SCHEME OF EXAMINATION AND SYLLABUS

FOR

Ph.D. Program in Mechanical Engineering

AND

M.Tech. Program in Mechanical Engineering With specialisation in CAD/CAM

(Effective From 2015-16)

(with amendments approved in academic council meetings MPUAT/AC-41/2014-02/04 dated 15-9-2014 and MPUAT/AC-42/2014-03/05 dated 08-12-2014)

COLLEGE OF TECHNOLOGY AND ENGINEERING

MAHARANA PRATAP UNIVERSITY OF AGRICULTURE & TECHNOLOGY

UDAIPUR, RAJASTHAN -313001

Eligibility for admission to

a. ***M.Tech. in Mechanical Engineering (specialization CAD-CAM)***: B.Tech./B.E. degree in 'Mechanical Engineering' or 'Production & Industrial Engineering' discipline.

b. ***Ph.D. (Mechanical Engineering):*** M.Tech./M.E. in 'Mechanical Engineering' or 'Production & Industrial Engineering' disciplines.

c. The other admission requirements will be same as approved for other branches of engineering .

Fee structure for Ph.D.: At par with payment/SFS seats for M.Tech.

Number. of seats: Four (Ph.D.); Eight (M.Tech.)

PG Program (M.Tech. & Ph.D.) in Mechanical Engineering

Subject	**Course No.**	**Credits**				
			I	**II**	**III**	**IV**
Core Courses: ***M.Tech.:***Total 12 Credits; two courses in first semester (6 credits) and 2 courses in the second semester (6 credits) to be evaluated externally ***Ph.D.:*** Total 6 Credits; one courses in first semester (3) credits) and one courses in the second semester (3 credits) to be evaluated externally						
Finite Element Analysis	MED511	3 (2+1)	3 (2+1)			
Computer Integrated Manufacturing	MED512	3 (2+1)	3 (2+1)			
Metal Cutting And Removal Processes	MED513	3	3			
Computer Aided Design	MED521	3 (2+1)		3(2+1)		
Dynamics of Machines	MED522	3 (2+1)		3 (2+1)		
Work Analysis And Work Measurement	MED523	3		3		
Heat Transfer	ME611	3	3			
Metal Working	ME621	3		3		
Major Courses: ***M.Tech.:***Total 15 Credits; two courses each in first and second semesters(6 credits in each semester) and one course in the third semester (3 credits) ***Ph.D.:***Total 12 credits; (6 credits in each semester) two courses in first and second semester each						
Stress Analysis	MED514	3	3			
Manufacturing Automation	MED515	3	3			
Ergonomics And Work Design	MED516	3	3			
Major Elective-I (*any one from list*)	MED524	3		3		
Major Elective-II (*any one from list*)	MED525	3		3		
Major Elective-III (*any one from list*)	MED531	3			3	
Internal Combustion Engines	ME612	3	3			
Value Engineering	ME613	3	3			
Direct Energy Conversion	ME614	3	3			
Applied Refrigeration	ME622	3		3		
Combustion Engineering	ME623	3		3		
Minor/Supporting Courses ***M.Tech.:***Total 9 Credits; one courses each in first and second semesters (3 credits in each semester) and one course in the third semester (3 credits) ***Ph.D.:***Total 9 credits, two courses in first semester (6 credits) and one course in second semester (3 credits)						
Computational Method & Programming	MED517	3 (2+1)	3			
Total Quality Management	MED518	3	3			
Computer Aided Modelling and Analysis	MED526	3(2+1)		3(2+1)		
Reliability And Maintenance Engineering	MED527	3		3		
Minor Elective (*any one from list*)	MED532	3			3	
Value Engineering And Productivity	ME615	3	3			
Air-Conditioning	ME616	3	3			
Refrigeration Engineering	ME624	3		3		
Compulsory Non-credit course						
Library and Information Services	PGS 501	NC				
Technical writing and communications skills	PGS 502	NC				
Others						
Seminar	MED533 ME691& ME692	1* 1** 1**	1**	1**	1*	
Comprehensive Examination/ Preliminary exam	MED534 ME634	NC				
Thesis	MED535 ME635					20* 45**
Total Credits offered (M.Tech)		**57***	**15***	**15***	**7***	**20***
Total Credits offered (Ph.D.)		**74****	**16****	**13****		**45****

