NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution – Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI – 628 503

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REGULATIONS - 2015

DEPARTMENT OF

MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – MANUFACTURING ENGINEERING

SEMESTER I

S.No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY								
1.	SFC	15MF11C	Probability and Statistics	3	2	0	4	B
2.	SFC	15MF12C	Metal Forming Processes	3	0	0	3	B
3	PCC	15MF13C	Advanced Materials Technology	3	0	0	3	B
4.	PCC	15MF14C	Computer Aided Integrated Manufacturing Systems	3	0	0	3	B
5.	PCC	15MF15C	Advanced Machining Sciences	3	0	0	3	B
6.	PCC	15MF16C	Advanced Metrology and Quality Engineering	3	0	0	3	B
PRACTICAL								
7.	PCC	15MF17C	Advanced Computing Laboratory	0	0	4	2	--
			Total	**18**	**2**	**4**	**21**	

SEMESTER II

S.No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY								
1.	PCC	15MF21C	Applied Hydraulics and Pneumatics	3	0	0	3	B
2.	PCC	15MF22C	Production and Operations Management	3	2	0	4	B
3	PCC	15MF23C	Advanced Welding and Casting	3	0	0	3	B
4.	PEC		Elective - I	3	0	0	3	
5.	PEC		Elective - II	3	0	0	3	
PRACTICAL								
6	PCC	15MF24C	Research Paper and Patent Review- Seminar	0	0	4	2	--
7.	PCC	15MF25C	Metrology and Materials Testing Laboratory	0	0	4	2	--
			Total	**15**	**2**	**8**	**20**	

SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course

SEMESTER III

S.No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY								
1.	PEC		Elective -III	3	0	0	3	
2.	PEC		Elective - IV	3	0	0	3	
3.	PEC		Elective - V	3	0	0	3	
4	OEC		Elective - VI	3	0	0	3	
PRACTICAL								
5.	PCC	15MF31C	Project Work Phase-I	0	0	12	6	--
			Total	**12**	**0**	**12**	**18**	

SEMESTER IV

S.No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
PRACTICAL								
1.	PCC	15MF41C	Project Work Phase-II	0	0	24	12	--
			Total	**0**	**0**	**24**	**12**	

Total Minimum Credits to be earned for the Award of the Degree: 71

SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course

PROGRAMME ELECTIVE COURSES

S.No.	Course Category	Course Code	Course Title	L	T	P	C	Question pattern⊕
THEORY								
1.	PEC	15MF01E	Advanced Manufacturing Processes	3	0	0	3	B
2.	PEC	15MF02E	Advanced Metal Cutting Theory and Practice	3	0	0	3	B
3	PEC	15MF03E	Advanced Tool Design	3	2	0	4	A
4.	PEC	15MF04E	Artificial Intelligence	3	0	0	3	B
5.	PEC	15MF05E	Composite Materials and Mechanics	3	2	0	4	B
6.	PEC	15MF06E	Computer Aided Product Design	3	0	0	3	B
7.	PEC	15MF07E	Design for Manufacturing and Assembly	3	2	0	4	B
8.	PEC	15MF08E	Financial Management	3	2	0	4	B
9.	PEC	15MF09E	Finite Element Application in Manufacturing	3	2	0	4	B
10.	PEC	15MF10E	Industrial Ergonomics	3	0	0	3	B
11.	PEC	15MF11E	Lean Manufacturing System and Implementation	3	0	0	3	B
12.	PEC	15MF12E	Manufacturing Management	3	0	0	3	B
13.	PEC	15MF13E	Manufacturing System Simulation	3	0	0	3	B
14.	PEC	15MF14E	Materials Management and Logistics	3	0	0	3	B
15.	PEC	15MF15E	Mechanical Behaviour of Materials	3	0	0	3	B
16.	PEC	15MF16E	Mechanical Processing and Properties of Nanostructure Materials	3	0	0	3	B
17.	PEC	15MF17E	MEMS and Nanotechnology	3	0	0	3	C
18.	PEC	15MF18E	Nano Composites	3	0	0	3	B
19.	PEC	15MF19E	Optimization Techniques in Engineering	3	2	0	4	B
20.	PEC	15MF20E	Polymers and Composite Materials	3	0	0	3	B
21.	PEC	15MF21E	Rapid Manufacturing	3	0	0	3	B
22.	PEC	15MF22E	Reliability Engineering	3	2	0	4	B
23.	PEC	15MF23E	Robot Design and Programming	3	0	0	3	B
24.	PEC	15MF24E	Statistical Quality Control	3	2	0	4	B
25.	PEC	15MF25E	Synthesis and Applications of NanoMaterials	3	0	0	3	B
26.	OEC		Courses offered by other PG programmes					

