Scheme of instruction and Syllabus

FOR FIRST YEAR POSTGRADUATE ENGINEERING PROGRAM
w.e.f AY 2014-15

DEPARTMENT OF MECHANICAL ENGINEERING
VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)
Sponsored by Vasavi Academy of Education
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VASAVI COLLEGE OF ENGINEERING (AUTONOMOUS)

SCHEME OF INSTRUCTION & EXAMINATION

M.E 1- YEAR
(Advanced Design and Manufacturing MECHANICAL ENGINEERING)

SEMESTER – I								
Sl No.	**Syllabus Ref .No.**	**SUBJECT**	**Scheme of Instruction**		**Scheme of Examination**			**Credits**
			Periods per Week		**Duration in Hours**	**Maximum Marks**		
			L	**D/P**		**Univ. Exam**	**Sessi–onals**	
THEORY								
1	MA5010	Mathematical methods for Engineers	3	-	3	70	30	3
2	ME5020	Metal Cutting and Forming	3	-	3	70	30	3
3	ME5030	Finite Element Techniques	3	-	3	70	30	3
4	ME5040	Computer Integrated Design and Manufacturing	3	-	3	70	30	3
5	ME5050	Flexible Manufacturing system	3	-	3	70	30	3
6	ME5XX0	Elective - 1	3	-	3	70	30	3
PRACTICALS								
1	ME5011	CAD / CAM Laboratory	-	3	3	50	25	1
2	ME5012	Seminar-I	-	3	-	-	25	1
		Total				**470**	**230**	**20**
SEMESTER - II								
THEORY								
1	ME5060	Robotic Engineering	3	-	3	70	30	3
2	ME5070	Metallurgy of Metal Casting & Welding/ Advanced material joining Processes	3	-	3	70	30	3
3	ME5080	Computer Aided Mechanical Design and Analysis	3	-	3	70	30	3
4	ME5XX0	Elective -2	3	-	3	70	30	3
5	ME5XX0	Elective – 3	3	-	3	70	30	3
6	ME5XX0	Elective - 4	3	-	3	70	30	3
PRACTICALS								
1	ME5021	Automation & robotics Laboratory	-	3	3	50	25	1
2	ME5022	Seminar-II	-	3	-	-	25	1
		Total				**470**	**230**	**20**

Syllabus Ref .No.	SUBJECT	Scheme of Instruction: Periods per Week		Scheme of Examination			Credits
				Duration in Hours	Maximum Marks		
		L	D/P		Univ. Exam	Sessi–onals	
SEMESTER – III							
ME6016	Project Seminar		3	-	-	50	2
ME6015	Project (Stage 1)		6	-	-	50	6
Total						**100**	**8**
SEMESTER – IV							
ME6025	Project (Stage 2)		12	-	**Viva-voce (Grade)**	-	12
	Total					**-**	**12**

Sl. No.	Code No.	Title
1	ME5090	Advanced Kinematics
2	ME5100	Dynamics and vibrations
3	ME5110	Advanced Mechanics of solids
4	ME5120	Theory of Elasticity and Plasticity
5	ME5130	Mechanics of composite materials
6	ME5140	Advanced Non destructive Evaluation Techniques
7	ME5150	Design for Manufacture
8	ME5160	Fracture Mechanics
9	ME5170	Rapid Prototyping, Tooling and Manufacture
10	ME5180	Engineering research methodology
11	ME5190	Neural Networks and Fuzzy Logic
12	ME5200	Experimental techniques and Data Analysis
13	ME5210	MEMS and Nano Technology
14	ME5220	An introduction to nano science and technology
15	ME5230	Gear Design
16	ME5240	Product Design and Process Planning
17	ME5250	Quality and Reliability Engineering
18	ME5260	Value Engineering
19	ME5270	Optimization Techniques

MA 5010 MATHEMATICAL METHODS FOR ENGINEERS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the basic operations of vector operators to prove vector Identities • To understand the basics of tensors to prove vector identities and theorems in tensor form • To understand the fundamentals of matrices to solve problems on Cramer's rule, singularity, inconsistency of equations, Gauss Elimination method, Gauss Seidal method , LU decomposition, Inverses, echelon form. To understand the fundamentals concepts of general solution of underdetermined system, generalizes inverses, least square solution for over determined systems, eigen vectors, orthogonalization and singular value decomposition and related problems • To understand the concepts of first and second order ordinary differential equations, linear ODEs with constant coefficients, Laplace transforms, second order homogeneous differential equations and their solutions, Sturm-Liouville problem, orthogonal functions, Gram-Schdmit procedure and related problems • Classification of Partial differential equations (PDEs). To understand the concept of Analytical solutions of linear PDEs, fourier series, fourier transforms, transformation of PDES between different coordinate systems and related problems	• The student is able to understand the basic operations of vectors to prove vector identities • The student is able to the understand the basics of tensors to prove vector identities and theorems in tensor form and able to solve related problems • The student is able to understand the basic operations of matrices to solve problems on Cramer's rule, singularity, inconsistency of equations, Gauss Elimination method, Gauss Seidal method , LU decomposition, Inverses, echelon form. Also he is able to understand the concepts on general solution of underdetermined system, Generalized inverses, least square solution for over determined systems, eigen vectors, orthogonalization and singular value decomposition and able to solve related problems • The student is able to understand the concepts of first and second order ordinary differential equations, ODEs with constant coefficients, the laplace transforms, second order homogeneous differential equations and their solutions, Sturm-Liouville problem, orthogonal functions, Gram- Schdmit procedure and able to solve related problems • The student is able to classify the Partial differential equations(PDEs) and able to understand the concept of analytical solutions of linear PDEs, fourier series, fourier transforms, PDEs between different coordinate systems and able to solve related problems

UNIT-I (8 classes)
Vectors: Vectors, Operations and operators, identities
UNIT-II (8 classes)
Tensors: Cartesian tensors: Definition, notation, transformation matrix, orthogonal properties, order of a tensor, operations, contraction, quotient rule, vector identities and theorems in tensor form
UNIT-III (13 classes)
Linear algebraic equations: Matrix form, matrix operations, determinants, Cramer's rule, inverse, singularity, inconsistent equations gauss elimination, Gauss-seidal, LU decomposition, finding inverses, echelon form, general solution for under determined systems, least squares solutions for over determined systems, eigen values and eigen vectors, orthogonalisation method, singular value decomposition
UNIT-IV (12 classes)
Ordinary Differential Equations: Applications of Laplace transforms to solve differential equations, Sturm-liouville problem, orthogonal functions, gram-Schdmit procedure
UNIT-V (12 classes)
Partial Differential Equations : Classification of second order PDEs, wave equation, heat equation, Laplace equation, transformation of PDEs in cylindrical and spherical coordination systems.
Suggested Reading:

1. Higher Engineering Mathematics by B S Greval, Khanna Publications
2. Advanced Engineering Mathematics, RK Jain, SRK Iyengar, Narosa Publications
3. Advanced Engineering Mathematics by ….. Kreyszig, 8th Edition, John Wiley and Sons Ltd., 2006
4. A text book of Engineering Mathematics by N.P. Bali & Manish Goyal, Laxmi Publications.

