

UNIVERSITY OF MUMBAI
No.UG/ 360 of 2005

CIRCULAR :

A reference is invited to the Ordinances, Regulations and syllabi relating to the Master of Engineering (M.E.) vide pamphlet No.190 and the Principals of the affiliated colleges of Engineering are hereby informed that the recommendation made by the faculty of Technology at its meeting held on 21st April, 2005 has been accepted by the Academic Council at its meeting held on 14th June, 2005 vide item No.4.16 and that in accordance therewith the M.E. (Mechanical) with Manufacturing Systems Engineering branch has been introduced by the University with effect from the academic year 2005-2006 and that the scheme of papers and syllabus for the course is as per Appendix.

Mumbai 400 032
3rd September, 2005

M. A. Khan
for REGISTRAR.

To,
The Principals of the affiliated colleges in Engineering.

A.C.4.16/14.06.2005

No.UG/ 360-A of 2005

3rd September, 2005

Copy forwarded with compliments to the Dean, Faculty of Technology, for information.

M. A. Khan
for REGISTRAR

Copy to :

The Director, Board of College and University Development, Deputy Registrar (Eligibility and Migration), the Director of students Welfare, the Personal Assistants to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar Administrative sub-centre, Ratnagiri, for information.

The O.S.D. cum- Controller of Examinations (10 copies), the F. & A.O. (Accounts Section). For (2 copies), Record Section (5 copies), Publication Section (5 copies), D.R., Enrolment (2 copies), D.R. (Statistical Unit), D.R., Accounts Section, Vidyanaagari, (2 copies), D.R. (Affiliation Section) (2 copies), A.R., A.A. Unit (2 copies). He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council/Management Council referred to in the above Circular and that no separate A.T.R. will be sent in this connection. A.R., CONCOI (1 copy), BUCTU (2 copies), In-charge, Central Computing Facility (1 copy), D.R., I.D.E. (10 copies), D.R., P.R.O., (2 copies), Supdt., Thesis Section (2 copies), Supdt., P.G. Section (2 copies), BUCTU (1 copy), Secretary, MUASA (1 copy), Dy. Acctt. (Unit V) (1 copy), Receptionist (1 copy), Telephone Operator (1 copy).

Notations



UNIVERSITY OF MUMBAI



Scheme and Syllabus
for
M.E. (Mechanical Engineering)
with
Manufacturing Systems Engineering

(with effect from the academic year 2005-2006)

COURSE: M.E. (MECHANICAL) MANUFACTURING SYSTEMS ENGINEERING

Semester-I

Sr. No	Subject	Lectures	Practical/Tutorials/Seminar	Duration of Examination in Hrs	Theory Paper (Marks)	Internal Assessment
1	Material Removal Science	3	2	4	100	50
2	Manufacturing System Simulation	3	2	4	100	50
3	Product Design and Development	3	2	4	100	50
4	CAD,CAM,CIM	3	2	4	100	50
5	Elective-I	3	2	4	100	50
	TOTAL	15	10	---	500	250

Semester-II

Sr. No	Subject	Lectures	Practical/Tutorials/Seminar	Duration of Examination in Hrs	Theory Paper (Marks)	Internal Assessment
1	Quantitative techniques in Management	3	2	4	100	50
2	Advanced Material Joining & Sheet Metal Processing	3	2	4	100	50
3	Advanced Material Science	3	2	4	100	50
4	Industrial Automation	3	2	4	100	50
5	Elective-II	3	2	4	100	50
	TOTAL	15	10	---	500	250

Elective-I

1. Quality & Reliability Engineering
2. Advanced FEM
3. Inventory Planning & Manufacturing System
4. ERP & Engineering Economy

Elective-II

1. Modeling & Optimization in FMS
2. Supply Chain Management
3. World Class Manufacturing Systems
4. Maintenance Management

COURSE: M.E.(MECHANICAL) MANUFACTURING SYSTEMS ENGINEERING
Semester-III

Sr. No	Subject	Internal Assessment
1	Seminar on Thrust Areas*	50
2	Dissertation Seminar	50
	TOTAL	100

Semester-IV

Sr. No	Subject	Internal Assessment	Oral Examination
1	Pre Synopsis Dissertation Seminar	50	-
2	Dissertation & Viva Voce	100	100
	TOTAL	150	100

During Semester III and IV, The students should work full time for each of his/her Seminar and dissertation work.

The student has to be in association with a staff member for conducting the seminar. The student should present the seminar in front of committee consisting of faculty members of the department and has to be evaluated by a committee.

Student teacher contact hours for dissertation during SEM- III & IV will be of TWO hours/teacher/week.

Student teacher contact hours for seminar during SEM- III & IV will be of TWO hours/teacher/week.