SFC – Specific Foundation Course, PCC – Programme Core Course, PEC – Programme Elective Course, OEC – Open Elective Course

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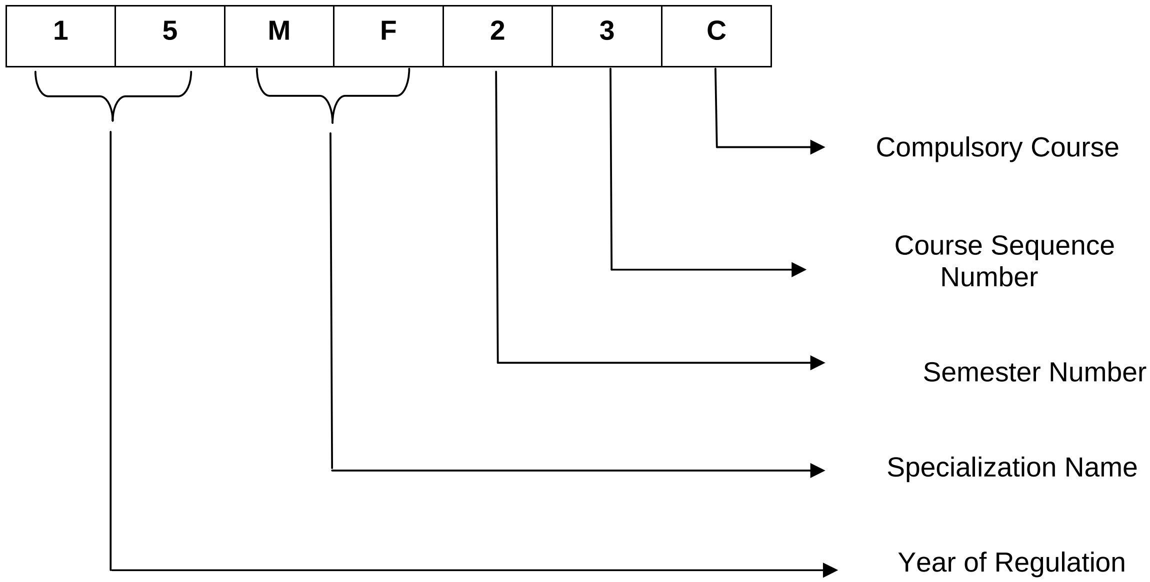
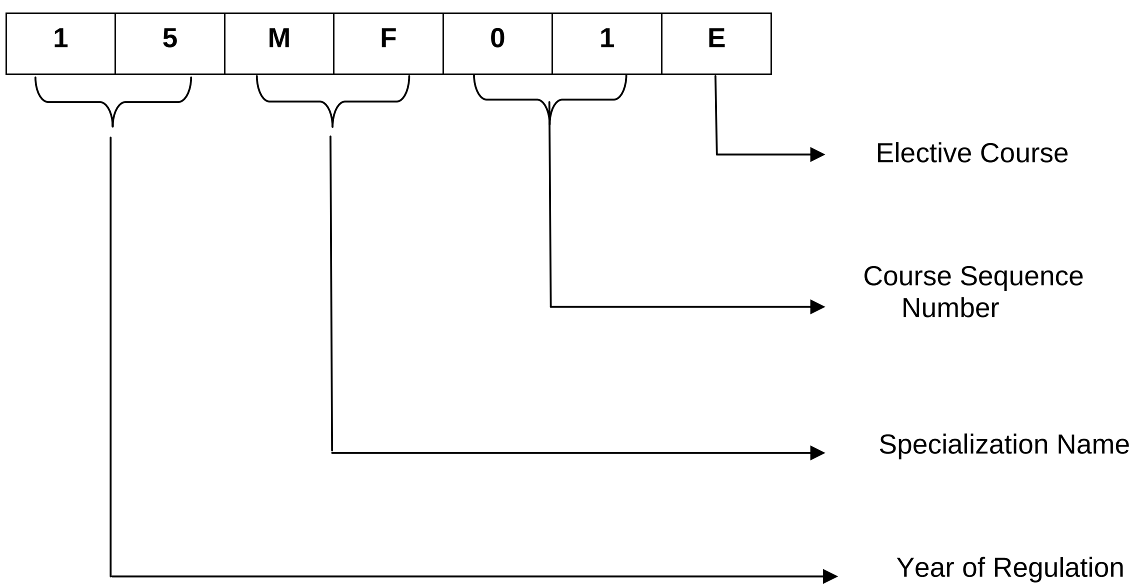
Question pattern	1 mark	2 marks	4 marks	10 marks	12 marks	16 marks	20 marks	Total
A	-	-	-	-	--	-	1 Qn Compulsory & 4 Qns (either or type)	100
B	-	10	-	-	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
C	10	-	10 out of 12	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
D	10	10	5 out of 6	1 Qn Compulsory & 4 Qns (either or type)	--	--	--	100
E	-	10	5 out of 6	-	1 Qn Compulsory & 4 Qns (either or type)	--	--	100

