DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, UTTAR PRADESH, LUCKNOW

Syllabus

For

M.Tech. (Mechanical Engineering)

(Effective from the Session: 2016-17)

Dr. A.P.J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh

COURSE STRUCTURE AND EVALUATION SCHEME FOR
M.TECH - MECHANICAL ENGINEERING
(EFFECTIVE FROM THE SESSION: 2016-17)

Semester -I

S. No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
							Theory			Practical		
			L	T	P		CT	TA	ESE	TA	ESE	
1	MTME 101	Simulation, Modelling & Analysis	3	0	0	3	20	10	70	--	--	100
2	MTME 102	Operations Research	3	0	0	3	20	10	70	--	--	100
3	MTME 01?	Departmental Elective-I	3	0	0	3	20	10	70	--	--	100
4		Departmental Elective-II	3	0	0	3	20	10	70	--	--	100
5		Research Process & Methodology	3	0	0	3	20	10	70	--	--	100
6	MTME 151	Simulation Modeling & Analysis Lab	--	--	3	2	--	--	--	20	30	50
7	MTME 152	Operations Research Lab	--	--	2	1	--	--	--	20	30	50
		Total				18						**600**

Departmental Elective–I	MTME 011	CAD/CAM
	MTME 012	Advanced Heat & Mass Transfer
	MTME 013	Renewable Energy System
	MTME 014	Reliability, Maintenance Management & Safety

Departmental Elective–II	MTTE 021	Turbo Machines
	MTME 021	Advanced Mechanical Vibrations
	MTTE 023	Advanced I.C. Engines
	MTME 022	Fracture Mechanics

Semester –II

S. No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
	MTME 201	Computer Integrated Manufacturing (CIM)	3	0	0	3	20	10	70	--	--	100
1	MTME 202	Advanced Mechanics Of Solids	3	0	0	3	20	10	70	--	--	100
3		Departmental Elective-III	3	0	0	3	20	10	70	--	--	100
4	MTME 04?	Departmental Elective-IV	3	0	0	3	20	10	70	--	--	100
5	MTME 05?	Elective -V	3	0	0	3	20	10	70	--	--	100
6	MTME 251	Computer Integrated Manufacturing (CIM) Lab	--	--	3	2	--	--	--	20	30	50
7	MTME 252	Seminar-I	--	--	--	1	--	--	--	50	--	50
		Total				18						**600**

Departmental Elective – III	MTME 031	Advanced Finite Element Analysis
	MTME 032	Industrial Automation And Robotics
	MTME 033	Advanced Welding Technology
	MTTE 202	Computational Fluid Dynamics

Departmental Elective – IV	MTME 041	Optimization Techniques & Design Of Experiments
	MTME 042	Total Quality Management
	MTME 043	Advanced Mechanical Design
	MTME 044	Management Information System

Elective – V	MTME 051	Flexible Manufacturing System
	MTME 052	Machine Vision
	MTME 053	Additive Manufacturing And Tooling
	MTME 054	Modern Manufacturing Process

Semester – III

S. No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1	MTME 352	Seminar-II	0	0	6	3	--	--	--	100	--	100
2	MTME 351	Dissertation	0	0	30	15	--	--	--	200	300	500
		Total				18						**600**

Semester – IV

S. No.	Subject Code	Name of the Subject	Periods			Credit	Evaluation Scheme					Subject Total
			L	T	P		Theory			Practical		
							CT	TA	ESE	TA	ESE	
1	MTME 451	Dissertation (Final)	0	0	36	18	--	--	--	200	400	600
		Total				18						**600**

SIMULATION, MODELLING & ANALYSIS

MTME 101 **L T P**
3 0 0

Introduction: Simulation: a tool, advantages and disadvantages of simulation, areas of application, systems and system environment, components of a system, discrete and continuous systems, discrete event system simulation.
General Principles: Concepts in discrete event simulation, time advance algorithm, manual simulation using event scheduling, basis properties and operations.

Models In Simulation: Terminology and concepts, statistical models: queuing systems; inventory systems; reliability and maintainability, limited data, discrete distributions: Bernoulli distribution; Bionomial distribution; Geometric distribution, continuous distribution: Uniform distribution; Exponential distribution; Gamma distribution; Normal distribution; Weibull distribution; Triangular Distribution; Lognormal distribution, poisson process,

Queueing Models: Characteristics of queuing systems, the calling population, system capacity, arrival process, service mechanism, queuing notations, long run measures of performance of queuing systems, server utilization in G/G/1/∞/∞ queues, server utilization in G/G/C/∞/∞ queues, server utilization and system performance, costs in queuing problems, Larkovian models.

Random Number Generation: Properties of random numbers, Pseudo random numbers, techniques of generating random numbers, tests of random numbers.
Random Variate Generation: Inverse transform technique, Direct transformation for the Normal and Lognormal distribution, Convolution Method, Acceptance rejection technique.

Input Modelling And Validation: Steps in the development of model, data collection, Distribution identification, Parameter estimation, Goodness of Fit Tests,selecting input models without data, verification and validation of simulation models.

Books:
1. Simulation Modelling and Analysis by Law and Kelton, Mc Graw Hill.
2. Simulation Model Design& execution by Fishwich, Prentice Hall.
3. Discrete event system simulation by Banks, Carson, Nelson and Nicol.

OPERATIONS RESEARCH

MTME 102 **L T P**
3 0 0

Introduction: definition and scope of OR; Techniques and tools; Model formulation; general methods for solution; Classification of optimization problems; Optimization techniques.

Linear Optimization Models: Complex and revised simplex algorithms; Duality theorems, sensitivity analysis; Assignment, transportation and transshipment models; Traveling salesman problem as an Assignment problem; Integer and parametric programming; Goal programming.