Period / Week 1 Period of 1 hour	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Introduction to Machining Processes. Development of Machine Tools and Cutting Tools Materials along with the level of controls.
2. Fundamental of machining processes
 - Mechanics of Chip Formation
 - Forces, Power & Stresses in machining
 - Surface finish and surface integrity
 - Tool wear & tool life
 - Machining economics
 - Experimental method to find tool life
 - Relationship exponents & constants
 - Tool force dynamometer
3. Cutting tool materials
 - High speed tool steel
 - Cast Cobalt alloys
 - Cemented carbides
 - Cermets
 - Ceramics, ultra hard tool materials
4. Machinability of materials, their prediction and improvement
 - Cutting Fluids & surface roughness, advancement in cutting tool material
 - Recent development in tooling for CNC machine applications.
5. Nomenclature of cutting tools. Systems of cutting tool nomenclature, American standard association system, German system, British maximum rake system., Interrelationship among different systems of Rake & Clearances angles of Turning tools.
6. Design of cutting tools
 - H.S.S. & Tungsten carbide single point Turing tools
 - Flat & circular form tools
 - H.S.S. Broaches for holes, keyways and splines
 - H.S.S. Drill and Reamers
 - Form relieved milling cutter such as Involute gear tooth disc type and End Mill type cutters
 - H.S.S. Hobbing and Shaper cutters

7. NTM Processes: Classification, comparison of equipments and process capabilities.
 Mechanical Processes: Abrasive jet machining, water jet machining, ultrasonic machining.
 Electrical Processes: Electrochemical machining, electrochemical grinding, Electrochemical deburring.
 Thermal Processes: Electron beam machining, laser beam machining, electrical Discharge machining
 Chemical Processes: Chemical Machining, chemical engraving, photo chemical Machining
8. Material removal analysis of AJM, USM, & ECM processes. Design of tool Head in USM.
9. NTM application to VLSI (Very Large Scale Integration) Technology.

TERM WORK :

1. Tool Nomenclature (MRS, ORS, NRS) and related interrelationships.
2. Numerical example in metal cutting and machining economics.
3. Design sheets for flat and circular form tools, H.S.S. broaches, H.S.S. drills and reamers and form milling cutters.
4. Practical experiments for chip formation and tool force measurements.
5. Case studies in non-traditional machining through seminars.
6. Case studies in metal cutting topics other than non-traditional machining through seminars.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

- 1 ASM handbook, vol. 16: Machining, ASM International materials park, Printed in USA.
- 2 Bhattacharya A. Metal cutting theory and practice, New Central Book Agency.
- 3 Boothroyd G. Fundamentals of metal machining and machine tools, Tata McGraw-Hill.
- 4 Osipov, Typical examples and solutions in Metal Cutting, Mir Publications.
- 5 Non-traditional machining conference proceeding, society of carbide and tool engineers.
- 6 Weller, Non-traditional machining processes, SME.
- 7 S.M.Sze, VLSI Technology.

ME – 2: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: Manufacturing System Simulation			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Systems and Modeling: Systems, sub-systems, parameters, variables, measures of performance, and types of models.
2. Introduction to simulation: Qualitative and quantitative simulation
3. Introduction to sampling: Sampling from historical data, empirical distributions and statistical distributions
4. Applications of simulation: Study of inventory system, project network, replacement model, production and operations scheduling, supply chain, and queuing system; development of business games.
5. Design of simulation experiments: Analysis of transient and steady states, and run length; variance reduction techniques; use of statistical tests for output data analysis.
6. Elements of stochastic simulation; design of and inference from simulation experiments; simulation of job shops and assembly job shops; some examples in simulation of manufacturing systems.
7. Use of simulation software.

TERM WORK

Minimum ONE Class Test to be conducted of 20 Marks.

Minimum 05 programming assignments on above mentioned topics.

REFERENCES:

- 1 Banks, J. Carson, S., Nelson, B.L., "Discrete Event System Simulation", (2nd edition), Prentice Hall of India, New Delhi.
- 2 Deo, N., "System simulation with digital computers", Prentice Hall of India.
- 3 Law, A.M., and Kelton, W.D., "Simulation Modeling and Analysis", (2nd edition), McGraw Hill, N.Y.

ME – 3: Manufacturing Systems Engineering			SEMESTER – I
SUBJECT: Product Design and Development			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	--	50

1. Meaning of Product, Classification of Products, Need for innovation, Product life cycle, Product Mix, Management issues, Product specifications Market research.
2. Design for customer, Standardisation, Value analysis, Design for manufacturing and assembly, Design for maintainability, Product costing.
3. Creativity techniques: Sources, Developing new product features, Existing product, Creative thinking, conceptualization, brain storming, Primary Design & drawing, Simulation, detail design, Aesthetic and Ergonomics, final design, Reducing costs Development time, Process selection.
4. Tools for Product Design: Study of Software for Drafting, Design modeling, Assembly, detailing, CAM interface.
5. Concurrent engineering, Rapid prototyping techniques. Product engineering data management Techniques, Strategies & control, Economics.

TERM WORK

Minimum 6 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

- 1 Hollins, B., and Pugh, S., Successful Product Design. Butterworths, London.
- 2 Baldwin, E.N. and Niebel, B.W., Designing for Production, Edwin, Homewood, Illinois.
- 3 Jones, J.C., Design Methods, Seeds of Human Futures, John Wiley, New York.
- 4 Bralla, J.G., Handbook of Product Design for Manufacture, McGraw Hill, New York.
- 5 L. D. Miles, Value Engineering

ME – 4: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: CAD, CAM, CIM			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	--	50

