CORE COURSES

MED611 STRESS ANALYSIS

	L	T	P
Credit	3	0	0
Hours	3	0	0

Components of stress and strain, their principal values and invariants. Stress tensor. Stress components along arbitrary plane, state of stress referred to principal axes. Octahedral stresses. Hydrostatic and pure shear states. Mohr's circles for three three-dimensional state of stress. State of strain at a point, strain components. Cubic dilation. Principal axes and strains. Strain deviator and its invariants. Plane stress and strain states. Stress-strain relations for linearly elastic solids, generalised Hooke's law, relation between elastic constants.

Differential equations of equilibrium, boundary conditions, compatibility conditions. Equations of equilibrium in cylindrical coordinates, axisymmetric and plane stress. Airy's stress function. Simple 2-D problems, bending, torsion, and axisymmetric problems.

Complex variable approach, complex representation of stresses, displacements and applied boundary loads. Different methods of solution of 2-D problems for infinite plates with simply connected regions.

Experimental methods of stress analysis. Strain gauges, photoeleasticity, birefringent coatings, brittle coatings, Moire fringes. X-ray techniques and holography.

Texts/References:

1. S.P. Timoshenko and J.N. Goodier: Theory of Elasticity, McGraw-Hill, 1982.
2. J.W. Dally and W.F. Riely: Experimental Stress Analysis, McGraw-Hill.
3. N.I. Mushelishvili: Some Basic Problems of the Mathematical Theory of Elasticity, Noordhoof, Netherlands.

MED612 FINITE ELEMENT METHOD

	L	T	P
Credit	3	0	0
Hours	3	0	0

Mathematical preliminaries, vectors, matrices, etc. Review of theory of elasticity, stress-strain relations, strain-temperature relations, plane stress, plane strain, axisymmetric case.

Direct or stiffness formulation of FEM. Element stiffness matrix, assembly, imposition of boundary conditions, solution of global system, stress and support reaction computation. Computation details, storage of global matrices.

Principle of stationary potential energy, principle of virtual work. Variational formulation of FEM. Rayleigh-Ritz method. weighted residuals and Galerkin method. Piecewise polynomial interpolation. Shape functions, degree of continuity. Shape functions for C^0 and C^1 elements. Lagrangian and Hermite interpolations.

Displacement based formulation for structural problems. Elemental matrices, consistent element nodal loads, lumping of loads. Equilibrium and compatibility in FE model. Convergence requirements. Bar, beam, frame, CST, plane bilinear, and plane quadratic elements. Natural (linear, area and volume) coordinates. Coordinate transformations.

Isoparametric formulation. Isoparametric bar, beam, plane bilinear and quadratic elements. Isoparametric triangular elements. Consistent load vector. Numerical integration, Gauss quadrature. Jacobian matrix. Subparametric and superparametric elements.

FE formulation for dynamic and vibration problems. Consistent and lumped mass matrix, lumping schemes. Damping matrix. Eigenvalue problem, mode shapes and natural frequencies.

Solution of equations in static analysis. Gauss elimination, LDL^T factorisation. Computational aspects. Introduction to frontal method of solution. Introductory concepts of condensation, incompatible elements, hybrid formulations, higher order elements, singularity elements, substructuring, reanalysis, symmetry considerations.

Applications of FEM to engineering mechanics, stress analysis, fluid flow and heat transfer problems.

Texts/References:

1. T. R. Chandrupatla and A. D. Belegundu: Introduction to Finite Elements in Engineering, PHI, New Delhi.
2. R. D. Cook, D.S. Malkus and M.E. Plesha: Concepts and Applications of Finite Element Analysis, John Wiley.
3. K.J. Bathe: Finite Element Procedure, Prentice Hall of India.
4. C.S. Desai and J.F. Abel: Introduction to Finite Element Method, Affiliated East-West Press.

MED613 COMPUTER INTEGRATED MANUFACTURING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Computer-integrated manufacturing: Types of manufacturing systems, machine tools and related equipment, material handling system, benefit of CIMS.

Introduction to numerical control, basic components of NC system, Problems with conventional NC, computer numerical control, direct numerical control, adaptive control machining systems.

NC coordinates and motion control systems, punched tape in NC, tape coding and format. Manual and computer assisted part programming, simple exercise in APT language.

