DEPARTMENT OF
MECHANICAL ENGINEERING

Scheme of Instruction and Syllabi

of

M.E. (Mechanical)

Specialization :

ADVANCED DESIGN AND MANUFACTURING

Full time / Part time

2010

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

HYDERABAD–500 007, A.P., INDIA

SCHEME OF INSTRUCTION & EXAMINATION

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

Sl. No.	Subject	Scheme of Instruction		Scheme of Examination		
		L/T	D/P	Duration in Hours	Max. Marks	
					Univ. Exam	Sessionals
			Semester-I			
1.	Core	3	- - -	3	80	20
2.	Core	3	- - -	3	80	20
3.	Core / Elective	3	- - -	3	80	20
4.	Core / Elective	3	- - -	3	80	20
5.	Core / Elective	3	- - -	3	80	20
6.	Elective	3	- - -	3	80	20
7.	Laboratory – I	- - -	3	- - -	- - -	50
8.	Seminar – I	- - -	3	- - -	- - -	50
	TOTAL:	**18**	**6**	**- - -**	**480**	**220**
			Semester-II			
1.	Core	3	- - -	3	80	20
2.	Core	3	- - -	3	80	20
3.	Core / Elective	3	- - -	3	80	20
4.	Core / Elective	3	- - -	3	80	20
5.	Core / Elective	3	- - -	3	80	20
6.	Elective	3	- - -	3	80	20
7.	Laboratory – I	- - -	3	- - -	- - -	50
8.	Seminar – I	- - -	3	- - -	- - -	50
	TOTAL:	**18**	**6**	**- - -**	**480**	**220**
			Semester-III			
1.	Dissertation + Project Seminar *	--	6	--	--	100**
			Semester-IV			
1.	Dissertation	--			Viva-Voce (Grade ***)	

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

* Project seminar presentation on the topic of Dissertation only

** 50 Marks awarded by the project guide and 50 marks by the internal committee.

*** Excellent / Very Good / Good / Satisfactory / Unsatisfactory

SCHEME OF INSTRUCTION & EXAMINATION

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

Sl. No.	Subject	Scheme of Instruction		Scheme of Examination		
		L/T	D/P	Duration in Hours	Max. Marks	
					Univ. Exam	Sessionals
			Semester-I			
1.	Core	3	- - -	3	80	20
2.	Core / Elective	3	- - -	3	80	20
3.	Elective	3	- - -	3	80	20
4.	Lab-I / Seminar – I	---	3	- - -	- - -	50
	TOTAL:	**9**	**3**	**- - -**	**240**	**110**
			Semester-II			
1.	Core	3	- - -	3	80	20
2.	Core / Elective	3	- - -	3	80	20
3.	Elective	3	- - -	3	80	20
4.	Lab-I / Seminar – I	---	3	- - -	- - -	50
	TOTAL:	**9**	**3**	**- - -**	**240**	**110**
			Semester-III			
1.	Core	3	- - -	3	80	20
2.	Core / Elective	3	- - -	3	80	20
3.	Elective	3	- - -	3	80	20
4.	Lab-I / Seminar – I	---	3	- - -	- - -	50
	TOTAL:	**9**	**3**	**- - -**	**240**	**110**
			Semester-IV			
1.	Core	3	- - -	3	80	20
2.	Core / Elective	3	- - -	3	80	20
3.	Elective	3	- - -	3	80	20
4.	Lab-I / Seminar – I	---	3	- - -	- - -	50
	TOTAL:	**9**	**3**	**- - -**	**240**	**110**
			Semester-V			
1.	Dissertation + Project Seminar *	--	6	--	--	100**
			Semester-VI			
1.	Dissertation	**--**			Viva-Voce (Grade ***)	

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

* Project seminar presentation on the topic of Dissertation only

** 50 Marks awarded by the project guide and 50 marks by the internal committee.

*** Excellent / Very Good / Good / Satisfactory / Unsatisfactory

Course duration: 4 semesters (full-time), 6 Semesters (part time)

