiplication and division, binary coded decimal addition, signed numbers, twos complement arithmetic, hexadecimal arith- metic, digital logic gates, MCS51 Micro controller – difference between micro controller and microprocessor, criteria for choosing a microcontroller, internal architecture of MCS51 microcontroller and its family.

UNIT-II

8051 assembly language programming: instruction set-arithmetic, logical, data transfer branching and Flag manipulation Instructions, addressing modes

UNIT-III

8051 timer/counter, serial communication programming, interrupts structure, interrupt programming, usage of C programming to 8051 family.

UNIT-IV

Real word interfacing: Analog to Digital converter, Digital to Analog converter, Mechanical switches, keypads, LEDs, seven segment display, LCDs, keyboard, DC motor, stepper motor, PWM, External Memory Interface.

UNIT-V

Microcontroller Applications: C programming of Podium timer, microcontroller based menu card, chimney sentinel, counting cars, anonymous voting, efficient lighting using microcontroller, I^2C interface with serial EPROM, reading a PWM waveform using microcontroller, 8051 based pick and place robot.

Suggested Reading:

1 Mazidi, The 8051 micro controller and embedded system, Pearson education , 2002
2 Han-way Huang, Using the MCS-51 microcontroller, Oxford University Press, 2009.
3 Ajay V Deshmukh, Microcontrollers(Tuning and applications), The McGraw Hill publications, 2007.
4 Parab, Shekale, Kamat & Naik, “Exploring C for Micro controllers: A hands on approach”, Springer Verlag Publications, 2007.
5 Kenneth Hintz and Daniel Tabak, Microcontrollers architecture, Implementation and programming, TMH, 2005
6 A. K. Stiffler, Design with microprocessors for Mechanical Engineers, McGraw Hill, 1992

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.

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.

ME2310

UNDER ACTUATED ROBOTICS

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

UNIT-I

Fully v/s under actuated systems, non linear dynamics of the simple pendulum, Acrobot and cart-pole controllability, partial feedback linearization(PFL), energy shaping

UNIT-II

Simple walking models- rimless wheels, compass gait, kneed compass gait, feedback control for simple walking models. Simple running models-spring loaded inverted pendulum (SLIP), Raibert hoppers, swimming and flapping flight.

UNIT-III

Function approximation and system identification, model systems with uncertainty, state distribution dynamics and state estimation

UNIT-IV

Introduction to optimal control, double integrator and pendulum examples, dynamic programming and value integration, grid world, quadratic regulator (Hamilton –Jacobi-Bellman sufficiency), min-time control (pontryagin), open loop optimal control, direct and indirect methods., trajectory stabilization, iterative linear quadratic regulator(ILQR).

UNIT-V

Motion planning: Dijkstra"s algorithm, A-star algorithm, randomized motion planning, rapidly exploring randomized trees, and probabilistic road maps, feedback motion planning-planning with funnels, linear quadratic regulator (LQR) trees,

Suggested Reading:

1 Strogatz steven.H, Non linear Dynamics and Chaos: with applications to physics, biology, chemistry and Engineering, Boulder, CO: westview press, 2001
2 Slotine, Jean-Jacques and Weiping Li, Applied Nonlinear control, Upper Saddle River, NJ, Prentice Hall, 1991
3 Fantoni, Isabelle and Rogelio Lozano, Non linear control for under actuated mechanical systems, Newyork, NY, Springer verlag, 2002
4 Bertsekas, Dimitri , Dynamic Programming and Optimal control 3rd edition, vol I and II Nausha, NH, Athena Scientific, 2007
5 Lavalle steven, Planning Algorithms, New york, NY, Cambridge University Press, 2006

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*.

ME2313

ADVANCED SOLID MECHANICS

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

UNIT-I

Bending of Beams: Introduction, straight beams and Asymmetrical bending, Euler –Bernoulli hypothesis, shear center, shear stresses in thin walled open sections, bending of curved beams, deflection of thick curved bars.

