

## M Tech CAD/CAM Scheme and Course Contents

Sr. No.	Subject Code No.	Name of the Subjects	Hrs/ Week			Total Hrs/ Week	Evaluation (marks)			
			Lectures	Tutorials	Practical		Internal	Theory	Practical	Total
<b>Semester-I</b>										
1.	ME-501	Computer Aided Design	4	1	-	5	50	100	-	150
2.	ME-502	Tribology	4	1	-	5	50	100	-	150
3.		Optimization Techniques	4	1	-	5	50	100	-	150
4.	ME-511 ME-512 ME-513	Elective-I ➤ MIS ➤ Mechanisms: Design Synthesis & Analysis ➤ Finite Element Method	4	1	-	5	50	100	-	150
5	ME-551	CAD/CAM Lab-I			4	4	100			100
<b>Semester-II</b>										
1.	ME-503	System Design & Analysis	4	1	-	5	50	100	-	150
2.	ME-506	Computer Integrated Manufacturing System	4	1	-	5	50	100	-	150
3.	ME-514 AM-501 ME-515 CS-501	Elective-II ➤ Mechatronics ➤ Adv. Mathematics ➤ Work Engg. & Ergonomics ➤ Neural Networks & Fuzzy Logic	4	1	-	5	50	100	-	150
4.	ME-516 EC-501 CS-502 ME-517	Electives-III ➤ Management of Production systems ➤ Instrumentation & Control Engg. ➤ Artificial Intelligence ➤ Diagnostic Maintenance & Monitoring	4	1	-	5	50	100	-	150
5	ME-552	CAD/CAM Lab-II			4	4	100			100
<b>Semester-III</b>										
1.	ME-504	Computer Ctr. in M/c Tools	3	1	-	4	50	100	-	150
2.	ME-505	Robotics	3	1	-	4	50	100	-	150
3.	ME-513 ME-519 ME-520	Elective-IV ➤ Interactive Computer Graphics ➤ Modeling & Simulation of Manufacturing Systems ➤ Computer Aided Process Planning	3	1	-	4	50	100	-	150
4.	ME-521 ME-522 ME-523	Elective-V ➤ Product Design and Development ➤ Design of Experiments ➤ Computer Aided Machine Design	3	1	-	4	50	100	-	150

**PTU/BOS/CDM/201/27-07-2004**

5.	ME-553	CAD/CAM Lab-III	-	-	4	4	100		-	100
<b>Semester-IV</b>										
1.		Seminar				2				150
2.		Thesis/ Dissertation								

COMPUTER AIDED DESIGN

ME-501

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**INTRODUCTION:** Definition and scope of CAD/CAM. Introduction to Design process and role of computers in the design process. Hardware and Software in CAD/CAM applications.

**GEOMETRIC MODELLING CURVES AND SURFACES:** Representation, Wire Frame models, Intrinsic and parametric representations, analytic and parametric curves and surfaces. Manipulations of curves and surfaces.

**GEOMETRIC SOLID MODELING:** Solid models, Fundamentals of Solid Modeling, Half -spaces, Boundary Representation(B-rep), Constructive Solid Geometry (CSG), Sweep Representation, Analytic Solid Modeling. Solid Manipulations.

**CAD/CAM DATA EXCHANGE FORMATS.**

**INTRODUCTION TO DESIGN AND ENGINEERING APPLICATIONS:** Geometry and mass property formulations; Design projects with CAE focus.

**INTRODUCTION TO REVERSE ENGINEERING TOOLS.**

**Recommended Books:**

1. Ibrahim Zeid, CAD/CAM, Tata McGraw Hill, New Delhi.
2. J. Rooney & P.Steadman, Principles of Computer Aided Design, Pitman/ Open University, London.
3. Joe Rooney & Philip Steadman, Computer Aided Design, Pitman/Open University, London.
4. Glen Mallineuse, Computational Concepts and Methods, Kogan Page Ltd. London.
5. Daniel L. Rayan, Computer Aided Graphical Design, Marcel Dekker, New York.
6. P. Radhakrishnan & C.P.Kothandaraman, Computer Graphics & Design(CADD), Dhanpat Rai Pub, New Delhi.
7. C.S. Krishnamoorathy, J.S. Rajeev, Computer Aided Design (Software and Analysis Tools), Narosa Pub House, New Delhi.

TRIBOLOGY

ME-502

L	T	P
4	1	0

Introduction: friction, wear and lubrication, types of engg., Contacts: conforming and non-conforming, Types of motion; rubbing sliding, oscillating, Roolling, Surface of interactions, elastic and plastic deformations, properties of materials, surface energy and flash temperature theory.

Friction: Laws of sliding friction, concept of adhesion, Tabor's model of friction elastic thermo friction, rolling friction, measurement of friction.

Wear: Laws of wear, types of wear such as adhesive, declamination, abrasive, fatigue, corrsice, fretting, erosice, electrical and oxidative. Measurement of wear and friction in atmosphere and different environments, Prevention and control of wear and friction in machines, wear of cutting tool and dies, study of abrasion in grading, lappling and honing.

Lubrication: Mechinism of lubrication, Boundry, squeeze film hydrodynamic and elasto dydro dynamic and hydro stative lubrications plasto hydrodynamic lubrication, solution of Reynold's equation in two and three dimensional flow, pressure distribution load carrying cpacity friction forces in oil film and Co-efficient of friction in journal bearing. Soild lubricants types and applications.

Bearing Design: Design of bearing: clearance in journal bearing, minimum film thickness, sommar-field numer, Oil grooves anf flow of oil in axial and circumferential grooves cavittion and turbulence in oil bearings. Heat generation and cooling or bearing Hydrostatic and dynamic and their applications in machine tools. Design of air bearing and other gas bearing.

Rolling Friction: Reynold's slip, Heathe cote concept selection of roller bearings and their methods of lubrication design aspects and modes of bearing failures and elasto hydrodynamic lubrication.

Solid Lubricants: Their applications in metal forming process.

Recommended Books:

1. Sharma Agarwal, A Test Book, Kataria
2. Main Engg. Hand Book, A M/c Design, McGraw Hill

OPTIMIZATION TECHNIQUES

ME-507

Linear Programming: The theory of simplex solution, alternate optimal solution, unbounded solutions, infeasible solutions, Formulation of LP models for production scheduling, network planning, inventory maintenance and capital budgeting and similar industrial problems. Two phase method, Revised simplex method and dual simplex method. Sensitivity analysis. The dual problem and its role for post optimality analysis.