Group technology: Part families, parts classification and coding systems, group technology machine cells, benefits of group technology.

Flexible manufacturing systems: Introduction, components of FMS, application work stations. Computer control and functions - planning, scheduling and control of FMS, knowledge based scheduling.

Computer aided process planning, process planning function CAPP. Computer generated time standards.

Computer monitoring: Types of production monitoring systems-structure model of manufacturing process-process control & strategies direct digital control-supervisory computer control-computer in QC - contact inspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM.

Texts/References:

1. M. P. Groover and E.W. Zimmers: CAD/CAM- Computer Aided Design and Manufacturing, Prentice-Hall of India, New Delhi.
2. T.K.Kundra, P.N. Rao and N.K. Tewari: Numerical Control and Computer Aided Manufacturing, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Surendra Kumar and A.K. Jha: Technology of Computer Aided Design and Manufacturing CAD/CAM, Dhapat Rai & Sons, Delhi.
4. A.S.T.M.E.: Manufacturing by Numerical Control Handbook, ASTME, U.S.A.
5. S. Krar and A. Gill: CNC Technology and Programming, McGraw Hill.
6. D. Gibbs: An Introduction to CNC Machining, Casell.
7. W.S. Seames: Computer Numerical Control Concepts and Programming, Delmar Publishers.
8. M. Lynch: Computer Numerical Control for Machining, McGraw Hill.

MEP614 MANUFACTURING AUTOMATION

	L	T	P
Credit	3	0	0
Hours	3	0	0

Product cycle, Manufacturing functions, Types of automation, Degree of automation, Technical, economic and human factors in automation, Technologies -Mechanical, Electrical, Hydraulic, Pneumatic, Electronic, Hybrid systems, Comparative evaluation.

Development of small automation systems using mechanical devices, Basics pneumatics, Synthesis of circuits, Basics of hydraulic systems, Synthesis of hydraulic circuits, Elements used for electrical circuits, Synthesis, Circuit optimization techniques.

Illustrative examples of the above types of systems as well as hybrid systems used for automation of working cycles of machines, Material Handling, Inspection and Assembly

Industrial logic control systems, Logic diagramming, Programmable controllers, Applications, designing for automation, Cost-benefit analysis.

Texts/References:

1. A.N. Gavrilov, Automation and Mechanisation of Production Process in Instrument Industry, Pergaman Press, Oxford.
2. G. Pippengerm, Industrial Hydraulics, MGH, New York.
3. F. Kay, Pneumatics for Industry, The Machining Publ. Co., London.
4. Asfhal Ray, Robots and Manufacturing Automation, John Wiley, New York.
5. G. Boothroyd, C. Poli, Automatic Assembly, Marcel Dekkar, New York.

MED615 COMPUTATIONAL METHODS AND PROGRAMMING

	L	T	P
Credit	2	0	1
Hours	2	0	2

Roots of Nonlinear (Algebraic and Transcendental) Equations: Bisection method, False position method, Newton Raphson method, Newton's second order method, secant method, roots of polynomials by Bairstow's method.

Solution of Simultaneous Linear Equations: Gaussian elimination, pivoting, Gauss-Jordan method, Gauss-Seidal method, Cholesky's method. Tridiagonal systems. Ill-conditioning. Evaluation of determinant. Matrix inversion, matrix inversion in-place.

Eigenvalues and Eigenvectors: Matrix iteration methods, power and inverse power method, Jacobi method.

Interpolation: Lagrangian and Hermite interpolation, cubic spline interpolation. Curve fitting, polynomial method, methods of least squares.

Numerical Integration and Differentiation: Numerical integration by trapezoid rule, Simpson's rule, Gauss quadrature. Romberg integration. Improper integrals. Numerical differentiation.

Solution of Differential Equations: Euler's method, modified Euler's method, Runge-Kutta methods, predictor-corrector methods. Finite difference methods. Numerical solution of elliptical, parabolic and hyperbolic equations.

PRACTICALS:

Introduction to C/C++ programming language and software packages like MATLAB. Programming exercises on numerical solutions of problems taken from various fields of mechanical engineering.

Texts/References:

1. S.S. Sastry: Introductory Methods of Numerical Analysis, PHI.
2. M. L. James, G. M. Smith and J. C. Wolford: Applied Numerical Methods for Digital Computers, Harper & Row Publishers, New York.
3. V. Rajaraman: Computer Oriented Methods, PHI.
4. Balagurusamy: Programming in ANSI C, TMH.
5. Brian W. Kernighan and Dennis M. Ritchie: The C Programming Language, PHI.

