ANNA UNIVERSITY COIMBATORE
CURRICULAM 2007-FULL TIME MODE

M.E. MANUFACTURING ENGINEERING

SEMESTER-I

Code no	Course Title	L	T	P	M	C
THEORY						
	Computational methods and probability	3	1	0	100	4
	Metrology and computer aided inspection	3	0	0	100	3
	Fluid power automation	3	0	0	100	3
	CAD in manufacturing	3	1	0	100	4
	Manufacturing processes	3	0	0	100	3
	Computer numerical control and robotics	3	0	0	100	3
LAB	Manufacturing engineering laboratory	-	-	3	100	2

SEMESTER-II

Code no	Course Title	L	T	P	M	C
THEORY						
	Advanced materials and their processing	3	0	0	100	3
	Micro systems technology	3	0	0	100	3
	Computer integrated manufacturing	3	0	0	100	3
	Elective I	3	0	0	100	3
	Elective II	3	0	0	100	3
	Elective III	3	0	0	100	3
LAB	Advanced manufacturing engineering laboratory	-	-	3	100	2
SEMINAR		0	0	2	100	

SEMESTER-III

Code no	Course Title	L	T	P	M	C
THEORY						
	Elective IV	3	0	0	100	3
	Elective V	3	0	0	100	3
	Elective VI	3	0	0	100	3
PRACTICAL						
	Project Work-Phase I	0	0	12	*	6

SEMESTER-IV

Code no	Course Title	L	T	P	M	C
	Project Work-Phase II	0	0	24	*	12

LIST OF ELECTIVES

M.E. MANUFACTURING ENGINEERING

Course code	Course title	L	T	P	M	C
	Metal forming theory and practice	3	0	0	100	3
	Advances in casting and welding	3	0	0	100	3
	Total quality management	3	0	0	100	3
	Maintenance and reliability engineering	3	0	0	100	3
	Image processing in manufacturing	3	0	0	100	3
	Human factors in engineering	3	0	0	100	3
	Purchasing and material management	3	0	0	100	3
	Engineering economics	3	0	0	100	3
	Rapid prototyping, tooling and manufacture	3	0	0	100	3
	IT in manufacturing	3	0	0	100	3
	Non traditional machining processes	3	0	0	100	3
	Product development strategies	3	0	0	100	3
	Six -sigma concepts	3	0	0	100	3
	Finite element analysis	3	0	0	100	3
	Integrated product and process development	3	0	0	100	3
	Optimization techniques	3	0	0	100	3
	Artificial intelligence in manufacturing	3	0	0	100	3
	Design for manufacture and assembly	3	0	0	100	3
	Flexible manufacturing systems	3	0	0	100	3
	Manufacturing system design	3	0	0	100	3
	Modeling and analysis of manufacturing systems	3	0	0	100	3

COMPUTATIONAL METHODS AND PROBABILITY 3 1 0 100 4

UNIT - I INTRODUCTION TO COMPUTATIONAL METHODS (7)
Examples, solving sets of equations, Gauss elimination method, Choleski method, Iterative methods, Relaxation method, System of non-linear equations- Newton Raphson method.

UNIT - II NUMERICAL INTEGRATION (8)
Newton-Cotes integration formulas, Trapezoidal rule, Simpson's rules, Gaussian quadrature, Adaptive integration, Cubic spline functions - Bezier curves and B-splines.

UNIT - III NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS (8)
Laplace's equations, representations as a difference equation, Iterative methods for Laplace's equations, Poisson equation, examples, Matrix patterns, Sparseness, ADI method.

UNIT - IV CURVE FITTING AND APPROXIMATION OF FUNCTIONS (5)
Least square approximation, fitting of non-linear curves by least squares, regression analysis.

UNIT - V PROBABILITY AND CONCEPT OF RANDOM VARIABLE (6)
Axiomatic Approach to Probability – Random variables – Discrete random variables: Bernoulli, Binomial, Geometric and Poisson – Continuous random variables – Uniform, Exponential, Gamma and Normal – Expectation of random variables – Jointly distributed random variable Moment Generating functions

UNIT-VI CONDITIONAL PROBABILITY AND CONDITIONAL EXPECTATION (6)
Introduction – Discrete case – Continuous case – Computing expectation by conditioning – Computing probabilities by conditioning – Applications.

UNIT - VII THEORY OF ESTIMATION (6)
Point estimation – characteristics of estimation – interval estimation – estimates of mean, standard deviation and properties.

UNIT - VIII TESTING OF HYPOTHESIS (7)
Probability density function and applications of t, F, Chi square distributions –Large sample tests for means, variances, and proportions – Small sample tests for means, variances, and attributes

UNIT - IX RELIABILITY (7)
Hazard Rate and Mean Time To Failure, Mathematical models for reliability systems - exponential and Weibull failure laws – System reliability – series system, parallel system, [k,n] system - system failure rate, system MTTF.

Reference Books **Total 60**

1. Curtis F Gerald and Patrick O Wheatley, "Applied Numerical Analysis", Pearson Education, 2002.
2. Rajasekaran S, “Numerical Methods in Science and Engineering – A Practical Approach”, Wheeler Publishing, 1999, Second Edition
3. Trivedi K.S., “Probability and Statistics with Reliability, Queueing and Computer Applications”, Prentice Hall, 2003.
4 .Akai “Applied numerical methods for engineers” Wiley India Edition, 2007
5. Sheldon M.Ross, “Introduction to Probability Models”, Academic Press, 2002.

CAD IN MANUFACTURING **3 1 0 100 4**

UNIT - I INTRODUCTION (6)

Role of numerical modeling and simulation in manufacturing, finite difference (FDM), finite element (FEM) and boundary element methods (BEM).

UNIT - II PARAMETRIC MODELING OF GEOMETRICAL ENTITIES (16)

Parametric representation of curves, wire frame models, curve manipulation; parametric representation of surfaces, surface models, surface manipulation; parametric representation of solids, boundary representation, constructive solid geometry; design applications.

UNIT - III FUNDAMENTALS OF FEM (25)

Weighted Residue Technique, variational approach, element types, plane triangular, quadrilateral, curved isoparametric elements, 3 dimensional elements, axisymmetric elements, automatic mesh generation.

UNIT - IV APPLICATION OF FEM IN MODELING OF MANUFACTURING PROCESSES (13)

Elasto-plastic modeling of forming processes, forging, extrusion and rolling. Thermo, mechanical modeling of manufacturing processes , welding, casting, metal forming and machining (single point tool)

Lecture 45 Tutorial 15 Total 60

REFERENCE BOOKS

1 Ibrahim Zeid, "CAD/CAM Theory and Practice", McGraw, Hill Inc., New Delhi, 2003.

2 Reddy J N, “Introduction to the Finite Element Method”, Second Edition, Tata McGraw Hill, 1993.

3 Radhakrishnan P and Subramanyan S, “CAD/CAM/CIM”, Wiley Eastern Limited, 1997.

4 Edward R Champion, “Finite Element Analysis in Manufacturing Engineering”, McGraw Hill, New York, 1992.

5 Vera B Anand, "Computer Graphics and Geometric Modeling for Engineers", John Wiley and Sons Inc., New Delhi, 2000.

6 Shiro Kobayashi, Soo Ikoh and Taylan Atlan, “Metal Forming and the Finite Element Method”, Shiro Kobayashi, Oxford and IBH Publishing, New Delhi, 1989.

7 Owen D R J and Himton E, “Finite Elements in Plasticity, Theory and Practice”, Pinevidge Press Ltd., 1980.

METROLOGY AND COMPUTER AIDED INSPECTION 3 0 0 100 3

UNIT - I THE INTERNATIONAL STANDARD OF LENGTH AND LASER METROLOGY (9)

Units of length – legal basis for length measurement – Traceability – Characteristics LASER light source – LASER interferometer – LASER alignment telescope – LASER micrometer – on-line and in-process measurements of diameter and surface roughness using LASER – Microholes and surface topography measurements – Straightness and flatness measurement.

UNIT - II CO-ORDINATE MEASURING MACHINES (9)

Evolution of measurement – coordinate measuring machines – Non Cartesian CMMS – Accessory elements – Application software – Performance evaluations – Temperature fundamentals – Environmental Control – Accuracy enhancement – Applications –Measurement integration.

UNIT - III OPTO ELECTRONIC MEASURING SYSTEMS & DEVELOPMENT IN METROLOGY (9)

Opto electronic devices contact and non contact types – Applications in on-line and inprocess monitoring systems – Tool wear measurement – Manufacturing metrology – 3D surface roughness – Pattern generation studies – Roundness measurement using LASER.