FORMAT FOR COURSE CODE





15MF11C	PROBABILITY AND STATISTICS	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: compute probabilities based on practical situations using the binomial, poisson and normal distributions (K5)

CO2: describe the sampling distributions and practical applications (K2)

CO3: determine an appropriate interval for estimating an unknown population mean and standard deviation (K5)

CO4: conduct hypothesis tests for population proportions and means (K4, A3)

CO5: choose an appropriate analysis procedure for forecasting the demand of products (K4)

UNIT I PROBABILITY THEORY 15

Random variables – probability density and distribution functions - moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications.

UNIT II SAMPLING THEORY 15

Sampling distributions – Standard error – t, F, Chi square distributions – applications.

UNIT III ESTIMATION THEORY 15

Interval estimation for population mean, standard deviation, difference in means, ratio of standard deviations – point estimation.

UNIT IV TESTING OF HYPOTHESIS AND ANOVA 15

Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square – Non parametric methods – Sign test – Rank sum test One, two factor models-Design of experiments

UNIT V CORRELATION, REGRESSION AND TIME SERIES ANALYSIS 15

Correlation analysis, estimation of regression line – Time series analysis – Trend analysis – cyclical variations – Seasonal variations – Irregular variations

L:45 T:30 TOTAL: 75 PERIODS

REFERENCES

1. Levin and Rubin, “Statistics for Management”, Prentice Hall of India, 2001.
2. Hooda, “Statistics for Business and Economics”, Macmillan India, 2001.
3. Gupta and Kapoor, “Fundamentals of Mathematical Statistics”, Sultan chand, 2002.
4. John.E.Freunds, “Mathematical statistics with applications”, Pierson Educations, 2007.

15MF12C	METAL FORMING PROCESSES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: acquire the knowledge of fundamental concepts of the basic mechanism of the plastic deformation and the mechanics of metal working (K2,A1)
CO2: analyze the forming processes, physical phenomenon constituting forming operation and force calculations (K4)
CO3: describe the various sheet metal forming process, advantages, limitations and application (K2)
CO4: describe the preparation of powder performs (P/M)and special forming processes and its applications (K2, S1)
CO5: describe the suitable surface treatment process for any metal forming process (K2)

UNIT I THEORY OF PLASTICITY 9

Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods– Overview of FEM applications in Metal Forming analysis.

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

UNIT III SHEET METAL FORMING 9

Formability studies – Conventional processes – HERF techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES 9

Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

UNIT V SURFACE TREATMENT AND METAL FORMING APPLICATIONS 9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and Sliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion and hot and cold forging.

Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. ALTAN.T, SOO-IK-oh, GEGEL.HL – "Metal forming, fundamentals and Applications", American Society of Metals, Metals Park, Ohio, 1983.
2. Shiro Kobayashi, Soo-Ik-oh-Altan, T, "Metal forming and Finite Element Method", Oxford University Press, 2001.
3. Altan T., " Metal forming – Fundamentals and applications" – American Society of Metals, Metals park, 2003.
4. Dieter G.E., "Mechanical Metallurgy "Revised Edition II - McGraw Hill Co., 2004
5. ASM Hand book, "Forming and Forging", 9^{th} Edition, Vol – 14, 2003
6. Marciniak.Z, Duncan J.L, Hu S.J., "Mechanics of Sheet Metal Forming", Butterworth - Heinemann An Imprint of Elsevier, 2006
7. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007.

15MF13C	ADVANCED MATERIALS TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the basic mechanical properties of materials and various strengthening Mechanisms (K2)

CO2: explain the fundamentals of fracture of metals (K2)

CO3: select suitable material for specific application based on requirements and cost (K5,A3)

CO4: describe the properties and the suitability of modern metallic Materials for specific applications (K2)

CO5: describe processing, properties and applications of Non-metallic materials (K2)

UNIT I ELASTIC AND PLASTIC BEHAVIOR 10

Elasticity in metals and polymers Anelastic and visco-elastic behaviour – Mechanism of plastic deformation and nonmetallic shear strength of perfect and real crystals – Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour – Super plasticity – Deformation of non crystalline materials.

UNIT II 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 III 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 – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 8

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 7

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. George E.Dieter, "Mechanical Metallurgy", McGraw Hill, 1988
2. Flinn, R.A., and Trojan, P.K., "Engineering Materials and their Applications", 4th Edition, Jaico, 1999.
3. Thomas H. Courtney, "Mechanical Behaviour of Materials", 2nd Edition, McGraw Hill, 2000
4. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., "Selection and use of engineering materials", 3rd Edition, Butterworth-Heiremann, 2001.
5. ASM Hand book, Vol.11, "Failure Analysis and Prevention", 10th Edition, ASM, 2002.
6. Ashby M.F., "Material Selection in Mechanical Design", 3rd Edition, Butter Worth 2005.