The transportation and assignment models. Traveling salesman model and their industrial applications.

Dynamic Optimization Models: Formulation of dynamic optimization models for common industrial problems. Optimization of non-linear objective function by dynamic programming.

Queues Models: Queuing with single and parallel channels with limited and unlimited service. Bulk input, bulk service, priority queue discipline.

Simulation Models: Generation of random number. Use of random numbers for system simulation. Use of computers for system design and assembly line balancing.

Books Recommended

1. Fundamental of Operations Research Ackoff and Saseini: Wiley Eastern
2. Principles of OR with applications to managerial decisions by Wagner: Prentice Hall
3. Introduction to OR by Hillier & Lieberman: Holden day

MANAGEMENT INFORMATION SYSTEMS

ME-511

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Introduction: Concepts of Management, Information and Systems, History of Information Systems. Philosophies Governing the development of Information Systems.

Role of Information Systems In Organisations: Local and Global context. Additional perspectives as benefits from Technical Trends and innovations, special characteristics and enigmas of information.

Information System And Business Processes: Analysing information system from a business perspective using work centred analysis of systems.

Information System Taxonomies: Transaction Processing system, Management Information Systems. Decision support system, Executive Information Systems. Artificial Intelligence, Expert Systems and Office Automation Systems.

System Analysis And Design: Information System Planning, introduction challenges, strategic issues, selecting systems, project management issues. Methodology and implications of system analysis and design, SDLC, Prototyping. End user Development, Off the shelf software, outsourcing and application software.

Tools For Information System Development: Structural tools for analysis and design, tools to represent system data and process. Tools for structured programming, tools to convert programs specification into code.

Database Design And Management: Components of DBMS, Database models, Principles of DBMS.

Strategic Information Systems: Characteristics, and Plan. Business Information Systems; MARIS, Information systems for Manufacturing, Human Resource, Finance and Accounts, and Quality.

Client Server Computing: Developing client server, organisational implications of c/s computing. Information system security and control.

ERP: Introduction, concepts, applications, advantages and disadvantages.

Recommended Books:

1. Uma G Gupta, Management Information Systems - A Managerial Perspective, Galgotia Publishers, New Delhi.
2. Edward Yourdon, Structured Analysis, Prentice Hall of India, New Delhi.
3. James A. O'Brien, Management Information System (Managing Information Technology in the Internetworked Enterprise, Tata McGraw Hills, New Delhi
4. Steve Alter, Management Information System, Benjamin Cummins, New York.
5. Davis & Olson, Management Information Systems, McGraw Hill, New York.
6. Gerald V Post & David L Anderson, Management Information Systems, Solving Business Problem with Information Technology, Tata McGraw Hills, New Delhi.
7. Jawedkar, Management Information Systems, Tata McGraw Hills, New Delhi.
8. Schultheis & Sumner, Management Information Systems (A Management Perspective), Tata McGraw Hills, New Delhi.
9. Landon & Landon, Management Information Systems, Prentice Hall of India, New Delhi.

MECHANISMS: DESIGN, SYNTHESIS AND ANALYSIS

ME-512

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INTRODUCTION TO KINEMATICS AND MECHANISMS: Motion, The four bar Linkage, The science of Relative motion, Kinematic diagrams, six-bar chains, Degrees of freedom, Analysis vs. Synthesis.

MECHANISM DESIGN PHILOSOPHY: Stages of design, the synthesis process, Design categories and mechanism parameters.

MECHANISM ANALYSIS: Displacement and velocity analysis, acceleration analysis.

KINEMATIC SYNTHESIS OF MECHANISMS: Number synthesis-The associated linkage concept. Graphical methods, tools and computer programming for synthesis of mechanisms for two, three and four prescribed positions, path generation, prescribed and un-prescribed timings. Analytical Synthesis Techniques. Function and motion generation. Number of prescribed positions vs. Number of Free Choices. Extension of Three-precision-Point Synthesis to Multi-loop mechanisms.

DYNAMICS OF MECHANISMS: Inertia forces, Kinetostatic Analysis by complex numbers, Superposition method, Matrix Method. Time response, modification of time response of mechanisms. Virtual work. Lagrange Equations of motion. Free vibration of systems with one degree of freedom. Decay of free vibrations. Forced vibrations of systems with one degree of freedom. Rotor balancing. Introduction to Force and Moment balancing of Linkages. Computer program for Force and Moment balancing. Elastic beam element in Plane Motion. Displacement fields for Beam element. Element and system mass and stiffness Matrices.

SPATIAL MECHANISMS: Transformations for spatial mechanisms, Analysis of spatial mechanisms. Link and Joint Modeling with Elementary Matrices. Kinematic analysis of an Industrial Robot, position, velocity and acceleration analysis..

## Recommended Books:

1. Sandor and A.G. Erdman, Mechanism Design (Analysis and Synthesis ), Vol.-I, Prentice Hall of India, New Delhi.
2. Sandor and A.G. Erdman, Advanced Mechanism Design (Analysis and Synthesis), Vol.-II, Prentice Hall of India, New Delhi.
3. J.E Shigley & J.J Uicker, Theory of Machines and Mechanisms, McGraw Hill, Singapore.
4. Rudolf A.Beyer, Kinematic Synthesis of Mechanisms, McGraw Hill, New York.
5. Alexander Cowie, Kinematics and Design of Mechanisms, International Textbook, Scranton.
6. Allen.S.Hall Jr, Kinematics and Linkage Design, Prentice Hall, New Jersey.
7. R.Hartenberg and J.Denavit, Kinematic Synthesis of Linkages, McGraw Hill, New York.
8. A.H Soni, Mechanism Synthesis and Analysis, Krieiger, Melbourne.
9. Lyndon. O. Barton, Mechanism Analysis, Marcel Dekker, New York.

FINITE ELEMENT METHODS

ME-513

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INTRODUCTION: finite element methods, history and range of applications.

FINITE ELEMENTS: Definition and properties, assembly rules and general assembly procedure, features of assembled matrix, boundary conditions.

CONTINUUM PROBLEMS: Classification of differential equations, variational formulation approach, Ritz method, element equations from variations. Galerkin's weighted residual approach, energy balance methods.