UNIT - IV IMAGE PROCESSING AND ITS APPLICATION IN METROLOGY (9)

Shape identification – Edge detection techniques – Normalization – Grey scale correlation – Template techniques – Surface roughness using vision system – Interfacing robot and image processing system – Measurement of length and diameters.

UNIT - V COMPUTER INTEGRATED QUALITY ASSURANCE (9)

Total quality control – Quality assurance Zero defects – POKE – YOKE Statistical evaluation of data using computer – data integration of CMM and Computers lagging in computers – TQM.

Total 45

REFERENCE BOOKS

1 Ulrich-Rembold, Armbruster and Ulzmann, “Interface technology for computer controlled manufacturing processes”, Marcel Dekker, Pub New York, 1993.
2 Thomas G.G, “International Journals on CIRP Engineering Metrology”, Butterworh Pub. 1974.
3.Watson.J, “Optoelectronics “, Van Nostrand Reinhold (UK) Co Ltd., 1988.
4.Robert.G. Seippel, “Optoelectronics for technology and Engineering”, Prentice Hall New Jersey, 1989.
5. Taguchi.G & Syed.L. etal.,” Quality Engg in Production systems”, McGraw Hill, 1980.
6. John Bank, “Essence of TQM”, Prentice Hall of India Pvt Ltd., 1990.

FLUID POWER AUTOMATION 3 0 0 100 3

UNIT - I INTRODUCTION (6)

Need for Automation, comparison with other power system-ISO symbols for fluid power elements – Economic consideration of fluid power systems-Oil hydraulics, pneumatic-Introduction and selection criterion.

UNIT - II HYDRAULIC POWER GENERATION, CONTROL & REGULATING ELEMENTS (10)

Basic elements in a fluid power system-Hydraulic pumps, Gear, Vane, piston-selection and specification, drive characteristics Hydraulic actuators-Linear and Rotary, Selection specification and characteristics, cushioning.

UNIT - III PNEUMATICS AND ELECTRO PNEUMATICS (9)

Generation and control of compressed air - Elements in pneumatic circuits, Fluidic devices and its application Flip- Flop, SRT Flip flop-Use of electrical switches, relays, timers in fluid power circuits - Electro pneumatics.

UNIT - IV CIRCUIT DESIGN (11)

Design and methodology-Sequential circuits, cascade, Karnaugh-Veitch map, step counter methods-Compound and combination circuit design .Typical Industrial and hydraulic circuits-Synchronising and accumulator circuits-Circuits for machine tools- Design and selection criteria. Electro pneumatic circuit design, Ladder diagram.

UNIT - V COMPUTER CONTROL & MAINTENANCE OF FLUID POWER CIRCUITS (9)

Fuzzy logic in fluid power circuits- PLC in fluid powers- PLC ladder diagram. Installation-Fault diagnosis in fluid power circuits.

Total 45

REFERENCE BOOKS

1. Majumdar, “Oil Hydraulics Systems: Principles and Maintenance”, Tata Mc Graw Hil, 2003.
2. Majumdar, “Pneumatic Systems: Principles and Maintenance”, Tata Mc Graw Hil,2003.
3. Antony Esposito, “Fluid power system and control ", Prentice Hall, 1998.
4. E.F. Fitch AND J.B. Suryaat Madyn, " Introduction to fluid power Logic ", McGraw Hill,1988
5. Peter Rohner, “Fluid Power Logic circuit design ", Macmillan Press, 1994.
6 “Hydraulic systems Handbook ", Utility Publication, Secunderabad, 1988.

MANUFACTURING PROCESSES 3 0 0 100 3

UNIT - I CASTING PROCESSES:: Solidification of pure metal and alloys - Shrinkage in cast metals - Principles of gating and risering - Degasification of the melt - Design considerations in casting - Designing for directional solidification and minimum stresses - casting defects. Shell moulding, Precision investment casting, Co_2 moulding, centrifugal casting, Die casting and Continuous casting - Recent trends in casting - Computer Aided design of Castings, Low pressure die casting, Squeeze casting, full mould casting process. (10)

UNIT – II WELDING PROCESSES : Heat affected Zone and its characteristics - Weldability of steels, cast iron, Stainless steel, aluminium and Titanium alloys - Hydrogen embrittlement - Lamellar tearing – Residual stress - Heat transfer and Solidification - Analysis of stresses in welded structures - pre and post welding heat treatments - Weld joint design - Welding defects - Testing of weldments. Special welding processes- Friction welding - Explosive welding - Diffusion bonding - High frequency Induction welding - Ultrasonic welding - Electron beam welding - Laser beam welding; Automation in welding - Welding robots. (10)

UNIT - III FORMING PROCESSES: Conventional processes - H E R F techniques - Explosive forming, electro - hydraulic forming, magnetic pulse forming - Principles and process parameters -Advantages - Limitations and Applications. Special forming processes- Orbital forging - Isothermal forging - High speed extrusion- Rubber pad forming - Water hammer forming - Fine blanking - Superplastic forming techniques electro forming. (10)

UNIT – IV POWDER METALLURY: Overview of P/M technique – Advantages – applications – Powder preform forging - Hot and cold Iso-static pressing - powder rolling - Tooling and process parameters. (6)

UNIT – V MATERIAL REMOVAL PROCESSES: Mechanics of chip formation – Nomenclature of single and multi point cutting tools - Tool life and machinability - Types of tool wear and failure of cutting tools – cutting fluids; Machining processes with single and multipoint cutting tools – bulk and finishing processes – shaping, turning, milling, grinding and polishing – process parameters and their selection. (9)

Total No of periods: 45

REFERENCES

1. S. Kalpakjian - "Manufacturing Engineering and Technology (III Edition)"- Addison Wesley,1995.
2. Lal. M. and Khanna.O.P-" A Text Books of foundry technology ", Dhanpat Rai & Sons,1996.
3. P.N.Rao - "Manufacaturing Technology (Foundry,Forming and Welding) II Edition", Tata McGraw Hil, 1998.
4. Ghosh and A.K. Mallik, “Manufacturing Science”, East-West Press Pvt. Ltd. 1993.
5. Heine Loper And Rosenthal," Principles of Metal Casting ", Tata McGraw Hill,1980
6. P.c. Mukherjee, "Fundamentals of Metal casting”, Oxford - IBH,1979.
7. Hosford,W.F. and Caddell,R.M. - "Metal Forming: Mechanics and Metallurgy ", Prentice Hall,1993.
8. Dieter,G.E. - " Mechanical Metallurgy (Revised Edition II) "- McGraw Hill Co,1980.

9. Nagpal, G.R.- " Metal Forming Processes ", Khanna Publishers1998
10. Chakrabarthy, J. - " Theory of Plasticity ", McGraw Hill Co,1987.
11. Narayanasamy. R. - "Theory of Metal Forming Plasticity ", Ahuja Book Co., 2nd Ed., 2001
12. M.c. Shaw – “Metal Cutting Principles”, Oxford Press, 2004
13. G. Kuppuswamy – “Principles of Metal Cutting – An Introduction”, Universities Press, 1996.
14. G.k. Lal and s.k. Choudhary – “ Fundamentals of Manufacturing Processes”, Alpha Science, 2005

COMPUTER NUMERICAL CONTROL AND ROBOTICS 3 0 0 100 3

UNIT - I INTRODUCTION TO MACHINE TOOLS (6)

Basic machine tool elements, types, applications, calculation of capacity, specifications, standards on NC machine tool, installation of NC machine, hard machining, high speed machining.

UNIT - II CNC MACHINES (9)

Machine structure, slides, guide ways, recirculating ball screws, spindle, bearing arrangements, tool magazines, turrets, ATC, APC, belts, pneumatic and hydraulic peripherals, design and selection of CNC machines, work holding, soft jaw, hard jaw, tooling for CNC.

UNIT - III CONTROL SYSTEM AND INTERFACING (7)

Open loop, closed loop, block diagram of CNC system, PLC, interpolation, standard and optional features of a control system, motors, drives, feedback devices, MCB, switches, interfacing of motor, controller, compensations, correction factors, trouble shooting.

UNIT - IV PART PROGRAMMING (7)

Coding of preparatory functions, miscellaneous function, ISO, EIA standards, axis definition, datum, absolute and incremental programming, tool offset, positioning control, point-to-point, linear, circular, spline interpolation, coordinate systems, cutter diameter compensate, fixed cycles, drilling, boring, area clearance programming, part programming examples

UNIT - V ROBOTICS (8)

Classification of robots, major components of robot, specifications, mechanical elements used in robot, motion conversion, end effectors, electrical elements, control of robotic joints, robotic sensory devices, applications.