ME 5020 METAL CUTTING & FORMING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• Explain the principles of metal cutting • Discuss various shear angle relations • Discuss effects of temperature and forces in metal cutting • Describe varius plastic deformation theories • Identify and differentiate various non conventional forming methods	• After the completion of the course the student will be able to: • Analysis various metal cutting processes. • Able to formulate equations of temperature distribution and forces in metal cutting. • Will be able to appreciate methods of improving cutting efficiency and economics. • Evaluate different metal forming methods. • Analyze various non conventional forming methods.

UNIT-I

Tool Materials: Tool material properties – HSS, Carbides, coated carbides, ceramic and CBN and diamonds, sialons, powder coatings – Relative advantages. Tool Geometry: Various methods of tool nomenclature and their inter relationship. Theoretical Determination of shear angle and cutting forces: Shear plane theory–Merchants models, Lee and Shofers model. Velocity relations. Estimation of shear angle experimentally. Metal cutting friction. Real area of contact-Rules of dry sliding, stress distribution of tool face-variation of co-efficient of tool face friction with the rake angle.

UNIT-II

Dynamometry: Theoretical and empirical estimation of force and power in turning, drilling, milling and grinding processes optimization in cutting forces – Dynamometer requirements – Force measurements – Electric transducers. Lathe, drilling and milling dynamometers. Cutting Temperatures: Shear Plane temperature – Average chip-tool interface temperature-interface temperature by dimensional analysis – Distribution of shear plane temperature-Measurement of temperature by radiation pyrometer – Moving thermo couple – Photo cell – Photographic method.

UNIT-III

Tool Wear, Tool life and Machinability: Mechanism of tool wear – Adhesive, Abrasive, Diffusive and Chemical wear – Taylor‟s tool life equation. Cutting Fluids – Carbon tetrachloride – Direction of fluid application – Chip curl-economics of machining – Comparison of machinability of different metals. Recent development in metal cutting: Hot machining. Rotary machining – High speed machining, rapid proto typing.

UNIT-IV

Plastic Deformation: Mechanism of plastic deformation, Factors affecting plastic deformation, Strain hardening behavior. Recovery, Recrystallization and grain growth. Variables affecting stress-strain curves, Ideal & Practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Tresca‟s and Von Mises‟s yield criteria under complex states of stress, including Plane stress & Plane strain condition.Rolling: Principle of rolling, process parameters. Estimation of rolling loads. Principles of roll pass design for various product shapes. Principles of ring rolling.

UNIT-V

Unconventional Methods In Metal Forming: High energy rate forming. Merits and limitations of HERF Processes. Principle, merits, limitations and applications of pneumatic-mechanical systems. Explosive forming, electro-magnetic forming, electro-hydraulic forming and water hammer forming. Forming with rubber pads – Guerin, Marform & Wheelon forming techniques.

Suggested Reading:

1. M.C. Shaw. *Metal cutting principles* – CBS Publications, New Delhi, 1992.
2. BhattaCharya, *Metal cutting* – Central book publishers, Calcutta – 1996.
3. Heinrich Makelt, *Mechanical presses*, Edward Arnold (Pvt) Ltd., London, 1968.
4. Bary. Donald.F and Reads. Edward A., *Techniques of press working sheet metal*, Prentice Hall Publ., 1974.
5. Kameschikov, *Forming Practice*, Mir Publishers, Moscow, 1970.
6. *High Velocity Forming methods*, ASTME, Michigan, 1968.

ME 5030 FINITE ELEMENT TECHNIQUES

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	**Course Outcomes**
• To equip the students with the Finite Element Analysis fundamentals. • To enable the students to formulate the design problems into FET. • To introduce basic aspects of finite element technology, including domain discretization, polynomial interpolation, application of boundary conditions, assembly of global arrays, and solution of the resulting algebraic systems. • To familiarise the students with higher order elements and eigen value problems in FET • To introduce the students to the concepts of 3D finite element analysis and FET software packages.	• Upon completing this course, the students will be able to: • Identify mathematical model for solution of common engineering problems. • Formulate simple problems into finite elements. • Solve structural, thermal, fluid flow problems. • Use professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer. • Derive element matrix equation by different methods by applying basic laws in mechanics and integration by parts. • Model 2D and 3D problems using FEA and work on software to model simple problems

UNIT-I

Introduction to 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.,
4. *An Introduction to Finite Element Methods,* Mc Graw Hill Company, 1984.

ME 5040 COMPUTER INTEGRATED DESIGN & MANUFACTURE

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the present trends of the product cycle. • To learn the modern manufacturing methods and its programming part. • To introduce the concepts of modern prototype manufacturing RPT • To introduce the present shop floor control methods • To learn the network methods of the digital devices.	• Student will able to understand the modern methods of design and manufacturing. • Student can grasp the knowledge of production planning and control methods in shop floor

UNIT-I

Product Design and CAD/CAM in the Production Systems - Product development through CAD and CAE: Geometric modeling techniques using wireframe, surface and solid modeling-graphic standards, Advanced modeling for curves, surfaces, NURBS- Advanced assembly – assembly constraints – subassembly – modification - concepts of engineering analysis and optimization using CAE techniques.

UNIT-II

Advanced Manufacturing Technology – Design drafting interface, Graphic libraries, Computer aided manufacturing technologies using Numerical Control, CNC and DNC, process interface hardware, programming languages, direct digital control, supervisory compiler controls and optical control, adoptive control – Agile and lean manufacturing.

UNIT-III

Rapid proto typing: Various techniques & mathematical background. Automated inspection & RE-engineering techniques: Point cloud data acquisition & analysis.

UNIT-IV

Concepts of Production Planning, Material Requirement Planning, up to down planning and bottom up replanning – Master production scheduling, PPC, Material Handling Requirements, Technology Planning.

UNIT-V

Communication aspects in CIM – Issues in Implementation of Advanced Manufacturing Technology – configuration management, database systems, networking concepts, LAN, MAN, SQL, CIM Models, Economics of CIM.

Suggested Reading:

1. MP Groover, „Automation, Production Systems and Computer Integrated Manufacturing‟, - Pearson Education, 2nd Edition, 2001.
2. Ibrahim Zeid, „CAD/CAM Theory and Practice‟, - Tata McGraw Hill, 1991.
3. FH Mitchell, „CIM Systems; An Introduction‟, - Prentice Hall, 1986.
4. Eric Teicholz & JN, „CIM Handbook‟, - McGraw Hill, 1986.