ELEMENT SHAPES AND INTERPOLATION FUNCTIONS: Basic element shapes, generalized coordinates, polynomials, natural coordinates in one-, two- and three-dimensions, Lagrange and Hermite polynomials, two-D and three-D elements for  $C^0$  and  $C^1$  problems, Coordinate transformation, iso-parametric elements and numerical integration.

APPLICATIONS & CASE STUDIES: Application of finite element methods to elasticity and structural, heat transfer, fluid-flow, lubrication and general field problems.

## Recommended Books:

1. K.H. Huebner, The Finite Element Method for Engineers, John Wiley, New York.
2. Jeffery M. Steche, Applied Finite Element Modeling, Marcel Dekker, New York.
3. O.C. Zienkiewicz, The Finite Element Method, Tata McGraw Hill, New Delhi.
4. Desai & Abel, Introduction to the FEM, (CBS)-affiliated to East West Press, New Delhi.
5. George R. Buchanan, Finite Element Analysis, Schaum MGH, New York.
6. Chandrupatla & Belgundu, Introduction to Finite Elements in Engineering, Prentice Hall of India, New Delhi.
7. J.N. Reddy, An Introduction to the Finite Element Method, McGraw Hill, New York.
8. Cheung Y.K, Lo.S.H.,Leung A.Y.T Finite Element Implementation, Blackwell Science Ltd, London.
9. Brebbia. C.A. and Walker. S., Boundary Element Techniques in Engineering, Newness-Butterworths Pub Ltd, London.
10. W.B. Bickford, A First Course in the Finite Element Methods, Tata McGraw Hill, New Delhi.
11. Ronald L. Huston and Chris E. Passerello, Finite Element methods: An Introduction, Marcel Dekker, New York.
12. Elward R.Champion al J. Michael Ensminger, Finite Element Analysis with Personal Computers, Marcel Dekker, New York.

SYSTEM DESIGN AND ANALYSIS

ME: 503

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**SYSTEM COMPONENTS:** The environment for system concept; system structure; system inputs and outputs; system approach to macro problems; problem definition with system concepts and approach.

**SYSTEM MODELING:** Model formulation; Representation of dynamics signal and system flow graph; System interactions; System compatibility; Sub-systems and inter-connections; Functional and equipment structuring. Linear graph approach. Time models.

**SYSTEM SIMULATION:** Basic philosophy of simulation; Analog and Digital Computers; System with feedback. Discrete system simulation.

**SYSTEM DYNAMICS :** Dynamic analysis of systems; Dynamic behavior of organization; Total flow of man, information and materials; Dynamic analysis of the models for capital equipment and orders; Derivation of the policies for management based on system models.

**OPTIMIZATION:** Optimization of system performance; Perturbation analysis of system parameters; Criteria for optimization, Gradient method; Dynamic programming method.

**SYSTEM DESIGN:** Elements of Decision analysis; Game theory; Application of game and decision theory to system design. Techniques for creative design; Elementary sensitivity analysis.

**Recommended Books:**

1. Chestnut, System Engg. Tools, John Wiley, New Delhi.
2. Gosling, Design of Engg. Systems, John Wiley, New Delhi.
3. A.D.Hall, System Engg., Van Nostrand, U.K.
4. Machol, System Engg. Handbook, McGraw Hill Inc., New York.
5. G.M.Sandquist, Introduction to System Science, Prentice-Hall , N.J.
6. Nagrath & Gopal, System Modeling and Analysis, Tata McGraw Hill, New Delhi.
7. Geoffrey Gordon, System Simulation, Prentice Hall of India, New Delhi.
8. Forester, Industrial Dynamics, MIT Press, Cambridge Mass: U.S.A.
9. Warren E. Wilson, Concepts of Engineering System Design, McGraw Hill, New York.
10. Philip A. Laplante, Realtime System Design and Analysis (Engg. Handbook), Prentice Hall of India, New Delhi.
11. Avadh, System Design & Analysis, Galgotia Publishers, New Delhi.

MECHATRONICS

ME-514

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Sensors: Strain gauge, Potentiometers, Tachometers, Linear variable differential transformer, Piezoelectric accelerometer, Hall effect sensors, Optical Encoders, Resolver, Inductosyn, Tactile and Force sensors.

Actuators: Pneumatic and Hydraulic Actuators, Electrical actuators, stepper motors, DC motors, AC motors.

Electronics fundamentals: Brief review of some semiconductor devices. The operational Amplifier, Binary variable and logic, Boolean Algebra, Logic circuits, Digital-to-analog converters, analog-to-Digital converters.

Microprocessor and computers: Introduction to 8085(8 bit microprocessor), architecture programming, I/O, Computer and interfacing, Programmable logic controller.

Control systems: Mathematical modeling of physical systems, sensors and actuators, System equations, controllability, observability, pole placement technique, PID Controller.

Applications: Case studies of control of hydraulic, pneumatic, mechanical and electrical system, Application of CNC machines & Robotics.

References:

1. Analytical Robotics and Mechatronics, Wolfram Stadler, McGraw Hill
2. Robotic engineering, Rafter, PHI.
3. Mechatronics, AMT
4. Automatic Control System, B.C. Kuo, Ogata, PHI
5. Introduction to Digital computer electronics, A.P. Mahind, TMH
6. Measurement Systems, E.O. Doebelin, McGraw Hill.

ADVANCED MATHEMATICS

AM-501

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Tensor Analysis: Introduction to Tensors, Algebra, Symmetric and unsymmetrical Tensors, Line element and Metric Tensor, Associated Tensor, Physical components, Covariant Differentiations, Christoffel Symbols of first and second kind.

Statistics: Statistical Distributions like Binomial, Normal and Poisson, Sampling, Design of Experiment-basic, Principles, Replication, Experimental error, Confounding Randomization, Local control Balancing, Blocking and Group

Conformal Mapping: Analytic Function, Bilinear Mapping, Conformal Mapping, Schwarz Christoffel Transformation, Application to fluid Flow and Head Transfer problems.

Matrices and Linear Systems of Equations: Direct method, Gauss method and its modifications, Method of Factorization, Iterative methods, Gauss Seidel method, Jacobi's method, Eigenvalues and Eigenvectors.