*For Master programme, Thesis minimum duration 2 semester

**For Doctoral programme, Thesis minimum duration 4 semester

List of Major Electives

Major Elective-I	
MED524(a)	Manufacturing Systems & Simulation
MED524(b)	Manufacturing Planning & Control
MED524(c)	Sheet Metal Working
MED524(d)	Quality Control And Industrial Inspection
Major Elective-II	
MED525(a)	Facilities Planning and Plant Engineering
MED525(b)	Product Design & Development
MED525(c)	Optimization Methods in Engineering
MED525(d)	Robotics
Major Elective-III	
MED531(a)	Design of Material Handling Equipment
MED531(b)	Machine Tool Design
MED531(c)	Design For Fatigue and Fracture
MED531(d)	Materials Management

List of Minor Electives

MED532(a)	Concurrent Engineering
MED532(b)	Design of Heat Transfer Equipment
MED532(c)	Materials Technology
MED532(d)	Non Traditional Machining Processes
MED532(e)	Maintenance Management

CORE COURSES

MED511 FINITE ELEMENT METHOD

	L	T	P
Credit	2	0	1
Hours	2	0	2

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.

Practicals:

Practice on FEA softwares available in lab.

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.

MED512 COMPUTER INTEGRATED MANUFACTURING

	L	T	P
Credit	2	0	1
Hours	2	0	2

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.

Practicals:

Study of pneumatic and hydraulic actuation systems; programming in G & M codes; practice on automated programming softwares in lab; job on CNC machines available in lab.

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, DhapatRai& 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.

MEP513 METAL CUTTING AND REMOVAL PROCESSES

	L	T	P
Credit	3	0	0
Hours	3	0	0

Orthogonal and Oblique cutting: Chip formation; Force and shear angle relationship; thin zone models, oblique cutting; cutting geometry, geometry of turning, milling, and drilling tools, shear angle, velocity relationships. Force and stress relationship, dynamometry, types of dynamometers, design features of dynamometers of turning, milling and drilling processes.

Friction and thermal aspects: Friction processes in metal cutting, action of cutting fluids, cooling effect, reduction of friction, tool life and shear strength of work material, application and selection of cutting fluids. Source of heat generation and temperature distribution in the cutting zone, dimensional analysis. Measurement of cutting temperature.

Tool wear and Machineability: Mechanism of tool wear, adhesion, abrasion, diffusion and fatigue, wear rate, tool life criteria, factors affecting tool life, testing of tool life. Machineability criteria; machining cost, criteria for optimisation, cutting speeds for minimum cost of production and maximum production rate, restriction for selecting economical conditions,

Abrasive machining processes: Mechanics of surface and cylindrical grinding, performance of grinding, honing and lapping operations, basic principles and mechanics of metal removal in abrasive, water-jet, ultrasonic machining. Variables governing the process, economic considerations, application and limitation.

Texts/References:

1. A. Bhattacharya: Metal Cutting Theory and Practice, New Central Book Agency.
2. G. Boothroyd, Fundamentals of Metal Machining and Machine Tools, McGraw Hill Book Co.
3. P.L.B. Oxley: The Mechanics of Machining, Ellis-Harwood.
4. M. C. Shaw: Metal Cutting Principles, Oxford.
5. J. McGeough: Advanced Methods of Machining, Chapman and Hall.

MED 521 COMPUTER AIDED DESIGN

	L	T	P
Credit	2	0	1
Hours	2	0	2

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, DhapatRai& Sons, Delhi.

MED 522 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.

MED 523 WORK ANALYSIS AND WORK MEASUREMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: Definition, Scope and History of Motion and time study, Work Methods design-Process and operation analysis. Micro motion and mini motion study

Work Measurement and Techniques: Stop watch study, Performance rating methods. Allowances personal. Process. fatigue and machine interference work sampling

Pre-determined Time System: Work Factor system. Method Time Measurement (MTM). Basic Motion Studies. Standard data system

Advanced Study of Topics in Works System Design : Physiological and other aspects of work design, Application of Physiological techniques of work measuring, problems, Fatigue

Analysis and Evaluation: Current work Measurement. techniques and Means of reducing and controlling such errors, Application of control charts, regression analysis and other statistical techniques to work measurement problems.