MED621 COMPUTER AIDED DESIGN

	L	T	P
Credit	3	0	0
Hours	3	0	0

Design process, application of computers for design, definition of CAD, benefits of CAD. CAD system components. Computer hardware for CAD. Display, input and output devices.

Computer Graphics: Graphics primitives, display file, frame buffer, display control, display processors. Line generation, graphics software. Points and lines, and other primitives. Homogeneous coordinates. Transformations. Planar and space curves design. B-spline and Beizer curves. Geometric modelling techniques. Wire frames. Introduction to solid modelling.

Recent developments in design techniques, optimum design, diagnosis and prognosis of component failures, fatigue design, reliability, design for production and assembly, developments in existing design performance and testing.

Optimisation methods in design. General techniques, exact and iterative techniques. Optimal design of elements and systems. Role of optimisation techniques and finite element method in CAD.

Practicals:

Practicals will be based on modelling and analysis of machine components using available software.

Texts/References:

1. D.F. Rogers and A. Adams: Mathematical Elements for Computer Graphics, McGraw Hill Inc., New York
2. I.D. Faux and M.J. Pratt: Computational Geometry for Design and Manufacture, John Wiley & Sons, NY.
3. Steven Harrington: Computer Graphics- A Programming Approach, McGraw Hill.
4. M. P. Groover and E.W. Zimmers: CAD/CAM- Computer Aided Design and Manufacturing, Prentice-Hall of India, New Delhi.
5. Surendra Kumar and A.K. Jha: Technology of Computer Aided Design and Manufacturing CAD/CAM, Dhapat Rai & Sons, Delhi.

MED622 DYNAMICS OF MACHINES

	L	T	P
Credit	2	0	1
Hours	2	0	2

Review of kinematic analysis – mobility, displacement, velocity and acceleration analysis. Analytical methods using complex algebra and vector approaches. Chace solutions.

Synthesis: Types of synthesis, function generation, path generation and body guidance. Chebychev spacing. Coupler curve synthesis. Roberts-Chebychev theorem. Bloch's method of synthesis. Fruendenstein's equations. Analytical synthesis using complex algebra.

Free damped and damped vibrations of single degrees of freedom system. Forced vibrations. Response to periodic excitation, Fourier series. Impulse and step response. Response to arbitrary excitation, convolution integral. System response by Laplace transformation method, transfer function. Vibration isolation and transmissibility.

Multi Degrees of freedom Systems: Equations of motion, coupling and coordinate transformation, principal modes, orthogonality of modes, mode shapes, modal matrix. Response to initial excitation, modal analysis. Influence coefficients, matrix method, Lagrange equations. Vibration absorbers.

Continuous Systems: Discrete vs. continuous systems. Concepts of boundary value problem, free vibration as eigenvalue problem, eigenfunctions or natural modes, orthogonality. Vibrations of strings, bars, beams and plates, torsional vibrations of shafts. Vibration of beams - effect of rotary inertia and shear deflection, elastic stability. Variational principles and Hamilton's equations, Lagrange's equation.

Approximate and numerical method for multi degrees of freedom systems- Rayleigh's method, Dunkerley's method, Stodola's method, and Holzer's method.

Vibration exciters and pickups. Introduction to advanced vibration analysis, signal analysis techniques. Introduction to self-excited, shock and random vibrations.

Practicals: Experiments/exercises on computer aided kinematic, dynamic analysis and synthesis of mechanisms; experiments on vibration measurements and analysis.

Texts/References:

1. Joseph E. Shigley and John J. Uicker, Jr.: Theory of Machines and Mechanisms (International Edition), McGraw Hill Inc.
2. H. H. Mabie and C. F. Reinholtz: Mechanisms and Dynamics of Machinery. John Wiley & Sons.
3. G. Sandor and A.G. Erdman: Advanced Mechanism Design Vol.1 &2, PHI.
4. K.S. Fu, R.C. Gonzalez, C.S.G. Lee: Robotics, Mc-Graw Hill.