Ordinary & Partial Differential Equations: Homogenous linear equations of the second order, General solution, Initial value problem, Cauchy equation, existence and uniqueness of solution, Non-homogenous linear equation, modeling of forced oscillations, Resonance Modeling of-vibrating string, 1-D wave equation, vibrating membrane, 2-D, wave equation, rectangular membrane.

## Books Recommended:

1. Vector analysis and introduction to Tensor analysis: Spiegel, Schaum publishers
2. Statistics in Research, Barnard Ostle, Oxford and IBH
3. Complex Variables, Spiegel, Schaum publishers
4. Advanced Engineering Mathematics: Wylie, McGraw Hill
5. Introductory methods of numerical analysis: S.S. Sastry Prentice Hall of India
6. Advanced Engg. Math. Erwin Kreyszig, New Age Int. (P) Ltd.

WORK ENGINEERING AND ERGONOMICS

ME-515

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Group A: Introduction to Industrial Engineering and productivity, measurement of productivity, factors affecting productivity. Introduction to work study; methods study principles & techniques viz flowcharts, diagrams and motion economy, filming techniques and micro-motion analysis, Introduction to work measurement; Time study, performance rating, allowances, work sampling, predetermined motion system standards job evaluation. Wage incentive plan, Hasley plan, Bedaux plan, Piece rate system, Rowan plan, Emerson's efficiency plan.

Group B: Introduction of Ergonomics, man/machine/environment systems concept.

Design approach: a new design modification of existing design, assessments of a design. Limitation of man & machine with respect to a each other, posture-standing at work, seated at work, work station heights and seat geometry. Human ethropometry and its use in work place latout.

Work Load: Static and dynamic muscular work. Human Motor activity, metabolism, physical work load, measurement of physical workload, Mental work load, measurement of mental work load, repetitive and inspection work, work duration and rest pauses principles of motion economy.

Controls: Hand controls and foot controls, location of controls and place envelope, Recommendation about hand and foot push buttons, rotary selector switches, hand sweels, cranks, leavers etc. instruments had displays.

Climates Heat Humidity: Body heat balance, effective temperature scales, zone of discomfort, effect of heat on body and work performance.

Vibration: Terminology, response of the body to low frequency (LF) vibration, vibration and discomfort, effect on health of worker, high frequency vibration, effect of H.F. vibrations, methods of reducing vibrations.

Noise: Terminology physiological effects of noise, annoyance of noise speed interference, hearing loss, temporary and permanent thread hold shift, effect of noise on performance reduction of noise, personal noise protection.

Recommended Books:

1. Intro to Ergonomics, Bridger, McGraw Hill
2. Ergonomics at work, Osborne, Wiley
3. Method & Time Work Study, Barnes, ILO

NEURAL NETWORKS & FUZZY LOGIC

CS-501

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Neural Networks characteristics, History of development in Neural Networks Principles, Artificial Neural Net terminology, Model of a neuron, topology, learning, types of learning, supervised, unsupervised, re-enforcement learning.

Basic Hopfield Model, the perceptron, linear separability, Basic learning laws, Hebb's rule, Delta rule, Windrow & Hoff LMS learning rule, correlation learning rule, instars and outstar learning rules.

Unsupervised learning, competitive learning, K-means clustering algorithm, Kohonen's feature maps.

Applications of neural nets such as pattern recognition, optimization, associative memories, vector quantization, control, Applications in speech and decision-making.

Fuzzy Logic: Basic concepts of Fuzzy Logic, Fuzzy Vs Crisp Set, Linguistic Variables, membership functions, Operations on Fuzzy sets, Fuzzy IF-THEN rules, variable inference techniques, defuzzification techniques, Fuzzy rule-based systems, Fuzzy Decision making, multiobjective decision making, Fuzzy classification, fuzzy multifeature pattern recognition, applications of Fuzzy Logic, Fuzzy system design, Implementation of Fuzzy system, Useful tools supporting design.

References:

1. Fuzzy Systems Design Principles, Building Fuzzy IF-THEN rules bases by Riza C.Berkin & Trubatch., Jeepers
2. Yegna Narayanan-Artificial Neutral Networks
3. Bart Kosko-Nural Networks & Fuzzy logic
4. Simon Haykin-Neutrak Networks
5. Introduction to Artificial Neural systems- Jack M. Zurada
6. Fuzzy logic with engineering Applications-Timothy J. Ross

COMPUTER CONTROL IN MACHINE TOOLS

ME-504

L T P

3 1 -

**INTRODUCTION:** Fundamental concepts in numerical control. Need of N.C. in machines tools, its advantages. Structure of NC System . Economics of NC for m/c tools.

**NUMERICAL CONTROL OF M/C TOOLS :** NC, CNC, DNC, Adaptive control – types, uses & benefits; Problems with conventional NC. Advantages of CNC, DNC their structure, combined CNC/DNC systems.

**N.C. M/C TOOLS :**Types, definition and designation of control axes, Constructional details of N. C. m/c tools, MCU structure and functions, Methods of improving accuracy and productivity using NC.

**SYSTEM DEVICES:** drives, feedback devices, counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, contouring system. Incremental and absolute systems,

**CLASSIFICATION OF N. C. M/C TOOLS:** Control systems for positional control and tool changing systems, Optical, pneumatic, hydraulic, electro-mechanical, and electromagnetic control systems, The digital computer and its functioning for m/c control, microprocessor in CNC.

**TOOLING FOR N. C. MACHINES:** Tool and zero presetting, Work holding and setting up of CNC M/c.

**PART PROGRAMMING:** Block format and codes, tool length and radius compensation, flexible tooling, tool path simulation on lathe and milling, Advanced programming features. Computer assisted part programming, the APT language - geometric, motion, post processor and auxiliary statements, Compilation control commands, repetitive macro programming.

**GEOMETRIC MODELING FOR NC MACHINING:** Machining of surfaces, Automatic NC program generation from CAD models, Mould, Casting and Die design and manufacture using CAD/CAM software.

Recommended Books:

1. Manuals of CAD/CAM software package on CAM module and CNC machines.
2. Yoram Koren, Computer Control of Manufacturing systems, McGraw Hill, Singapore.
3. T. K. Kundra, P. N. Rao, N. K. Tewari, Numerical Control and Computer Aided Manufacture, Tata McGraw Hills, New Delhi.
4. S. Pabla, M. Adithan, CNC Machines, Willey Eastern, New Delhi.
5. Y. Koren and J. Benuri, Numerical Control of Machine Tools, Khanna Publishers, New Delhi

ROBOTICS

ME-505

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**INTRODUCTION:** Definition of a Robot, Difference between hard automation and robotic automation, Characteristics of a robot. Need for robots & their benefits, Economic aspects in robot applications. Robot classifications and their applications, Robot generations.