Text/References:

1. R.M. Barnes: Motion & Time Study Design and Measurement of Work, John Wiley and Sons.
2. A. Abruzzi: Work Measurement, Columbia University Press, NY.
3. B.L. Hansen: Work Sampling for Modern Management, Prentice Hall
4. S.M. Lowry, H.B. Maynard and G.J. Stegemerten: Time and Motion Study, MGH
5. B.W. Niebel: Motion and Time Study, Homewood.

ME 611 HEAT TRANSFER

	L	T	P
Credit	3	0	0
Hours	3	0	0

Conduction: General heat conduction differential equation in rectilinear, cylindrical and spherical Coordinates. Straight fins of rectangular, triangular, and trapezoidal sections; effectiveness of fins

One-dimension steady state conduction with internal heat generation; local heat source in a non-adiabatic plate, thermo-couple conduction error

Two-dimensional steady state conduction; semi-infinite and finite flat plate; temperature field in infinite and finite cylinders; conduction through spherical shells; graphical methods; numerical methods

Unsteady state conduction; sudden changes in the temperature of infinite plates, cylinders, and other semi-infinite bodies; solutions using Grover's and Heisler's charts

Convection: Review of continuity and momentum, differential equations for incompressible fluids; differential equation of energy momentum and thermal boundary layers; convective heat transfer coefficient; local and integrated values; Nusselt and Stanton numbers

Heat transfer in laminar flow; free convection between parallel plates, forced internal flow through circular tubes, fully developed flow, velocity and thermal entry lengths, solutions with constant wall temperature and with constant heat flux; forced external flow over flat plate; the two dimensional velocity and temperature boundary layer equations, the Karman- Pohlhausen approximate integral method

Heat transfer in turbulent flow; eddy heat diffusivity, Reynolds analogy between skin friction and heat transfer, .

Prandtl, Taylor, Von Karman, Maritnelii analogies; turbulent flow through circular tubes

Radiation: Review of radiation principles; Kirchoff's law, Lambert's cosine law, Planck's Law, Stefan Boltzmann law, Wien's displacement law

Radiation through non-absorbing media, Hottel's method of successive reflection, review of methods of analogous electrical circuits; Gabhart's unified method; Polank's method using integral equation shields

Radiation through absorbing media, logarithmic decrement of radiation; gas radiation; apparent absorptivities of simple shaped gas bodies, net heat exchange between surfaces separated by an absorbing gas; Radiation of luminous gas flames

Texts/References:

1. Holman: Heat Transfer, TMG
2. E.R.G. Eckerest and R.M. Drake Jr: Analysis of Heat Transfer, MGH
3. B. Gebhart: Heat Transfer, MGH

ME 621 METAL WORKING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Theory of plasticity: Mohr's circle for two-dimensional and three-dimensional principal stresses; yield criteria, determination of working load, upper bound and lower bound techniques, work hardening, slip line theory and its applications.

Rolling: determination of roll separating force and rolling torque; design of rolls, camber design, elements of roll pass design, roll materials and treatments

Forging: determination of compression load for thin strips, low friction and high friction condition; forging of flat circular discs.

Other metal working processes: Analysis of extrusion processes, forward and backward extrusion: analysis of wire drawing processes, analysis of tube sinking, tube expanding and deep drawing.

Friction and lubrication in metal working: Influence of friction in metal working; lubricants used in various metal working process, tools and equipment for metal cutting processes.

Texts/References:

1. Society of Mfg. Engineers: Die Design Handbook, SME Publications, Michigan.
2. A. M. Sabaroff et. al: Forging Material and Practices, Reinhold Publishers.
3. C. Pearson: Extrusion of Metals, Wiley.
4. K. Lange: Handbook of Metal Forming, McGraw Hill.
5. W. Johnson and P.B. Mellor: Plasticity for Mechanical Engineers, Van Nostrand.

MAJOR COURSES

MED 514 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.

MED 515 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.