MED623 CAD/CAM LAB

	L	T	P
Credit	0	0	2
Hours	0	0	4

Use of popular analysis and simulation packages (for example ANSYS, CATIA, etc.) for engineering analysis related to mechanical engineering. Exercise on part programming and simulation.
The students will be required to undertake a couple of minor projects in analysis and design using computers.

Texts/References:

Reference Manuals of the relevant software.

MAJOR ELECTIVE – I

MED624(a) MANUFACTURING SYSTEMS & SIMULATION

	L	T	P
Credit	3	0	0
Hours	3	0	0

Computer modeling and simulation systems: Monte Carlo simulation, Nature of computer modeling and simulation. Limitation of simulation, areas of application.

Components of a system - discrete and continuous systems. Models of a system - a variety of modeling approaches.

Random number generation: Techniques for generating random numbers - midsquare method - the mid product method - constant multiplier technique - additive congruential method - linear congruential method - tests for random numbers – the Kolmogorov - Smirnov test - the Chi-Square test.

Random variable generation: Inverse transform technique - exponential distribution - uniform distribution - Weibull distribution. Empirical continuous distribution - generating approximate normal variates - Erlang distribution.

Distribution and evaluation of experiments: Discrete uniform distribution - Poisson distribution - geometric distribution - acceptance rejection technique for Poisson distribution gamma distribution.

Simulation Experiments - Variance reduction techniques - antithetic variables - verification and validation of simulation models.

Discrete event simulation: Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem.

Programming for discrete event systems in GPSS - Case studies.

Texts/References:

1. Jerry Banks and John S. Carson, II, "Discrete Event System Simulation", Prentice Hall Inc. 1984.
2. Gordon G, " Systems Simulation", Pentice Hall of India Ltd., 1991.

MED624(b) MANUFACTURING PLANNING AND CONTROL

	L	T	P
Credit	3	0	0
Hours	3	0	0

Production Planning: Planning horizons, product exploring, make or buy decisions, operation planning, demand forecasting, conversion of forecast into production goals.

Routing and scheduling: preparation of route sheets, master route sheets, scheduling orders and products, operation sequencing and balancing. Scheduling for mass production and job order production.

Inventory Systems: Cost factors relevant to operations and inventory control, EOQ with shortages and uniform productions, quantity discounts, uncertainty; Interrelationship of operations inventory control of maintenance and repairs items.

Project planning and control: Network control, control cost considerations and optimisation. Resources allocations and levelling. Despatching and follow up as production control procedures.

Aggregate Production planning models: Criteria for effectiveness, Decision rules. Organisation and documentation for PPO, Performance reporting.

Texts/References:

1. D.D. Bedworth and J.E. Bailey: Integrated Production Control, System – Management, Analysis and Design, John Wiley.
2. E.A Elsayed and T.O. Boucher: Analysis and Control of Production Systems, Prentice Hall.
3. J.R. King: Production Planning and Control, Pergamon Press.
4. P.F. Bestwick and K. Lockyer: Quantitative Production Management, Pitman Publications.
5. A.C. Hax and D. Candea: Production and Inventory Management, Prentice Hall.
6. L.A. Johnson and D.C. Montgomery: O.R. in Production Planning, Scheduling and Inventory Control, John Wiley & Sons.
7. M.G. Korgaonkar: JIT in Manufacturing, McMillan Publication Co.

MED624(c) SHEET METAL WORKING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Sheet metal production, Mechanical properties and their assessment, Forming Limit Diagram (FLD), Anisotropic yield criteria, Stress and strain paths.

Sheet metal forming processes: Shearing, Punching/ Blanking, Bending, Deep drawing, Pre and post treatment of sheet metal parts.

Process modeling & analysis of typical processes, Scope of CAD/CAM in sheet metal forming, Numerical Analysis of forming processes.

Forming Machines: Conventional and Advanced CNC shears, Press brakes, Turret punching press etc., Sheet handling equipment.

Tool design & Design of inspection fixtures, Component handling. Super plastic forming.

PRACTICALS: Development of surfaces, Design of dies, tools and fixtures.

Text/References:

1. American Soc. for Metals: Metals Handbook (10th Edition, Vo1. 15 on Metal Forming), ASM.
2. David, Smith (Editor): Die Design Handbook, SME Publications.
3. P. Polukhin *et. al.*: Rolling Mill Practice, Mir Publishers.
4. K. Lange: Handbook of Metal Forming, McGraw Hill.
5. D.F. Eary and E.A. Reed: Techniques of Press working Sheet metal and Engineering Approach to Die Design, Prentice Hall.