UNIT-II

Bending of Plates: Behaviour of Flat plates , bending of a plate in one direction, bending of a 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-III

Asymmetric Bodies: Introduction, Thick-walled cylinder subjected to internal and external pressures, stresses in composite tubes-shrink fit, rotating disks of uniform thickness, disks of variable thickness, rotating shafts and cylinders.

UNIT-IV

Thermal Stresses : Introduction, thermoelastic stress–strain relations, equations of equilibrium, strain-displacement relations, thin circular disk, normal stresses in straight beam due to thermal loading, stresses in curved beams due to thermal loading.

UNIT-V

Elastic Stability : Euler's Buckling load, beam column equations, beam column with concentrated load, continuous lateral loads, beam-Column with end couple, General treatment of column stability problems.

Suggested Readings:

1. L Srinath, " Advanced Mechanics ofSolids ", Tata McGraw-Hill Education, 2009
2. Stephen P. Timoshenko & James M. Gere, " Theory of Elastic Stability", Dover Publications
3. Abdel-Rahman Ragab & Salah Eldin Bayoumi, " Engineering Solid Mechanics", CRC Press
4. Stephen P. Timoshenko & J N Goodier, " Theory of Elasticity", McGraw Hill Publications.
5. Bruhns, Otto T., "Advanced Mechanics of Solids" Springer Verilag, 2003
6. Arthur P. Boresi, Richard J. Schmidt, "Advanced Mechanics of Materials", Wiley International Publications.
7. Allan F Bower, "Advanced Mechanics of Solids", Taylor & Francis, 2014

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.

ME2403

COMPUTER INTEGRATED MANUFACTURING

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

Objectives:

1. To understand the need for CIM, evolution of CIM, fundamentals of CIM and the Concept of Concurrent Engineering.
2. 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.
3. 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

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.

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.

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.

ME2211

ROTOR DYNAMICS

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

UNIT-I

Single degree of freedom system – Free vibrations. Damped vibrations and forced vibrations, Two degree of freedom systems – Undamped vibration, absorbers, Forced Damped vibrations, Vibration isolation.

UNIT-II

Close coupled systems – Eigenvalue problem. Orthogonality of mode shapes. Modal analysis Critical speeds.

UNIT-III

Vibrations of multi rotor systems – Matrix method, Influence coefficient methods, Transfer matrix analysis and Holzers method.

UNIT-IV

Torsional vibrations in rotating machinery – Equivalent discrete system, transient response, branched system.

UNIT-V

Out-of-rotors in rigid supports, simply supported rotor with overhangs. Gyroscopic effects. Rotor mounted on fluid film bearings – Transfer matrix analysis of turbine rotor by distributed elements, Dual rotor system analysis. Balancing of rotors.

Suggested Reading:

1. J.S. Rao, *Rotor dynamics*.

2. J.S. Rao, K. Gupta, *Mechanical Vibrations*.

ME2216

NUMERICAL METHODS

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

UNIT-I

Solving linear sets of equations Gauss Elimination, LV Decomposition, Matrix Inversion, Scalar Tridiagonal Matrix, Thomas Algorithm, Gauss Seidel Method, Secant Method

UNIT-II

Solving nonlinear sets of equations Minimization of function, Newton's Method, Quasi-Newton Method, Steepest Descent Method, Eigen Values & Vectors.

UNIT-III

Interpolation & Polynomial Approximation Least Squares Method, Lagrange Interpolation, Hermite Interpolation, Cubic Spline Interpolation, Chebeshev Polynomials & Series

UNIT-IV

Numerical Differentiation & Integration Numerical Differentiation, Richardson's Extrapolation, Definite & Indefinite Integrals, Simpson's Rule, Trapezoid Rule, Gaussian Quadrature

UNIT-V

Ordinary Differential Equations: First and Higher Order Taylor Series, First order Runge-kutta Method, Fourth order Runge-kutta Method, Stiff Equations, Errors, Convergence Criteria.