**ROBOT IN WORK PLACE:** Need for interfacing, Part feeding, Magazines, Orienting devices. Special fixtures, Conveyor belts, Overhead transport, Work cell organization in robotic environment, Work Cell Design and Control.

**REPRESENTATION OF A ROBOT:** Functional and graphical representation of robots, Arm structures in use, Structure of end effectors, Degrees of freedom of a rigid body, Degrees of freedom of a robot, Degrees of freedom and mobility.

**ROBOT TECHNOLOGY:** Robot anatomy & functional units, Work volume, Elements and types of drive and control systems, Precision of movement, Actuators, Power Transmission Systems, Manipulator Kinematics and path control, Configuration of a robot controller.

**TYPES OF GRIPPERS:** Mechanical grippers, Consideration in gripper selection and design

**SENSORS AND VISION:** Tactile, Proximity and Range sensors in robots; Velocity sensors, Robot Vision. Introduction to motion planning and image processing.

**METHODS OF ROBOT PROGRAMMING:** Robot programming languages, Introduction to Intelligent Robots.

**ROBOT APPLICATIONS IN INDUSTRIES:** Material handling and processing, Metal cutting processes, Welding, Spray Coatings, Inspection, Assembly and Hazardous operating conditions; Safety in robotics; Social and labour issues in robotics. Material handling using AGVs, automated storage systems using mobile robots. Issues in implementation of Robotics in Industry.

**Recommended Books:**

1. Groover, Weiss, Nagel and Odrey, Industrial Robotics : Technology, Programming and Application, McGraw Hill, New York.
2. Lee, Fu & Gangalase, Robotics:Control, Sensing, Vision, and Intelligence, McGraw Hill, New York.
3. Robert J. Schilling, Fundamentals of Robotics Analysis & Control, Prentice Hall of India, New Delhi.
4. Klafter, Chmielewski and Negui, Robotic Engineering: An Integrated Approach, Prentice Hall of India, New Delhi.
5. Y. Koren, Robotics for Engineers, McGraw Hill, New York.
6. J.J.Craig, Introduction to Robotics, Addison - Wesley Publishing Company.
7. S. R Deb, Robotics and Flexible Automation, Tata McGraw Hill, New Delhi.
8. William. C. Burns Jr and Janet Evens Werthington, Practical Robotics-Systems, Interfacing and Applications, Prentice Hall, New Jersey.
9. Coiffet and Chirouze, Introduction to Robot Technology, McGraw Hill, New York.
10. Heath.L. Reston, Fundamentals of Robotics : Theory and Applications, Reston Prentice Hall, Virginia.
11. Bernard Hodges, Industrial Robotics, Jaic Publishing House, Bombay.

12. David D. Ardayfio, Fundamental of Robotics, Marcel Dekker, New York.

MANAGEMENT OF PRODUCTION SYSTEM

ME-516

L	T	P
4	1	-

System Theory and Concepts: System defined, functional elements of a system, general systems theory, systems theory and organization, systems concept and management, the system approach, planning and system concepts. Control and system concepts, information and system concepts.

Quantitative Techniques of System Analysis: System analysis, problem solving, scientific method, mathematical analysis models, computers, techniques of analysis, linear programming input output analysis queuing monte carlo techniques, simulation, industrial dynamics.

Behavioural Aspect of System Design: The motivation factor in system design, leadership factor in systems design. The need for systematic human relationships, the need for systems change, resistance to change, behavioural consequence of system changes, microanalysis of complex, man-machine open systems concept as a basis of human integration, meeting the human and social problems.

Flow System: Increasing complexity in distribution and production, increasing cost of a distribution, the total flow system, planning the transformation, the service system integration systems.

Program Management: Impact of advancing technology, large scale integrating systems. Program-management concept functional stage of program-management organizational medications, matrix organization applications of program-management.

Management Cybermatics: Management cybermatics in controlling a manufacturing firm, production and inventory control systems, production, inventory and employment control system, the enterprise control systems.

Recommended Books:

1. Strategic Management of Technology and Innovation by Rober A. Burgelman & A. Maidique, McGraw Hill
2. Logistical Management by Donald Bowerson and David Closs, McGraw Hill
3. Production and Operations Management by James Dilworth, McGraw Hill
4. Global Operations Management by M. Therese Flaherty, McGraw Hill

INSTRUMENTATION & CONTROL ENGG.

EC-501

L	T	P
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INTRODUCTION: Review of basic principles of measurement & process control systems; Elements of instrumentations.

MEASUREMENT: Principles of dynamic measurement; Transducers, amplifiers and recording systems; measurement of physical variables, i.e. motion, strain, force, torque, temperature, pressure and flow etc. Principles of optical, eddy current based and ultrasonics based measurement devices for metrological applications; Interferometers; Principles of Holography; Calibration its importance and general principles.

CONTROL SYSTEMS: Concepts, Controller characteristics. Transfer functions of mechanical, electrical, pneumatic and hydraulic systems; Transients and frequency response; types of control action.

STABILITY : Concept, criterion and determination by analytical and graphical methods Routh, Hurwitz, Bode and Niquist.

Adaptive control systems; Applications to mechanical systems and CNC machines.

## Recommended Books:

1. Doebelin, Measurement Systems, McGraw Hill, New Delhi (Pub. at Singapore).
2. Nagrath & Gopal, Control System Engg.,
3. Moore, Theory & Applications of Mechanical Engg. Measurements, Affiliated East West, New Delhi.
4. Benjamin C. Kuo, Automatic Control Systems, Prentice Hall of India, New Delhi.
5. K.Ogata, Modern Control Engg., Prentice Hall of India, New Delhi.
6. Krstic, Kandlakopoulos, Kokotovic, Non linear and Adaptive Control Design, Wiley interscience Publishers, New York..
7. Holman, Experimental Methods for Engineers, McGraw Hill, New Delhi.
8. Gupta & Syal, Introduction to Metrology, Dhanpat Rai & Sons, New Delhi.
9. Bechwith & Buck, Mechanical measurements, Addison-Wesley.
10. D.S. Kumar, Mechanical measurements, Metropoliton, New Delhi.
11. George J. Thaler, Design of Feedback Systems, Jaico Publishers, Bombay.