Game Problems: Mini-max criterion and optimal strategy; Two person zero sum game; Games by simplex dominance rules.

Waiting Line Problems: Classification of queuing situations; Kendall's notation, Poisson arrival with exponential or Erlang service time distribution; Finite and infinite queues; Optimal service rates; Application
of queuing theory to industrial problems.

Dynamic Programming: Characteristic of dynamic programming problems (DPPs); Bellman's principle of optimality; Problems with finite number of stages; Use of simplex algorithm for solving DPPs.

Non-linear Programming: One dimensional minimization methods; Unconstrained optimization techniques; Optimization techniques characteristics of a constrained problem; Indirect methods; Search and gradient methods.

Books:

1. Operations Research, H.A. Taha, Prentice Hall
2. Engg. Optimization, S.S. Rao, New Age Publication

SIMULATION, MODELLING & ANALYSIS LAB

MTME 151 **L T P**
0 0 3

1. Study of simulation software Like ARENA , MATLAB.
2. Simulation of translational and rotational mechanical systems
3. Simulation of Queuing systems
4. Simulation of Manufacturing System
5. Generation of Random number
6. Modeling and Analysis of Dynamic Systems
7. Simulation mass spring damper system
8. Simulation of hydraulic and pneumatic systems.
9. Simulation of Job shop with material handling and Flexible manufacturing systems
10. Simulation of Service Operations

OPERATIONS RESEARCH LAB

MTME 152 **L T P**
0 0 2

1. Using queuing theory method to solve a given facility design problem.
2. Writing a program to solve a sequencing problem.
3. Using Monte Carlo simulation to solve a given problem.
4. Solving a given product mix problem.
5. Optimizing weight of a given truss or any machine element.
6. To optimize operational time by using Genetic Algorithm method.
7. To optimize system reliability by using simulated annealing method.
8. Optimization of maintenance time by using artificial neural network method.
9. Optimization of transport cost by using transportation problem.
10. Optimization of life cycle costing

DEPARTMENTAL ELECTIVE-I

CAD/CAM

MTME 011

L	T	P
3	0	0

Mathematical Elements, CAD, Solid modeling methods, Database structures for CAD, CSG formulation, B-rep and wire frame methods, Intersection surface generation methods, Boundary file generation methods, Feature based modeling systems, Surface modeling, B- splines, Coons and Bezier surfaces, NURBS and surface patches, fitting surfaces for arbitrary digested points, Offset surfaces, Fillet surfaces, Sewn surfaces.
Features recognition from the databases, IGES, STEP, PDES, and DXF data exchange formats, Graphic standards for CAD/CAM such as GKS, PHIGS and VDI.

Concurrent engineering integration of manufacturing principles and analytical principles in design, Manufacturing
information generation from CAD data, Planar sectioning, Penalty functions, cavity milling, Optimization of cutter path, Effect of tool profile geometry, Methods for multi-axis machining, Methods for software design for CAD/CAM system, use of software libraries, Development of software package for a specific problem as part of course using software libraries.

Introduction to automation, CAM/CIM, Part programming, Interpolator & Control.

Books:

1. Computer Graphics D Hearn & M P Baker Prentice Hall
2. CAD/CAM Theory and Practice Ibrahim Zeid & R Sivasubramanian Tata McGraw-Hill
3. Mathematical Elements for Comp. Graphics D F Rogers and J A Adams McGraw-Hill International
4. Computer Aided Engineering & Design Jim Browne New ATC International
5. The Engineering Database D.N. Chorafas and S.J. Legg Butterworths
6. Principles of CAD J Rooney &P Steadman Longman Higher Education
7. CAD/CAM H P Groover and E W Zimmers Prentice Hall
8. Computer Integrated Design and Manufacture D Bedworth, M Henderson & P Wolfe MacGraw Hill Inc.

ADVANCED HEAT & MASS TRANSFER

MTME 012

L	T	P
3	0	0

Review: Reviews of basic laws of Conduction, Convection and Radiation

Conduction: One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source, Local heat source in non-adiabatic plate, Thermocouple conduction error, Extended Surfaces-Review, Optimum fin of rectangular profile, straight fins of triangular and parabolic profiles, Optimum profile, Circumferential fin of rectangular profile, spines, design considerations. 2D steady state conduction, semi-infinite and finite flat plates, Temperature fields in finite cylinders and in infinite semi-cylinders, spherical shells, Graphical method, relaxation technique. Unsteady state conduction, Sudden changes in the surface temperatures of infinite plates, cylinders and spheres using Groeber's and Heisler charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation: Review of radiation principles, Diffuse surfaces and the Lambert's cosine law. Radiation through non-absorbing media, Hottel's method of successive reflections, Gebhart's unified method, Poljak's method. Radiation through absorbing media, Logarithmic decrement of radiation, Apparent absorptive of simple shaped gas bodies, Net heat exchange between surfaces separated by absorbing medium, Radiation of luminous gas flames.

Convection: Heat transfer in laminar flow, free convection between parallel plates, Forced internal flow through circular tubes, Fully developed flow, Velocity and thermal entry length, solutions with constant wall temperature and with constant heat flux, Forced external flow over a flat plate, two-dimensional velocity and temperature boundary layer equations, Karman Pohlhousen approximate integral method. Heat transfer in turbulent flow, Eddy heat diffusivity, Reynold's analogy between skin friction and heat transfer, Prandtl-Taylor, Von Karman and Martineli's analogies, Turbulent flow through circular tubes.