Suggested Reading:

1. Cheney E. Ward, Kincaid D.R., Numerical Methods and Applications, 2008, Cengage Learning
2. Gerald C.F., Wheatley P.O., Applied Numerical Analysis, 7th Ed, Pearson Education.
3. Burden R.L., Faires J.D., Numerical Analysis: Theory and Applications, 2005, Cengage Learning.
4. Chapra S.C., Canale R.P., Numerical Methods for Engineers, 4th Ed, Tata McGraw Hill.
5. Mathews J.H., Fink K.D., Numerical Methods using MA TLAB, 4th Ed, Pearson Education.
6. Press W.H., Taukolsky S.A., Vetterling W.T., Flannery B.P., Numerical Recipes in C++, 2nd Ed, Cambridge University Press.

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.

ME2331

AUTOMATION AND ROBOTICS LABORATORY

Instruction 3 periods/week CIE 50 Marks
CREDITS 2

Objectives:

- To expose students to Mathematical tools like Matlab
- To expose students to modeling of Fluid power elements using H,P simulators.
- To explain the importance and usage of Microcontrollers.
- To expose students to softwares like Flexsim software for plant layout optimization

List of Experiments

I- MATLAB

1. Basic syntax and command-line exercises, Basic array exercises, Relational and logical operations
2. Control of flow: if-blocks , Loop constructs: for and while
3. Basic 2D & 3D Plots
4. Solving ordinary differential equations
5. Curve fitting and interpolation
6. Data Analysis and statistics
7. Solving non-linear algebraic equations
8. Introduction to optimization methods like GA, Fuzzy, Neural & PSO
9. Introduction to SIMULINK
10. Modeling of problems related to kinematics and dynamics of robot using MATLAB

II- SIMULATION SOFTWARE

11. Hydraulic equipment simulation using H-Simulator
12. Pneumatic equipment simulation using P-Simulator
13. PLC simulator

III- 8051 Microcontroller

14.LCD interfacing with 8051 MC
15.Interfacing of PMW with DC motor using 8051 MC interface
16 ADC and DAC interfacing with 8051 MC
17. Temperature control using 8051 MC interface
18. Traffic Light control using 8051 MC interface .
19. Servo motor Interfacing with 8051 MC

IV. FLEXSIM SOFTWARE

20. Flexsim basics and how to building basic models in Flexsim
21. Addition of model logic andmanaging data
22 Managing entities and time tables
23 Modeling of Randomness
24 Simulation of Production flow lines

ME2332

COMPUTATION LABORATORY

Instruction 3 periods/week CIE 50 Marks
CREDITS 2
Objectives:

- To expose students to structural analysis like Ansys, Abaqus
- To expose students to Kinematic and dynamic analysis like MSC Adams
- To provide students with the necessary tools to analyze practical systems for both static and dynamic analysis.
- an ability to analyze, design, simulate, and experimentally validate systems while taking into account practical limitations of operations.

List of Experiments: using Abaqus Software & Ansys software

1. Introduction to Finite Element Analysis Software.
2. Static analysis of a corner bracket.
3. Determination of Beam stresses and Deflection & bending analysis of Tee shaped beam.
4. Bending of a circular plate using axisymmetric shell element.
5. Analysis of cylindrical shell under pressure.
6. Solidification of a casting.
7. Transient Heat transfer analysis in an infinite slab & cylinder.
8. Vibration analysis of a Simply supported & cantilever beams .
9. coupled structural/thermal analysis.
10. Drop test of a container (Explicit Dynamics).

List of Experiments: using Msc Adams Software

11. Kinematic analysis of Single Link Pendulum
12. Impact test of a falling stone body
13. Kinematic and dynamic analysis of a 4 bar mechanism

14 Kinematic and dynamic analysis of a slider crank mechanism

15.Contact analysis of a Journal bearing

Usage of analysis software's like Ansys, Abaqus & Msc Adams