ME 5050 FLEXIBLE MANUFACTURING SYSTEMS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To have an in-depth knowledge in modern manufacturing using automation • To be able to analyze the complexities in a given manufacturing situation and be able to suggest alternate and effective methods to overcome the complexities • To be able to set up schemes for machine and accessory layouts for effectie manufacture under CIM • To analyze mathematically the manufacturing situations so as to prevent bottlenecks in manufacture under CIM • To have a thorough knowledge in part family identication using graph technology • To be in a position to choose the most appropriate material handling scheme of relevance in CIM operations • To understand the peripheral managerial techniques of JIT (Just-in-Time), small lot production through Kanban, Vendor development, purchaser suplier relationships and team organization. • To plan for hardware and software for the various computational resources and electronic devices used in FMS	• At the end of the course, the students must be capable of having acquired the following knowledge • Meaning, importance and utility of various layouts • Planning for FMS operations and to plan for giving FMS scheme to an enterpreneur • Managerial aspects including human resources, quality, procurement, just-in-time (JIT), benefits of small lot production, quality aspects, material handling overall rquirements etc. • Specifying machine tool, cutting tool and metrology equipment for FMS oprations after detailed study of requirements through group technology, process planning and technology planning • Distinguish between material handling requirments in traditional manufacture with those needed in FMS environment like AGVs, ASRSs, Carousals and special coveyors • Specifying the harware and software requirements for i) FMS supervisory computer ii) CNC machine tools computers iii) CMM's and laser scanners iv) PLCs and cell controllers • Integration aspects of the different subsystems

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 supervisors role, personnel selection, job classifications, employee training.

UNIT-II

Manufacturing's 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

ME 5060 ROBOTIC ENGINEERING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
Students will be able to learn • Laws of robotics terms related with robotics, manipulator configurations, types of actuators, applications of robots. • Kinematics of robotics and its homogenous transformation matrix. • Inverse kinematics and jacobian with singularities and about bug algorithms, trajectory. • Dynamics of a robotics and programming methods. • Types of sensors including vision.	Students shall be • Obtain knowledge and understand basic concepts of industrial robotics and application of robotics with different manipulator configurations. • Model the motion of robotic systems in terms of kinematics using Denavit-Hartenberg algorithm. • Deriving inverse kinematics and jacobian using forward kinematics, trajectory path planning and also sensor based motion planning. • Dynamics using Largrange_Euler and Newton-Euler methods, controls and robotic programming. • 5. Obtain knowledge about sensors used for displacement, velocity, acceleration, force and Machine vision

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, sensor based motion planning: The Bug Algorithm, The Tangent Bug Algorithm, The Incremental Voronoi Graph.

UNIT-IV

Static force analysis of RP type and RR type planar robots, Dynamic analysis using Lagrangean and Newton-Euler formulations of RR and RP type planar robots, , Independent joint control, PD and PID feedback, actuator models, nonlinearity of manipulator models, force feedback, hybrid control. Introduction to robot programming.

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 Reading:

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. Steve LaValle, "Planning Algorithms", Cambridge Univ. Press, New York, 2006.
5. Howie Choset, Kevin Lynch, Seth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki and Sebastian Thurn, "Principles of Robot Motion: Theory, Algorithms, and Implementations" , Prentice Hall of India, 2005.

ME 5070 METALLURGY OF METAL CASTING AND WELDING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To familiarize the concepts of Fe-Fe_3C equilibrium diagram. • To impart knowledge about metallurgy of castings of copper and zinc. • To familiarize the concepts of various heat treatment processes. • To study the welding aspects of various ferrous and non-ferrous alloys. • To study about the defects in welding process.	• Metallurgy of casting s of iron, copper and zinc based alloys and their heat treatment process. • Welding metallurgy and their heat treatment processes. • Aspects of welding of alloys of iron, aluminium, magnesium and titanium. • Microstructure and stresses in welding and their relief. • The defects in welding processes

UNIT-I

Metallurgy of Cast Steel and Cast Iron: Solidification microstructure, effect of cooling rate, carbon content, malleable and ductile Cast Iron.

Solidification of Castings: Solidification of pure metals and alloys, solidification rate and directional solidification, grain structure of cast metals, shrinkage, gases in cast metals, degassification.

Miscellaneous Practices: Refractories, metallurgical control, Inoculation, malleabilisation. Heat treatment of cast steel, cast iron, stress relieving, solution treatment, age hardening of castings.

UNIT-II

Metallurgy of copper base alloys-brass, bronze, Berillium Bronze, Chromium copper. Alluminium alloys – Heat treated and not heat treated.

Zinc based die casting alloys, Nickel chromium high temperature alloys, Foundry practices of copper, aluminium and magnesium base alloys.

UNIT-III

Welding metallurgy – Weld zone, Fusionboundary zone, Heat affected Zone. Heat treatment and relatged processes in Fusion welding – Annealing, Normalizing, Austempering stress relieving, Solution treatment.

UNIT-IV

Microstructural products in weldments – Schaeffler diagram, Delta Ferrite, Austenite, pearlite, Martensite. Effect of Alloying elements on microstructure. Welding stresses – Residual stresses, effects, methods of relieving.

UNIT-V

Weldability aspects of low alloy steels, strainless steels, aluminium alloys, Magnesium and Titanium alloys.

Weld cracks – cold and hot cracks; Liquation cracks, Hydrogen Induced cracks, Lamellar cracks.

Suggested Reading:

1. Taylor, Flemings & Wulff, Foundry Engineering, N.Y,Wiley & Song,Inc,1987
2. Heine, Richard.W, and others, Principles of metal casting, Tata McHill, New York, 1983.
3. Udin Funk & Wulff, Welding for Engineers, N.Y.John Wiley,1954.
4. J.F. Lancaster, Metallurgy of welding, London,George Allen & Unwio,1970.
5. R.S. Parmar, Welding Processes & Technology, Delhi, Khanna Publishers, 1992.

ME 5080 COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• Explain the design procedure for pressure vessels • Discuss the plate bending theories and equations • Demonstrate the concept of fracture mechanics • Describe the Eigen value problems • Identify various methods to perform dynamic analysis	• Analysis the pressure vessels • Formulate the plate bending equations • Interpret the behaviour of crack and crack propagation • Generate and formulate an Eigen value problem and solve it • Use various methods to obtaine solutions in Dynamic analysis

UNIT-I

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.

UNIT-II

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-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.

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- method, Newmark method, Mode superposition, Single degree of freedom system response, Multi degree of freedom system response, Rayleigh damping, Condition for stability. (Note: The related algorithms and codes to be practiced by students)

Suggested Reading:

1. John, V. Harvey, Pressure Vessel Design: Nuclear and Chemical Applications, Affiliated East West Press Pvt. Ltd., 1969.
2. Prasanth Kumar, Elements of Fracture Mechanics, Wheeler Publishing, New Delhi-1999.
3. V. Rammurti, Computer Aided Mechanical Design and Analysis, Tata Mc Graw Hill-1992.
4. Bathe, J., Finite Element Procedures, Prentice Hall of India-1996.

ME 5090 ADVANCED KINEMATICS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To learn the graphical and analytical methods to perform kinematic analysis • To learn Number and dimensional synthesis of different linkages • To learn D-H convention and transformations to do kinematic analysis of RGGR spatial mechanism • To learn how the cam and follower mechanism are applied for different motion requirements and their design. • To learn the methods for kinematic analysis of Two degree of freedom Robot.	• After successful completion of the course, student will be able to • Perform kinematic analysis of complex mechanisms • Demonstrate principles of kinematic synthesis • Analyze spatial mechanism • Design the cam profile for given required motion of the follower. • Perform kinematic analysis for two degree of freedom Robot manipulator.