- 1 Introduction to Computer Graphics, Graphics Devices & their Control, Building & Drawing Curves, Interactive Graphics, Vectors & their use in Graphics, 2 – D Ray tracing, Reflections in a chamber.
- 2 Modeling surfaces, Transformation of Pictures, Raster Graphics Technique, Curve & surface Design for CAD, Visual Realism, Color Theory, Hidden Surface Elimination, Introduction to Ray Tracing, Graphics Standards
- 3 Data processing machines. Continuous sampled data on digital control systems. Positioning, straight cut and contouring control systems. Numerical control application. Manual & computer aided programming, specialized manufacturing applications.
- 4 Basic principle of numerical control, classification of NC & CNC systems. Drives, feedback devices, counting devices used in NC system. Interpolators for manufacturing system. Control loops for NC system, Tooling on CNC, Fixtures on CNC, NC part programming- (Manual and Computer aided).
- 5 Direct numerical control (DNC) and computer numerical control (CNC), adaptive control of manufacturing processes. Computer processes monitoring and control, off-line use of computers. Computer - process interface.
- 6 Introduction to CIM, Evolution, Objectives, benefits, limitations & Obstacles of CIM, Basic building blocks of CIM
- 7 Material handling systems. Material handling and storage systems like Robots, AGVS, AS/RS etc, Development for total material handling system. Automatic inspection systems use of CMM, Communication systems, Links in the network, Computer control systems, from product design to manufacturing.
- 8 Introduction to GT-GT Techniques, PFA, Similarity Coefficient Matrix, CAPP, Scheduling, MRP, Flexible cell, FMS system design, development and utilization, Computer simulation of FMS, Packages available.
- 9 Product data management for CIM. Integration of the production management and Business functions for CIM, Socio-techno-economic aspects of CIMs.

TERM WORK

Minimum 6 Assignments on CAD SOFTWARE like IDEAS, PRO-E, CATIA etc
Minimum 2 CNC PROGRAMS on CNC.
Minimum THREE C++ Programs on above topics.
Minimum ONE Class Test to be conducted of 20 Marks.

REFERENCES:

- 1 Rogers, D.F. and Adams, A., Mathematical Elements for Computer Graphics, McGraw Hill Inc, NY.
- 2 Faux, I.D. and Pratt, M.J., Computational Geometry for Design and Manufacture, John Wiley & sons, NY.
- 3 Mortenson, M.E., Geometric Modeling, John Wiley & sons, NY.
- 4 Choi, B.K. Surface Modeling for CAD/CAM, John Wiley & sons, NY.
- 5 Paul G. Ranky, The Design and operation of FMS, I.F.S publ.
- 6 Richard Stover, An analysis of CAD/CAM Application with introduction to C.I.M., Prentice Hall Inc. Englewood Cliffs, NJ.
- 7 David Bedworth, et al., Computer Integrated Design and Manufacturing, McGraw Hill.
- 8 Scholz. B. & Reiter, C.I.M Interfaces, Chapman & Hall.
- 9 David L. Goetsch, Fundamental of CIM technology, Delmar publication.

ME – 5: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: Quality & Reliability Engineering (Elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Basic Concepts in Assurance Technology: Terminologies, Definitions, Approaches and Important issues. Concepts of quality, quality control, quality economics, design for quality, statistical aids in limits & tolerances.
2. Product Quality Control: Acceptance Sampling Methods-Single Multiple and Sequential Sampling Plans; Recent developments in inspection methods. Process Evaluation and Control-by-Control Charts: Various control charts including CUSUM charts and Multivariate charts.
3. Process Evaluation and Control by Designs of Experiment: Various basic designs; Special Methods like EVOP, RSM and ROBUST Designs
4. Process Capability Studies: Use of control charts, Various indices, SPAN PLAN METHOD and use of Nomographs
5. Total Quality Management perspective, methodologies and procedures
6. Road map to TQM: Quality Function Deployment, Poka Yoka, ISO 9000, Quality Cost System, KAIZEN, Quality Circles, Quality Policy Deployment and Models for organisational excellence.
7. Reliability Engineering; Statistical analysis of lifetime data and determination of Reliability, Availability and Maintainability; Development and Applications of Fault Tree Diagrams, Cause and Effect Diagrams, FMECA and FRACAS.
8. JIT, Total Productivity Maintenance and Quality perspectives

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

1. A.J. Duncan, "Quality Control and Industrial Statistics", Richard D. Irwin INC USA.
2. A.V. Feigenbaum, "Total Quality Control", McGraw Hill International Editions, USA,
3. S. Halpern, "The Assurance Sciences". Prentice Hall India Ltd., New Delhi
4. A. Zaidi, "SPC, Concepts, Methodologies and Tools." Prentice Hall India Ltd., New Delhi.
5. D.C. Montgomery, "Design and Analysis of Experiments". John Wiley and Sons, USA.
6. J. Juran, "Quality Control Handbook", McGraw Hill Book Company USA.
7. W.E. Deming, "Out of Crisis", Productivity and Quality Publishing Private Limited, Madras.
8. Masaaki Imai, "KAIZEN, The key to Japan's Competitive Success", McGraw Hill International Editions, USA.

ME – 6: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: Advanced FEM (Elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Review of basic FEM concepts
2. Advanced topics in linear problems
 - a. Static condensation and sub-structuring
 - b. Patch test and incompatible element
 - c. P-formulation
3. Advanced Beam, Plate and Shell elements
 - a. Timoshenko beam theory (shear locking)
 - b. Plate and shell theory
 - i. Thin plate and Mindlin plate (shear and membrane locking)
 - ii. Mixed formulation for plate and shell
 - iii. Degenerated shell formulation
4. Dynamic analysis using FEM
 - a. Consistent mass and lumped mass, mass lumping technique
 - b. Time integration methods: explicitly, implicit, explicit-implicit methods.
 - c. Stability, convergence and consistency
 - d. Hyperbolic systems: structural dynamics and wave propagation
 - e. Parabolic system: transient heat transfer
 - f. Modal solution for natural frequencies and mode shapes
 - g. Modal Superposition method for structural dynamics
5. Nonlinear analysis
 - a. Nonlinear solution procedures
 - b. Newton-Raphson, modified Newton-Raphson, and secant methods
 - c. Line search algorithm
 - d. Automatic time step control
6. Material nonlinearity
 - a. Rate independent elastoplasticity with return-mapping algorithm
 - b. Isotropic and kinematics hardening with Baushinger effect
 - c. Consistent tangent operator
 - d. Objective rate and finite rotation elastoplasticity
 - e. Multiplicative decomposition and finite deformation elastoplasticity