REFERENCES:

1. Principals of Heat Transfer/Frank Kreith/Cengage Learning
2. Elements of Heat Transfer/E. Radha Krishna/CRC Press/2012
3. Heat Transfer/RK Rajput/S.Chand
4. Introduction to Heat Transfer/SK Som/PHI
5. Engineering Heat & Mass Transfer/Mahesh Rathore/Lakshmi Publications
6. Heat Transfer / Necati Ozisik / TMH
7. Heat Transfer / Nellis & Klein / Cambridge University Press / 2012.
8. Heat Transfer/ P.S. Ghoshdastidar/ Oxford Press
9. Engg. Heat & Mass Transfer/ Sarit K. Das/Dhanpat Rai

RENEWABLE ENERGY SYSTEM

MTME 013

L	T	P
3	0	0

Introduction: Energy and Development; Energy demand and availability; Energy crisis; Conventional and Nonconventional energy; Renewable and Non-renewable energy resources; Environmental impacts of conventional energy usage; Basic concepts of heat and fluid flow useful for energy systems.

Solar Energy Systems: Solar radiations data; Solar energy collection, Storage and utilization; Solar water heating; air heating; Power generation; Refrigeration and Air-conditioning; Solar Energy system Economics.

Micro and Small Hydro Energy Systems: Resource assessment of micro and small hydro power; Micro, mini and small hydro power systems; Economics; Pump and turbine; Special engines for low heads; Velocity head turbines; Hydrams; Water mill; Tidal power.

Bio mass Energy Systems: Availability of bio mass-agro, forest, animal, municipal and other residues; Bio mass
conversion technologies; Cooking fuels; Biogas; producer gas; Power alcohol from biomass; Power generation; Internal engine modifications and performance; system economics.

Wind Energy Systems: Wind data; Horizontal and vertical axis wind mills; Wind farms; Economics of wind energy.

Integrated Energy Systems: Concept of integration of conventional and non-conventional energy resources and systems; Integrated energy system design and economics.

Books:

1. Energy Efficient Buildings in India Mili Majumdar Tata Energy Research Institute
2. Understanding Renewable Energy Systems Volker Quaschning -
3. Renewable Energy Systems Simmoes Marcelo Godoy CRC Press
4. Renewable Energy Resources John Twidell Taylor and Francis
5. Renewable Energy Sources and Their Environmental Impact Abbasi & Abbasi Prentice Hall of India

RELIABILITY, MAINTENANCE MANAGEMENT & SAFETY

MTME 014

L	T	P
3	0	0

Reliability Engineering: System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models. Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Optimization, Reliability – Cost trade off, Prediction and analysis, Problems.

Maintainability, Availability & Failure Analysis: Maintainability & Availability – Introduction, formulae, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability, simple problems, Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

Maintenance Planning and Replacement: Maintenance planning – Overhaul and repair; Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

Maintenance Systems: Fixed time maintenance, Condition based maintenance, Operate to failure, Opportunity
maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

Condition Monitoring: Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant
monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis, Control structure for machine diagnosis.

Safety Aspects: Importance of safety, Factors affecting safety, Safety aspects of site and plant, Hazards of commercial chemical reaction and operation, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

Books:

1. Concepts in Reliability Engineering L.S. Srinath Affiliated East West Press
2. Maintainability and Reliability Handbook Editors: Ireson W.A. and C.F. Coombs McGraw Hill Inc.
3. Failure Diagnosis and Performance Monitoring L.F. Pau Marcel Dekker
4. Industrial Maintenance Management S.K. Srivastava S. Chand & Co Ltd.
5. Management of Industrial Maintenance Kelly and M.J. Harris Butterworth and Co.
6. Maintenance, Replacement and Reliability A.K.S. Jardine Pitman Publishing
7. Engineering Maintainability: How to Design for Reliability and Easy Maintenance B.S. Dhillon Prentice Hall of India

DEPARTMENTAL ELECTIVE-II

TURBO MACHINES

MTTE 021 **L T P**
3 0 0

FUNDAMENTALS OF TURBO MACHINES: Classifications, Applications, Thermodynamic analysis, Isentropic flow. Energy transfer. Efficiencies, Static and Stagnation conditions, Continuity equations, Euler's flow through variable cross sectional areas, Unsteady flow in turbo machines

STEAM NOZZLES: Convergent and Convergent-Divergent nozzles, Energy Balance, Effect of back pressure of analysis. Designs of nozzles.
Steam Turbines: Impulse turbines, Compounding, Work done and Velocity triangle, Efficiencies, Constant reactions, Blading, Design of blade passages, Angle and height, Secondary flow. Leakage losses, Thermodynamic analysis of steam turbines.

GAS DYNAMICS: Fundamental thermodynamic concepts, isentropic conditions, mach numbers and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Super sonic flow, oblique shock waves. Normal shock recoveries, Detached shocks, Aerofoil theory.
Centrifugal compressor: Types, Velocity triangles and efficiencies, Blade passage design, Diffuserand pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

AXIAL FLOW COMPRESSORS: Flow Analysis, Work and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Drgree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance
Cascade Analysis: Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

AXIAL FLOW GAS TURBINES: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifels relation, Design cascade analysis, Soderberg, Hawthrone, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, Off design performance.

REFERENCES:

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Fundamentals of Turbomachinery/William W Perg/John Wiley & Sons
3. Element of Gas Dynamics/Yahya/TMH
4. Principles of Jet Propulsion and Gas Turbine/NJ Zucrow/John Wiley & Sons/Newyork
5. Turbines, Pumps, Compressors/Yahya/TMH
6. Practice on Turbo Machines/ G.Gopal Krishnan & D.Prithviraj/ Sci Tech Publishers, Chennai
7. Theory and practice of Steam Turbines/ WJ Kearton/ELBS Pitman/London
8. Gas Turbines Theory and Practice/Zucrow/John Wiley & Sons/Newyork
9. Element of Gas Dynamics/Liepeman and Roshkow/ Dover Publications

ADVANCED MECHANICAL VIBRATIONS

MTME 021

L	T	P
3	0	0

Introduction: Characterization of engineering vibration problems, Review of single degree freedom systems with free, damped and forced vibrations

Two-degree of Freedom Systems: Principal modes of vibration, Spring coupled and mass coupled systems, Forced vibration of an undamped close coupled and far coupled systems, Undamped vibration absorbers, Forced damped vibrations, Vibration isolation.