Unit-I

Kinematic analysis of plane mechanism: Analytical method of kinematic analysis of four bar mechanisms. 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 Gosh and Ashok Kumar Mallik, '*Theory of Mechanisms and Machines*', Affiliated East-West Press Pvt. Ltd., New Delhi, 1998.
2. Artur, G.Erdman and George.N.Sandor, '*Mechanism Design*', Volume-I and -II, Prentice Hall of India, 1984.
3. Joseph Edward. Shigley and J.Joseph Uicker, '*Theory of Mechanisms and Machines*', McGraw-Hill Company, 1995.

ME 5100 DYNAMICS AND VIBRATIONS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• Explain the concept of vibrations ,with single and multidegree freedom • Discuss the numerical methods involved in vibrations • Demonstrate the concept of Transient vibrations and Random vibrations • Identify various methods of vibration control. • Describe the concept of Non-Linear vibrations Identify various methods of vibration control.	• After the completion of the course the student will be able to : • Analyse the multi degree of freedom systems vibrations • Formulate vibration problem using various numerical methods • Interpret the concept of the Random and Transient vibrations • Apply various methods for vibration control • Interpret the non-linear phenomenon of vibrations and their formulation

Unit-I

(A) Multi Degree Freedom System:-Free Vibration equation of motion. Influence Coefficient i)Stiffness Coeff. (ii) Flexibility Coeff. Generalized co ordinates, and Coordinate couplings. Langranges Equations Matrix Method Eigen Values Eigen Vector problems. Modal Analysis. Forced Vibrations of undamped system and modal analysis.

(B) Multi Degree System Numerical Methods:-(i)Rayleigh`s Method, (ii)Rayleigh-Ritz Method (iii)Holzer`s Method (iv)Methods of Matrix iterations (v) Transfer Matrix Method, Impulse response and frequency response functions.

Unit-II

Continuous System:- Vibrations of String, Bars, Shafts and beams, free and forced vibration of continuous systems.

Unit-III

Transient vibrations:-Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response functions.

Unit-IV

Vibration Control:-Balancing of rotating machine, In-situ balancing of rotors, control of naturalfrequency introduction of damping, vibration isolation & vibration absorbers..Vibration Measurement:- FFT analyzer, vibration exciters, signal analysis. Time domain & Frequency domain analysis of signals. Experimental modal analysis, Machine Conditioning and Monitoring, fault diagnosis.

Unit-V

Random Vibrations:- Expected values auto and cross correlation function, Spectral density, response of linear systems, analysis of narrow band systems.

Non Linear Vibrations:-Systems with non-linear elastic properties, free vibrations of system with non-linear elasticity and damping, phase-plane technique, Duffing's equation, jump phenomenon, Limit cycle, perturbation method.

Suggested Reading:

1. Theory of Vibrations with Applications: W T Thomson CBS Publishers
2. Mechanical Vibrations: S S Rao Addison-Wesley Publishing Co.
3. Fundamentals of Vibration: Leonard Meirovitch , McGraw Hill International Edison.
4. Principles of Vibration Control: Asok Kumar Mallik, Affiliated East- West ess.
5. Mechanical VibrationsA H Church ,John Wiley & Sons Inc
6. Mechanical VibrationsJ P Den Hartog ,McGraw Hill.
7. Mechanical Vibration Analysis: Srinivasan ,McGraw Hill.
8. Mechanical Vibrations: G K Groover.
9. Vibration and Noise for Engineers: Kewal Pujara , Dhanpat Rai & co

ME 5110 ADVANCED MECHANICS OF SOLIDS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To make the students understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity. • To enhance the competency level and develop the self confidence through quality assignments in theory of Elasticity. • To inculcate the habit of researching and practicing in the field of elasticity.	• Able to solve the problems of 3-D elasticity with confidence. • Can independently work with the problems of 2-D elasticity in Cartesian/Polar Coordinates. • Familiarized with the use of airy's stress function in 2-D problems of elasticity in Cartesian/Polar Coordinates. • Equipped with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion. • Able to interpreted and apply the theory of elasticity to practical problems of Structural engineering.

Unit – I

Definition and notation of stress. Components of stress and stain. Generalized Hooke's law. Stress and strain in three dimensions. Stress components on an oblique plane. Transformation of stress components under change of co-ordinate system.

Principal stresses and principal planes. Stress invariants. Mean and deviator stress. Strain energy per unit volume. Octahedral shear stress. Strain of a line element. Principle strains. Volume strain.

Unit – II

Two dimensional problems in elasticity: Plane stress and plane strain situations. Equilibrium equations. Compatibility equations. St. Venant's principle. Uniqueness of solution. Stress components in terms of Airy's stress functions. Applications to cantilever. Simply supported and fixed beams with sample loading.

Unit – III

Solutions of problems in polar co-ordinates.

Equilibrium equations. Stress Strain Components. Compatibility equation. Applications using Airy's stress functions in polar co-ordinates for stress distributions symmetric about an axis. Effect of hole on stress distribution in a plate in tension. Stresses due to load at a point on a semi-infinite straight boundary. Stresses in a circular disc under diametrical loading

Unit -IV

Torsion – Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars. Prandtl's membrane analogy, Solution of torsion of rectangular bars by (i) Raleigh Ritz method and (ii) Finite difference method

Unit-V

Bending of curved beams:

Winkler-Bach Formula, Elasticity solution for : pure bending of curved beams, curved cantilever under end loading

Suggested Reading:

1. S. Timoshenko & N. Goodier, 1951"Theory of Elasticity", Mc Graw Hill.
2. Valiappan,2010 "Theory of Elasticity", Mc. Graw Hill.
3. L.S. Srinath, "Advanced Mechanics of Solids" Tata McGraw Hill, 2007

ME 5120 THEORY OF ELASTICITY AND PLASTICITY (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To enable the student to understand the basic concepts of stress • To enable the student to understand the basic concepts of strain • To interpret the stress strain relations and differential equations of equilibrium • To understand the yeild criteria • To describe the various flow processes for material deformation	After completion of the course student will be able to : • Derive the mathematical formulation for stress • Derive mathematical formulation for strain • Apply the stress-strain relations for elastic behaviour to various materials • Understand various yeild criteria and their applilcation • Analyse various platic flow processes

Unit-I

Basic concepts of stress: Definition, State of stress at a point, stress tensor, invariants of stress tensor, principal 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 Reading:

1. Timoshenko and Goodier,– '*Theory of Elasticity'*, McGrawHill Publications 3rd Edition.
2. Madleson, Theory of Plasticity,
3. J. Chakrabarty, Theory of Plasticity, 2nd Edition, McGraw Hill Publications 1998

George E Dieter, Mechanical Metallurgy, McGraw Hill Publications 1988

ME 5130 MECHANICS OF COMPOSITE MATERIALS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To Discuss the basic structure of composites • To Define Elastic constants and Hygro thermal stresses • To identify stress-strain relations in composites • To Describe the behaviour and Design with composites • To Demonstrate the basic equations of plate bending	After the completion of the course the student : • Gets a first-hand knowledge on composites and their structure • Will be able to predict the Elastic constants and Hygrothermal stresses • Analyse the stress - strain relationship in composites • Will be able to summarise and apply the Design procedure and the failure criteria. • Can formulate Plate bending equations for various Boundary conditions of composite plates.