MAJOR ELECTIVE – II

MED625(a) FACILITIES PLANNING AND PLANT ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Plant location: Factors affecting the plant location, theories of plant location, procedure for plant location. Planning for physical facilities. Definition, scope, importance, objectives, functions, and activities. Facility design and productivity. Type of layout and their economy, Organisation layout department.

Methodology for development of optimum layout and design: information collection necessary for layout planning, factors including plant layout- man, material, machine and equipment, flow and building services, safety, storage, procedure and stages for development of layout.

Techniques for analysis of method flow: need for the analysis of flow and use of process chart, multiproduct charts. Assembly chart, flow diagram. Flow process chart, activity relationship diagram, Travel and load charts, etc.

OR approval to plant layout: Line balancing, need for line balancing. Heuristic approach for line balance, mathematical models for line balance. Computerised layout: criteria for computerised layout programme, advantages and limitations of the method.

Material handling analysis and equipment: Principals of material handling and advantage of good handling. Design of material handling system and integration with plant layout. Selection and replacement of material handling equipment. Analysis of handling problems; Study and application of various types of material handling equipment.

Texts/References:

1. J.A. Tompkins and J.A. White, Facilities Planning, Wiley.
2. J.M. Apple, Plant Layout and Materials Handling, Wiley, 1977
3. R.L. Francis and J.A. White, Facilities Layout and Location, PHI
4. J.A. Moore, Plant Layout and Design, Mcmillan
5. D.M. Smith, Industrial Location, An Economic Geographic Analysis, Wiley
6. Mirchandani and Handler, Location on Network, Wiley

MED625(b) PRODUCT DESIGN & DEVELOPMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction to Design Engineering: Morphology of design, need analysis, specification of a problem. Problem formulation and problem analysis, design process and design cycle, creative design and introduction to decision making. Analysis of the product, standardization, simplification. Basic design considerations.

Design for Production: Producibility requirements in the design of machine components. Design for forging, casting, machining ease and powder metallurgical parts.

Strength, stiffness and rigidity considerations in product design.

Design Optimisation: Search for alternative solution and optimization aspects in design, qualitative discussions of various optimisation techniques.

Human factors in engineering design: Aesthetic and ergonomic considerations. Design of controls and displays.

Value Engineering: Nature and measurement of value, maximum value, normal degree of value, importance of value, the value analysis job plan. Steps to problem solving and value analysis, value analysis tests, material and process selection in value engineering.

Economic Factors Influencing Design: Product value. Design for safety, reliability and environmental considerations. Economic analysis, profit and competitiveness, break-even analysis. Economics of a new product design.

Modern Approaches to Product Design: Concurrent Design, Quality Function Deployment (QFD).

Texts/References:

1. Chitale and Gupta: Product Design and Manufacturing, Prentice Hall of India.
2. Ulrich, K. T., and Eppinger, S.D., Product Design and Development, McGraw-Hill.

MED625(c) OPTIMIZATION METHODS IN ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Need for optimisation and historical development. Classification and formulation of optimisation problems, classical optimisation methods, differential calculus, Lagrangian theory, Kuhn Tucker condition. Unconstrained minimisation techniques, one dimensional minimisation techniques Fibonnacci, Golden section and quadratic interpolation methods. Multi-dimensional minimisation, Univariate, Conjugate direction, gradient and variable metric methods. Constrained minimisation techniques, penalty function methods, feasible direction and gradient projection methods. Introduction to geometric programming, linear programming and simplex method. Examples and applications of the above methods in the recent engineering design literature.

Texts/References:

1. S.S. Rao: Optimisation-Theory and Applications, Wiley Eastern Ltd.

2. R.L. Fox: Optimisation Methods for Engineering Design, Addison Wesley.

3. W.I. Zangwill: Non-Linear Programming, A Unified Approach, Prentice Hall.

MAJOR ELECTIVE – III

MED631(a) ROBOTICS

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction. Construction of manipulators, Advantages and disadvantages of various kinematics structure. Applications, Actuators, Pneumatic, Hydraulic and electric. Characteristics and control. Non servo Robots, Motion Planning. Feed back systems, Encoders, Servo controls, PTP and CP. Kinematics, Homogenous coordinates, Solutions of the inverse kinematics problems, Multiple solutions, Jacobian, Work envelopes. Trajectory planning.