UNIT - VI ROBOT KINEMATICS (8)

Homogeneous coordinates, homogeneous transformation and manipulator, forward solution, inverse solution, motion generation, Jacobian control.

Total : 45

REFERENCE BOOKS

1. Richaerd D. Klafter, Thomas Achmielewski and Mickael Negin, “Robotic Engineering – An Integral Approach”, Prentice-Hall India, New Delhi, 2001.
2. David Gibbs, Thomas M. Crandell, “An Introduction to CNC Machining and Programming” Industrial Press Inc., New York, 2000.
3. Yoram Koran, Joseph Ben-uri, “Numerical Control of Machine Tools”, Kanna Publishers, New Delhi, 1998.
4. Steve Krar, “Computer Numerical Control”, Industrial Press Inc., New York, 2001.
5. Thyer G.E., “Computer Numerical Control of Machine Tools”, BHNEWNES, Second Edition, 1991.

PRACTICALS

MANUFACTURING ENGINEERING LABORATORY **0 0 3 100**

LIST OF EXPERIMENTS

1. Solid modeling and assembly of machine components using modeling software
2. Manual part program generation for a CNC machine
3. CNC part programming using CAM software
4. Measurement of cutting forces and surface finish in CNC milling (DoE concepts for experimentation)
5. Measurement of material removal rate and surface finish in grinding / AJM / EDM/ USM
6. Measurement of roundness using concentricity tester
7. Programming of robot – revolute type robot
8. Sequencing of cylinders using pneumatic trainer kit
9. Programming of PLC for automation systems
10. Development of ANN model of machining parameters using MATLAB software

Total : 45

ANNA UNIVERSITY, COIMBATORE
M.E.MANUFACTURING – II - SEMESTER (FULL- TIME)
LIST OF CORE SUBJECTS

ADVANCED MATERIALS AND THEIR PROCESSING 3 0 0 100 3

Unit 1: BEHAVIOUR OF MATERIALS 10

Elasticity in metals and polymers - Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution hardening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non crystalline material.

Unit 2: FRACTURE BEHAVIOUR 10

Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

Unit 3: SELECTION OF MATERIALS 10

Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

Unit 4: MODERN METALLIC MATERIALS 7

Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials.

Unit 5: NON METALLIC MATERIALS 8

Polymeric materials - Formation of polymer structure - Production techniques of fibres, foams,adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, AI2O3, SiC, Si3N4, CBN and diamond - properties, processing and applications.

Total No of periods: 45

REFERECNES:

1. Flinn, R.A. and Trojan, P.K., " Engineering Materials and their Applications ", (4th Edition),Jaico, 1999.
2 George E.Dieter, " Mechanical Metallurgy ", McGraw Hill, 1988.
3. Thomas H.Courtney, " Mechanical Behaviour of Materials ", McGraw-Hill, 2000.
4. Charles J.A., Crane, F.A.A and Furness, J.A.G., " Selection and use of Engineering Materials", (3rd Edition), Butterworth-Heiremann, 1977.
5. Metals Hand Book, Vol.10, " Failure Analysis and Prevention ", (10th Edition), 1994.
6. “Manufacturing Science Processes” , R.S.Khurmi, S.Chand Publishers.

MICRO SYSTEMS TECHNOLOGY **3 0 0 100 3**

Unit 1

Introduction to Mechatronics – Systems – Mechatronics in Products - Measurement Systems – Control Systems – Traditional design and Mechatronics design **7**

Unit 2

Sensors and Transducers – Introduction – Performance Terminology – Displacement, Position and Proximity – Velocity and Motion – Fluid Pressure – Temperature sensors – Light sensors – Selection of sensors – Signal processing – Servo systems. **10**

Unit 3

Microprocessors in Mechatronics – Introduction – Architecture – Pin Configuration – Instruction set – Programming of microprocessors using 8085 instructions – Interfacing input and output devices – Interfacing D/A converters and A/D converters – Applications – Temperature control – Stepper motor control – Traffic light controller. **10**

Unit 4

Programmable Logic Controllers – Introduction – Basic structure – Input and output processing – Programming – Mnemonic Timers, Internal relays and counters – Data handling – Analog input/output – selection of PLC. **10**

Unit 5

Design and Mechatronics – Designing – Possible design solutions – Case studies of Mechatronic systems **8**

Total No of Periods: 45

References

1. Michael B.Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill International Editions, 1999
2. Bradley D.A, Dawson D, Buru N.C and Loader A.J, “Mechatronics”, Chapman and Hall, 1993
3. Ramesh S Gaonkar, “Microprocessor Architecture, Programming and Applications”, Wiley Eastern, 1998
4. W.Bolton, “ Mechatronics” HMT limited , McGraw-Hill International Editions, 1999
5. Lawrence J.Kamm, “Understanding Electro-Mechanical Engineering – An Introduction to Mechatronics”, Prentice Hall, 2000
6. Ghosh P.K and Sridhar P.R. “0000 to 8085 – Introduction to Microprocessors for Engineers and Scientists”, Second Edition, Prentice Hall 1995.

COMPUTER INTEGRATED MANUFACTURING 3 0 0 100 3

Unit 1

Introduction to CIM - Nature of the CIM system - Types of manufacturing systems – Evolution of CIM - Computers in CIM. Process definition and manufacturing planning - Structures of a process plan - CAD based process planning - coding systems - Methods of CAPP – Process planning systems. Background - Role of MRP - II in CIM systems - Major modules of MRP – II software - Manufacturing, engineering, financial, marketing and misc. applications. **9**

UNIT 2

CNC Machine tools - Principle of Numerical Control - Types of CNC machine tools – Features and programming of CNC machine tools - CNC programming based on CAD - Applications and economics of usage of CNC machine - Capabilities of a typical NC - CAM software – Integration of computers in CIM environment. **9**

UNIT 3

Computer communications - Principles of networking, Techniques, components of networking and wiring methods - Network interface cards - Network standards, examples - Operating system - Security - Managing remote systems - design activity in a networked environment – networking in an manufacturing company. **9**

UNIT 4

Flexible manufacturing - Introduction, types, major elements and optimization of FMS - Operational elements in a typical FMC - Typical FMS layout - Lean manufacturing - Agile manufacturing database and DBMS requirements - Features and architecture of a DBMS - Query language - SQL - SQL as a knowledge base query language. Integration and Implementation issues in CAD/CAM/CIM - Introduction, requirements for integrated manufacturing systems - Economic justification of CAD/CAM/CIM technologies - Steps to implement CIM.

9

UNIT 5

Artificial Intelligence - Robots -Elements, types and specifications of robots, robot programming methods, robot operation, applications of industrial robots, integration of robots in CIM systems -Expert system - AI in vision system and scheduling - DSS in CIM environment.

9

REFERENCES:

1. Ibrahim Zeidi, “CAD/CAM - Theory and Practice”, TMH, 1991.
2. Groover, “Automation of Production Systems”, PHI, 2003.
3. Radhakrishnan P, Subramanyan S, “CAD/CAM/CIM”, Wiley Eastern Limited, New Delhi, 1994.
4. Eric Teicholz, “Computer Integrated Manufacturing Handbook”, McGraw Hill.

ADVANCED MANUFACTURING ENGINEERING LAB. 0 0 3 100

CIM Lab

Computer Aided Drafting – Operating System – Wire Frame, Surface and Solid Modeling – Simulation and Machining using CNC/DNC Machine Tools – Use of FEM packages – Relational Database – Networking – Practice on Computer Aided Measuring Instruments – Image Processing –Software Development for Manufacturing – CNC Controllers – Use of Advanced CNC Machine Packages – Business Data Processing.