Unit-I

Introduction: Fibres, Matrix materials, interfaces, polymer matrix composites, metal matrix composites, ceramic matrix composite, 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

Macro-mechanics 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 liminate 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 material. 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*', McGraw Hill Co., 1998.
5. Carl. T.Herakovich, '*Mechanics of Fibrous Composites*', John Wiley Sons Inc., 1998.

ME 5140 ADVANCED NON-DESTRUCTIVE EVALUATION TECHNIQUES (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To study the importance of various non-destructive testing method. • To study different methods to find the surface and subsurface defects in the components • To study different methods of finding surface, internal defects and properties of the components. • To study computer aided inspection processes to find defects in components used in medical field • To study inspection method using light source.	• Understand the importance and practical applications of various non-destructive methods in industry • Acquire the knowledge about the methods to the followed in finding the surface and sub surface defects of the components produced in industry. • Will be able to decide the methods to be followed in inspecting surface, internal defects and to find mechanical properties of the components. • Student will be able to decide the appropriate computer aided method of inspection of the components depending upon applications • Student will be able to select appropriate inspection methods based on using light as source of inspection.

Unit-I

Types of defects and characteristics, Quantification aspects relevant for NDE including fracture aspects and stress intensity factors - NDT overview – quality assurance–visual inspection–comparative features of conventional Nondestructive Testing and Evaluation Methods including Optical, Radiography, Ultrasonic Testing, Dye penetrant testing, Eddy current testing etc.

Unit-II

Leak testing – liquid penetrant testing – penetrant used – equipment – penetration, emulsification, solvent removal. Eddy current testing – material conductivity – coil impedance–coils and instruments–testing in non-ferromagnetic conducting materials and ferro magnetic materials – skin effect – frequency used – inspection probes – phase analysis.

Unit-III

Radiography–sources of radiation–shadow formation, enlargement and distortion – recording media – exposures, markers.

Infrared and thermal testing – imaging systems – detectors – analysis methods.

Ultrasonic testing – generation of ultrasound – methodologies – transducers and equipment used – flaw detection - sensitivity and calibration.

Magnetic particle testing–magnetization methods–continuous and residual methods – sensitivity – demagnetization.

Unit-IV

Computer aided image processing methods for radiography and ultrasonics, tomography in these areas.

Optical techniques of nondestructive evaluation: Principles of Photoelasticity, holographic Interferometry and Laser speckle techniques; use of fibre optics, noninvasive techniques in medical field and NDT.

Unit-V

Machine Vision-system components, Sensors, specifications for resolution & range.

Grid and Moire NDT, acoustic, ultrasonic and shearography, Principles of Microwave, acoustic emission techniques and Infrared thermography.

Suggested Reading:

1. Barry Hull, '*Non-Destructive Testing*' –Vernon John, ELBS/ Macmillay, 1988.
2. Baldev Raj, T.JayaKumar, M.Thavansimuthee, '*Practical Non-Destructive Testing*', - Narosa Publishing House, New Delhi, 1997.
3. Journals: British Journal of NDT, Materials Evaluation, ISNDT Journal.

ME 5150 DESIGN FOR MANUFACTURE (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• Design principles, mechanical properties and geometrical tolerances • Design of metallic components • Design of non-metallic components • Design of assembled parts	The student will be able to understand • Principles, materials, design recommendations and tolerances obtained for various processes used to produce metallic and non-metallic components. • Design considerations, minimizing number of parts in the assembly and guidelines for assembly improvement.

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.

ME 5160 FRACTURE MECHANICS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To study different types of fractures • To study the stress field of elastic crack and its solution. • To study about the crack growth and crack arrest • To study about the elastic-plastic fracture mechanics • To study about the application of fracture mechanics	• Understand the crack and its effect on the service. • Solve the elastic crack problems • Understand factors effecting crack growth and its arrest • To solve crack problems using FEM • Relation between fracture design and selection of materials.

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.

ME 5170 RAPID PROTOTYPING PRINCIPLES AND APPLICATIONS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the importance of RPT • Apply various liquid and solid based RPT Systems • Apply various powder based RPT systems and rapid tooling • Recognize various STL formats and slicing methods and tessellation • Application of RPT in Engineering, Jewelry and Bio medical etc.	• Know the developments of RPT and its terminology, Advantages and limitations of RPT • Understand mechanism involved in stereo lithography apparatus system, and terminated object manufacturing, fused deposition modeling and their applications. • Understand mechanism in selective laser interims and its application. Understand the importance of Rapid tooling • Recognize various types of file format and slicing methods in RP and various software available to convert 3D models. • Appling RPT in various fields like Engineering, Jewelry, medical and Bio – Medical Engineering

Unit-I

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

Unit-II

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

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

Unit-III

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

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

Unit-IV

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

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

Unit-V

RP Applications: Application – Material Relationship, application in design, application in engineering, Analysis and planning, aerospace industry, automatic industry, Jewelry industry, coin industry, GIS application, Arts and Architecture. **RP Medical and Bioengineering Application:** Planning and simulation of complex surgery, customized implant and prosthesis, design and production of medical devices, forensic science and anthropology, visualization of biomolecules.

Suggested Reading:

1. Rapid prototyping: Principles an 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 and Manufacturing – Paul F. Jacobs, ASME Press, 1996

ME 5180 ENGINEERING RESEARCH METHODOLOGY (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
In this course student will learn • To explore the significance of different research methods. • To locate sources of information for research and its reviews • To setup good research design as per standards and codes. • To adopt different methods of data collection and its analysis. • To write a research proposal and research report.	On completion of the course, the Students will be able to • Understand the process and requirements for conducting successful research • Effectively use the library and its resources in gathering information related to research project of the individual • Understand the process of data collection, analysis and report preparation • The application of statistical techniques for data analysis • Be able to present, review and publish technical articles

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: Exploring the data, Description and Analysis of Data, Sample Design and Sampling, Role of Statistics for Data Analysis, Functions of Statistics, Estimates of Population, Parameters, Parametric V/s Non Parametric methods, Descriptive Statistics, Points of Central tendency, Measures of Variability, Measures of relationship, Inferential Statistics-Estimation, 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, Style of writing report, References/Bibliography/Webliography, Technical paper writing/Journal report writing.