MED 516 ERGONOMICS AND WORK DESIGN

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: Definition and brief history, aims, ergonomics as Multidisciplinary approach to industrial problems, industrial change

Physical basis of perception: His environmental; metabolism and heat regulation; dynamic and static anthropometry; nervous system and psychosensorial processes; measurement of work and work capacity

Environmental Ergonomics: Mechanical environment, perceptual environment, thermal and other ambient environment. Design of Equipment and Work place, visual and auditory displays, console design and panel layout, work place envelope and work place arrangement

Individual in the Work: Organization; motivation to work studies of the nature of man at work; developing effective social systems for work

Ergonomics for Accident Prevention Systems Ergonomics: Introduction to the systems approach, analysis of dynamic systems, man management and administrative systems, systems analysis and design

Text/References:

1. E.J. McCormic, Human Factors in Engineering Design, TMG.
2. O.P. Astrand and R. Kaare, Text Book of Work Physiology, McGraw Hill.
3. R.D. Huchingson, New Horizon for Human Factors Design, McGraw Hill.

MED 524 (MAJOR ELECTIVE – I)

MED524(a) MANUFACTURING SYSTEMS & SIMULATION

	L	T	P
Credit	3	0	0
Hours	3	0	0

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

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

MED524(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.AElsayed 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.

MED524(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.

MED524(d) QUALITY CONTROL AND INDUSTRIAL INSPECTION

	L	T	P
Credit	3	0	0
Hours	3	0	0

Quality Control: Quality improvement, need of Control, process capability analysis, quality capability study. Statistical quality control; objective, applications, organization, cost aspects, theory of statistical tolerances

Control Charts: General theory of control charts, group control charts, control charts with variable sub-group *size,* moving average and moving range charts, acceptance control charts cumulative sum control charts and difference control charts

Sampling Plans: Acceptance sampling, single, multiple and sequential sampling plans, multi-level continuous sampling, acceptance sampling by variables, sampling plans using different criteria, comparison of various types of sampling plans

Industrial Inspection: Need and function of inspection in industry, organization, inspection, procedures and equipment, automatic and continuous inspection, inspection of screw threads, gears and surface finish flatness

Non-destructive Testing: Radiography, magnaflux and fluorescent penetrant inspection, eddy current and ultrasonic tests

Texts/References:

1. A.J. Duncan, Quality Control and Industrial Statistics. Richard D. Irwin Inc., USA
2. A.V. Feigenbaum, Total Quality Control, MGH, USA.
3. S. Halpern, The Assurance Sciences, PHI, New Delhi.
4. D.C. Montgomery, Design and Analysis of Experiments, John Wiley And Sons, USA.

MED 525 (MAJOR ELECTIVE – II)

MED525(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

MED525(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.

MED525(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.

MED525(d) 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.

MED 531 MAJOR ELECTIVE – III

MED531(a) 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.

MED531(b) 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.

MED531(c) 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.

MED531(d) MATERIALS MANAGEMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: scope of materials management, primary and secondary objectives; integrated materials management, relation with other functional areas of organization.

Organizing for materials management: basis for forming organizations, conventional and modern approaches to organizing materials management

Materials identification: classification, codification, standardization, simplification and variety reduction, Value analysis

Inventory control: techniques– FSN, VED, ABC, Various inventory models. Inventory models with quantity discount – Deterministic & Probabilistic Models.

Management of stores: location, types of stores, methods of storing, safety and security of materials, stores equipment; materials handling equipment, factors affecting materials handling. Stores issues and receipts, procedures, forms and policies in stores transactions, stores accounting, stores organization.

Management of surplus obsolete and scrap materials: reasons for accumulation of surplus obsolete and scrap materials, methods of disposal, regulations and procedures

Purchasing: planning purchasing materials, Materials requirements planning, Make or buy decision; vendor - rating, selection and development; purchasing procedures and methods; legal aspects, insurance of materials, supply management, sources of supply, out sourcing

Sub contracting: reasons for subcontracting, criteria for selecting sub contractors – rating, factors affecting subcontract rate fixing, internal and external subcontract

Texts/References :

1. Ballot, Materials Management, Taraporewala, Bombay.
2. Ammer D.S., Materials Management, Taraporewala.
3. Gopalakrishnan P .,Handbook of Materials Management. Prentice Hall of India.
4. Baily P.and Farmer D., Materials
5. Management. Handbook, Gower Publications.