Multi-degree Freedom systems: Eigen-value problem, Close coupled and far coupled systems, Orthogonality of mode shapes, Modal analysis for free, damped and forced vibration systems, Approximate methods for fundamental frequency- Rayleigh's, Dunkerely, Stodola and Holzer method, Method of matrix iteration, Finite element method for close coupled and far coupled systems.

Continuous systems: Forced vibration of systems governed by wave equation, Free and forced vibrations of beams/ bars

Transient Vibrations: Response to an impulsive, step and pulse input, Shock spectrum

Non-linear Vibrations: Non-linear systems, Undamped and forced vibration with non-linear spring forces, Self-excited vibrations.

Books:

1. Theory and practice of Mechanical Vibrations J.S. Rao and K. Gupta New Age International
2. Mechanical Vibrations G.K. Groover Nem Chand & Brothers
3. Mechanical Vibration Practice V. Ramamurti Narosa Publications
4. Mechanical Vibrations V.P. Singh Dhanpat Rai & sons
5. Textbook of Mechanical Vibrations R.V. Dukkipati & J. Srinivas Prentice Hall of India

ADVANCED I.C. ENGINES

MTTE 023

L	T	P
3	0	0

Introduction to Different types of IC Engine Systems.

Classification, Construction, Valve arrangements, Fuels, Properties of fuels, Rating of fuels, Alternative fuels, Fuel air cycle, Actual cycles, Combustion in SI engines, Combustion in CI engines, Effect of engine variables, Combustion chambers, Carburation and fuel injection, Knocking, Engine cooling, Friction and lubrication, Supercharging, Turbocharging, Boost control, Testing and performance, Pollution due to engines.

Design for SI and CI Engines.

Books:

1. Internal Combustion Engines: Applied Thermo sciences Ferguson Colin R John Wiley
2. Fundamentals of Internal Combustion Engines H.N. Gupta Prentice Hall
3. Internal Combustion Engines SK Agrawal New Age international
4. Engineering Fundamentals of the Internal Combustion Engine WW Pulkrabek Prentice Hall of India

FRACTURE MECHANICS

MTME 022

L	T	P
3	0	0

Introduction and overview, Concepts of fracture mechanics and strength of materials, Elements of solid mechanics, Elasticity and plasticity, Incremental plasticity and deformation theory.

Elastic crack-tip fields, Basic concepts of linear elastic fracture mechanics, Griffth's theory, stress intensity factor, Energy release rate, Plastic zone and fracture toughness, path invariant integrals and numerical approach.

Plastic crack-tip fields, Mode-I fields and fracture criterion, Engineering approach to plastic fracture, J-integral approaches and numerical concepts, Tearing modulus, Time dependent fracture, non-linear aspects of fatigue crack growth, Theoretical models, Fatigue cracks in welds, standard tests and testing procedures.

Brittle fracture of welded structures, Notch toughness, weld cracks and joint restrains, Weld defects and service behaviour, Application of fracture mechanics concepts and limitations, Weld cracking tests and elimination of joint restraints, Residual stress and its interaction in fracture behaviour, Numerical approaches for estimation of fracture parameters.

Books:

1. Fracture Mechanics: Fundamentals and Applications Anderson, T. L CRC Press
2. Mechanical Behavior of Materials: Engineering Methods for Deformation, Fracture, and Fatigue Dowling, Norman E Dowling Prentice Hall
3. Advanced Fracture Mechanics Kanninen, Melvin F Popelar, Carl H Oxford University Press
4. Analytical Fracture Mechanics Unger, David J Dover Publications

COMPUTER INTEGRATED MANUFACTURING (CIM)

MTME 201

L	T	P
3	0	0

Introduction to CNC Machine Tools: Development of CNC Technology-Principles and classification of CNC machines, Advantages & economic benefits, Types of control, CNC controllers, Characteristics, Interpolators, Applications, DNC concept.

CNC Programming: Co-ordinate System, Fundamentals of APT programming, Manual part programming-structure of part programme, G & M Codes, developing simple part programmes, Parametric programming, CAM packages for CNC machines-IDEAS, Unigraphics, Pro Engineer, CATIA, ESPIRIT, MasterCAM etc., and use of standard controllers-FANUC, Heidenhain and Sinumeric control system.

Tooling for CNC Machines: Cutting tool materials, Carbide inserts classification; Qualified, semi-qualified and preset tooling, Cooling fed tooling system, Quick change tooling system, Tooling system for machining centre and turning center, tool holders, Tool assemblies, Tool magazines, ATC mechanisms, Tool management.

Robotics and Material Handling Systems: Introduction to robotic technology, and applications, Robot anatomy,
material handling function, Types of material handling equipment, Conveyer systems, Automated guided vehicle systems, Automated storage/retrieval systems, Work-in-process storage, Interfacing handling and storage with manufacturing.

Group Technology and Flexible Manufacturing System: group Technology-part families, Parts classification and coding, Production flow analysis, Machine Cell Design, Benefits of Group Technology, Flexible manufacturing systems- Introduction, FMS workstations, Computer control system, Planning for FMS, Applications and benefits.