Manipulator dynamics and forced control. Sensors: Vision, Ranging, Lasers, Acoustics, Tactile. Development in sensor technology, sensory control. Programming language: VAL, RAIL, AML. Mobile robots, Walking devices. Robot reasoning.

Texts/References:

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee: Robotics, Mc-Graw Hill.

2. Y. Koren: Robotics for Engineers, McGraw Hill.
3. J.J. Craig: Robotics, Edison Wesley.

MED631(b) DESIGN OF MATERIAL HANDLING EQUIPMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Objectives of material handling systems and the basic principles, classification and selection of material handling equipment. Characteristics and applications. Discussion of various material handling equipments functions and parameters effecting service. Packaging and storage of materials and their relations with material handling. Theory, construction and design of various component parts of mechanical handling devices, wire ropes, chains, hooks, shackles, grabs, ladles, and lifting electromagnets, pulleys, sheaves, shears, sprockets and drums, winches, brakes and ratchet stops, gears and power transmission systems, runner wheels and rails, buffers and controls of travel mechanisms.

Kinematics and dynamic analysis of various types of cranes and elevators. Stability and structural analysis. Discussion of principles and application of conveyors and related equipment. Design of various types of conveyors and their elements. Fault finding and failure analysis of material handling systems. System design and economics.

Texts/References

1. N. Rudenko: Materials handling Equipments, Peace Publishers, Moscow.

2. Spivakowsky and V. Dyachke, Conveyors and Related Equipments, Peace Publishers, Moscow.

3. R. John Immer, Materials Handling McGraw- Hill.

4. E. Ernst, Die Hebezeuge, Band I and II, Springer Verlag.

MED631(c) MACHINE TOOL DESIGN

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction to metal cutting machine tools, kinematics of machine tools. Basic principles of machine tools design, estimation of drive power. Measurement of power.

Machine tool drives. Electrical, mechanical and fluid drives. Stepped and stepless arrangements and systems.

Design of mechanical drives. Design of main and feed gear boxes. Special drives viz. Norton, Meander, etc. Gear calculations, choice of spindle bearings, belts, etc. typical gear layout of machine tools.

Machine tool structures – beds, columns, tables and supports, stock feed mechanisms. Control of machine tools, protective and safety devices. Design of precision machine tools, mircofeeding device, concepts of modularity of design and integration for SPMs.

Machine tool structure design, strength and rigidity of machine tool structures, selection of structure shapes and materials. Static compliance. Design of lathe bed, use of reinforcing stiffeners in lathe bed. Design of column of drilling machine. Force analysis and design of milling machine.

Design of machine tool spindles, selection of bearings, slideways and guideways. Hydrodynamic action in slides.

Concepts of aesthetic and ergonomics applied to machine tools. Acceptance tests and standardisation of machine tools. Latest trends in machine tool design, introduction of CAD techniques.

Texts/References:

1. G. C. Sen and Amitabha Bhattacharya: Principles of Machine Tools, New Central Book Agency, Calcutta.
2. N.K. Mehta: Machine Tool Design and Numerical Control, , Tata McGraw-Hill Co. Ltd, New Delhi.
3. Chitale and Gupta: Product Design and Manufacturing, Prentice Hall of India.
4. N. Acherkan: Machine Tool Design (Vol 3 & 4), PIR publishers, Moscow.
5. CMTI Machine Tool Design Handbook.
6. A. Koenigsburger: Design Principles of Metal Cutting Machine Tools, Pergamon Press.

MED631(d) DESIGN FOR FATIGUE AND FRACTURE

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction to fatigue and fracture of machine elements, necessity of designs based on fatigue and fracture.

High cycle fatigue and low cycle fatigue, fatigue data representation, parameters influencing fatigue strength and life, fatigue phenomena, various stages of fatigue process, designs based on static properties and dynamic properties of materials, fatigue design procedures, preventing fatigue failures.

Brittle fractures, modes of fracture, linear elastic fracture mechanics, determination of stress intensity factor, fracture toughness, testing, elastic plastic fracture mechanics, design for fracture. Fracture mechanics and fatigue crack propagation. Failure analysis, investigation methods.