Sl No.	Syllabus Ref. No.	Subject	Scheme of Instruction			Scheme of Examination	
			Periods/ week		Duration in Hrs.	Max. Marks	
			L/T	D/P		Univ. Exam	Sessionals
		CORE SUBJECTS					
1	ME 507	Robotic Engineering	3	–	3	80	20
2	ME 502	Theory of Metallurgy of Metal Casting and Welding	3	–	3	80	20
3	ME 532	Computer Aided Mechanical Design and Analysis	3	–	3	80	20
4	ME 564	Metal Processing Science	3	–	3	80	20
5	ME 568	Computer Integrated Design and Manufacture (CIDM)	3	–	3	80	20
6	ME 522	Flexible Manufacturing Systems	3	–	3	80	20
		ELECTIVES					
1	ME 530	Advanced Kinematics	3	–	3	80	20
2	ME 508	Finite Element Techniques	3	–	3	80	20
3	ME 511	Optimization Techniques	3	–	3	80	20
4	ME 534	Vibration Analysis and Condition Monitoring	3	–	3	80	20
5	ME 512	Neural Networks and Fuzzy Logic	3	–	3	80	20
6	ME 514	Mechanics of Composite Materials	3	–	3	80	20
7	ME 516	Theory of Elasticity and Plasticity	3	–	3	80	20
8	ME 517	Experimental Techniques and Data Analysis	3	–	3	80	20
9	ME 519	Product Design and Process Planning	3	–	3	80	20
10	ME 569	Mechatronics and Applications	3	–	3	80	20
11	ME 570	Quality and Reliability Engineering	3	–	3	80	20
12	ME 571	Value Engineering	3	–	3	80	20
13	ME 572	Advanced Non-Destructive Evaluation Techniques	3	–	3	80	20
14	ME 573	MEMS and Nano-Technology	3	–	3	80	20
15	ME 557	Design for Manufacture	3	–	3	80	20
16	ME 559	Fracture Mechanics	3	–	3	80	20
17	ME 506	Rapid prototyping, Tooling & Manufacturing	3	–	3	80	20
18	ME 574	Creative Engineering Design	3	–	3	80	20
19	ME 521	Engineering Research Methodology	3	–	3	80	20
	DEPARTMENTAL REQUIREMENTS						
1	ME 562	CAD/CAM Lab (Lab I)	–	3	–	–	50
2	ME 536	Automation and Robotics Lab (Lab II)	–	3	–	–	50
3	ME 525	Seminar-I	–	3	–	–	50
4	ME 526	Seminar-II	–	3	–	–	50
5	ME 527	Project Seminar	–	3	–	–	100
6	ME 528	Dissertation	–	9	–	Viva-Voce (*Grade)	

* Excellent / Very Good / Good / Satisfactory / Unsatisfactory.

ME 507

ROBOTIC ENGINEERING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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 work space, 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, Eular 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.

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.

References:

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, Wlfram Burgard, Lydia Kavraki and Sebastian Thurn, “Principles of Robot Motion: Theory, Algorithms, and Implementations”, Prentice Hall of India, 2005

ME 502

THEORY OF METALLURGY OF METAL CASTING AND WELDING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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 related 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 stress – Residual stresses, effects, methods of relieving.

Unit-V

Weldability aspects of law alloy steels, strainless steels, aluminium alloys, Magnesium and Titanium alloys.
Weld cracks – cold and hot cracks; Liquation cracks, Hydrogen Induced cracks, Lamellar cracks.

References:

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 532

COMPUTER AIDED MECHANICAL DESIGN AND ANALYSIS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Design of press Vessels: Introduction and constructional features of pressure vessels, stresses in pressure vessels, shrink fit stresses in built up cylinders, 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 center 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-θ method, Newmark method, mode superposition, single degree freedom system response, multi degree freedom system response, Rayleigh damping, condition for stability.

(Note: The related Algorithms and Codes be practiced by students)

References:

1. John V. Harvey, '*Pressure Vessel Design: Nuclear and Chemical Applications*', Affiliated East West Press Pvt. Ltd., 1969.
2. Prashant Kumar, '*Elements of Fracture mechanics*', Wheeler publishing, New Delhi-1999.
3. V.Ramamurti, '*Computer Aided Mechanical Design and Analysis*', Tata McGraw Hill, 1992.
4. Bathe, '*Finite Element Procedures*', Prentice hall of India, 1996.