7. Geometric nonlinearity
 - a. Generalized strain and stress
 - b. Total and Updated Lagrangian formulation
 - c. Kirchhoff stress and Cauchy stress
8. Boundary nonlinearity
 - a. Frictionless contact problems
 - b. Penalty, Lagrange multiplier, augmented Lagrange multiplier, and perturbed Lagrange multiplier methods
 - c. Frictional contact problems including frictional return-mapping algorithm

TERM WORK

Minimum 5 Assignments on above mentioned topics.
Minimum ONE Class Test to be conducted of 20 Marks.

REFERENCES:

- 1 M. A. Crisfield, Non-linear Finite Element Analysis of Solids and Structures. Volume 1, Wiley, Chichester.
- 2 Philippe G. Ciarlet, Elsevier, The Finite Element Method for Elliptic Problems , North-Holland.
- 3 J N Reddy, Finite Element Methods, TMH
- 4 Chandrupatla, Belagundu, Introduction to FEM in Engg, PHI
- 5 Bathe, FE Procedures, PHI

ME – 7: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: Inventory Planning & Manufacturing System (Elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

- 1 Introduction: Basic inventory systems, types of inventory, Reasons for keeping inventory, inventory control, objectives, benefits, Q system, and Quantity discounts.
- 2 Inventory system under risk: introduction, static and dynamic inventory system with depend following probabilities distribution, service level and safety stock, back ordering, lead time variability, anticipated price increase, inventory control system in practice.
- 3 Material consumption control: Disposal of wastes and surplus and obsolete materials, causes of wastes and scraps salvaging, reverse logistics.
- 4 Maintenance of materials and spare parts management: general considerations, capital insurance spares, control of maintenance of material and spare parts.
- 5 Material requirement planning: independent demand, mechanics of MRP, objectives, inputs, output, implementation, lot sizing techniques, system nervousness firm planned orders and time fences, management information from MRP, lot sizing considerations, MRP II, CRP.
- 6 Distribution inventory management: multi location systems, industrial dynamics Centralization inventories, distribution requirement planning.

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

1. S. L. Narasimhan, Production Planning and Inventory Controls: PHI
2. A. K. Datta, Materials management, Inventory control and logistics, JAICO.
3. Arnold and Chapman, Introduction to material management, Pearson Education Asia.
4. Starr and Miller; Inventory control; Prentice Hall.

ME – 8: Manufacturing Systems Engineering		SEMESTER – I	
SUBJECT: ERP & Engineering Economy (elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Perspectives of enterprise management, Essentials of competitive excellence, Different approaches for enterprise management, Innovations and excellence in enterprise management.
2. Issues related to different aspects of enterprise management including: Value management, Engineering economic analysis, Decision making, Advances in manufacturing management, Assurance technology, Supply chain management and logistics, Technology management, Business process reengineering and Strategic alliance.
Issues related to new innovations of IT including, System Simulation, Inter-operability for enterprise management, Enterprise application integration, Software project management, Role of Software engineering, Object oriented architecture, Browser based front-ends, Cyber- me diary and Web Services.
3. The emergence and need for ERP concept, ERP systems for manufacturing and service based organizations, Software Architecture of a typical ERP System, Options of various paradigms, and Identification of suitable platforms.
4. Selection and implementation of ERP Systems. Critical factors guiding selection and evaluation. Strategies for successful implementation. Impediments and initiatives to achieving success. Critical success and failure factors, Integrating ERP into organizational culture. False proofing and confidence building.
5. Post ERP experiences and beyond, the role of data warehousing and data mining. Lecture cum demo of well-known systems like People soft, SAP, MFG Pro and Baan.
6. Basic Concepts: Cost concepts, job order and process costing, standard costs and variances. Cost volume profit relationships. Costing of joint products and by products.
7. Profit measurement. Financial statement analysis. Capital investment planning, perfect ranking using present worth, internal rate of return and MAPI urgency rating.
8. Replacement analysis. Financing of manufacturing enterprises. Cost of capital. Capital budgeting risk and uncertainty, application of linear programming. Full and variable cost pricing. Transfer pricing. Income tax and engineering economy.

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

1. ASAP Consultancy and Blain, J. Understanding SAP R/3; Prentice Hall India Ltd.
2. Hiquet, B.H. and Kelly, A.F., SAP R/3, Implementation Guide; Tec media.
3. Clewett, A., Franklin, D. and Me Cown, A.; Net work Resource Planning for SAP R/3, Bann IV and People Soft; Tata McGraw Hill.
- 4 G.L. Moore and R.K. Jaekicke, Managerial Accounting south-Western Publishing Co., Chicago, 22nd Ed.
- 5 Matz and M.F. Usry, Cost accounting Planning and Control, Taraporevala-South-Western 6th Ed.
- 6 H.N. Weingamer, Mathematical Programming and the analysis of Capital Budgeting problems, Prentice Hall.