ME612 INTERNAL COMBUSTION ENGINES

	L	T	P
Credit	3	0	0
Hours	3	0	0

Thermodynamics of actual working fluid. Fuel air cycle. The actual cycle

Air capacity of Four-stroke engines, Two-stroke engines Heat losses. Performance of un-supercharged and super- charged engines. Altitude behaviour of the un-supercharged engines

Normal combustion, detonation and Pre-ignition in S.I. Engines. Combustion in Diesel Engines. Combustion in petrol Engines

Mixture Requirements, Carburettor Design of S.I. Engines, Fuel injection

Wankel Engine, Stratified Charge Engines. Dual and Multiple fuel Engines

Texts/References:

1. P.W.Gill, J.H. Smith Jr and E.J. Ziurys: Fundamentals of Internal Combustion Engines, Oxford and IBH Publishing Co.
2. L.C. Lichty: Internal Combustion Engines, MGH
3. E.F. Obert: Internal Combustion Engines Analysis and Practice, International Textbook Co.
4. S.J. Young and R.W.J. Pryer: The testing of Internal Combustion Engines, DV Nostrand Co.

ME613 VALUE ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Value: meaning and analysis of function, Meaning of use, esteem and exchange values

Anatomy of functions - Basic Vs Secondary Vs Unnecessary functions -Evaluating functions,

Role of Management in value engineering - Responsibilities - Organization for VE - Orientation of management - budget auditing - Merit recognition.

Value engineering techniques, Scheduling of value engineering activity, Training for value engineering, training of value engineering, Value management and Life Cycle costing.

ME614 DIRECT ENERGY CONVERSION

	L	T	P
Credit	3	0	0
Hours	3	0	0

Background of Direct Energy Conversion: Primary Energy Sources, Limitation on Energy Utilization, Principles of Energy conversion

Irreversible Thermodynamics. Unified Theory of energy Conversion

Thermoelectric Generation: Thermoelectric effect, The analysis of Thermoelectric Generator, Analysis of Thermoelectric Cooler; Figure of merit, Device configuration. Magneto-thermo-electricity

Thermionic Generation: Radiation Principles

Thermionic Generation: Thermodynamic Analysis of Thermionic Consert. The closed space High Vacuum thermoinic converter. The Low Pressure Diode. The High Pressure Cesium Converter

Photovoltaic Generator: Radiation Principles. The p-n junction as a converter, the properties desired in Semiconductor for cell use. The design of a converter, Fabrication of cell, Reliability of solar Cells

Magneto-Hydrodynamic Power Generators: Gaseous Conductor, Analysis of a M.H.D. Generator, Problem Associated with M.H.D. Power Generators

Fuel Cells: Thermodynamic Principles. The efficiency of a Fuel Cell, Types of Fuel Cells, Design Considerations

Texts/References:

ME622 APPLIED REFRIGERATION

	L	T	P
Credit	3	0	0
Hours	3	0	0

Perishable Foods and the need for processing: Perishable foods. Pre-cooling Techniques and equipment. Time temperature histories and cooling loads

Freezing: Techniques and equipment, Calculation of freezing rates

Storage: Storage requirements for foods, Design and operation of cold stores, cold storage insulations, controlled atmosphere stores

Dehydration: Convective drying and freeze drying, Heat and mass transfer during drying. Techniques and Equipments Transportation: Methods of refrigeration for land rail, sea and air transport of foods

Design of Ice Plants, water coolers and milk storage plants Heat Pumps: Types and their design

Application of Refrigeration: Manufacture and cold treatment photographic, libraries and museums. Air conditioning, fisheries, breweries, in civil engineering, etc.