ME 564

METAL PROCESSING SCIENCE

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Tool materials: Tool material properties–HSS, carbides, coated carbides, ceramic and cermets 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 – Merchant's models, Lee and Shofer's 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 coefficient 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-Tayor's tool life equation. Cutting fluids-Carbon tetrachloride-Direction of fluid application-Chip curl-economics of machining-Comparison of machinability of different material.

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 and practical stress-strain curves. Cold working, warm working and hot working. Plasticity cycle. Tresca's and Von Mises's yield criteria under complex state of stress including plane stress and plain strain condition. Rolling: Principle of rolling, process parameters. Estimation of rolling loads. Principles of roll pass design for various product shapes, Principle of ring rolling.

Unit-V

Uncoventional 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 Publishers and distributors, New Delhi, 1992.
2. BhataCharya, '*Metal Cutting*', Central book publishers, Calcutta, 1996.
3. Heinrich Makelt, '*Mechanical Presses*', Edward Arnold (Pvt.) Ltd., London, 1968.
4. Eary,Donald F and Reads,Edward A, '*Techniques of press working sheet metal*', Prentice Hall,1974.
5. Kameschikov, Forming Practice, Mir Publishers, Moscow, 1970
6. High Velocity Forming methods, ASTME, Michigan, 1968

ME 568

COMPUTER INTEGRATED DESIGN & MANUFACTURE

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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 re-planning – 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.

References:

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 522

FLEXIBLE MANUFACTURING SYSTEMS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 530

ADVANCED KINEMATICS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 508

FINITE ELEMENT TECHNIQUES

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Introduction to Finite Element Method for 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 nodded, 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 to 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 a thin plate.

Time dependent field problems: Applications to one dimensional heat flow in a rod.

Dynamics analysis: Formulation of finite element modeling of Eigen value problems 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 to 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.

References:

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

ME 511

OPTIMIZATION TECHNIQUES

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 534

VIBRATION ANALYSIS AND CONDITION MONITORING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Causes and effects of vibrations, Vibrations of Single Degree, Two Degree and Multi Degree of Freedom systems. Steady state and transient characteristics of vibration.

Unit-II

Introduction to Condition Monitoring. Failure types, investigation and occurrences, Causes of failure. Characteristics of vibration – SHM, Periodic motion, Displacement, Velocity and acceleration. Peak to peak & RMS, Linear and logarithmic scales and phase angle.

Unit-III

Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers.

Unit-IV

Condition Monitoring through vibration analysis, Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards. Contaminant analysis, SOAP and other contaminant monitoring techniques.

Unit-V

Special vibration measuring techniques – Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, modal analysis, Critical speed analysis, Shaft-orbit & position analysis.

References:

1. Collacott, R.A., '*Mechanical Fault Diagnosis and Condition Monitoring*', Chapman & Hall, London, 1982.
2. John S.Mitchell, '*Introduction to Machinery Analysis and Monitoring*', Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
3. Nakra. B.C., Yadava, G.S. and Thuested, L., '*Vibration Measurement and Analysis*', National Productivity Council, New Delhi, 1989.
4. Pox and Zenkins, '*Time Series Analysis*'.
5. A.H.Search, '*Vibration and Time Series Analysis*'.

ME 512

NEURAL NETWORKS AND FUZZY LOGIC

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 514

MECHANICS OF COMPOSITE MATERIALS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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:

Transile 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 methods. Analysis of composite cylindrical shells under axially symmetric loads.

References:

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 516

THEORY OF ELASTICITY AND PLASTICITY

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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
4. George E Dieter, Mechanical Metallurgy, McGraw Hill Publications 1988

ME 517

EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 519

PRODUCT DESIGN AND PROCESS PLANNING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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 & laws of appearance.

Unit-II

Product Reliability, Mortality curve, Reliability operations. 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 information 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, manufacturing and production control.