Web Reference

http://www.mie.utoronto.ca/lahs/ciml/cimhome.html

Simulation Lab

Simulation – Random Number Generation, Discrete and Continuous Random Variates – Introduction to Simulation Languages – Simulation of Manufacturing Systems – Use of Simulation Soft wares - PROMODEL, ARENA. Optimization of Manufacturing Systems – use of Optimization Packages – SIMRUNNER, Evaluation of Model and Validation

Web Reference

http://www.promodel.com/

LIST OF ELECTIVE SUBJECTS

METAL FORMING THEORY AND PRACTICE 3 0 0 100 3

Unit 1 - THEORY OF PLASTICITY:

Theory of Plastic deformation - Yield criteria - Work of plastic deformation - Equilibrium in Cartesian, Cylindrical and Spherical coordinates - Energy-Slab method - Upper bound and Lower bound solution methods -Overview of FEM Applications in Metal Forming Analysis - Formability studies **15**

Unit 2 - THEORY AND PRACTICE OF BULK FORMING PROCESSES:

Analysis of Plastic deformation in Forging, Rolling, Extrusion and rod/wire drawing processes-Effects of friction, Calculation of forces, Work done-process parameters, equipments used - Defects-Applications-Recent advances in forging, Rolling, Extrusion and drawing processes-Experimental techniques of evaluation of friction in metal forming, ring compression and double cup extrusion tests. **12**

Unit 3 - SHEET METAL FORMING:

Conventional processes-HERF techniques-Explosive forming, electrohydraulic forming,magnetic pulse forming - Principles and process parameters- Advantages -Limitations and Applications. **6**

Unit 4 - P/M FORMING

Overview of P/M technique-Advantages-applications-Powder preform forging- Hot and cold Isostatic pressing-powder rolling-Tooling and process parameters. **6**

Unit 5 - SPECIAL FORMING PROCESSES

Orbital forging-Isothermal forging- High speed extrusion-Rubber pad forming-Water hammer forming-Fine blanking -Superplastic forming techniques- electro forming. **6**

Total No of periods: 45

REFERENCES:

1. DIETER,G.E. - " Mechanical Metallurgy(Revised EditionII) "- McGraw Hill Co,1980
2. NAGPAL,G.R.- " Metal Forming Processes ", Khanna Publishers1998
3. CHAKRABARTHY,J-" Theory of Plasticity ", McGraw Hill Co,1987
4. SCHULER - " Metal Forming Handbook "- Springer Verlag Publication,1998
5. HOSFORD,WF and CADDELL,R.M. - " Metal Forming:Mechanics and Metallurgy ", PrenticeHall,Eaglewood Cliffs,1993
6. ALTAN .T.-" Metal Forming-Fundamentals and applications-American Societyof Metals ", Metals park,1983.
7. SHIRO KOBAYASHI,SOO-IK-oh-ALTAN,T - " MetalForming and Finite Element Method", Oxford University Press,1989
8. NARAYANASAMY.R. -" Theory of Metal Forming Plasticity ", Ahuja Book Company,,2001,2nd Ed.
9. ALTAN T, SOO-IK-oh,GEGEL,HL - "Metal Forming, fundamentals and applications", American Society of Metals,Metals Park,Ohio,1983.

ADVANCES IN CASTING AND WELDING 3 0 0 100 3

Unit 1 - CASTING METALLURGY AND DESIGN

Heat transfer between metal and mould-Solidification of pure metal and alloys-Shrinkage in cast metals -progressive and directional solidification-Principles of grating and risering-Degasification of the melt-Design considerations in casting-Designing for directional solidification and minimum stresses-casting defects **9**

Unit 2 - SPECIAL CASTING PROCESSES:

Shell moulding,Precision investment casting,Co2,moulding,centrifugal casting,Die casting and Continuous casting. **9**

Unit 3 - WELDING METALLURGY AND DESIGN:

Heat affected Zone and its characteristics-Weldability of steels,cast iron,Stainless steel,aluminium and Titanium alloys-Hydrogen embrittlement-Lamellar tearing-Residual stress-Heat transfer and Solidification-Analysis of stresses in welded structures-pre and post welding heat treatments-Weld joint design-Welding defects-testing of weldment. **12**

Unit 4 - UNCONVENTIONAL AND SPECIAL WELDING PROCESSES:

Friction welding- Explosive welding-Diffusion bonding-High frequency Induction welding-Ultrasonic welding- Electron beam welding-Laser beam welding. **6**

Unit 5- RECENT ADVANCES IN CASTING AND WELDING:

Layout of mechanised foundry-sand reclamation-Material handling in foundry - pollution control in Foundry- Recent trends in casting-Computer Aided design of Castings,Low pressure die casting,Squeeze casting,full mould casting process. Automation in welding-Welding robots-Overview of automation of welding in aerospace,nuclear,surface transport vehicles and under water welding. **9**

Total No of periods: 45

REFERENCES:

1. JAIN, " Principles of Foundry Technology ", Tata McGraw Hill,3rd Edition,2000.
2. " ASM Metals of Hand book on Casting " - Revised Edn,1995.
3. LAL.M. and KHANNA.O.P-" A Text Books of foundry technology ", Dhanpat Rai & Sons,1996.
4. HEINE LOPER & ROSENTHAL," Principls of Metal Casting ", Tata McGraw Hill,1980
5. “CHAKRABARTHI.A.K” , “ Casting Technology and Cast alloys”,Prentice Hall of India.
6. SEROPE KALPAKJIAN-"Manufacturing Engineering and Technology(III Edition)".-Addison Wesley Publishing Co.1995
7. P.N.RAO - "Manufacaturing Technology (Foundry,Forming and Wekding)II Edition",Tata McGraw Hill Pub.Co. Ltd,.New Delhi,1998.
8. " Foundry Engineering Handbook ", Utility publishers Ltd.,1989.
9. TITOUN.D. & STEPANOV .YU.A.-" Foundry Practice ", MIR Publishers,Moscow,1981.

10 P.C.MUKHERJEE," Fundamentals of Metal casting Oxford " - IBH,1979.

11. IOTROWSKI-" Robotic welding-a guide to selection and application " - Society of Mechanical Engineers,1987.
12. SCHWARIZ . M. M.,-"Source book on Innovative Welding Processes"-American society formetals(OHIO),1981.
13. CORNU. J. ,-"Advaanced Welding systems"-Volumes I,II and III,JAICO Publishers,1994.
14. LANCASTER . J.F. - "Metallurgy of Welding"-George Allen & Unwin Publishers,1980.
15. Welding HandBook(Section I) American Welding Society,1986.
16. KAZAKOV.N.F.-"Diffusion bonding of materials",MIR Publishers,Moscow,1985.

TOTAL QUALITY MANAGEMENT 3 0 0 100 3

Unit 1 - EVOLUTION OF QUALITY:
Quality control-Quality Assurance-total quality management-Core concepts-Quality Gurus and their contribution- Quality costs-Quality measurement. **8**

Unit 2 - TOOLS OF QUALITY:
Review of SQC -Quality control Vs Process control-Control charts-Applications-Problems-Old and New seven tools of quality-Applications. **7**

Unit 3 - TECHNIQUES OF QUALITY:
Quality Function Deployment (QFD) -Failure mode effect Analysis(FMEA)- Just in time(JIT)-KANBAN-KAIZEN- 5S Principles-Zero defects-POKA-YOKE-Quality circles- Six Sigma. **15**

Unit 4 - ISO 9001:2000
Philosophy- Elements – Requirements – Benefits – Procedures – Documentation - Certification-Auditing-Implementation- Cost of Certification. **8**

Unit 5 - CASE STUDIES:
Case studies in Quality Management (The students may be asked to select case studies and present). **7**

Total No of periods: 45

REFERENCES:

1. MOHAMED ZAIRI - "Total Quality Management for Engineers", Woodhead Publications,1991.
2. ZAIDI,-“SPC - Concepts,Methodologies & Tools ", Prentice Hall of India,1990
3. FEIGENBAUM - " Total Quality Control ", McGraw Hill ,1995.
4. John Bank, " Essence of TQM ", Prentice Hall of India, 1990
5. TAGUCHI .G. ,L. SYED et al', " Quality Engineering production systems " - McGraw Hill, 1980.
6. JURAN, - " Quality Control Handbook ", McGraw Hill,1995.
7. VINCENT K. OMACHONU and JOEL E.ROSS - " Principles of Total Quality ", Kogan press,1994.
8. PERRY L. JOHNSON - " ISO 9000 ",McGraw Hill,1993.