ARTIFICIAL INTELLIGENCE

CS-502

L	T	P
4	1	0

Basic concepts of AI. Problem formulation and solution techniques. Expert systems. Knowledge representation, Knowledge acquisition, inference mechanisms. Introduction to machine learning, Intelligence for manufacturing tools, manufacturing brain, eye and hand. Trends in robot intelligence. Case studies in the application of AI in manufacturing.

Recommended Books:

1. E.Rich, Artificial Intelligence, Tata McGraw Hills, New Delhi.
2. G.F Luger and W.A. Stubblefield, AI and the design of Expert Systems Bengamin/Cummins.
3. Dan W. Patterson, AI and Expert Systems, Prentice Hall of India, New Delhi.
4. Omidvar.O and Smagt.P., Neural Systems for Robotics, Academic Press, San Diego.
5. P. Radhakrishnan, S. Subramanyam, CAD/CAM/CIM, New Age International Pub, New Delhi.

DIAGNOSTIC MAINTENANCE AND MONITORING

ME-517

L	T	P
4	1	0

Introduction to maintenance techniques, Preventive and predictive maintenance, signature analysis

Observational and Estimation Techniques. Non-destructive and Destructive testing, Malfunction Analysis of Materials

Wear Analysis through Thermography and Ferrography.

Various Techniques of Condition Monitoring.

Application of Diagnostic Maintenance to Industrial Machines and Plants such as Sugar Industries, Textile Mills, Thermal Power Plants and Railways.

Recommended Books:

1. Creating customer Value through Industrial Maintenance by G.K. Gureja, McGraw Hill
2. Power Station Engineering by Skrotzki, McGraw Hill
3. An Introduction to Reliability and Maintain-ability Engineering by Charles Ebneling, McGraw Hill
4. Maintenance Engineering by Lindley R. Higgins, McGraw Hill

COMPUTER INTEGRATED MANUFACTURING SYSTEMS

ME-506

L	T	P
4	1	-

INTRODUCTION: Types of production systems and their automation. CAD/CAM integration. Concept of FMS and CIMS.

ELEMENTS OF A GENERAL CIM SYSTEM: Types of CIM systems. CAD-CAM link for CIMS. Manufacturing data base in a CAD/CAM system. Benefits of CAM, FMS and CIMS. Automated material handling systems, equipment and their functions. Integration of Robots in CIMS, Automatic Storage and Retrieval Systems (AS/RS), Carousel. Palletization and fixtures. In process interfacing of storage with manufacture.

GROUP TECHNOLOGY: Concept and terminology, part family formation, classification and coding systems for components, Group Technology machine cells.

Computer Aided Process Planning and route sheet development, CAPP system, Computer aided plant layout.

COMPUTER AIDED PRODUCTION PLANNING AND CONTROL: Inventory control and MRP, Computer aided cost estimation. Computer aided shop floor control, process monitoring. Computer aided Inspection and Quality Control, SQC, SPC.

NETWORKING: Introduction to fundamentals of computer communications, networking, computer-machine-personnel communication links. Network architectures & techniques. Information flow in networks, network standards.

CIM DATABASE AND DATABASE MANAGEMENT SYSTEMS: Types, Management Information System, Manufacturing data preparation. Shop floor data collection systems, shop floor control, sensors used, Tool management system, automatic identification systems, Barcode system.

CIMS configurations, DNC based factory management and control, Integrated CAD/CAM system and shared database, Factories of the future. Impact of implementing CIMS on society.

Introduction to rapid prototyping, and rapid tooling

Introduction to the concept of concurrent engineering.

Recommended Books:

1. M. P. Groover and E. W. Zimmers, CAD/ CAM, Prentice Hall of India, New Delhi.
2. M. P. Groover, Automation, Production systems and Computer Integrated Manufacturing, Prentice Hall of India, New Delhi.
3. S Kant Vajpayee, Principles of Computer Integrated Manufacturing, Prentice Hall, New Delhi.
4. P. N. Rao, N. K. Tewari, T. K. Kundra, Computer Integrated Manufacturing, Tata McGraw Hill, New Delhi.
5. Besant and Lui, CAD/CAM, Tata McGraw Hills, New Delhi.
6. H. Mitchell, CIM Systems -An Introduction to Computer Integrated Manufacturing, Prentice Hall, New Jersey.
7. P. Radhakrishnan and S. Subramanian, CAD/CAM/CIM, New Age International Pub, New Delhi.
8. Dr. Surender Kumar and Dr. A. K. Jha, CAD/CAM, Dhanpat Rai and Sons, New Delhi.
9. John Hartley, FMS at Work, IFS Pub UK and North Holland, New York.

Charles S. Knose, CAD/CAM System Planning & Implementation, Marcel Dekker, New York.

INTERACTIVE COMPUTER GRAPHICS

ME-518

L	T	P
3	1	-

**COMPUTER HARDWARE:** Introduction to architecture of graphics workstation. Graphic input Devices-Pointing and positioning devices, Graphic Display Devices, Line and point plotting systems; Display processors, Character Generators, Hard copy output devices.

**DISPLAY DESCRIPTION:** Screen coordinates, user coordinates; Graphical data structures, Display code generation; Graphical functions. Two- and three- dimensional transformations, mapping and projections.

**INTERACTIVE GRAPHICAL TECHNIQUES AND TOOLS:** Geometric modifiers, dragging, rubber-banding, names, Layers, Colours, Grids, Groups. Interactive computer programming. Graphic User Interface features, design and use.

**GRAPHIC MANIPULATIONS AND EDITING:** Object selection methods, manipulation and editing operations.

**GRAPHICS SOFTWARE PACKAGE DESIGN :** Primitive (constants, actions, operators, variables), plotting and geometric transformations. viewing, windowing and clipping algorithms.