References:

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 569

MECHATRONICS AND ITS APPLICATIONS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Introduction to Mechatronics: Concepts of system integration- Mechanical systems with electronic actuation, sensoring, Monitoring and control – Applications of Mechatronics in Mechanical industries.

Unit-II

Sensors for various parameters – portion sensors – potentiometer – LVDT – proximity sensors – ultrasonic, inductive, optical, Hall effect – force sensors – tactile sensors. Various types of Actuators like electrical, hydraulic and pneumatic actuators –Solenoids, relays, DC motors, stepper motors, servo motors – Hydraulic and pneumatic systems – system components.

Unit-III

Digital circuits and systems: Digital representation, combinational logic gates – timing diagrams – Boolean expressions and truth tables – sequential logic.

Unit-IV

Data Analysis tools- MATLAB and LABVIEW software-features and capabilities of the software. Applications to machine control, Robotics and Engines.

Unit-V

Electronic inter facing–introduction to data acquisition–quantizing theory–Hardware for DAC and ADC Fundamentals of digital signal processing – Microcontrollers and principles of their programming- Embedded single chip computer Systems – Digital signals processors.

References:

1. Bolton,W, '*Machatronics*', Addison Wesley, Longma, 1999.
2. D.Neseuleseu, '*Mechatronics*', Pearson Education in Asia, 2002.
3. Ogate,K, System Dynamics, Prentice Hall, 1992.
4. MB Histand and DA Alciatore, '*Introduction to Mechatronics and Measurement System*', McGraw Hill, 1999.

ME 570

QUALITY & RELIABILITY ENGINEERING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 571

VALUE ENGINEERING

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

Unit-II

Information phase, Functional phase, Creation – phase, Evaluation phase, Recommendation phase. DARSIRI method, Functional Analysis Technique (FAST).

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 possish 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.

References:

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 572

ADVANCED NON-DESTRUCTIVE EVALUATION TECHNIQUES

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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 nonferromagnetic 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.

References:

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 573

MEMS AND NANO-TECHNOLOGY

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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

References:

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 557

DESIGN FOR MANUFACTURE

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Introduction: General design principles for manufacturability, strength and mechanical factors, mechanisms selection, evaluation method, geometrical tolerances, tolerance control and utilization.

Economic Use of Raw Materials: Ferrous steel, hot rolled steel, cold finished steel, stainless steel, non ferrous materials aluminium, copper, brass, non metallic materials, plastics, rubber and composites.

Unit-II

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

Unit-III

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

Unit-IV

Non Metallic Components Design: Thermosetting plastic, injection moulded and rotational moulded parts, blow moulded, welded plastic articles, ceramics.

Assembled Parts Design: Welded parts, arc, resistance, brazed and soldered parts, gear box assembly, bearing assembly.

Unit-V

Assembled Parts Design: Retension, bolted connection, screwed connections, flanged connections, centred connections, press fitted connections, surface finishing, plated parts, heat treated parts, NC machining, group technology, low cost automation, computer aided manufacture, product design requirements.

Case Studies: Identification of economical design and redesign for manufacture.

References:

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 559

FRACTURE MECHANICS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

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

Unit-II

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

Unit-III

Energy Principle: Energy release rate – Criterion for crack growth – Crack resistance curve – Principles of crack arrest – Crack arrest in practice.

Fatigue Crack Growth: Fatigue crack growth test, stress intensity factor, factors affecting stress intensity factor – Variable amplitude service loading, retardation model.

Unit-IV

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

Unit-V

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

References:

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 506

RAPID PROTOTYPING PRINCIPLES AND APPLICATIONS

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

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.

References:

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 574

CREATIVE ENGINEERING DESIGN

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

The Design Process: The design process – Morphology of Design – Design Drawings – Computer Aided Engineering – Designing to standards – Concurrent Engineering – Product life cycle – Technological Forecasting – Market Identification – Competition Bench marking – Systems Engineering – Life Cycle Engineering – Human factors in Design – Industrial Design.

Unit-II

Design Methods: Creativity and problem solving–Product design specifications – conceptual design – Decision theory – Decision trees – Embodiment design – Detail design –mathematical modeling – Simulation – Geometric modeling – Finite element modeling – Optimization – Search methods – Geometric programming – Structural and shape optimization.