MAINTENANCE AND RELIABILITY ENGINEERING 3 0 0 100 3

Unit 1 - MAINTENANCE MANAGAMENT

Need for maintenance-Objective- Concepts-Types of maintenance-Organisation-Trade force mix, type and location-Maintenance costs-Benefits-Computer Aided Maintenance management-Total productive maintenance. **10**

Unit 2 - TYPES OF MAINTENANCE

Breakdown and Preventive maintenance-Advantages and Limitations-Maintenance prevention-Diagnostic maintenance-Design out maintenance-Opportunity maintenance. **8**

Unit 3 - DIAGNOSTIC MAINTENANCE

Leak detection-wear monitoring-Temperature monitoring-Vibration monitoring-Signature analysis-Shock monitoring-Lubricant-Analysis-Methodology-Equipments-Applications **10**

Unit 4 - CONCEPTS OF RELIABILITY

Elements of Probability-Reliability Definition-Measures of Reliability-Failures-Classification of failures-Failure data Analysis-Availability-Criticality matrix-Event tree analysis-Utilization factor-Factors affecting reliability. **7**

Unit 5 - DESIGN FOR RELIABILITY

Analysis of reliability data-Weibull analysis-Design and manufacture for Reliability-Reliability of parts and components-Design for system reliability-Economics of standby or redundancy in a production system-reliability testing-Types. **10**

Total No of periods: 45

REFERENCES:

1. O'CONNOR,P.D.T', " Practical Reliability Engineering ", John Wiley-1994.
2. GARG.H.P," Industrial Maintenance" , S.Chand.
3. HIGGINS and MORROW,-" Maintenance Engineering Handbook ", Tata McGraw Hill,1985.
4. COLLACT, " Mechanical Fault Diagnosis and Condition monitoring "- McGraw Hill-1985.
5. MILLER & BLOOD .- " Modern maintenance Management " -Tarapooriwala & sons,1976.
6. JENTRY EJ and KUMAMOTO,H, " Reliability Engineering and Test assessment ", Prentice Hall,1992.
7. CARTER,A.D.S. " Mechanical Reliability ",-Macmillan,1984.
8. NAKAJIMA.S.. ," Introduction to TPM - Total Productive Maintenance", Productivity Press-1995.
9. KELLEY.A.& M.J.HARRIS,-" Management of Industrial Maintenance" , Newnes-Butter worth.

IMAGE PROCESSING IN MANUFACTURING 3 0 0 100 3

Unit 1 - INTRODUCTION

Image representation and nomenclature-Relationship of image processing and computer vision-Digital image fundamentals-Geometric model for imaging and applications- Imaging requirements. **8**

Unit 2 - IMAGE PROCESSING FUNDAMENTALS

Image transformers-Sampling-Enhancement-Restoration and conversions-Segmentation-Thresholding representation and description. **12**

Unit 3 - IMAGE ANALYSIS

Processing binary images-Image measurements - Multilevel image analysis-Higher dimensional modeling-Image based knowledge manipulation **10**

Unit 4 - PRACTICAL IMAGE PROCESSING]

2D/3D Image acquisition-3D image Visualisation- Imaging surfaces-Image processing system components. **10**

Unit 5 - APPLICATION IN MANUFACTURING

Measurement of surface finish - Sorting and counting of objects -Tool Wear measurement, measurement technique - Robot application. **5**

Total No of periods: 45

REFERENCES:

1. JOHN C RUSS - " The Image Processing Hand Book, 3rd Edition " , CRC Press/IEEE Press,2000
2. ROBERT J SCHALKOFF -" Digital Image Processing and Computer Vision ", John Wiley & Sons Inc,1998
3. RAFEL C, GON ZALEZ & RICHAR E WOODS - " Digital Image Processing ", Addison Wesley Publishing,1993.
4. RAMESH C JOHN - " Introduction to machine vision ", ,Tata Mc Graw Hill, 1995.

HUMAN FACTORS IN ENGINEERING 3 0 0 100 3

Unit 1 - INTRODUCTION

Concepts of human factors engineering and ergonomics-Man-Machine system and Design Philosophy-Physical work- stress-manual lifting-work posture-repetitive motion- environmental factors. **9**

Unit 2 - ANTHROPOMETRY

Physical dimensions of the human body as a working machine-Motion size relationships-Static and dynamic anthropometry- Design principles-Using anthropometric measures for industrial design- Procedure for anthropometric design **8**

Unit 3 - DESIGN OF SYTEMS

Displays-Controls-Work place-Seating-Work process-Duration of rest periods-Hand tool design-Design of visual displays-Design for shift work **10**

Unit 4 - ENVIRONMENTAL FACTORS IN DESIGN

Temperature-Humidity-Dust-Noise-Illumination and contrast-Use of Photometers-Recommended illumination levels-The ageing eye-Use of indirect (Reflected) lighting – Cost efficiency of illumination-Special purpose lighting for illumination and quality control-Measurement of sound-Noise exposure and hearing loss-Hearing protectors analysis and reduction of noise-Effects of noise performance-annoyance of noise and interface with communication-Sources of vibration discomfort it. **10**

Unit 5 - WORK PHILOSOPHY

Provision of energy for muscular work-Role of oxygen physical exertion-Measurement of energy expenditure- Respiration-Pulse rate and blood pressure during physical work-Physical work capacity and its evaluation. **8**

Total No of periods: 45

REFERENCES:

1. E.J.McCORMIC, " Human factors in engineering design ", McGraw Hill 1976.
2. P.V.KARPOVICH,W.E.SINNING, " Physiology of muscular activity ", W.E.Saunders Co.1971.
3. " Applied Ergonomics HandBook ", I.P.C. Science and Technology Press.1978
4. Martin Helander, " A guide to the Ergonomics of manufacturing ", East West Press,1996

PURCHASING AND MATERIAL MANAGEMENT 3 0 0 100 3

Unit 1 - INTRODUCTION

Objectives of material management-material circle-Organisation for material management-Integrated materials management approach-Organisation and control-Materials research-Corporate policy-Value analysis **6**

Unit 2 - MATERIALS PLANNING AND INVENTOREY MANAGEMENT

Materials forecasting-Selective inventory control-Fixed order size and fixed order interval systems-Deterministic models-Static inventory models-Probabilistic models-ABC Analysis-Spare parts management-Materials requirement planning and aggregate inventory management-Implementation of inventory systems. **12**

Unit 3 - MATERIALS STORAGE AND WAREHOUSING

Standard - Variety reduction-Codification-Storage designs-Store layout-Storage systems-Mechanisation of automation of warehouses-Materials handling-transportation and traffic management-Stores management- Procedure-Incoming materials control, Obsolete, Surplus and Scrap management. **10**

Unit 4 - PURCHASING

Purchasing policies and procedures-Legal aspects of purchasing-Selection of sources of supply-Make or buy decisions-Vendor development-Price-Cost analysis and negotiations-Forward buying-Speculation- Commodity markets-Capital equipment buying-Imports and customs clearance-Purchasing research-Creative purchasing **10**

Unit 5 - MATERIALS ACCOUNTING, BUDGETING AND ADMINISTRATIVE CONTROL

Materials accounting-Stock verification-Budgeting, Evaluation of materials management performance-Information systems in material management-Buyer seller relationships in ethics. Application of operations research techniques in material managements. **7**

Total No of periods: 45

REFERENCES:

1. P.GOPALAKRISHNAN and M.SUNDARESAN, " Materials Management Integrated approach ", PHI1996
2. LEARNER LEE J and DONALD .M.DOBBLER, " Purchasing and Material management", Tata McGraw Hill,1996
3. J.G.MONKS, "Operation Management ", McGraw Hill,1984.
4. J.K.WESTING,I.V.FINE and C.T.ZONE, " Purchasing Management ", John Wiley and Sons,1976.
5. M.K.STARR, "Operations Management ", Prentice Hall,1982.

ENGINEERING ECONOMICS 3 0 0 100 3

Unit 1 - FINANCIAL ACCOUNTING

Accounting Principles-Basic records depreciation-Depreciation methods-Preparation and interpretation of profit and loss statement-Balance sheets-Fixed assets-Current assets. **12**

Unit 2 - COSTING

Elements of cost -Cost Classification-Material cost-Labour costs-Overheads-Costs of a product-Costing systems-Cost determination-Process costing-Allocation of overheads-Standard costing-Variance analysis. **10**

Unit 3 - WORKING CAPITAL MANAGEMENT

Current assets and Liability decisions-Estimation of working capital requirements-Management of accounts receivable-Inventory-cash- inventory valuable methods. **8**

Unit 4 - CAPITAL BUDGETING

Significance of capital budgeting-payback period-Present value method-Accounting rate of return method. **7**

Unit 5 - ENGINEERING ECONOMICS

Economics-Engineering economics-Demand analysis-Laws of demand-Production and costpricing methods- Cost volume profit analysis **8**

Total No of periods: 45

REFERENCES:

1. ADITHAN M , " Production Engineering Estimating and Costing " , Konark Publishers Pvt.Ltd
2. C.JAMES , VANHORN, " Fundamentals of Financial management " , PHI 1996.
2. CHARLES T.HOMGREN, " Cost accounting ", PHI 1985.
3. S.N.MAHESWARI, " Management Accounting and Financial Control ", Sultanchand,1992.
4. PRASANNA CHANDRA, " Financial Management ", Tata Mc Graw Hill 1998
5. J.L.RIGGS, " Engineering Economics ", McGraw HILL,1987.
6. G.B.S.NARANG, " Production and costing ", Khanna Publishers,1993.