ME – 2: Manufacturing Systems Engineering			SEMESTER –II
SUBJECT: Advanced Material Joining & Sheet Metal Processing			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

- 1 Production and application of sheet metal. Control of properties.
- 2 Formability testing of sheet metal.
- 3 Power presses: Types, Major components, Selection sheering, slitting and cutting of flat sheet. Blanking & Piercing with press working tools. Design of dies and the die components. Design of progressive dies and the die components. Design of the progressive blanking dies. Strip layout. Compound dies. Bending and forming dies.
- 4 Bending and forming dies.
- 5 Drawing dies. Die design, Single and double action dies. Blank development.
- 6 Hydro forming, Rubber pad forming, Explosive forming, Bending & Forming of tubes.
- 7 Joining by adhesives, Soldering and Brazing processes.
- 8 Fundamentals of fusion welding. Solid state welding. Cold welding, Diffusion welding, Co extrusion welding, Ultrasonic welding, Friction welding, Explosion welding, Electron Beam welding, Laser beam welding, Eutectic repair welding. Joining in surface mount technology. Automation in welding.
- 9 Material joining requirements in VLSI technology.

TERM WORK :

1. Assignments based on press tool design & metal joining (minimum four)
2. One case study on the design of dies.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

1. J. A. Waller, Press Tools and Presswork, Porttucullis press
2. W. Johnson & P. B. Mellor, Engineering Plasticity, Van Nostrand Reinhold

3. C. W. Hinman, Press Working of Metals, McGraw Hill
4. Paul Schubert, Die methods Book One & Two., Industrial Press
5. Metal Handbook (10th edition) Vol 15 on Metal Forming,
6. Die Design Handbook, ASM publication.
7. Rossi, Welding Engineering.
8. A. W. S. Welding Engineers Handbook, Vol I to IV.
9. Metals Handbook, Welding and Soldering.
10. R. L. Little, Welding and Welding Technology.
11. R. F. Tylecote, Solid Phase Welding Metals.
12. ASTM, Tool and Manufacturing Engineers Handbook.
13. Nikolaev and Olshansky, Advanced Welding Processes, MIR Publishers.
14. N. Lashko and S. Lashko, Brazing and Soldering of Metals.
15. Uddin, Funk and Wulf, Welding of Engineers.
16. S. M. Sze, VLSI Technology.

ME – 3: Manufacturing Systems Engineering		SEMESTER –II	
SUBJECT: Advanced Material Science			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

- 1 Review of fundamentals: Covalent, Ionic, Metallic and Van der Waals Bond, Bond strength and Melting point, crystalline structures, vacancies, dislocations and other crystal defects. Metals Vs Alloys – Micro structural characterization.
2. Mechanical Behavior of Metals and Alloys :
Tensile and compressive stress-strain relations, fracture toughness, fatigue, creep, wear and abrasion.
3. Metallic Materials for Engineering Applications :
HSLA steels, tool and die materials, alloy cast irons, stainless steels, PH and mar aging steels, materials for low temperature applications, refractory metals and super alloys, high speed steels, ball bearing steels and bearing metals, automobile alloys and aerospace alloys.
- 4 POLYMERS:
 - A. Structure of plastics:
Distinction between polymers and plastics; monomers and polymers; addition polymerization, condensation polymerization, carbon backbone with linear chain, branched chain or cross-linked chain.
Branching and tacticity – Isotactic, syndiotactic, atactic forms
Copolymer – Alternating, random, block and graft copolymers.
Crystalline structure of polymers –
Fringed micelle model, folded chain theory, lamellae and spherulites in crystalline polymers
 - B. Types of Plastics :
Thermoplastic materials – crystalline and amorphous, thermosetting plastics, structural foam, elastomers and thermoplastic elastomers, polymer alloys and liquid crystal polymers.
 - C. Viscoelastic, Thermal, Electrical and Optical Behaviour of Polymers.
 - D. Mechanical Behaviour of Polymers :
Strength and stiffness, notched impact toughness, flexural modulus, creep and relaxation, fatigue
 - E. Engineering Polymers and their applications
 - F. Environmental effects in polymers

- 5 **CERAMICS:**
 Ceramic Crystal Structures –
 Binary ceramic structures:
 [Rock Salt], [Fluorite], [Rutile] and [Silica] Structures.
 Ternary Ceramic Structures :
6. Introduction to phase equilibria in ceramics :
 Phase equilibrium diagrams and composition calculations.
 Thermal, electrical, magnetic and optical behaviour of ceramics
 Mechanical behaviour of ceramics :
 Toughening mechanisms in ceramic, cyclic fatigue of ceramics, thermal stress in ceramics, creep in ceramics.
 Ceramics for Engineering applications :
 Engineering ceramics and their applications, (Glass and Glass-Ceramics, Aluminium Oxide, Silicon Nitride, Zirconia and Zirconia-Toughened Aluminium, sialons)
 Environmental Effects in Ceramics.
- 7 **COMPOSITES:**
 A. Fundamentals :
 Definition; classification of composite materials; laws of mixtures, factors affecting composite properties; interfacial bonding
- B. Mechanical Behaviour of Composite:
 Young's Modulus & strength Considerations for continuous FRCs & short FRCs, Halpin-Tsai Equations.
- Interfacial Mechanics:
 Mechanics of load transfer from matrix to Fiber, Toughening Mechanisms in composites.
- Fabrication & Properties of Fibers-
 Glass Fibers, Carbon Fibers, Aramid Fibers, Silicon Carbide Fibers & Metallic Glasses.
- Comparatives Study, Illustrations & Applications:
 PMCs, CMCs & MMCs.
- Fatigue of Laminate Composites.