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. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
4. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
5. P. Ramdass and A. Wilson Aruni, Research and Writing across the Disciplines, MJP Publishers, Chennai, 2009

ME 5190 NEURAL NETWORKS AND FUZZY LOGIC (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	**Course Outcomes**
• To **understand** basic concepts of fuzzy sets and uncertainty • To **explain** the basic principles involved in how the fuzzy systems frame rules themselves • **Understand** the mapping between the input and output in fuzzy sets and neural networks • **Understand** basic architecture and algorithms of neural networks	**The student will be able to** • **Perform** various operations on fuzzy sets and **identify** uncertainty in information • **Design** adaptive fuzzy systems that frame their own rules • **Explain** the mapping between fuzzy systems and neural networks using different theories • **Design** neural networks using different algorithms

Unit-I

Concepts of fuzzy sets: Introduction-Crisp sets, notation of fuzzy sets, basic concepts of fuzzy sets, operation, fuzzy compliment, union, intersection. Binary relation, Equivalence and similarity relations, belief and plausibility measurements, 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 uncertainty.

Unit-II

Adaptive fuzzy systems: Neural and Fuzzy intelligence, Fuziness 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 of 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 uncertainty an information*', Prentice Hall of India, New Delhi, 2000.
4. James.A.Freeman, '*Simulating Neural Networks*', Adison Publication, 1995.

ME 5200 EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• Understanding measurement of force, temperature, flow measurement • Applying the above techniques in experimental setup. • Recognise micro-structure & surface measurement techniques • Design various experiments and validate using testing method. • Introduce Taguchi method and conclude quality loss function	The student will able to : • Estimating force using strain gauges, transducers and strain by photoelasticity, holography, interferometer. • Estimating temperature by electrical resistance, pyrometers thermo couples, biometalic etc and flow measurement by laser dopler, hot wire anemometer, ultrasonic, shadow graphs. • Recognise various microstructure of metals and alloys under different working conditions. Measurement of surface finish. • Validating various hypothesis using t-, F & chi-square test, selection of process parameters and factorial design for experiments, ANOVA to estimate contribution of each parameter. • Applying orthogonally array for experimental design and optimization of response function, estimating loss function and its applications.

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 fluids, Obstruction and drag methods. Vortex shredding flow meters. Ultrasonic, Laser Dopler and Hotwire anemometer. Flow visualization techniques, Shadow graphs, Schilieren 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 Measurement: Micro hardness, roughness, accuracy of dimensions and forms. 3-D Co-ordinate measuring machines.

Unit-IV

Experiment design & data analysis: Statistical methods, Randomised block design, Latin and orthogonal squares, factorial design. Replication and randomization.

Data Analysis: Deterministic and random data, uncertainty analysis, test of 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: Experimental 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. Concepts 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 Chandersekharan, '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, Sanfransisco
5. Dove and Adama, 'Experimental Stress Analysis and Motion Measurement', Prentice Hall of India, Delhi.
6. Tapan P.Bagchi, 'Taguchi methods explained', Prentice Hall of India, Delhi.

ME 5210 MEMS AND NANO-TECHNOLOGY (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the basic principles involved in Micro-Electro Mechanical System (MEMS) • To categorize various mechanical, electrical, magnetic and bio actuators and sensors. • To understand fundamentals of nanotechnology • To explain the technology needed for making various devices using MEMS and nanotechnology	At the end of this course the student will be able to • Explain various fabrication techniques for Micro-Electro Mechanical System (MEMS) • Describe applications of MEMS actuators and sensors • Explain the fabrication methods and devices used in nanotechnology • Apply nanotechnology and MEMS to make various devices

Unit-I

MEMS: Introduction to Micro-manufacturing - Semiconductor Manufacturing: Lithography and Oxidation - Diffusion – Etching (Dry and Wet) and Thin Film Deposition - Ion Implantation, Interconnections and Contacts, Packaging and Yield – Clean rooms and vacuum systems – Metrology for MEMS components. Concept of Accuracy and Factors Effecting Accuracy Microfinishing Processes.

Unit-II

Micro-Electro Mechanical System (MEMS): Scaling - Materials - Fabrication - LIGA, X-ray based Fabrication.

Unit-III

Application of Sensors & Actuators – Mechanical – MEMS Devices (Cantilevers, anemometers, pressure transducers and micro pumps) – RF, Electrical and Magnetic MEMS – Bio-MEMS.

Unit-IV

Nano-technology: Fabrication – Nanolithography – Nano-Devices – atomic force microscope–Scanning Electron Microscope – TEM - Nanoindentation Spin devices.

Unit-V

Technology to make components like Computer Hardware, Optical Systems, Fibre Optics & Allied components, Micro Injection Moulding and Nano Technology

Suggested Reading:

1. Murthy., R.L., '*Precision Engineering in Manufacturing*', - New Age International Publishers, 1996.
2. Mohamed Gad-elHak, '*The MEMS Handbook*', CRC Press, 2002
3. Groover, M. P., '*Fundamentals of Modern Manufacturing: Materials, Processes, and Systems*,' second edition, Wiley, 2002.
4. Jeager, '*Introduction to Microelectronic Fabrication*', Addison-Wesley, 1993.
5. Zant, '*Microchip Fabrication*', fourth edition, McGraw Hill, 2000.
6. Quirk, Serda, '*Semiconductor Manufacturing Technology*', Prentice Hall, 2001.

ME 5220 AN INTRODUCTION TO NANOSCIENCE AND TECHNOLOGY (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand basic fundamentals of nanotechnology • To identify and classify nano materials • To explain synthesis and processing of nano powders • To explain nano, micro fabrication techniques	At the end of this course the student will be able to: • Explain basic fundamentals of nanotechnology and differentiate it from nano science • Classify nano materials and identify their applications • Explain various synthesis and processing steps for nano materials • To describe and use nano, micro fabrication techniques

Unit-I

Introduction: Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology – Definition – Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moores law, Role of Bottom up and top down approaches in nanotechnology, challenges in Nanotechnology.

Unit-II

Nano materials: History of materials, Nanomaterials – Definition, Classification of Nanostructured materials, cause of interest in nanomaterials, some present and future applications of nanomaterials.

Unit-III

Synthesis and processing of nano powders: Processes for producing ultrafine powders – mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Design and Synthesis of self assembled nano structured materials.

Unit-IV

Special nanomaterials, characterization and tools: Carbon nanotubes, nano composites, carbon fullerenes: An overview of preparation, properties applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Probe Microscopy – X ray methods.

Unit-V

Nanoelectronics: Introduction to micro, nano fabrication: Optical lithography, Electron beam lithography, Atomic lithography, Molecular beam epitaxy, MEMS:- Introduction, Principles, Types of MEMS:- Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

Suggested Reading:

1. Nano materials by A S Edelstein & R C Cammarata, Institute of physics publishing, Bristc and Philadelphia.
2. Nano materials by J.Dutta & H.Hofman.
3. Nano structures & Nano materials by Guozhong cao, Imperial college press.
4. Micro manufacturing and Nano Technology by N.P.Mahalik.
5. Nano Technology by Mark Ratner & Danier Ratner, Prentice Hall.

ME 5230 GEAR DESIGN (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the principles of gear tooth action, gear manufacturing process, gear tooth failure modes, stresses developed in them and selection of a right kind of gear for the given application. • To understand the design considerations and methodology involved in design of spur , helical , worm and bevel gear teeth. • To understand the different gear trains (simple, compound and epicyclic) • To understand the different parameters involved in gear design optimization.	• Will be able to interpret the type of gear teeth failure from the failed specimen. • Will be able to design a gear shaft with different types of gears (spur, helical, worm and bevel). • Will be able to design a gear box for an automobile and gear trains from the propeller shaft of airplane for auxiliary systems. • Will be able to design compact gear trains using optimization techniques.