RAPID PROTOTYPING, TOOLING AND MANUFACTURE 3 0 0 100 3

UNIT 1

Introduction : Need for time compression in product development, Product development - conceptual design - development - detail design - prototype - tooling. **7**

UNIT 2

Classification of RP systems, Stereo lithography systems - Principle - process parameters - process details - machine details, Applications. Direct Metal Laser Sintering (DMLS) system - Principle - process parameters - process details - machine details, Applications. **9**

UNIT 3

Fusion Deposition Modeling - Principle - process parameters - process details - machine details, Applications.Laminated Object Manufacturing - Principle - process parameters - process details - machine details, Applications. **9**

UNIT 4

Solid Ground Curing - Principle - process parameters - process details - machine details, Applications. 3-Dimensional printers - Principle - process parameters - process details – machine details, Applications, and other concept modelers like thermo jet printers, Sander's model maker, JP system 5, Object Quadra system. **10**

UNIT 5

Laser Engineering Net Shaping (LENS), Ballistic Particle Manufacturing (BPM) - Principle. Introduction to rapid tooling - direct and indirect method, software for RP - STL files, Magics, Mimics. Application of Rapid prototyping in Medical field. **10**

Total No. of Periods : 45

TEXT BOOK:

Pham,D.T. & Dimov.S.S., Rapid manufacturing, Springer-Verlag, London, 2001.

REFERENCE:

1. Terry wohlers, Wohlers Report 2000, Wohlers Associates, USA, 2000.
2. Paul. F. Jacobs, "Stereo lithography and other RP&M Technologies", SME, NY, 1996.

IT IN MANUFACTURING 3 0 0 100 3

Unit 1

Introduction – The evolution of order policies from MRP to MRP II, the role of Production organization, Operations control. **7**

Unit 2

Database – Terminologies – Entities and Attributes – Data models, schema and subschema – Data Independence – ER Diagram – Trends in database. **7**

Unit 3

Designing database – Hierarchical model, Network approach – Relational data model – concepts, principles, keys, relational operations – functional dependence – Normalization, types – Query languages. **10**

Unit 4

Manufacturing consideration – The product and its structure, Inventory and process flow – Shop floor control – Data structure and procedure – various models – the order scheduling module, input/output analysis module, the stock status database – the complete IOM database. **11**

Unit 5

Information system for manufacturing – Parts oriented production information system – concepts and structure – computerized production scheduling, online production control systems, computer based production management system, computerized manufacturing information system – cast study. **10**

Total No of Periods: 45

REFERENCES:

1. Luca G. Sartori, "Manufacturing Information Systems", Addison-Wesley Publishing Company,1988.
2. Date C.J, "An Introduction to Database Systems", Narosa Publishing House, 1997.
3. Orlicky.G, "Material Requirements Planning", McGraw – Hill Publishing Co" 1975
4. Kerr.R, "Knowledge based Manufacturing Management", Addison-Wesley, 1991.

Web Reference

1. www.ist.psu.edu

NON TRADITIONAL MACHINING PROCESSES 3 0 0 100 3

Unit 1

Introduction – Non-Traditional Machining Techniques – Classification based on Source of Energy, Transfer Media and Mechanism. Abrasive Jet Machining– Description of Apparatus, Nozzles, Metal Removal Rate, Process Parameters, Process Probabilities and Applications. **9**

Unit 2

Ultrasonic Machining – Principles, Equipments, Power Supply, Transducer, Tool Holder, Tools, Abrasive, Process Parameters, Process Capabilities. Ultrasonic Welding – Principle Equipments, Power Supply, Transducers, Coupling System – Clamping Systems, Process Parameters, Power Clamping Force, Welding Time, Frequency, Process Capabilities and Applications. **9**

Unit 3

Electro-Chemical Machining - Principles, Equipments, Chemistry of Process, Electrolytes, Tools, Metal Removal Rate, Accuracy and Surface Finish, Process Parameters, Process Capabilities and Applications. Electro-Chemical Grinding and Electro-Chemical Discharge Grinding – Principles, Process Parameters, Equipments, and Applications. **9**

Unit 4

Electro-Discharge Machining - Principles, Equipments, Power Supply, Dielectric System, electrodes, Servo System, Process Capabilities and Applications. Electrical Discharge Wire Cutting -Principles, Equipments, Positioning System, Wire Drive System, Power Supply, Dielectric System, Process Parameters, Process Capabilities. Electrical Discharge Grinding - Principles, Equipments, Process Parameters, Process Capabilities and Applications. **9**

Unit 5

Electron Beam Machining - Principles, Equipments, Power Supply, Electron Beam Gun and Electron Beam Machining System. - Process Parameters, Process Capabilities and Applications. Overview of Electron Beam Welding - Laser Processing – Process capabilities, Equipments, Solid State Laser, Gas Laser, Thermal features – Applications – Drilling – Cutting, Marking, Welding, Heat Treating and Cladding. Plasma Arc Machining - Principles, Equipments, Process Capabilities and Applications. **9**

Total No of Periods: 45

TEXT BOOKS:

1. Gary F Benedict, “Non-Traditional Machining Processes”, Marcell Dekker Inc, NY 1987
2. Bhattacharya A, “New Technology”, IE Publishers 1984

REFERENCES

1. Pandy P.C and Shanan S, “Modern Machining Processes”, Tata McGraw Hill, 2005
2. HMT, Production Technology, Tata McGraw Hill 2005
3. RAI. G.D “ Non Conventional Sources of Energy “ Thanna Publishers.

PRODUCT DEVELOPMENT STRATEGIES 3 0 0 100 3

Unit 1 - DESIGN FOR MANUFACTURE

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits – Datum features - Tolerance stacks. **8**

Unit 2 - FORM DESIGN OF CASTINGS AND WELDMENTS

Redesign of castings based on parting line considerations - Minimizing core requirements - Redesigning a cast members using weldments-factors influencing form design-Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials-on from design - form design of welded members, forgings and castings. **9**

Unit 3 - DESIGN FOR ASSEMBLY

Assembly processes-Handling and insertion process-Manual ,automatic and robotic assembly-Cost of Assembly-Number of Parts-DFA guidelines **6**

Unit 4 - VALUE ENGINEERING

Value –types –functional –operational –aesthetic –cost- –material – Design process – value and worthiness –procedure -brainstorming sessions –evaluation –case studies –value estimation-Value analysis - Design for value - Selection of alternatives - optimization – Implementation **12**

Unit 5 - PRODUCT DEVELOPMENT ECONOMICS

Elements of Economics analysis-Quantitative and qualitative analysis-Economic Analysis process-Estimating magnitude and time of future cash inflows and out flows-Sensitivity analysis-Project trade-offs-Trade-offs rules-Limitation of quantitative analysis-Influence of qualitative factors on project success **10**

Total No. of Periods : 45

TEXT BOOKS:

1. Harry Peck, Designing for Manufacture, Pitman Publications, 1983.
2. George E Dieter, Engineering Design,McGraw-Hill Int Editions, 2000

REFERENCES:

1. S.S.Iyer ,Value Engineering, New Age International, 2000
2. Charles E. Ebeling, Reliability and Maintainability Engineering,, TMH, 2000

SIX-SIGMA CONCEPTS 3 0 0 100 3

Unit 1 :OVERVIEW OF SIX-SIGMA CONCEPTS: History of Six- sigma; Benefits; Tools and Themes of Six-Sigma programme. Ingredients of six-sigma; Cost of quality. **5**

Unit 2 :KEY CONCEPTS OF THE SIX-SIGMA SYSTEM: A six-sigma vision of business leadership; An introduction to sigma measurement; Six-Sigma improvement and management strategies; The DMAIC Six-Sigma improvement model; Six-Sigma v/s TQM (comparison with TQM). **7**

Unit 3: THE SIX-SIGMA ROAD MAP: Advantages of six-sigma roadmap; Steps in roadmap; over view and rationale behind each step. Application of six-sigma in service: Comparison of service and manufacturing; challenges making six-sigma work in services; using lean sigma in service. **5**

Unit 4: ADOPTING SIX-SIGMA: Relevance of six sigma programme; Strategy phase of six-sigma program; preparing leaders to launch and guide effort. Preparing black belts and other key roles- Master Black belt; Champion and Green belts. **5**

Unit 5: TRAINING THE ORGANIZATION FOR SIX-SIGMA: Essentials of effective training; planning curriculum; selecting the right six-sigma projects-Essentials; process and Do's & Don'ts. **5**