TERM WORK

The term work will comprise of at least five assignments on the above topics.
 Minimum ONE Class Test to be conducted of 20 Marks.
 ONE Seminar should be conducted in class on topic related to latest areas in above subject

REFERANCES :

1. Material Science by R.S.Kurmi & R.S.Sedha ,S.Chand & Company Ltd.
2. Mechanical Behaviour of Materials by Thomas H.Courtney(McGraw-Hill).

3. Mechanical Metallurgy by George E. Dieter (McGraw-Hill).
4. Engineering Metallurgy-Part I & II by Ramond A. Higgins, (ELBS).
5. Heat Treatment Principles & Techniques by Rajan, Sharma & Sharma
(Prentice-Hall of India)
6. Elements of Materials Science & Engineering by Lawrence H. Van Vlack (Addison-Wesley Publishing Company).
7. Principles of Materials Science & Engineering by William E. Smith (McGraw-Hill Publishing Company)
8. The Science & Engineering of Materials by D.R. Askeland & P.P. Phule (Thomson Asia Pte Ltd, Singapore).
9. Plastics Engineering by R.J. Crawford (Butterworth-Heinemann).
10. Plastics Technology Handbook by M. Chanda & S.K. Roy (Marcel Dekker, Inc.)
11. Plastics mould Engineering By DuBois, J.H. & Pribble, W.I. (Van Nostrand Reinhold, New York).
12. Plastics Engineering Handbook of the society of Plastics Industry, Inc. by Frados, J. (Van Nostrand Reinhold, New York).
13. Engineering Materials & their Applications by R.A. Flinn & P.K. Trojan (Jaico Publishing House).
14. Engineering Materials & their Applications by R.A. Flinn & P.K. Trojan (Jaico Publishing House).
15. Materials Science by J.C. Anderson, K.D. Leaver, R.D. Rawlings & J.M. Alexander (Chapman and Hall).
16. Mechanical Properties of Ceramics by John B. Wachtman (John Wiley & Sons Inc.)
17. Modern Ceramic Engineering Properties, Processing & Use in Design by David W. Richerson (Marcel Dekker, Inc.)
18. Composite Materials : Engg. And Science by F. L. Matthews and R. D. Rawlings (Chapman and Hall)
19. Composite Materials Science and Engineering by Krishan K. Chawla (Springer-Verlag).
20. Metal Matrix Composites : Thermomechanical Behaviour, by Taya M., Arsenault R. J. (Pergamon Press, Oxford).
21. Analysis and Performance of Fiber Composites, by B. D. Agarwal and L. J. Broutman (John Wiley & Sons, New York).

ME – 4 : Manufacturing Systems Engineering		SEMESTER –II	
SUBJECT : Industrial Automation			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Control Theory: Feedback control, mechanism of feedback, system representation, open and closed loop systems, Introduction to Laplace transform, Laplace transform of system, equations and concept of s- plane representation of system characteristic equation, Routh's stability criterion. Transient response and steady state error analysis : Frequency domain : root locus plots, frequency response, Nyquist plots and Bode diagrams, robustness and stability margins , compensation via lead, lag and lead-lag compensators, stability margins. Introduction to optimum control concepts such as performance index etc.; Introduction to digital control system.
2. Manufacturing Automation: Mechanisation and automation, product cycle, hard Vs, flexible automation, capital-intensive Vs low cost automation. Types of systems mechanical, electrical, hydraulic, pneumatic and hybrid systems. Drives and their selection, synthesis of automatic systems. Automation using cams, Geneva mechanisms, gears etc. Hydraulic devices, valves, auxiliary elements. Synthesis of circuits - Synthesis of pneumatic circuits, hybrid systems. Examples of the above in manufacturing applications.
3. Automation strategies: flow lines, automated assembly systems, transfer systems; Vibratory bowl feeders, non-vibration feeders. Part orienting, feed track, part placing and part escapement systems; Part Handling, mechanisation of part handling, manipulators, industrial robots & their types, Production design for automation.
4. Computer Controlled Systems: Overview, computer interfacing, continuous and discrete data, data converters. Sampling fundamentals: stroboscopic and process models of sampling, sampling theorem, aliasing, frequency domain interpretation of sample and hold. Transform analysis of sampled data systems: Fourier and Laplace transforms, starred and Z-transforms, block diagram analysis, implementation of continuous filters in difference equations, design of sampled data systems using z- and w-planes. State space formulation: state transition matrix, concept of observability and controllability, stability analysis, state feedback and pole placement. Design case studies of computer controlled systems.
5. Artificial Intelligence in Engineering : Overview, Computational techniques for representing and solving problems. Biological perspectives. Representation, production systems and search. Heuristics. First order logic and resolution. Fuzzy logics. Planning spatio temporal reasoning, learning, Qualitative reasoning engineering.

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

REFERENCES:

- 1 K.Ogata, "Modern Control Engineering", Prentice Hall India.
- 2 F.H.Raven, "Automatic Control Engineering", Fourth Edition, McGraw-Hill Book Co.,
- 3 B.C.Kuo, "Automatic Control Systems", Fifth Edition, Prentice Hall India,
- 4 C. Ray Asfahl, Robotics and Manufacturing, John Wiley & Sons.
- 5 V. Tergan, I. Andreev and B. Liberman, Fundamentals of Industrial Automation, Mir Publishers.
- 6 Y. Karen, and J.S.Yun, Numerical Control of Machine Tools, Khanna Publishers.
- 7 S. Pressman and Roger, E. Williams John, Numerical Control and Computer Aided Manufacturing, N.Y. Wiley.
- 8 M. Gopal, Digital Control Engineering, Wiley Eastern Limited
- 9 G.F. Franklin, J.D. Powell and M.L. Workman, Digital Control of Dynamic Systems, Addison Wesley.
- 10 K.J. Antrom, and B. Wittenmark, Computer Controlled Systems, Prentice Hall.