**3-D GRAPHICS:** Hidden line and Surface elimination, Transparent solids, shading, colouring.

**COMPUTER ANIMATION:** Conventional and computer animation, Animation systems, types, and techniques.

**MECHANICAL ASSEMBLY:** Assembly modeling, Representation schemes, Assembly sequences, Assembly analysis.

**Recommended Books:**

1. Ibrahim Zeid, CAD/CAM, Tata McGraw Hill, New Delhi.
2. P.Radhakrishnan & C.P.Kothandaraman, Computer Graphics & Design(CADD), Dhanpat Rai Pub, New Delhi.
3. Giloi, W.K., Interactive Computer Graphics, Prentice Hall, New Delhi.
4. Harrington, S., Computer Graphics. A Programming approach, Tata McGraw- Hill, New York.
5. Newman. W.& Sproul R.F., Principles of Interactive Computer Graphics, McGraw Hill, Auckland.
6. Roy. A. Plastock and Gordvan Kally, Computer graphics (Scheme Series), McGraw Hills, New Delhi.
7. C.S.Krishnamoorathy, J.S.Rajeev. Computer Aided Design (Software and Analysis Tools), Narosa Pub House, New Delhi.
8. Rogers, D. F., Procedural Elements for Computer Graphics, McGraw Hill, New York.
9. Foley. J.D. & Van Dam. A., Fundamentals of Interactive Computer Graphics, Addison-Wesley.
10. Hearn. D. & Baker P.H., Computer Graphics, Prentice-Hall of India, New Delhi.
11. Tosijasu, L.K., Computer Graphics, Springer-Velag, Berlin.
12. Adan and Rogers, Mathematical Element for Comptuer Graphics, Tata McGraw Hill, New Delhi.
13. Daniel L. Ryan, Computer Aided Graphics and Design, Marcel Dekker, New York.
14. R.G.S. Asthana and N.K. Sinha, Computer Graphics, New Age Internatinoal Publishers, New Delhi.

MODELLING & SIMULATION OF MANUFACTURING SYSTEMS

ME-519

L	T	P
3	1	-

Introduction and overview, concept of system, system environment, element of system, system modeling, types of models, Monte Carlo method, system simulation, simulation-management laboratory, advantages limitations of system, simulation, continuous and discrete systems.

Simulation of continuous systems: characteristics of a continuous system, comparison of numerical integration with continuous simulation system, Simulation of an integration formula.

Simulation of discrete system: Time flow mechanism, discrete and continuous probability

Density function, Generation of random numbers. Testing of random numbers for randomness and for auto correlation, generation of random variates for continuous probability distributions-binomial, normal, exponential and beta distributions, combination of discrete event and continuous models.

Simulation of queuing systems: Concept of queuing theory, characteristics of queues, stationary and time dependent queues, queue discipline, time series analysis, measure of system performance, Kendall's notation, auto covariance and auto correlation function and effects in queuing systems, simulation of single server queues, multi server queues, queues involving complex arrivals and service times with blanking renegeing.

Simulation of inventory systems: Rudiments of inventory theory, MRP, in process inventory, Necessity of simulation in inventory problems, forecasting and regression analysis, forecasting through simulation, generation of Poisson and Erlang variates, simulation of complex inventory situations.

Design of simulation experiments: Length of run, elimination of initial bias. Variance reduction techniques, stratified sampling, antipathetic sampling, common random numbers, time series analysis, spectral analysis, model validation, optimization procedures, search methods, single variable deterministic case search, single variable non-deterministic case search, regenerative techniques.

Simulation of PERT: Simulation of- maintenance and replacement problems, capacity planning production system, reliability problems, computer time sharing problem, the elevator system,

Simulation languages: continuous and discrete simulation languages, block structured continuous languages, special purpose simulation languages, SIMSCRIPT, GPSS, SIMULA, importance and limitations of special purpose languages.

## Reference Books:

- |  |                                     |
|--|-------------------------------------|
| 1. Simulation and modeling                 | Loffick Tata McGraw Hill            |
| 2. System Simulation with Digital computer | Deo Narsingh Prentice Hall of India |
| 3. System Simulation                       | Dr. D. S. Hira S.Chand & Co.        |
| 4. Computer Simulation and Modeling        | Meelamkavil John Willey             |
| 5. System Simulation                       | Gordon Prentice Hall of India       |

COMPUTER AIDED PROCESS PLANNING

ME-520

L	T	P
3	1	-

Introduction: Traditional process planning; process planning elements; product design evaluation; selection of tooling and process parameters; operation sequence evaluation.

Group Technology: Introduction; advantages; part families; classification and coding systems; production flow analysis; design of machine cells.

Production Systems at Operation Level: Manufacturing support systems and concepts at the level of production processes; computer generated time standards; machinability data system; cutting condition optimization.

Production Systems at Plant Level: Communication oriented production information and control system (COPICS); material requirements planning; capacity planning; shop floor control and operation scheduling.

Automated Process Planning: Advantages of automated process planning; standardization of manufacturing process plans; variant process planning; its features; and different stages; different variant systems; advantages and limitations of variant process planning; generative process planning; its features; design strategies; planning modeling and coding scheme; decision mechanism for software; decision trees for process; process information; artificial intelligence; overview & application; search strategies for AI production systems; resolution and reduction systems; knowledge acquisition; machine selection, cutting tool selection; software; various generative process planning systems; advantages of generative process planning systems; case studies.

## List of Recommended Books

- |  |                    |                 |
|--|--------------------|-----------------|
| 1. An Introduction to the Automated Process Planning | Chand & Wysk       | Prentice Hall   |
| 2. Computer Aided Design & Manufacturing             | Groover & Zimmers  | Prentice Hall   |
| 3. Group Technology; Prod. Method in Manufacturing   | Gallagher & Knight | Ellis Hosewood  |
| 4. Principle of Artificial Intelligence              | Nilson             | Springer Verlag |
| 5. Automation; Production System & Computer          | Groover            | Prentice Hall   |

Integrated Manufacturing.