UNIT – I

Introduction, Principles of gear tooth action, Generation of Cycloid and Involute gears, Involutometry, gear manufacturing process and Inspection, gear tooth failure modes, stresses, selection of right kind of gears.

SPUR GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of spur gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

UNIT – II

HELICAL GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology,Complete design of helical gear teeth considering Lewis beam strength,Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

GEAR FAILURES: Analysis of gear tooth failures, Nomenclature of gear tooth wear and failure, tooth - breakage, pitting, scoring, wear, overloading, gear-casing problems, lubrication failures.

UNIT – III

WORM GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of worm gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Heat dissipation consideration. Design of gear shaft and bearings.

UNIT – IV

BEVEL GEARS: Tooth loads, Principles of Geometry, Design considerations and methodology, Complete design of bevel gear teeth considering Lewis beam strength, Buckingham's dynamic load and wear load. Design of gear shaft and bearings.

UNIT – V

GEAR TRAINS: Simple, compound and epicyclic gear trains, Ray diagrams, Design of a gear box of an automobile, Design of gear trains from the propeller shafts of airplanes for auxiliary systems.

OPTIMAL GEAR DESIGN: Optimization of gear design parameters. Weight minimization, Constraints in gear train design-space, interference, strength, dynamic considerations, rigidity etc. Compact design of gear trains, multi objective optimization of gear trains. Application of Traditional and non-traditional optimization techniques.

Suggested Reading:

1. W Dudley, Handbook of Practical Gear Design, CRC Press LLC, 2002.
2. Gitin M Maitra, Handbook of Gear Design, 2nd Edition, Tata McGraw-Hill, 2003.
3. H. E Merritt, Gear Engineering 3rd Indian Edition, Wheeler Publication, 1992.
4. AE-15, Gear Design Manufacturing and Inspection Manual, SAE International, 1990.
5. AGMA Standards Collection, American Gear Manufacturing Association, 2009.
6. Design Data, PSG College of Technology, 1995.
7. Joseph E Shigley, Charles R Mischke, Mechanical Engineering Design, 6th Edition, Tata McGraw Hill, 2003.
8. Robert C Juvinall, Kurt M Marshek, Fundamentals of Machine Component Design, 3rd Edition, John Wiley & Sons, 2000.
9. Analytical mechanics of gears/ Earle Buckingham/ Dover publications, New York, 1949.
10. Machine Design/ Maleev and Hartman/ C.B.S Publishers, India.

ME 5240 PRODUCT DESIGN AND PROCESS PLANNING (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	**Course Outcomes**
• To know about the features of good product design. • To familiarize the cost concepts, reliability systems. • To apply the design rules for manufacturing process and improving tolerances. • To familiarize the Ergonomic considerations, Just-in time, Kanban systems and RPT • To familiarize the concepts of computers in manufacturing.	On completion of the course, the Students will be able to do: • Effective product and process design elements such as function and producibility, cost, schedule, reliability, customer preferences etc. • Process capability studies, methods of improving tolerances and product design rules for various manufacturing processes. • Ergonomic considerations, Just-in time, Kanban systems and RPT • Application of computers in the manufacturing.

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, evaluations 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 system, Manufacturing reliability and quality control.

Patents: Definitions, classes of patents, applying for patents. Trade marks and copy rights. Cost & 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 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-Kogakusha Ltd., Tokyo, 1974.
2. Chitale A.K., & 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.

ME 5250 QUALITY & RELIABILITY ENGINEERING (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
• To understand the process capability and control charts • Analysis the importance of tolerance design • Relate QFD and house of quality and its use in product design • Apply various techniques to improve reliability systems • Selective maintainability and availability of equipment	• Able to understand importance of quality applications of various control charts and acceptance sampling in quality engineering • Estimation of loss function, and consequence of tolerance design for a product and checking of online quality control • Prepare a house of quality for a product and QFD matrix, importance of ISO and quality circles. • Analyze Various methods to estimate system reliability and how to improve it. Usage of weibull distribution in quality control and reliability • Identify the best way of maintenance of an equipment, How to increase the availability and economics of reliability engineering.

Unit-I

Quality value and engineering – Quality systems – quality engineering in product design and production process – system design – parameter design – tolerance design quality costs – quality improvement.

Statistical Process Control-x, R, P, C charts, process capability. Acceptance Sampling by variables and attributes, Design of Sampling Plans, Single, Double, Sequential plans.

Unit-II

Loss Function, Tolerance Design – N Type, L Type, S Type; determination of tolerance for these types, nonlinear tolerances. Online Quality Control – Variable Characteristics, Attribute Characteristics, Parameter Design.

Unit-III

Quality function deployment – House of Quality, QFD Matrix, Total Quality Management Concepts. Quality Information Systems; Quality Circles, Introduction to ISO 9000 Standards.

Unit-IV

Reliability – Evaluation of design by tests - Hazard Models; Linear, Releigh, Weibull. Failure Data Analysis System, Reliability, Reliability of series, Parallel Standey Systems; reliability prediction and system effectiveness, reliability prediction based on weibull distribution, Reliability improvement.

Unit-V

Maintainability, Availability, Economics of Reliability Engineering; Replacement of items, Maintenance Costing and Budgeting, Reliability Testing – Burn in testing by binomial, exponential models, Accelerated life testing.

Suggested Reading:

1. G Taguchi, '*Quality Engineering in Production Systems*', - McGraw Hill, 1989.
2. W.A. Taylor, '*Optimization & Variation Reduction in Quality*', Tata McGraw Hill, 1991, 1st Edition.
3. Philipposs, '*Taguchi Techniques for Quality Engineering*', McGraw Hill, 1996, 2nd Edition.
4. E.Bala Guruswamy, '*Reliability Engineering*', Tata McGraw Hill, 1994.
5. LS Srinath, '*Reliability Engineering*', Affiliated East West Pvt. Ltd., 1991, 3rd Edition.
6. Grant, '*Statistical Process Control*', McGraw Hill, 1988, 6th Edition.

ME 5260 VALUE ENGINEERING (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	Course Outcomes
The course will enable the student to: • Know the gbasic concepts of value engineering • Learn different types of manufacturing proceses with respect to time, cost etc. • Use critical path of function for quick analysis • Improve the quality of the product by choosing proper design and manufacturing method. • Select alternate and best possible method. • Enhance the value of th existing product.	The end of the semester student will be able to: • Understand the manufacturing methods to be implemented. • Identify the materials needed to meet the required mechanical properties. • Arrive quickly and conclude best possible method. • Help in improving the productivity using value analysis techniques. • Develop a product which is functionally sound.