Texts/References:

1. R.J. Dossat: Principles of Refrigeration, Pearson Education Asia
2. J.L. Threlkeld: Thermal Environmental Engineering, Prentice Hall
3. ASHRAE Fundamentals, 1989

ME623 COMBUSTION ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Thermodynamics of Combustion: Internal energy of reaction, enthalpy of combustion, enthalpy of formation. Bond energies. Adiabatic flame temperature. Equilibrium composition of gaseous mixtures

Chemical Kinetics : Reaction order. Complex reactions, Reaction kinetics. Kinetics of chemical chain reactions, Reaction of hydrogen with oxygen, CO with CO2

Fuels and Combustion: Solid, liquid and gaseous fuels, their combustion

Laminar Flame Propagation: Theories. premixed flames, structure of Laminar flame. Determination of burning velocities

Turbulent Flame Propagation: Theories, Structure of turbulent flame; factors effecting turbulent burning velocity

Diffusion Flames: Theories, gaseous diffusion flames, theory of turbulent diffusion flames, Jet flames

Detonation Waves in Gases: Shock wave, detonation wave, calculation of detonation velocity

Ignition: Self ignition, ignition delay, forced ignition factors affecting ignition energy

Combustion Generated Pollution: Sources, nature of pollutants, their effect on man. Vegetation and materials. Vehicular emission, emission from power plants. Control measures. Measurement techniques. Air Pollution legislation

Texts/References:

1. N.A. Chigier: energy, Combustion and Environment, MGH.
2. I. Glassman: Combustion, Academic Press.
3. A. Murthy Kanury: Introduction to Combustion Phenomena, Gordon and Breach, NY.
4. S.P.Sharma and Chandra Mohan: Fuels and Combustion, TMGH.

Minor/Supporting Courses

MED 517 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.

MED 518 TOTAL QUALITY MANAGEMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Concept and philosophy of Total Quality Management. Understanding Quality .Quality Maintenance and Quality assurance, Quality Management Systems ISO 9000, Quality Planning Strategy; Quality audit documentation and information systems, Quality of work life, Quality circles, Organising and managing employee involvement, Union involvement and managers at various management levels, Statistical and Quantitative Techniques for total Quality control and assurance of products and process, Quality function development, Taguchi methods for offline control, The need for lifestyle approach to design and evaluation, Careful need for integration of Quality of maintenance, Reliability and productivity, Integrated Technology, People, Quality and productivity for achieving higher Quality of life.

MED 523 COMPUTER AIDED MODELLING AND ANALYSIS

	L	T	P
Credit	2	0	1
Hours	2	0	2

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

Texts/References:

Reference Manuals of the relevant software.

MED 527 RELIABILITY AND MAINTENANCE ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Reliability: Meaning, scope and objectives; reliability function and overall reliability; Availability and system effectiveness. Statistical concepts for reliability: Probability distributions and their use – Normal, Log normal, Poissons,, exponential, Weibull, gamma & binomial.

Reliability of Systems: Models of reliability – series, parallel, redundant & Markov model.

Failure: Classification, causes, factors influencing failures; Failure data analysis; Failure analysis for design. General principles of design for reliability.

Risk Assessment: Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

Reliability Improvement and Simulation: Design and use of simulation models in reliability; Reliability audits.

Reliability Assessment and Testing: Reliability prediction; Reliability of mechanical and electrical systems. Reliability testing – requirement, methods and standards,

Maintenance: Maintenance information system – objectives and design; implementation ; Use of computers in maintenance. Objectives and levels of maintenance.

Maintenance practices: Unplanned & planned; Preventive & scheduled; condition based & reliability centered maintenance; Total Productive Maintenance; Maintenance planning and scheduling; Maintainability.

Organisation for Maintenance: Objectives and functions; types of structures; Manpower planning. Materials for maintenance: planning and control.

Economic aspects of Maintenance: Life cycle costing; costs associated with maintenance and optimisation. Safety and Environmental aspects of maintenance.

Texts/References:

1. R.C. Mishra: Reliability and Maintenance Engineering, New Age International Pub., New Delhi.
2. L.S. Buffa: Modern Production/Operations Management, Wiley Eastern, New Delhi
3. L.S. Shrinath: Mechanical Reliability, Affiliated East-West Press P.Ltd.
4. Modarres: Reliability and Risk analysis, Mara Dekker Inc., 1993.
5. John Davidson: The Reliability of Mechanical system, Institution of Mechanical Engineers, London, 1988.
6. Smith C.O.: Introduction to Reliability in Design, McGraw Hill, London, 1976.

MED 532 MINOR ELECTIVE

MED532(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 physical approach - An intelligent design for manufacturing system - JIT system - low inventory - modular - Modelling 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", SpringerVerlog, 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.