Texts/References:

1. L. Sors, Fatigue Design of Machine Components, Pergamon Press.
2. S. T. Rolfe and J.M. Barsom: Fracture and fatigue Control in Structures, Prentice Hall.
3. D. Broek: Elementary Engineering Fracture Mechanics, Noordhoff.
4. A.F. Madayag: Metal Fatigue- Design and Theory.

MINOR ELECTIVE

MED632(a) CONCURRENT ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: Extensive definition of CE - CE design methodologies - Organizing for CE - CE tool box collaborative product development

Use of information technology: IT support - Solid modeling - Product data management -Collaborative product commerce - Artificial Intelligence- Expert systems - Software hardware co-design.

Design stage: Life-cycle design of products - opportunity for manufacturing enterprises - modality of Concurrent Engineering Design - Automated analysis idealization control - Concurrent engineering in optimal structural design - Real time constraints.

Manufacturing concepts and analysis: Manufacturing competitiveness - Checking the design process - conceptual design mechanism – Qualitative physial approach - An intelligent design for manufacturing system - JIT system - low inventory - modular - Modeling and reasoning for computer based assembly planning - Design of Automated manufacturing.

Project management: Life Cycle semi realization - design for economics - evaluation of design for manufacturing cost – concurrent mechanical design - decomposition in concurrent design - negotiation in concurrent engineering design studies - product realization taxonomy - plan for Project Management on new product development – bottleneck technology development.

Texts/References:

1. Anderson MM and Hein, L. Berlin, "Integrated Product Development",Springer Verlog, 1987.
2. Cleetus, J, "Design for Concurrent Engineering", Concurrent Engg. Research Centre, Morgantown, WV, 1992.
3. Andrew Kusaik, "Concurrent Engineering: Automation Tools and Technology", Wiley, John and Sons Inc., 1992.
4. Prasad, "Concurrent Engineering Fundamentals: Integrated Product Development", Prentice Hall, 1996.
5. Sammy G Sinha, "Successful Implementation of Concurrent Product and Process", Wiley, John and Sons Inc., 1998.

MED632(b) DESIGN OF HEAT TRANSFER EQUIPMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Review of Fundamentals: Overall coefficient of heat transfer; controlling film coefficient, log-mean temperature difference (LMTD) for counter flow and parallel flow heat exchangers, caloric or average fluid temperature, wall temperature, and various types of heat exchangers. Introduction to heat exchanger optimization .

Design of Double-pipe Heat Exchangers: Introduction. Film coefficients for fluids in pipes and tubes. Film coefficients and equivalent diameter for flow in annuli. Fouling factors. Pressure drop in pipes and annuli, Double-pipe exchangers in series-parallel arrangements.

Design of Shell and Tube Heat Exchangers: 1-2 Parallel- Counter flow shell and Tube Heat Exchangers: Constructional features of various types, Layout of tubes, various types of baffles and expansion joints. Shell-side film coefficients, shell-side mass velocity and shell equivalent diameter. True temperature difference in a 1-2 exchanger. Shell and tube side pressure drops. Analysis of performance. Exchangers without baffles.

Flow arrangements for increased Heat. Recovery: 2-4 Exchangers and their comparison with 1-2 exchangers. 1-2 exchangers in series. 1-1 true counter flow exchangers. Design Calculations.

Design of Heat Exchangers with Extended Surfaces : Introduction and classification. Fin efficiency. Longitudinal fins and double pipe exchangers. Extended-surface shell and tube exchangers: cross-flow LMTD, film coefficients and pressure drop for transverse fins.

Design of Condensors : Dropwise and filmwise condensation. Condensing heat transfer coefficients. Horizontal and vertical tube condensors. Brief introduction to desuperheater condensors and condensor-subcoolers.

Texts/References:

1. E.R.G. Eckerest and R.M. Drake Jr: Analysis of Heat Transfer, MGH
2. S. Kokac: Heat Exchangers- Thermal Hydraulic Fundamentals and Design Hemisphere, MGH
3. D.Q. Kern and A.D. Kraus: Extended Surface Heat Transfer, MGH
4. W.M. Kays and A.C. London: Compact Heat Exchangers, MGH

MED632(c) MATERIALS TECHNOLOGY

	L	T	P
Credit	3	0	0
Hours	3	0	0

Structure of' Metals: Inter-atomic bounds, crystalline and amorphous solids, crystal imperfections.