Computer Integrated Manufacturing: Introduction, Evaluation of CIM, CIM hardware and software, Requirements of computer to be used in CIM system, Database requirements, Concurrent engineering-Principles, design and development environment, advance modeling techniques.

Books:

1. Computer Numerical Control Machines P. Radahkrishnan New Central Book Agency
2. CNC Machines M.S. Sehrawat and J.S. Narang Dhanpat Rai and Co.
3. CNC Programming Handbook Smid Peter Industrial Press Inc.
4. Automation, Production systems and Computer M.P. Groover Prentice Hall of India Integrated Manufacturing
5. Computer Integrated Manufacturing Paul Ranky Prentice Hall of India

ADVANCED MECHANICS OF SOLIDS

MTME 202

L	T	P
3	0	0

Mathematical Preliminaries: Scalars, vectors and matrix variables, index notation and the related rules, Cartesian tensors and their algebra, coordinate transformation, transformation rules for the *n*th order tensors, elements of tensor calculus and the related theorems (divergence, Stokes' and Green's), principal value theorem, eigenvalues and eigenvectors, invariants of a 2nd order tensor.

Kinetics of Deformation: Types of forces (point, surface and body), traction vector, state of stress at a point, Cauchy's relation and its proof, conservation of linear and angular momentum, stress equilibrium equations, symmetry of stress tensor, stress transformation, principal stresses and the associated planes, 3D Mohr's circle representation, planes of maximum shear, octahedral planes, hydrostatic and deviatoric stress, first and second Piola-Kirchoff stress tensors and their properties.

Kinematics of Deformation: Material and spatial co-ordinates, Eulerian and Lagrangian description of motion; deformation and displacement gradients, Green-Lagrange and Almansi strain tensor; Cauchy's small strain tensor and the rotation tensor, geometrical interpretation of strain components and sign convention, principal strains and directions, strain invariants, octahedral strain, maximum shear strain, volumetric strain, strain compatibility equations.

Constitutive Modeling: Thermodynamic principles, first and second law of thermodynamics, Generalized Hooke's law for isotropic materials, elastic constants and their relations, anisotropic, hyperelastic and viscroelastic material models, strain hardening, constitutive relations for elasto-plastic materials, flow and hardening rules.

Boundary Value Problems in Linear Elasticity: Field equations and boundary conditions, Navier equations, Beltrami-Michell stress compatibility conditions, 2D approximations (plane stress and plane strain) and solution strategies.

Variational Principles in Solid Mechanics: Elements of variational calculus, extremum of a functional, Euler-Lagrange equation and its application, types of boundary conditions, principle of virtual work, Principle of total potential energy and complementary potential energy, Ritz method, time-dependent problems and Hamilton's principle for continuum.

Name of Authors/ Books / Publisher

Sadd, M.H., "Elasticity Theory Applications and Numerics", Elsevier Academic Press.
Boresi, A.P., Sidebottom, O. M., "Advanced Mechanics of Materials", 5th Ed., John Wiley and Sons
Singh, A.K., "Mechanics of Solids", PHI Learning Private Limited
Timoshenko, S.P., and Goodier, J.M., "Theory of Elasticity", 3rd Ed., McGraw Hill
Srinath, L.S., "Advanced Mechanics of Solids",Tata McGraw Hill Education Private Limited
Fung, Y.C., " Foundations of Solid Mechanics", Prentice Hall Inc.

COMPUTER INTEGRATED MANUFACTURING LAB

MTME 251

L	T	P
0	0	3

1. 3D Modeling using CAD software.
2. CNC programming on turning.
3. CNC programming on milling.
4. Simulation of CNC programming on CAM Software
5. Study and demonstration on Robots.
6. Basic Robot Programming and Simulation.
7. Study of computer controlled business functions.
8. Study of interfacing requirements in CIMS.
9. Generation of any surface using any CAD software.
10. Design/ Thermal Analysis by CAD Software.

EPARTMENTAL ELECTIVE-III

ADVANCED FINITE ELEMENT ANALYSIS

MTME 031

L	T	P
3	0	0

Introduction to Finite Difference Method and Finite Element Method, Advantages and disadvantages, Mathematical formulation of FEM, Variational and Weighted residual approaches, Shape functions, Natural co-ordinate system, Element and global stiffness matrix, Boundary conditions, Errors, Convergence and patch test, Higher order elements.

Application to plane stress and plane strain problems, Axi-symmetric and 3D bodies, Plate bending problems with
isotropic and anisotropic materials, Structural stability, Other applications e.g., Heat conduction and fluid flow problems.

Idealisation of stiffness of beam elements in beam-slab problems, Applications of the method to materially non-linear problems, Organisation of the Finite Element programmes, Data preparation and mesh generation through computer graphics, Numerical techniques, 3D problems, FEM an essential component of CAD, Use of commercial FEM packages, Finite element solution of existing complete designs, Comparison with conventional analysis.

Books:

1. The Finite Element Method O.C. Zienkiewicz and R.L. Taylor McGraw Hill
2. An Introduction to Finite Element Method J. N. Reddy McGraw Hill
3. Finite Element Procedure in Engineering Analysis K.J. Bathe McGraw Hill
4. Finite Element Analysis C.S. Krishnamoorthy Tata McGraw Hill
5. Concepts and Application of Finite Element Analysis R.D. Cook, D.S. Malcus and M.E. Plesha John Wiley
6. Introduction to Finite Elements in Engineering T.R Chandragupta and A.D. Belegundu Prentice Hall India
7. Finite Element and Approximation O.C. Zenkiewicy & Morgan

INDUSTRIAL AUTOMATION AND ROBOTICS

MTME 032

L	T	P
3	0	0

Introduction to Automation: Automation production system, Mechanization and automation, Types of automation, Automation strategies, Mechanical, electrical, hydraulic and Pneumatic automation devices and controls, Economics of automation.