Unit-I

Basic concepts of Value Engineering – Function, Value, Value analysis, Value of job plan, Study of Engineering materials specially latest materials with respect to their mechanical properties, Cost and availability. Study of wide range of manufacturing processes based on the factors – productivity time, cost, surface finish, tolerance etc. Mechanical properties of products based on manufacturing processes.

Unit-II

Information phase, Functional phase, Creation – phase, Evaluation phase, Recommendation phase. DARSIRI method.

Fast diagramming: Critical path of function, how, why and when logic, supporing and all time functions, Ground rule for FAST diagram.

Unit-III

Productivity, improvement by Value Engineering and Value analysis – Selection of Engineering Products of different applications and studying each one of them about design, types of stresses induced, manufacturing method.

Unit-IV

Results acceleration – Basic steps, valuation of Value Engineering, Problem setting, Problem solving case studies alternative methods and best possible method.

Unit-V

Work study and Value Engineering Methods: Case studies in work study and Value Engineering methods – product Design implementation using Value Engineering.

Developing any one product (important in functional aspect) which actually adds Value to Existing product in use.

Suggested Reading:

1. L.D. Miles, '*Techniques of Value Analysis and Engineering*', McGraw Hill, 1961
2. A.E. Mudge, '*Value Engineering A Systematic Approach*', McGraw Hill, 1971.
3. Greve J.W. and Wilson, '*Value Engineering in Manufacturing*', Prentice Hall, Englewood Cliffs, 1967.
4. SS Iyer, '*Value Engineering*', New Age International Pvt. Ltd.

ME 5270 OPTIMIZATION TECHNIQUES (ELECTIVE)

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	70 Marks
Sessional	30 Marks
Credits	3

Course Objectives	**Course Outcomes**
• Understand linear programming & transportation & sensitivity analysis • Compute non L.P and unconstrained optimization. • Compute the non L.P.P and constrained optimization. • Apply principle of optimality in dynamic programming and integer programming • Apply CPM & PERT for project scheduling and control.	• Able to understand simplex, dual simplex and revised simplex & sensitivity analysis and transportation and their applications for shop floor problems. • Application of non LPP like unconstrained method univariate method, steepest descent conjugate gradient, quasi Newton method. • Application of Lagrangues multipler, Kuhn-Tucker conditions, Beal's method penality, Function for constrained optimization problems. • Understand the importance of dynamic principles and its applications like Cargo loading, product scheduling and forecasting. Integer programming like branch and bound and Gromery's cutting plane method. • Applying the project management techniques like CPM & PERT Queuing theory techniques and to minimize the total cost.

Unit-I
Statement of Optimization Problem, Linear Programming: Simplex method, revised simplex method, sensitivity analysis, parametric programming, and transportation problem.

Unit-II
Nonlinear programming approach, convergence and scaling of design variables; Unconstrained optimization direct search methods: Random Search, Univariate, Simplex Method; Indirect Search methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton, DFP Methods.

Unit-III
Nonlinear programming constrained optimization direct methods: Lagrange multipliers, Kuhn-Tucker conditions, Beal's method, indirect method: Penalty function and applications

Unit-IV
Introduction to dynamic programming; Concept of sub optimization and the principle of optimality; Linear and continuous dynamic programming with applications; Introduction to integer programming; Cutting plane method; Branch and bound method; Introduction to genetic algorithms, particle swarm optimization.

Unit-V
Sequencing and scheduling, Project scheduling by PERT-CPM; Probability and cost consideration in project scheduling; Queuing theory, Single and multi server models; Queues with combined arrivals and departures; Queues with priorities for service.

Suggested Reading:

1. Rao, S.S., Engineering Optimization Theory and Practice, New Age Int. Pub., 3rd Ed., 1996
2. Haug, E.J. and Arora, J.S., Applied optimal design Wiley Inter Science Publication, NY, 1979
3. Douglas J. Willde, Globally optimal design Jhon Wiley & Sons, New York, 1978
4. Johnson Ray C., Optimum design of mechanical elements, John Wiley & Sons, 1981
5. S.D. Sharma, "Operations Research", Khanna Publications, 2001
6. David Goldberg, Genetic Algorithms, pearson publications, 2006
7. Prem Kumar Gupta, "Operations Research", S Chand Publications, 2008
8. Maurice Cleric, Particle Swarm Optimization, ISTE Publications, 2006

ME 5011 CAD / CAM LABORATORY (Lab-I)

Instruction	3 periods/ week
Sessional	25 Marks
University Exam	50 Marks
Credits	1

List of Experiments:

CAD

1. Undestanding 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 detials such as dimensioning, sectional views, adding esthetics
7. Assembling of part models using constraints
8. Assembly operations – part modifications, adding another assembly featuers – display.

CAM

1. Understanding of CNC Machines and CNC Programming and Creation of 2-D controur 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.

ME 5021 AUTOMATION AND ROBOTICS LABORATORY (Lab-II)

Instruction	3 periods/ week
Sessional	25 Marks
University Exam	50 Marks
Credits	1

List of Experiments

I MAT LAB

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

II SIMULATION SOFTWARE

14. Hydraulic equipment simulation using H-Simulator
15. Pneumatic equipment simulation using P-Simulator
16. PLC simulator

III ROBOTICS

17. Study of Articulated Robot
18. Introduction to various Robotic Programming Languages
19. Modelling and analysis of serial manipulators using softwares like Robotworks. RoboKinematics and Robo cammotion

ME 5012 SEMINAR-I

Instruction	3	Periods per week
Sessional	25	Marks
Credits	1	

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his/ her specialization.

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

Topics to be selected from published Journals / Conference Proceedings in the area of Design and Production Engineering.
Literature survey, Organisation of material, Preparation of PPT and Technical Writing skills are to be presented in the report.

Each student is required to

1. Submit a one page synopsis of the seminar talk.
2. Give a 30 minutes presentation through OHP, PC, Slide projector followed by a 10 minutes discussions
3. Submit a report on the seminar topic with literature survey

Seminars are to be scheduled from the 3rd week to the last week of the semester and any change in schedule should be discouraged.

The sessional marks will be awarded to the students by atleast 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.

ME 5022

SEMINAR-II

Instruction	3	Periods per week
Sessional	25	Marks
Credits	1	

Oral presentation is an important aspect of engineering education. The objective of the seminar is to prepare the student for a systematic and independent study of state of the art topics in a broad area of his/ her specialization.

Seminar *topics* may be chosen by the students with advice from the faculty members. Students are to be exposed to following aspects of seminar presentations.

Topics to be selected from published Journals / Conference Proceedings in the area of Design and Production Engineering so as to complete the abstract and methodology to be adopted to start the project during the 3^{rd} semester
Literature survey, Organisation of material, Preparation of PPT and Technical Writing skills are to be presented in the report.

Each student is required to

1. Submit a one page abstract of the seminar talk.
2. Give a 30 minutes presentation through PPT followed by a 10 minutes discussion.
3. Submit a report on the seminar topic with literature survey.

Seminars are to be scheduled from the 3^{rd} week to the last week of the semester and any change in schedule should be discouraged.

The sessional marks will be awarded to the students by atleast 2 faculty members on the basis of an oral and a written presentation as well as their involvement in the discussions.