Unit 6 :IMPLEMENTING SIX-SIGMA: Identifying core process; Defining customer requirements; measuring current performance. Six sigma process improvement; six sigma process design/ redesign; expanding and integrating the six sigma system. **8**

Unit 7: DESIGN FOR SIX- SIGMA (DFSS): Introduction; Need for DFSS; DFSS Phases; Differences between six sigma and DFSS; Features of a sound DFSS strategy. **4**

Unit 8: DFSS DEPLOYMENT AND PROJECT ALGORITHM: Black belt-DFSS Team; Cultural change; DFSS Deployment strategy; DFSS strategy goals; DFSS sustainability factors; Introduction for six- sigma project algorithm. **6**

Total No of periods: (45)

REFERENCES:

1. Kai Yang and Basemel-Haik, "Design for Six-Sigma: A Roadmap for Product Development", McGraw Hill, 2003.
2. Crrevelng C.M., Slutsky J.L. and Antis D., "Design for Six Sigma", Pearson Education;2003.
3. Michael.L.George, "Lean Six Sigma for Service", Tata McGraw Hill, 2003.
4. Peter S. Pande, Robert P.Neuman, Roland Cavanagh R., "The Six-Sigma way-How GE",Motorola and Other Top Companies are Honing their Performance, McGraw Hill, 2001.
5. Stamatis D.H., "Six-Sigma and Beyond-Foundations of Excellent Performance", St. Lucie press 2001.
6. Mikel Harry and Richard Schroeder.A., "Six-Sigma: The Break through Management Strategy", Currency Book Published by Doubleday, 2000.

FINITE ELEMENT ANALYSIS **3 0 0 100 3**

Unit 1 - 1D. FINITE ELEMENT ANALYSIS

Historical Background - Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. - Ritz Method - Finite Element Modelling - Element Equations – Linear and Quadratic Shape functions - Bar, Beam Elements - Applications to Heat Transfer. **10**

Unit 2 - FINITE ELEMENT ANALYSIS OF 2D PROBLEMS

Basic Boundary Value Problems in 2 Dimensions - Triangular, quadrilateral, higher order elements - Poissons and Laplaces Equation - Weak Formulation - Element Matrices and Vectors- Application to solid mechanics, Heat transfer, Fluid Mechanics. **10**

Unit 3 - ISO-PARAMETRIC FORMULATION

Natural Co-ordinate Systems - Lagrangian Interpolation Polynomials - Isoparametric, Elements - Formulation - Numerical Integration - ID - IID Triangular elements - rectangular elements - Illustrative Examples. **8**

Unit 4 - SOLUTION TO PLANE ELASTICITY PROBLEMS

Introduction to Theory of Elasticity - Plane Stress - Plane Strain and Axisymmetric Formulation - Principle of virtual work - Element matrices using energy approach. **9**

Unit 5 - SPECIAL TOPICS

Dynamic Analysis - Equation of Motion - Mass Matrices - Free Vibration analysis – Natural frequencies of Longitudinal - Transverse and torsional vibration - Introduction to transient field problem. Non linear analysis. Use of softwares - h & p elements - special element formulation. **8**

Total No. of Periods 45

TEXT BOOK

1. Reddy J.N. An Introduction to the Finite Element Method, McGraw Hill, International Edition, 1993.

REFERENCES:

1. Rao S.S., “Finite Element Method in Engineering”, Pergamon Press, 1989.
2. Chandrupatla & Belagundu, “Finite Elements in Engineering”, Prentice Hall of India Private Ltd., 1997.
3. Cook, Robert Davis etal, “ Concepts and Applications of Finite Element Analysis “, Wiley , John & Sons , 1999.
4. George R Buchaman , “ Schaum’s Outline of Finite Element Analysis” , McGraw Hill Company , 1994.
5. Segerlind L.J., “Applied Finite Element Analysis”, John Wiley, 1984

WEB REFERENCES :

1. http://www.vector-space.com/
2. http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm

INTEGRATED PRODUCT AND PROCESS DEVELOPMENT 3 0 0 100 3

Unit 1 - INTRODUCTION

Need for IPPD-Strategic importance of Product development - Integration of customer, designer, material supplier and process planner. Competitor and Customer-behaviour analysis Understanding customer-promoting customer understanding - Involve customer in development and managing requirements - Organization - Process management and Improvement - Plan and establish product specifications. **5**

Unit 2 - CONCEPT GENERATION AND SELECTION

Task - Structured approaches - clarification-search-extemally and intemally-explore systematically- reflect on the solutions and processes - concept selection - methodology - benefits. **5**

Unit 3 - PRODUCT ARCHITECTURE

Implications - Product change - Variety - Component standardization - Product performance - Manufacturability - Product development Management - establishing the architecture - Creation - Clustering - Geometric layout development - Fundamental and incidental interactions – related system level design issues - Secondary systems - Architecture of the chunks - Creating detailed interface specifications **10**

Unit 4 - INDUSTRIAL DESIGN

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools - Simulating product performance and manufacturing processes electronically - Need for industrial design - impact - design process - Investigation of customer needs - conceptualization - refinement - Management of the industrial design process - technology driven products - User - driven products - Assessing the quality of industrial design. **10**

Unit 5 - DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs - Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic analysis - Understanding and representing tasks-baseline project planning-accelerating the project - Project execution.

N.B.A.Consumer product design project is recommended. **15**

Total No. of Periods :45

REFERENCES

1. Product Design and Development,Kart T.Ulrich and Steven D.Eppinger, McGraw-Hill International Edns. 1999.
2. Concurrent Engg./Integrated Product Development, Kemnneth Crow, DRM Associates,26/3, Via Offvera, Palos Verdes, CA 90274(310)377-569, Workshop Book.
3. Tool Design - Integrated Methods for Successful Product Engineering, Stuart Pugh, Addison Wesley Publishing Neyourk, NY, 1991, ISBN 0-202-41639-5.
3. Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992, ISBN, 1-55623-603-4.
5. www./me.mit/2.7444

OPTIMIZATION TECHNIQUES 3 0 0 100 3

Unit 1 : NONLINEAR OPTIMIZATION: Introduction, unconstrained optimization, one-dimensional optimization, elimination methods, Fibonacci method, golden section methods, interpolation methods, quadratic, cubic interpolations, direct root methods, multivariable optimization, direct search methods, pattern search methods, univariate method, Hooks and Jeeves method, Powel's method, simplex method, descent methods, steepest descent, conjugate gradient, Newton methods. **9**

Unit 2 : CONSTRAINED NON LINEAR OPTIMIZATION: Direct methods, the complex method, cutting plane method, indirect methods, transformation techniques, interior and exterior penalty function methods, Khun-Tucker conditions, Lagrangian method. **6**

Unit 3 :INTEGER AND DYNAMIC PROGRAMMING: Introduction to integer programming, solution techniques, graphical method, the branch and bound technique, Gomary's cutting plane method, examples on the application in manufacturing / design systems, introduction to dynamic programming, Bellman's principle of optimality, examples on the application on routing problem, inventory problem, and marketing problem. **7**

Unit 4 : NETWORK OPTIMIZATION MODELS: Terminology of networks, the shortest route problem, the minimum spanning tree problem, the maximum flow problem, the minimum cost flow problem, the network simplex method. **7**

Unit 5 :NON-TRADITIONAL OPTIMIZATION – I: Introduction to non-traditional optimization, computational complexity, NP-hard, NP-complete, no free lunch theorem, working principles of simulated annealing, tabu search, and neural networks, simple applications. **8**

Unit 6 : NON-TRADITIONAL OPTIMIZATION – II: Introduction to genetic algorithms, ant colony algorithm, particle swap algorithm, hybrid algorithms, simple applications. **8**

Total No of periods: (45)

REFERENCES:

1. Kalyanmoy Deb, "Optimization for Engineering Design", Printice-Hall India (Pvt) Ltd., New Delhi, 2000.
2. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley-Interscience, 3rd Edition, 1996.
3. Stephen G Nash and Ariela Sofer, "Linear and Nonlinear Programming", McGraw Hill College Div., 1995.
4. Cihan H Dagli**,** "Artificial Neural Networks for Intelligent Manufacturing", Chapman and Hall, London, 1994, ISBN 0 412 48050.
6. David E Goldberg, "Genetic Algorithms in Search, Optimization and Machine Learning", Addison-Wesley Pub Co., 1989.
7. Dimitri P Bertsekas, "Dynamic Programming: Deterministic and Stochastic Models", Prentice Hall, 1987.
8. Fred Glover, Manuel Laguna and Fred Laguna, "Tabu Search", Kluwer Academic Publishers, 1997.