ME – 5 : Manufacturing Systems Engineering		SEMESTER –II	
SUBJECT : Modeling & Optimization in FMS (Elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. Overview of basic elements and features of flexible manufacturing systems; classification of systems and configurations; nature of decision problems in design, operation and control of the systems; methods for part selection, grouping of machines, allocation of tools; scope of application of group technology;
2. Overview of design, planning, scheduling and control decision problems of flexible manufacturing systems; parts production ratios, allocation of pallets and fixtures, and machine loading and part routing, parts input strategy.
3. Objectives and approaches in dynamic loading problems; modeling and optimization in routing decisions; closed queuing networks and related models for performance analysis; Mean Value analysis; models for design and operational control of AGV systems; sequencing activities of machine tending robots; coordination of simultaneous operations by multiple robots;
4. Elements of real time scheduling; deadlock problems, their detection and prevention; Petri Net models, their simulation and scope of application; approaches to simulation of FMS; concepts of hierarchical control and applications; parts launching, routing and sequencing decisions in flexible assembly systems.
5. Methodologies for analysis/optimization and their range of applications. Open and closed queuing networks, estimation of average production rate, queue lengths and machine utilizations, Mean value Analysis(MVA), mathematical programming for machine loading and part routing subject to practical constraints, concepts for optimizing flow-control and route-control, scheduling techniques for a flexible manufacturing line.
6. FMS scheduling with dynamic features such as look-ahead, scheduling for machine centers served by a cyclic conveyor, sequencing problems in NC punch process. AGV scheduling, stacker crane scheduling, sequencing of robot activities, concepts of timed Petri Nets, scope for use of expert systems, use of simulation methods. Performance evaluation of FMS
7. Case studies and applications from leading journals-such as International Journal of Productions Research, International Journal of FMS etc.,

TERM WORK

Minimum 5 Assignments on above mentioned topics.
Minimum ONE Class Test to be conducted of 20 Marks.

REFERENCES:

1. Viswanadham N. and Narahari Y., 'Performance Modeling of Automated Manufacturing Systems,' Prentice Hall India.
2. Ranky P.G., 'Flexible Manufacturing Cells and Systems in CIM,' CIMWare Ltd., Guildford, Surrey, England, 1990.
3. Jha N.K. (Ed.), 'Handbook of Flexible Manufacturing Systems,' Academic Press
4. Kusiak A., 'Modelling and Design of Flexible Manufacturing Systems,' Elsevier, Amsterdam.
5. Askin R.G. and Standridge C.R., 'Modelling and Analysis of Manufacturing Systems,' John Wiley and Sons.
6. Gershwin S.B., 'Manufacturing Systems Engineering,' PTR Prentice Hall, Englewood Cliffs, New Jersey.
7. Luggen W.W., 'Flexible Manufacturing Cells and Systems,' Prentice Hall, Englewood Cliffs, N.J.
8. Kusiak, A. (ed.), Modeling and Design of Flexible manufacturing Systems, Elsevier Science Publishers, Amsterdam
9. Raouf A. and S.I. Ahmed (Eds), Flexible Manufacturing, Elsevier
10. Kusslak, A. (Ed), Flexible Manufacturing Systems; Methods and Studies, North Holland,
11. Selected articles in standard international Journals such as Int. J. of FMS, IJPR, IIE Transaction etc.

ME – 6 : Manufacturing Systems Engineering		SEMESTER –II	
SUBJECT : Supply Chain Management (Elective)			
Period / Week	Lecture	3	
1 Period of 1 hour	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

- 1 Introduction: Understanding Supply Chain , strategic Supply Chain management,(SCM) decision phases, Importance of Supply Chain flows, Examples.
- 2 Supply Chain performances, Customer driven strategies in production and distribution systems. Customer focus in SCM, Management of supply sources, Drivers & Obstacles.
- 3 Planning Demand & Supply in SC, Demand forecasting, Aggregate Planning, Planning & Managing inventories in SC.
- 4 Transportation, Coordinating SC, Integrated production and distribution networks. Network Design & IT in SC, Supply chain management in the context of JIT and MRP - II. Distribution Resource planning. Management of dealer networks. Total quality control and product innovation across the supply chain. Incoming logistics and supplier relationships. Value addition analysis. Metrics for measurement of supply- chain performance. Mathematical models and computer assisted decision support for supply chain management. Mathematical programming and other models for supply chain decisions.
- 5 RE Engineering of SC, IT Enabled SC, Best practices & Bench marking for SC, towards Green SC, towards World class SCM.
- 6 Case studies from the literature and practice. Prerequisites : Basic familiarity with mathematical modeling and optimization.

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

- 1 Sunil Chopra, P. Meindl Supply Chain Management Pearson Education Asia
- 2 R. P. Mohanty, S. G. Deshmukh Essentials of Supply Chain Management Phoenix Publishing House Pvt Ltd

- 3 Martin Christopher, Logistics and Supply Chain Management, Richard Erwin.
- 4 Thomas F. W., Customer Driven Strategies, Oliver White,
- 5 Bradley S.P., Hax A. Magnanti T.L., Applied Mathematical Programming, Addison Wesley,
- 6 William A. Sandras, (Jr), JIT : Making it happen, Oliver White
- 7 Korgaonkar M.G., Just-in-time manufacturing, Macmillan.