High Volume Manufacturing Automation: Classification and type of automatic transfer machines; Automation in part handling and feeding, Analysis of automated flow lines, design of single model, multimodel and mixed model production lines.

Programmable Manufacturing Automation: CNC machine tools, Machining centers, Programmable robots, Robot time estimation in manufacturing operations.

Flexible Manufacturing Automation: Introduction to Group Technology, Grouping methods, Cell Design, Flexible manufacturing system.

Assembly Automation: Assembly systems, Automatic transfer, feeding and orienting devices, Flexible assembly systems, Performance evaluation and economics of assembly systems.

Robotics: Review of robotic technology and applications, Laws of robotics, Robot systems and anatomy, Robot
classification, End Effectors, Robot kinematics, Object location, Homogeneous transformation, Direct and inverse
kinematics, Manipulator motions, Robot drives, actuators and control, Drive systems, Hydraulic, Pneumatic Electrical DC and AC servo motors and stepped motors, Mechanical transmission method-Rotary-to-rotary motion conversion, Robot motion and path planning control and Controllers, Robot sensing, Range sensing, Proximity sensing, touch sensing, Force and torque sensing etc., Robot vision, Image representation, Image recognition approaches.

Robot Applications: Robot applications in manufacturing-Material transfer and machine loading/unloading, Processing operations like Welding & painting, Assembly operations, Inspection automation, Robot cell design and control, Robot cell layouts-Multiple robots & Machine interference, Economics and social aspects of robotics, Future applications.

Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Prentice Hall India
2. Principles of Automation & Automated Production Process Malov and Ivanov Mir Publication
3. Automation in Production Engineering Oates and Georgy Newness -
4. Stochastic Models of Manufacturing Systems Buzacott & shanty Kumar Prentice Hall India
5. Robotics K.S. Fu, R.C. Gonzalez, C.S.G. Lee McGraw Hill
6. Robotics J.J. Craig Addison-Wesely
7. Robot Engineering: An Integrated Approach R.D. Klafter, t.a. Chmielewski and M. Negin Prentice

ADVANCED WELDING TECHNOLOGY

MTME 033

L	T	P
3	0	0

Welding Metallurgy: Welding as compared with other fabrication processes, Classification of welding processes; Heat affected zone and its characteristics; Effects of alloying elements on weldability, Weldability of steels, stainless steel, cast iron, and aluminum and titanium alloys, Weld testing standards, Hydrogen embrittlement, Lammellar tearing, residual stresses and its measurement, heat transfer and solidification, Analysis of stresses in welded structures, Pre and post welding heat treatments, Metallurgical aspects of joining, Conditions of soldering, Brazing and welding of materials.

Weld Design & Quality Control: Principles of sound weld design, Welding joint design, Welding defects; Testing of weldament, Material joining characteristics, Welding positions, Allowable strength of welds under steady loads, Weld throat thickness; Weld quality, Discontinuities in welds, their causes and remedies and quality conflicts.

Modern Trends in Welding: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Plasma arc welding, Laser welding.

Mechanisation in Welding: Mechanisation of flat/circular joints, Thin/thick sheets (resistance/arc weld), Mechanisation of I beams (arc weld), Longitudinal circumferential SA welding (roller blocks, column booms, flux supports), Circular/spherical welding joints (rotating tables positioners), Manufacture of welding longitudinal welded pipes by induction, TIG, Plasma and SA welding of spiral welded pipes.

Robotics in Welding: Robot design and applications in welding, Programming of welding robots, tolerances for
assemblies for robot welding, New generation of welding robots, Self alignment by current arc variation, Robots for car body welding, Microelectronic welding and soldering, Efficiency of robotics in welding.

Books:

1. Advanced Welding Processes Nikodaco & Shansky MIR Publications
2. Welding Technology and Design VM Radhakrishnan New Age International
3. Source Book of Innovative welding Processes M.M. Schwariz Americal Society of Metals (Ohio)
4. Advanced Welding Systems, Vol. I, II, III J. Cornu Jaico Publishers
5. Manufacturing Technology (Foundry, Forming and Welding) P.N. Rao Tata McGraw Hill

COMPUTATIONAL FLUID DYNAMICS

MTTE 202

L	T	P
3	0	0

Introduction, Conservation equation, Mass Momentum and Energy equations, Convective form of the equation and general description.

Clarification into various types of equation, Parabolic, Elliptic, Boundary and initial conditions, Overview of numerical methods.

Finite difference methods; Different means for formulating finite difference equations, Taylor series expansion, Integration over element, Local function method; Finite volume methods; Central, upwind and hybrid formulations and comparison for convection-diffusion problem, Treatment of boundary conditions; Boundary layer treatment; Variable property, Interface and free surface treatment, Accuracy of F.D. method.

Solution of finite difference equations; Iterative methods; Matrix inversion methods, ADI method, Operator splitting, Fast Fourier Transform applications.3

Phase change problems, Rayleigh-Ritz, Galerkin and Least square methods; Interpolation functions, One and two
dimensional elements, Applications. Phase change problems; Different approaches for moving boundary; Variable time step method, Enthalpy method.