ARTIFICIAL INTELLIGENCE IN MANUFACTURING 3 0 0 100 3

Unit 1 - Introduction to AI and Expert Systems

Introduction - Pattern recognition - Control strategies - Heuristic search, Forward and Backward reasoning - Search algorithms - Game playing - Knowledge representation – structural representation of knowledge - Planning - Real-World Planning Problems, Action and Plan Representation – Expert systems in manufacturing. **10**

Unit 2 - Artificial Intelligence Programming

LISP – Introduction & Development of simple programs, Knowledge based systems, Knowledge representation methods, Search methods and matching techniques. **10**

Unit 3 - Expert Systems

Applications of expert systems, Structure of expert systems, Inference engine, Building expert system, Knowledge acquisition issue, Tools for building expert systems, Expert systems shells (VP expert and Vidwan) and their evaluation, Application of expert systems in manufacturing. **10**

Unit 4 - Image Processing and Machine Vision

Machine vision fundamentals, application in manufacturing. **7**

Unit 5 - Neural Networks and Fuzzy Logic

Introduction to fuzzy logic, Fuzzy logic based decision making, Artificial Neural network, Architecture of neural network system, Applications of neural one words and Fuzzy logic in manufacturing. **8**

Total No of periods: 45

REFERENCES:

1. Patterson, D.W, “Artificial Intelligence and Expert System”, Prentice Hall of India.
2. Ermine J.L., “Expert Systems”, Prentice Hall of India
3. J.A. Freeman & D.M. Skapura, “Neural Networks” Pearon Education Asia, New Delhi.
4. Charmaik, “Introduction to AI,” Pearson Education Asia, New Delhi
5. Rich E. and Knight K., " Artificial Intelligence ", McGraw Hill Inc, 1991.
6. Pham D.T., " Expert Systems in Engineering ", IFS Publishers, Springer-Verlag, 1988.
7. Stuart Russell and Peter Norvig “AI: A Modern Approach, , Prentice Hall, 1995

DESIGN FOR MANUFACTURE AND ASSEMBLY 3 0 0 100 3

Unit 1 - INTRODUCTION

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks. **5**

Unit 2 - FACTORS INFLUENCING FORM DESIGN

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings. **13**

Unit 3 - COMPONENT DESIGN - MACHINING CONSIDERATION

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly. **8**

Unit 4 - COMPONENT DESIGN - CASTING CONSIDERATION

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology – Computer Applications for DFMA **10**

Unit 5 - DESIGN FOR THE ENVIRONMENT

Introduction - Environmental objectives - Global issues - Regional and local issues - Basic DFE methods - Design guide lines - Example application - Lifecycle assessment - Basic method - AT&T's environmentally responsible product assessment - Weighted sum assessment method - Lifecycle assessment method - Techniques to reduce environmental impact - Design to minimize material usage - Design for disassembly - Design for recyclability - Design for remanufacture - Design for energy efficiency - Design to regulations and standards. **9**

Total No. of Periods ; 45

REFERENCES:

1. Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2. Bralla, Design for Manufacture handbook, McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
4. Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
5. Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004
6. Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
7. Fixel, J. Design for the Environment McGraw hill., 1996.

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WEBSITE

1. www.ulrich - Epingar. Net
2. www.dfma.com

FLEXIBLE MANUFACTURING SYSTEMS 3 0 0 100 3

Unit 1 - MANUFACTURING IN A COMPETITIVE ENVIRONMENT 12

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible, fixturing - Design for assembly, disassembly and service. Group Technology - Part families - classification and coding - Production flow analysis - Machine cell design.

Unit 2 - FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - Components of FMS - Application workstations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer - Application of simulation - Manufacturing data systems - data flow - CAD/CAM considerations -Planning FMS database.

Unit 3 - AUTOMATED MATERIAL HANDLING AND STORAGE 9

Functions - types - analysis of material handling equipments. Design of conveyor and AGV systems, storage system performance - AS/RS - carousel storage system - WIP storage system - interfacing handling storage with manufacturing.

Unit 4 - MODELING AND ANALYSIS OF FMS 8

Queuing- single server, multiple servers, queue disciplines, markovian queing models. Process Planning - Approaches to process planning, study of a typical process planning, manufacturing planning and control, overview of production control.

U nit 5 - JUST IN TIME 7

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads – close supplier ties - flexible work force - line flow strategy - preventive maintenance – Kanban system - strategic implications - implementation issues - MRD JIT - Lean manufacture.

Total No. of Periods: 45

REFERENCES

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Prentice-Hall of India Pvt. Ltd., New Delhi, 1996.
2. Kalpakjian, " Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
3. Viswanadham N and Narahari Y, “Performance Modeling of Automated Manufacturing Systems”, Prentice Hall India (P) Ltd, 1992.
4. Parrish D J, “Flexible Manufacturing”, Butter Worth Heinemann Ltd, Oxford, 1993.
5. Jha, N.K. " Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
6. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd., 1992.

Web Reference

1. http://www.engineeringtalk.com/news/lvd103.htm

MANUFACTURING SYSTEM DESIGN 3 0 0 100 3

Unit 1 - INTRODUCTION TO MANUFACTURING SYSTEMS ENGINEERING

Process Planning-Logical design of a process planning-Shortcomings of traditional process planning-Computer aided process planning-Computerization of files management-Variant(Retrieval) approach-generative approach-Semi generative approach-General remarks on CAPP developments and trends. **10**

Unit 2 - PRODUCTION CONTROL

Overview of production control-Forecasting-Master production schedule-Materials requirements planning-Order release-shop floor control-Cellular manufacturing-JIT and MRP II-Computer generated time standards . **9**

Unit 3 - LOADING AND SCHEDULING

Information retrieval for loading and scheduling-master scheduling-perceptual loadingdespatching - progress chasing-expediting-order scheduling devices **8**

Unit 4 - MATERIAL FLOW PATH ANALYSIS IN MANUFACTURING

Material handling function-Types of equipment used-conveyor systems-Automated guided vehicle systems- Guiding and routing-Traffic control and safety-Interfacing handling and storage with manufacturing-design factors in material handling systems. **9**

Unit 5 - LAYOUT OF MANUFACTURING SYSTEMS

Plant layout-Definition-Objectives-Principles-Factors influencing layout-Types of layout - cellular layout- Tools and tooling system for cellular manufacturing **9**

Total No of periods: 45

REFERENCES:

1. S.N.CHARY, " Production and Operations Management ", Tata McGraw Hill,New Delhi,1991.
2. M.P.GROOVER, " Automatic Production system and computer integrated manufacturing", PrenticeHall,1990.
3. BARY HAWKES ," CAD,CAM Processes ",1990.
4. EVERT E. ADAMS Jr AND DONOLD J. EBERT, " Production and Operation Management", PrenticeHall of India,1994
5. G.HALEVI ANS R.D.WEILL, " Principles of Process Plannning", Chappman and Hall Madras 1995.

MODELING AND ANALYSIS OF MANUFACTURING SYSTEMS 3 0 0 100 3

Unit 1: MANUFACTURING SYSTEMS AND MODELS: Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building. (8)

Unit 2 : MATERIAL FLOW SYSTEMS: Assembly lines-Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems – paced lines without buffers, unpaced lines. Shop scheduling with many products. Flexible manufacturing systems- System components, planning and control. Group technology-Assigning machines to groups, assigning parts to machines. Facility layout-Quadratic assignments problem approach, graphic theoretic approach. (12)

Unit 3 : SUPPORTING COMPONENTS: Machine setup and operation sequencing-integrated assignment and sequencing. Material handling systems-conveyor analysis, AGV systems. Warehousingstorage and retrieval systems, order picking. (8)

Unit 4: GENERIC MODELING APPROACHES: Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models-Event models, process models,
simulation system, example manufacturing system (10)

Unit 5: PETRI NETS: Basic definitions – dynamics of Petri nets, transformation methods, event graphs, modeling of manufacturing systems. (7)

Total No of periods: 45

REFERENCES:

1. Ronald G Askin, “Modeling and Analysis of Manufacturing Systems”, John Wiley and Sons, Inc, 1993
2. Mengchu Zhou, “Modeling, Simulation, and Control of Flexible Manufacturing Systems: A Petri Net Approach”, World secientific Publishing Company Pvt Ltd., 2000
3. Jean Marie Proth and Xiaolan Xie, “ Petri Nets: A Tool for Design and Management of Manufacturing Systems”, John Wiley and Sons, New York, 1996.
4. P Brandimarte, A Villa, “ Modeling Manufacturing Systems” Springer Verlag, Berlin, 1999.