Deformation of Metals: Elastics behaviour, Plastics deformation. Theory of dislocation, Strain hardening, Fracture of metals: ductile and brittle fracture

Creep And Elevated Temperature Behaviour : Mechanism of creep, Analysis of creep curves, Prediction of creep behaviour, Creep tests. Effect of properties of elevated temperature, oxidation and scaling

Fatigue: Mechanism of Fatigue Statistical nature *o*f fatigue: Factors affecting fatigue: Fatigue testing. Thermal stresses, Thermal shocks and thermal fatigue.

Corrosion and Radiation: Mechanism of corrosion, Mechanical effects of corrosion; Protection against corrosion. Types of radiation, Effect of radiation on the mechanical behaviour of materials, Selection of materials

Texts/References:

1. S.L. Kakani and A. Kakani: Material Science, New Age International.

MED632(d) NON TRADITIONAL MACHINING PROCESSES

	L	T	P
Credit	3	0	0
Hours	3	0	0

Non Traditional processes: Classification, Areas of application.

Electric Discharge Machining: Principle, Process parameters, EDM machines and controls, Wirecut EDM, Process optimization and control, Tool design for EDM.

Abrasive and Water jet machining: Mechanism of material removal, Process parameters, Process capabilities.

High energy beam processes like Laser beam machining, Electron beam machining, Plasma arc machining.

Chemical and allied processes like Chemical machining, Electro chemical machining Principle of Ultrasonic machining, capabilities and application.

Text/References

1. H.M. T.- Production Technology, Tata-McGraw Hill, New Delhi, 1980.
2. Pandey, P .C. and Shan, Modern Machining Processes, Tata-McGraw Hill Publ. Co. Ltd., New Delhi, 1980.
3. McGeough, J.A., Advanced Methods of Machining Chapman and Hall, London, 1988.

COURSES OFFERED FOR OTHER DEPARTMENTS

ME618 CAD/CAM

	L	T	P
Credit	2	0	1
Hours	2	0	2

Computer Aided Design: CAD system components. Computer hardware for CAD. Display, input and output devices. Applications of computers to design modelling, engineering analysis and simulations. Introduction to FEM and its applications in CAD.

Design Optimisation: Search for alternative solution and optimization aspects in design, qualitative discussions of various optimisation techniques.

Computerised optimum design of simple machine elements i.e. shafts, springs, gears and gear trains etc (flow charts only).

Computer Graphics: Role of computer graphics in CAD/CAM. Introduction to product data standards and data structures. Database integration for CAD/CAM.

Introductory concepts of display file, frame buffer, display control, display processors. Graphics primitives, points , lines, and other primitives. Homogeneous coordinates. Transformations. B-spline and Beizer curves. Geometric modelling techniques, wire frames and introduction to solid modelling.

Computer Aided Manufacturing: Introduction to CAM, Components of NC system, NC coordinates and motion control systems. Computer numerical control, direct numerical control, combined CNC/DNC, economics of NC system. Punched tape, tape coding and format, manual and computer assisted part programming, APT language.

PRACTICALS:

Preparation of drawings and modelling of engineering parts using popular CAD packages like AutoCAD, etc. Analysis of simple machine parts using software like ANSYS, CATIA, etc.

Development of simple computer programme for computer aided design of simple machine parts. Elementary exercises in part programming.

Texts/References:

1. M. P. Groover and E.W. Zimmers: CAD/CAM- Computer Aided Design and Manufacturing, Prentice-Hall of India, New Delhi.
2. Surendra Kumar and A.K. Jha: Technology of Computer Aided Design and Manufacturing CAD/CAM, Dhapat Rai & Sons, Delhi.
3. T. R. Chandrupatla and A. D. Belegundu: Introduction to Finite Elements in Engineering, Prentice Hall of India, New Delhi.
4. T. Ramamurty: Computer Aided Mechanical Design and Analysis. Tata McGrawHill, New Delhi.
5. I.D. Faux and M.J. Pratt: Computational Geometry for Design and Manufacture, John Wiley & Sons, NY.
6. Steven Harrington: Computer Graphics- A Programming Approach, McGraw Hill.
7. Donald Hearn and M. Pauline Baker: Computer Graphics, Prentice-Hall Of India, N Delhi.