Books:

1. Computational Methods for Fluid Dynamics Ferziger Joel H Springer-Verlog
2. Principles of Heat Transfer Kaviany M Wiley-International
3. Radiative Heat Transfer Modest Michael Academic Press
4. Middleman Stanley John Wiley

DEPARTMENTAL ELECTIVE-IV

OPTIMIZATION TECHNIQUES & DESIGN OF EXPERIMENTS

MTME 041 **L T P**
3 0 0

SINGLE VARIABLE NON-LINEAR UNCONSTRAINED OPTIMITION: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

MULTI VARIABLE NON-LINEAR UNCONSTRAINED OPTIMIZATION: Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

GEOMETRIC PROGRAMMING: Polynomials – arithmetic – geometric inequality – unconstrained G.P – constrained G.P
DYNAMIC PROGRAMMING: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

LINEAR PROGRAMMING: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. **Simulation**: Introduction – Types – Steps – application – inventory – queuing – thermal system.

INTEGER PROGRAMMING: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

STOCHASTIC PROGRAMMING: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution – stochastic linear, dynamic programming.

REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin.
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia.
7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.

TOTAL QUALITY MANAGEMENT

MTME 042

L	T	P
3	0	0

Introduction and Components of TQM: Concept and Philosophy of TQM, Value and Quality assurance, Total Quality Control, Quality policy, Team-work and participation, Quality cost measurement, Quality Circle, Customer/Supplier integration, Education and training.

Tools and Techniques of TQM: Statistical method in quality control, Process control chart, Acceptance sampling plan, Statistical Productivity control (SPC)

Reliability: Failure analysis, System reliability and redundomy

TQM implementation: Steps in promoting and implementing TQM in manufacturing industries, Industrial Case studies.

ISO 9000 Quality Systems: Concepts, designation Standards, Quality system documentation, Quality manual, Quality procedures and work inspection.

Books:

1. Total Quality Control F. Ammandev Tata McGraw Hill
2. Total Quality Management Besterfield, et. al. Prentice Hall of India
3. Total Quality Management: Text and Cases B. Janakiraman & RK Gopal Prentice Hall of India
4. What is Total Quality Control? K. Ishikawa Prentice hall
5. Total Quality Management: The Route to Improving Performance J.S. Oakland Butterworth Heineman Oxford
6. Out of Crisis W.E Dming Centre of Advance Engineering Study, Cambridge

ADVANCED MECHANICAL DESIGN

MTME 043

L	T	P
3	0	0

Introduction: Concepts related to kinematics and mechanisms, Degrees of freedom, Grubler's Criteria, Transmission and Deviation angles, Mechanical advantage.

Kinematic Synthesis: Type, number and dimensional synthesis, Spacing of accuracy points, Chebyshev polynomials, Motion and function generation, Graphical synthesis with two, three and four prescribed motions and points, The complex number modeling in kinematic synthesis, The Dyad, Standard form, Freudentein's equation for three point function generation coupler curves, Robert's law, Cognates of the slider crank chain.

Path Curvature Theory: Fixed and moving centrode, Inflection points and inflection circle circle, Euler'-savary
Equation, Bobillier's and Hartsman construction.

Dynamic Force Analysis: Introduction, Inertia force in linkages, Kineto static analysis by superposition and matrix approach, Time response of mechanisms, Force and moment balancing of linkages.

Spatial Mechanism: Introduction to 3-dimensional mechanisms, Planar Finite, Rigid body and spatial transformation, Analysis of spatial mechanisms.

Books:

1. Fundamentals of applied Kinematics D.C. Tao Addison Wesley
2. Kinematic Synthesis of Linkages R. Hartenberg and Denavit McGraw Hill
3. Kinematic Analysis and Synthesis of Mechanisms A.K. Mallik and A. Ghosh CRC Press
4. Theory of Mechanisms A.K. Mallik and A. Ghosh East west Press
5. Kinematics and Dynamics of Plane Mechanisms J. Hirschern McGraw Hill, NY
6. Mechanism Synthesis & Analysis Soni McGraw Hill

MANAGEMENT INFORMATION SYSTEMS

MTME 044

L	T	P
3	0	0

Introduction; Meaning and definition of management information systems (MIS); Systems approach; Role of MIS in facing increasing complexity in business and management.

Conceptual information systems design; defining the problem; setting system objectives; Establishing system constraints; Determining information needs; Determining information sources; Developing alternative conceptual designs; Documenting the conceptual designs.

Detailing information systems design; Informing and involving the organization; Project management of MIS; Identifying dominant and tradeoff criteria; Subsystem definition and sources.

Evaluation of information systems; Basic information systems; Financial information systems; Production and operations information systems; Marketing information systems; Personal information system etc.

Information systems for decision making; Programmed and non-programmed decisions; Components of decision support systems, Strategic and project planning.

Enterprise wise information systems; Integration with ERP systems; Real-time organizations; Integration with external organizations; Virtual organizations; data warehousing; Data mining; OLAP (OnLine Analytical Processing) Systems, Business analytics. Issues in ethics, crime and security.

Books:

1. Management Information Systems O' Brien, J Tata McGraw Hill
2. Management Information Systems W.S. Jawedker Tata McGraw Hill
3. Management Information Systems S Sadagopan Prentice Hall of India
4. An Information System for Modern Management R.G. Mudrick Pearson
5. Management Information Systems M. Jaiswal Oxford University Press

ELECTIVE-V

FLEXIBLE MANUFACTURING SYSTEM

MTME 051

L	T	P
3	0	0

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of
flexibility, Concept of flexibility, Types of flexibilities and its measurement.

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic
justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment.

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Partmachine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production. *FMS related problem and Solution Methodology:* · FMS design problems: Part assignment, Machine selection, Storage system selection, Selection of pallets and fixtures, Selection of computer hardware and software, designing for layout integration of machine storage, Material handling System and computer system, Communication networks.

· FMS planning problems: Strategic planning, Part type selection, Machine grouping, production ratio and resource allocation, Machine loading problems.

· Operational & Control problems: Part scheduling, Machines robots & AGVS, Process monitoring & control.