MED532(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

MED532(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 of 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.

MED532(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.

MED532(e) MAINTENANCE MANAGEMENT

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: General objectives, Functions; Organization and administration of maintenance systems; Requirements, Concepts and structure of suitable organizations for maintenance systems.

Failure Analysis: Analysis for source identification, Classification land selectivity of failure; Statistical and reliability concepts and models for failure analysis;

Classification of Maintenance Systems: Basis and models for various maintenance systems;

Decision Models For Maintenance Planning : Operation and Control, Optimum level of maintenance; Replacement aspects of break down and preventive types, Group and individual types, Obsolete facility, Deteriorating and completely failing facilities, Replacement vs. reconditioning, Economics of overhaul, Addition replacement models-additive damage case, Zero memory case, Partially observed situation, Planning horizon procedure. spare planning and control: Static spares, Insurance spares with and without salvage value.

Low moving spares: Manpower planning crew size, Allocation etc. stand-by machines: Economical and operational aspects: Scheduling planning of activities, Monitoring and updating, Resource allocation, Assigning priorities.

Cost Management for Maintenance: Cost estimates - Recording, Summarizing and Distributing cost data, Maintenance budget.

Other Relevant Topics: Work measurement for maintenance, Maintenance control indices, Maintenance service contracts, Preventive maintenance management-guidelines. Procedures, General management of lubrication systems, Organizing preventive maintenance

Program using vibration signature analysis, some basic ideas, Management of records for maintenance, Computerization of maintenance activities, Major plant shut-down procedures.

Texts/References

1. Higgins L.T., Morrow L.C., Maintenance Engineering Hand-Book, McGraw Hill.
2. Newborought B.T., Effective Maintenance Management, McGraw Hill.
3. Lewis G.T. and W.W. Pearson, Maintenance Management, JE Rider.
4. Kelly A. & Harris M.J, Management of Industrial Maintenance, Newness- Butterworths, London.
5. Jarding A.K., Operations Research in Maintenance, Manchestor University Press.
6. Foster J.W., Phillips D.T. and Rogers T.R., Reliability, Availability and Maintainability, MIA Press.
7. Heintzelman J.E., The Complete Handbook of Maintenance Management, Prentice Hall.

ME615 VALUE ENGINEERING AND PRODUCTIVITY

	L	T	P
Credit	3	0	0
Hours	3	0	0

Concepts of Value and Utility: Philosophy of value Analysis and Value Engineering

Techniques of Value Analysis : V.A. Job Plan, Determination of functions and functional evaluation, FAST diagram.

Application of Value Analysis : To make or buy, Elements of cost and cost classification. Maintainability and Availability

Productivity: Concepts and measurements

Productivity Analysis and Controls: Personnel-inventory and equipment

ME616 AIR-CONDITIONING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Introduction: Industrial and comfort air-conditioning human requirements, physiological principles, effective temp, applications psychrometry, air-conditioning processes and combinations supply air state and rate

Cooling and Dehumidification: Cooling dry and wet coils, chilled water spray, air washers and evaporative cooling, by- pass factor, chemical dehumidification

Heating and Humidification : Heating by coils and heated spray humidification air, system analysis of heating and cooling processes

Year Round controller, Psychrometry of automatic control of room conditions, dehumidification preheating and year round control

Load Calculations: Solar radiation on building, solar angle and calculation of solar incidence, heat gain calculation of air-conditioning

Ventilations : General principles of natural and mechanical ventilation, air cleaning and the equipment used

Effects of Thermal Environment: Thermal exchanges of body with environment, .body regulating processes, comfort air-conditioning, Industrial thermal environment

Design: Detailed design of air-conditioning systems, involving equipment selection for year round control of conditions, designs of air distribution systems, plant room layout, fan and pumps

Texts/References:

1. ASHRAE Handbook: Fundamentals
2. ASHRAE Handbook: HVAC Systems and Equipments
3. J.L. Threlkeld: Thermal Environmental Engineering, Prentice Hall