## MCE 516 PRODUCT DESIGN AND DEVELOPMENT

ME-521

L	T	P
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Introduction: to Product Design: Design by Evolution and Innovation, Essential factors of product design, Production consumption cycle, Flow and value addition in Production consumption cycle, The Morphology of Design, Primary design phases and flowcharting, Role of Allowances, process capability and tolerances in detailed design and assembly

Product Design and Industry: The Designer- his role, myth and reality, the industrial design organization, basic design considerations, Role of Aesthetics in product design, Functional design practice

Design for Production: Producibility Requirements in the design of machine components, Forging design, Pressed component design, Casting design for economical molding, eliminating defects and features to aid handling, Design for machining ease, the role of process Engineer, Ease of location and Clamping, Some additional aspects of production design, Design of powder metallurgical parts

Economic Factors Influencing Design: Product value, Design for safety, reliability and Environmental considerations, Manufacturing operations in relation to design, Economic analysis, profit and competitiveness, break even analysis, Economics of a new product design( Samuel Eilon Model)

Value Engineering and Product Design: Introduction, Historical perspective, Value, Nature and measurement of value, Maximum value, Normal degree of value, Importance of value, The value Analysis Job Plan, Creativity, Steps to problem solving and value analysis, Value Engg. Idea generation check list, Cost reduction , materials and process selection in value engineering

Modern Approaches to product Design: Concurrent Design, Quality Function Deployment, reverse engineering,

Rapid Prototyping: Stereo lithography, Solid ground cutting, Selective laser sintering, Laminated object manufacturing, data transfer to RPT, Constraints on the Model, RPT in manufacturing, tooling, RPT in Industrial Design, Medical applications verses conventional technologies

## Books Recommended

1. Product Design and Development by Kail T Ulrich and Steven D Eppinger
2. Product Design and Development by AK Chitale and Gupta
3. Design of Systems and Devices by Middendorf Marcel Dekker

## DESIGN OF EXPERIMENTS

MCE 522

L	T	P
3	1	-

**INTRODUCTION**

Strategy of experimentation, Some typical applications of experimental design, Basic principles, Guidelines for designing experiments, A brief history of statistical design, Using statistical design in experimentation.

**SIMPLE COMPARATIVE EXPERIMENTS**

Introduction, Basic statistical concepts, Sampling and sampling Distribution, Inferences about the Differences in means, randomized designs, Inferences about the Differences in means, Paired comparison Designs, Inferences about the Variances of Normal Distributions.

**RANDOMIZED BLOCK DESIGNS**

Randomized complete block design, Latin square design, Balanced incomplete block design.

**INTRODUCTION TO FACTORIAL DESIGN**

Basic definition and principles, Advantages of factorials, The two factor factorial design, General factorial design, Fitting response curves and surfaces, Blocking in a factorial design.

**FITTING REGRESSION MODELS**

Introduction, Linear regression models, Estimate of parameters in linear regression models, Hypothesis testing in multiple regression, Confidence intervals in multiple regression, Prediction of new response observations, Regression model diagnostics, Testing for lack of fit

**TAGUCHI METHOD OF DESIGN OF EXPERIMENTS**

Concept design, Parameter design, Tolerance design, Quality loss function, Signal-to- Noise ratio, Orthogonal array experiments, Analysis of Mean(ANOM), Quality characteristics, Selection and testing of noise factors, Selection of control factors, Parameter optimization experiment, Parameter design case study.

**ANALYSIS OF VARIANCE (ANOVA)**

Introduction, Example of ANOVA process, Degrees of freedom, Error variance and pooling, Error variance and application, Error variance and utilizing empty columns, the F-test.

**Books Recommended**

1. Design and Analysis of Experiments, Douglas C Montgomery, John Wiley
2. Statistical Design and Analysis of Experiments, John P.W.M., Macmillan,
3. Introduction to Linear Regression Analysis, Montgomery D.C., Runger G. C.,
4. Response Surface Methodology: Process Ang Product Optimisation Using Designed Experiments, Myres R.H., Montgomery D. C., Wiley, New York
5. Introduction to Quality Engineering, Taguchi , G., Asian Productivity Organisation, UNIPUB, White Plains, New York

6. System of Experimental Design: Engineering Methods to Optimize Quality and Minimize Cost, Taguchi, G. UNIPUB, White Plains, New York
7. Statistical Analysis for Engineers And Scientists, J. Wesley Barnes, McGraw Hill Inc.

## COMPUTER AIDED MACHINE DESIGN

ME-523

L	T	P
3	1	-

1. Fundamentals of CAD: Introduction: Design Process: Application of computers in design: Creating manufacturing database: benefits of CAD. Computer Hardware; Graphic input devices; display devices; Graphics output devices; Central processing unit (CPU)
2. CAD software and Database: Software configuration of a graphics system: functions of a graphics package: geometric modeling: Database structure and control;
3. Geometric Transformations: Mathematics preliminaries, matrix representation of 2 and 3 dimensional transformation: Concatenation of transformation matrices. Application of geometric transformations.
4. Computer aided design of Transmission Belts (Flat & V) using C++/VC.
5. Computer aided design of Journal Bearing.
6. Application programs for selection of Ball and roller bearings using C++/VC
7. Computer aided design of Knuckle joint using C++/VC.
8. Computer aided design & drafting of spur gear using C++/VC.
9. Introduction to Design and Engineering Applications- geometry and mass property formulations, design projects with CAE focus

## Books Recommended

1. CAD/CAM Ibrahim Zeid
2. Principles of computer aided design- J Rooney and P Steadman
3. Computer Aided Graphical Design – Daniel L Rayan
4. Computer Graphics and Design- P Radhakrishnan and Kothandaraman

ME-551          CAD/CAM Lab-I

The following experiments are to be conducted using appropriate software:

1. Use of computer in the design process
2. Wire frame modelling of objects.
3. Solid Modelling.
4. Hidden line removal and shading
5. Rendering
6. Geometry & Mass Property Calculations

- Minimum of two problems of optimisation techniques be solved using appropriate softwares
- In addition to above a visit to some facility where any of the above is actually used and to prepare report of that.

ME-552

CAD/CAM Lab-II

Practical to be conducted covering various aspects of CIMS including:

1. Automatic material handling system
2. Automatic Storage and Retrieved System (AS/RS)
3. Computer aided process planning
4. Computer aided Production planning and control
5. CIMS Database management Systems
6. Computers basic Networking.

In addition to above a visit to some facility where any of the above is actually used and to prepare report of that.

ME-553

CAD/CAM Lab-III

Practical to be conducted covering various aspects of Computer control in M/C tools and robotics including:

Study of structure of NC System  
Introduction and use of NC Codes  
NC part programming of various parts  
Tool and zero pre setting  
Flexible tooling  
Different types of NC motions  
Study of various drives, feedback devices, counters. ADC and DAC DEVICES ETC.

In addition to above a visit to some facility where any of the above is actually used and to prepare report of that.