· FMS Implementation: Objectives, acceptance testing, Performance goals and expectation maintenance concerns.

Books:

1. Automation, Production System & Computer Integrated Manufacturing Groover Englewood
2. Design and Operation of SMS Rankey IFS
3. Flexible Manufacturing System Wernecks Spring-Verlag
4. FMS in Practice Bonctto Northox Ford
5. Flexible Manufacturing Cells and systems W.W. Luggen Prentice Hall India
6. Performance Modelling of Automated Manufacturing Systems Vishwanathan

MACHINE VISION

MTME 052

L	T	P
3	0	0

Image capture and digitization; Image transforms; Digital Fourier transform; Fast Fourier transform; Other transforms; Convolution; Image enhancement; Spatial methods; Frequency domain methods; Image restoration.
Geometric transformation; Image compression; error free and lossy compression; Edge detection; Hough transform; Region based segmentation; image feature / region representation and descriptors; Morphological operators.

Feature based matching; Baye's classification; Low level vision; Introduction to stereopsis, Shape from shading; Optical flow; Rule based picture segmentation; tutorial exercise will emphasize development and evaluation of image algorithms.

Books:

1. Image Processing, Analysis and Machine Vision Milan Sanka, Vaclav Hlavac and Roger Boyle Vikas Publishing
2. Digital Image Processing Kenneth & Castleman Prentice Hall India
3. Digital Image Processing Conzalez RC & P Wint Addision Wesley
4. Digital Image Processing & Analysis Chandra and Mazumdar Prentice Hall India

ADDITIVE MANUFACTURING AND TOOLING

MTME 053

L	T	P
3	0	0

Introduction: Historical developments, Fundamentals of RP Systems and its Classification, Rapid prototyping process chains, 3D modeling and mesh generation, Data conversion and transmission.

RP Systems: Liquid polymer based rapid prototyping systems, Teijin Seikis' solid form and other similar commercial RP systems, Solid input materials based rapid prototyping systems, laminated object manufacturing (LOM) and fused deposition modelling systems etc., Power based rapid prototyping systems, selective Laser sintering, Soligen Diren's shell production casting (DSPC), Fraunhofer's multiphase jet solidification (MJS) and MIT's 3D printing (3DP) etc.

RP Database: Rapid prototyping data formats, STL format, STL file problems, STL file repair, Network based operations, Digital inspection, Data warehousing and learning from process data.

RP Applications: Development of dies for moulding, RP applications in developing prototypes of products, application in medical fields, Development of bone replacements and tissues, etc., RP materials and their biological acceptability.

Books:

1. Rapid Prototyping Of Digital Systems: A Tutorial Approach Hamblen James O Kluwer Aca
2. Rapid Prototyping: Principles And Applications Kai Chua Chee World Scie
3. Rapid System Prototyping With Fpgas: Accelerating The Design Process R C Cofer Newnes
4. Rapid Prototyping of Digital Systems James O Hamblen Springer

MODERN MANUFACTURING PROCESSES

MTME 054

L	T	P
3	0	0

Metal cutting: Need for rational approach to the problem of cutting metals-Observation in metal cutting, Energy
considerations in machining, Modern theories in mechanics of cutting, Review of Merchant and Lee Shaffer theories, critical comparison, Measurement of cutting forces-Classification of cutting force dynamometers, Lathe tool dynamometer, Drill, Milling and grinding dynamometer, Heat distribution in machining-Effects of various parameters on temperature, Method of temperature measurement in machining, Hot machining, Cutting fluids.

Tool Materials, Tool Life and Tool Wear & Wear Mechanisms: Essential requirements of tool materials, Developments in tool materials, ISO specifications for inserts and tool holders, Tool life, Conventional and accelerated tool life tests, Concepts of machinability and mach inability index, Economics of machining, Reasons for failure of cutting tools, Forms of wear, Chatter in machining, Chatters types, Mechanism of chatter based on force vs Speed graph, Mechanism of grinding, Various parameters affecting grinding process, Machinability data systems.

Sheet Metal Forming & Special Forming Processes: Review of conventional processes, HERF techniques, Super plastic forming techniques, Principles and Process parameters, Advantages, applications and limitations of HERF techniques, Orbital forging, Isothermal forging, Hot and cold iso-static pressing, High speed extrusion, Rubber pad forming, Water hammer forming, Fine blanking.

Unconventional and special Welding Processes and Automation: Friction welding, Explosive welding, Diffusion bonding, High frequency induction welding, Ultrasonic welding, Electron beam welding, Laser beam welding, Automation in welding, Welding robots, Overview of automation of welding in aerospace, Nuclear, Surface transport vehicles and under water welding.

Special Casting Processes & Recent Advances in Casting: Shell moulding, precision investment casting, CO2 moulding, Centrifugal casting, Die and continuous casting, Low pressure die casting, Squeeze casting, Full mould casting process, Layout of mechanized foundry, sand reclamation, Material handling in foundry, Pollution control in foundry, recent trends in casting, Computer aided design of casting.

Books:

1. Metal Cutting Principles M.C. Shaw Oxford Clarendon Press
2. Metal Cutting Theory and Practice Bhattacharya New Central Book Agency
3. Fundamentals of Metal Cutting and Machine Tools B.L. Juneja and G.S. Sekhon New Age International
4. Principles of Metal Cutting G. Kuppuswamy Universities Press
5. Fundamentals of Machining and Machine Tools D.G. Boothroy and W.A. Knight Marcel Dekker, NY
6. Fundamentals of Metal Casting H. Loper and Rosenthal Tata McGraw Hill
7. Metal forming-Fundamentals and Applications T Altan, Soo-Ik-Oh and H.L. Gegel American Society of Metals, Metal Park, 1983