Unit-III

Material Selection Processing and Design: Material selection process – Economics – Cost Vs performance – Weighted property index – Value analysis – Role of processing in design classification of manufacturing processes – Design for manufacture – Design for assembly – Designing with plastics – Design for castings, forgings, metal forming, machining and welding – Residual stresses – Fatigue, fracture and failure.

Unit-IV

Economics cost and planning: Mathematics of time valve of money – Cost comparison – Profitability – Sensitivity and break even analysis – Benefit/Cost analysis – Cost estimates – Factor methods of cost estimation – Life cycle casting planning and scheduling – CPM and PERT.

Engineering statistics and reliability: Statistics and design – Probability – Distributions – Test of hypotheses – Design of experiments.

Unit-V

Regression analysis – Probabilistic approaches to design – Reliability theory – Design for reliability – Fault tree analysis.

Quality engineering and Communications: Total quality concept– Quality assurance – Statistics process control – Taguchi methods – robust design – Failure modes – Product liability – Design communications – Recording of results – Technical report writing – Visual aids and graphics.

References:

1. Dieter, George E., Engineering Design – A Materials and Processing Aproach, McGraw Hill International Editions, Mechanical Engineering Series, 1991
2. Pahl, G, and Beitz, W., Engineering Design, Springer-verlag, Newyork, 1984
3. Ray, M.S., Elements of Engineering Design, prentice Hall Inc., 1985
4. Suh, N.P., The Principles of Design, Oxford University Press, NY, 1990

ME 521

ENGINEERING RESEARCH METHODOLOGY

Instruction	3 periods/ week
Duration of University Examination	3 Hours
University Examination	80 Marks
Sessional	20 Marks

Unit-I

Introduction: Scope of research, objective / motivation, characteristics an prerequisites of research. Research needs in engineering, benefits to the society in general.

Unit-II

Review of Literature: Role of review, search for related literature, online search, and web-based search conducting a literature search. Evaluating, Organizing, and synthesizintg the literature. Identifying and descriing the research. Finding the research problem. Sources of research problem. Criuteria / Characteristics of a good research.

Unit-III

Planning for Research Design

The Natuer and role of data in research. Linking data and research methodolgy. Validity of method. Planning for Data collection. Choosing a research approach. Use of Quantitiative / Qualitative research design. Feasibility of research design. Establishing reserarch criteria. Justifiction of research methodology.

Research Proposal Preparation.

Characeteristics of a proposal. Formatting a research propsal. Preparation of proposal. Importance of interpretatin of data and treatment of data.

Unit-IV

Exploring the data. Description an analysis of Data. Role of statistics for Data Analysis. Functions of statistis, estimtes of population. Parameters. Parametric V/s. non praametric methods. Descriptie statistics, points of central tendency, measures of varibility, measures of relationship. Inferenctial statistics – estimation, hypothesis tsting. Use of statistical software.

Data Analysis: Deterministic and random data, uncerttainty analysis, tests for significance: Chi-square, student's 't' test. Regression modeling, direct and interaction effects. ANOVA, F-test. Time series analysis, autocrorrelation and autoregressive modeling.

Unit-V

Research report writing format of the research report. Style of writing report. References and bibliography. Technical paper writing / journal report.

Suggested Reading:

1. Practical Research: Planning and design (8^{th} Edition) Paul D. Leedy and Jeanne E. Ormrod.
2. A Hand Book of Education Research – NCTE
3. Methodology of Education Research – K.S. Sidhu
4. Research Methodology Methods and Technique: Kothari. C.R.
5. Tests, Measurements and Research methods in Behavioural
6. Statistical Methods – Y.P. Agarwal
7. Box and Jenkins; Time Series analysis, Forecasting and control, holden Day, Sanfrancisco
8. Holman, J.P.: Experimental Methds for Engineers, MCGraw Hill Int., New York.

ME 562

CAD / CAM LABORATORY

Instruction 3 periods/ week
Sessional 50 Marks

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 536

AUTOMATION AND ROBOTICS LABORATORY

Instruction 3 periods/ week
Sessional 50 Marks

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