ME - 7 : Manufacturing Systems Engineering			SEMESTER -II
SUBJECT : World Class Manufacturing Systems(Elective)			
Period / Week 1 Period of 1 hour	Lecture	3	
	Practical / Seminar	2	
		Hours	Marks
Evaluation System	Theory	4	100
	Internal Assessment	-	50

1. The Imperative of WCM, Evolution of WCM. Basis Building Blocks of WCM. Benchmarking for WCM.
2. Advanced Manufacturing Technology (AMT) for WCM - Definition, Evaluation and their Competitive Potential. AMTs in Use - CAD/CAM.
3. Computer Aided Process Planning (CAPP). Flexible Manufacturing Systems (FMS), Computer Integrated Manufacturing (CIM). Enabling Systems for World Class Manufacturing (WCM), Just in Time (JIT) Systems. Group Technology (GT).
4. Design Manufacturing Integration (DMI), Learning Organisation, Integrative Planning Systems (MRPII/ERP), Accounting Systems (ABC), Benefits and Economic Justification of WCMs. Implementations of WCMs. Barriers to Implementation.
5. Strategic Implications of WCM. Role of WCM in Competitive Strategy. Choice and Supplier Selection.

TERM WORK

Minimum 5 Assignments on above mentioned topics.

Minimum ONE Class Test to be conducted of 20 Marks.

ONE Seminar should be conducted in class on topic related to latest areas in above subject.

REFERENCES:

1. M. P. Groover, Automation, Production Systems and Computer Integrated Manufacturing, PHI.
2. M. G. Korgoanker, Just in Time Manufacturing, Macmillan India.
3. R. J. Schonberger, World Class Manufacturing, The Free Press.

ME – 8 : Manufacturing Systems Engineering			SEMESTER –II	
SUBJECT : Maintenance Management (Elective)				
Period / Week		Lecture	3	
1 Period of 1 hour		Practical / Seminar	2	
			Hours	Marks
Evaluation System		Theory	4	100
		Internal Assessment	-	50

1. Introduction: General objectives, Functions; Organization and administration of maintenance systems; Requirements, Concepts and structure of suitable organizations for maintenance systems.
2. Failure Analysis: Analysis for source identification, Classification and selectivity of failure; Statistical and Reliability concepts and models for failure analysis.
3. Classification of Maintenance Systems: Basis and models for various maintenance systems.
4. Decision Models For Maintenance Planning: Operation and Control, Optimum level of maintenance; Replacement aspects of break down and preventive types, Group and individual types, Obsolete facility, Deteriorating and completely failing facilities, Replacement vs. reconditioning, Economics of overhaul, Additional replacement models-additive damage case, Zero memory case, Partially observed situation, Planning horizon procedure. Spares planning and control: Static spares, Insurance spares with and without salvage value, Slow moving spares , Manpower planning-crew size, Allocation etc. Standby machines: Economical and operational aspects: Scheduling/planning of activities, Monitoring and updating, Resource allocation, Assigning priorities.
5. Cost Management for Maintenance: Cost estimates - Recording, Summarizing and distributing cost data; Maintenance budget.
6. Other Relevant Topics: Work measurement for maintenance, maintenance control indices, Maintenance service contracts, Preventive maintenance management - guidelines, Procedures, Management of lubrication systems, Organizing preventive maintenance programme using vibration signature analysis - some basic ideas, Management of records for maintenance, Computerization of maintenance activities, Major plant shut - down procedures.

TERM WORK

Minimum 5 Assignments on above mentioned topics.
Minimum ONE Class Test to be conducted of 20 Marks.

REFERENCES:

1. Higgins L. T., Morrow L. C., Maintenance Engineering Hand Book, McGraw Hill.
2. New borough B. T., Effective Maintenance Management, McGraw Hill.
3. Lewis G.T. and W.W. Pearson, Maintenance Management, JE Rider.

4. Kelly A. & Harris M. J, Management of Industrial Maintenance, Newness - Butterworths, London.
5. Jardine A. K., Operations Research in Maintenance, Manchester University Press.
6. Foster J. W., Phillips D. T. and Rogers T. R., Reliability, Availability and Maintainability, M/A Press.
7. Heintzelman J. E., The Complete Handbook of Maintenance Management, Prentice Hall.

SEMESTER III

SEMINAR

A student has to present a seminar on thrust areas that should contain

1. Literature survey
2. Basic study of the topic & formulating the principles for solving of the problems.
3. Basic design the above.
4. Working out details of control mechanism required if any.
5. Development of software if necessary.
6. Suggestion for improvements.
7. Cost analysis.

The seminar report should be submitted in bound form.

SEMESTER IV

PROJECT

A project should be assigned to each student at the beginning of the third semester either through industry sponsorship or of academic but practical utility topic on any of the subject areas, which involves the principles being studies in the above subjects. The general scheme of working will be as follows:

1. Literature survey.
 2. Basic study of the project and formulating the principles for solving of the problem.
 3. Basic design of the above.
 4. Working out details of control mechanism required if any.
 5. Development of software required.
 6. Fabricating a prototype model.
 7. Testing of the model.
 8. Suggestion for improvements.
 9. Cost analysis.
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