ME624 REFRIGERATION ENGINEERING

	L	T	P
Credit	3	0	0
Hours	3	0	0

Vapour Compression Refrigeration Systems: Review of vapour and air refrigeration systems. Theoretical and actual Cycles. Multi-stage systems and various combination, Cascade refrigeration systems. Properties of refrigerants and secondary refrigerants

Vapour Absorption Systems: Developments, Theory of Mixtures and some processes. Use of charts. Principal of operating line, Ammonia-Water systems. Lithium Bromide-water systems. Three fluid absorption systems

Other Refrigeration Systems: Water refrigeration, centrifugal refrigeration, steam jet refrigeration. Vortex tube and Pulse tube refrigeration systems, Thermoelectric systems, Production of dry Ice (solid carbon di-oxide)

Cryogenics: Minimum work required to liquefy a gas, cooling by expansion. Linde and Claude air liquefaction cycles and their analysis. Separation of air, liquefaction of hydrogen and helium

Refrigeration Equipment: Evaporators, compressors, condensers Expansion devices, Ducts, etc. Design of above equipments. Balancing of components of refrigeration systems, control and production devices

Texts/References:

1. Dossat: Principles of Refrigeration, Pearson Education
2. R. Barron: Cryogenic Systems, MGH

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, DhapatRai& 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.

COMPULSORY NON-CREDIT COURSES

(Compulsory for Master's programme in all disciplines; Optional for Ph.D. scholars)

PGS 501:LIBRARY AND INFORMATION SERVICES

	L	T	P
Credit	0	0	1
Hours	0	0	2

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources. to carry out literature survey. to formulate information search strategies. and to use modern tools (Internet OPAC. search engines etc.) of information search.

Practical

Introduction to library and its services: Role of libraries in education. research and technology transfer: Classification systems and organization of library; Sources of information-Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index. Biological Abstracts. Chemical Abstracts. CABI Abstracts, etc.); Tracing information from reference sources: Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases. Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

PGS 502 TECHNICAL, WRITING AND COMMUNICATIONS SKILLS

	L	T	P
Credit	0	0	1
Hours	0	0	2

Objective

To equip the students/scholars with skills to write dissertations. research papers, etc. To equip the students/scholars with Skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings- thesis, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship, contents page, preface, introduction, review of literature, material and methods, experimental results and discussion), Writing of abstracts, summaries, precis, citations etc.; commonly used abbreviations in the thesis and research communications: illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof reading; Writing of a review article.

Communications Skills - Grammar (Tenses. parts of speech, clauses. Punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription: Accentual pattern: Weak, forms in connected speech: Participation in group discussion: Facing 211, lnterview, presentation of scientific papers.

Suggested Readings

1. Chicago Manual of Style. 14.h Ed. 1996. Prentice Hall of India.
2. Collins' Cobuild English Dictionary , 1995. Harper Collins.
3. Gordon HM & Walter .J A. 1970. Technical Writing-. 3 rd Ed. Holt. Rinehart & Winston.
4. Hornby AS. 2000. Comp. Oxford Advanced Learner's Dictionary, of Current English. 61 Ed. Oxford University Press.
5. James HS. 1994. Handbook for Technical Writing,. NTC Business Books.
6. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
7. Mohan K. 2005, Speaking English Effectively MacMillan India.
8. Richard WS. 1969. Technical writing. Barnes & Noble.
9. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language, Abhishek.
10. Sethi J & Dhamija PV. 2004. Course in Phonetics and Spoken English. 2nd Ed. Prentice Hall of India.
11. Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PCS 503 INTETELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

	L	T	P
Credit	1	0	0
Hours	1	0	0

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection system; their significance and use of' IPR as a tool for wealth and value creation in a knowledge-based economy. Theory Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents. copyrights, geographical indications, designs and layout. trade secrets and traditional knowledge. trademarks. protection of plant varieties and farmers' rights and Biodiversity protection, Protectable subject matters, protection in biotechnology, protection of other biological materials. ownership and period of protection; National Biodiversity protection initiatives: Convention on Biological Diversity: International Treaty on Plant Genetic. Resources for Food and Agriculture; Licensing of technologies. Material transfer agreements. Research collaboration Agreement. License Agreement.

Suggested Readings

Erbisch FH & Maredia K.1998. Intellectual Property Rights Agricultural technology. CABI