15MF14C	COMPUTER AIDED INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1: describe the basic concepts of CIM systems (K2)
- CO2: identify the automation strategies in production operations (K2)
- CO3: develop machining programs for CNC equipment and study the concept of FMS (K6,A2)
- CO4: select an appropriate automated inspection systems for quality control in manufacturing (K5,A3)
- CO5: develop a control system for manufacturing cells (K6)

UNIT I COMPUTER INTEGRATED MANUFACTURING 8

Introduction, nature, evolution, development of CIM, fundamentals of CAD/CAM, computerized networks for manufacturing, future trends in CIM.

UNIT II FUNDAMENTALS OF MANUFACTURING AND AUTOMATION 8

Production operations and automation strategies, production economics.

UNIT III NUMERICAL CONTROL PRODUCTION SYSTEMS 8

Numerical Control, computer numerical control, part programming, flexible manufacturing system.

UNIT IV COMPUTER AIDED QUALITY CONTROL AND INSPECTION 13

Automated inspection and testing, QC and CIM, computer aided inspection using robots, integrated computer aided inspection system, flexible inspection system.
Group Technology and Computer aided process planning, DNC and integration requirements, FMS design.

UNIT V CONTROL SYSTEMS 8

Introduction to control systems, linear control systems, linear feedback control systems, optimal control, sequence control and programmable controllers, process control.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Kant Vajpayee. S, “Computer Integrated Manufacturing”, Prentice Hall, Inc, 1995.
2. Viswanathan.N and Narahari.Y, “Performance Modeling and Automated Manufacturing Systems”, Prentice Hall of India Pvt. Ltd., 2000.
3. James A.Retrg, Herry W.Kraebber, “Computer Integrated Manufacturing”, Pearson Education, Asia, 2001.
4. Radhakrishnan.P, Subramanyan.S and Raju.V, “CAD/CAM/CIM”, New Age International Publishers, 2002.
5. Kant Vajpayee. S, “Computer Integrated Manufacturing”, Prentice Hall of India, New Delhi, 2007.
6. Mikell P.Groover, “Automation, Production system and Computer integrated Manufacturing”, Prentice Hall of India Pvt. Ltd., 2008.
7. Alavudeen and Venkateshwaran, “Computer Integrated Manufacturing”, PHI Learning Pvt. Ltd., New Delhi, 2008.

15MF15C	ADVANCED MACHINING SCIENCES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: describe the fundamentals of mechanics of metal cutting and calculate the cutting forces (K2)

CO2: define the mechanisms of tool wear and machinability of tool materials (K1)

CO3: identify the methods of manufacturing the gears and gear finishing operations (K2,S3)

CO4: identify the role of computers in machining systems (K2)

CO5: develop part programming for machining operations in lathe & milling machines (K6, A2)

UNIT I MECHANICS OF METAL CUTTING 10

Cutting tool angles – tool signature – orthogonal & oblique cutting – cutting forces, Merchant circle diagram – force & velocity relation.

UNIT II TOOL MATERIAL, TOOL WEAR AND TOOL LIFE 9

Requirement of tool materials – types of tool materials – Tool wear – Types, mechanism – Tool life Machinability - types of chips – cutting fluids.

UNIT III GEAR MANUFACTURE 8

Different methods of gear manufacture – Gear hobbling and gear shaping machines specifications – gear generation – different methods – gear finishing and shaving – grinding and lapping of hobs and shaping cutters – gear honing – gear broaching.

UNIT IV CNC MACHINES 9

NC, CNC & DNC – types of CNC – constructional features – drives and control systems – feedback devices – Interchangeable tooling system – preset & qualified tools – ISO specification – Machining center – Turning center – CNC wire cut EDM.

UNIT V CNC PROGRAMMING 9

Manual part programming – steps involved – sample program in lathe & milling. - Computer aided part programming – APT program - CAM package – canned cycles - Programming.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. J Pandey P.C. & Shan.H.S, "Modern Machining Processes", Standard Publishing Co., 1980
2. Jaeger R.C, "Introduction to microelectronic fabrication", Addison Wesley, 1988.
3. Brahem T. Smith, "Advanced machining", I.F.S. UK 1989.
4. Nario Taniguchi, "Nano technology", Oxford University Press, 1996.
5. More Madon, "Fundamentals of Microfabrication", CRC Press, 1997
6. Julian W. Hardner, "Micro senors Mems & smart devices", 2002

15MF16C	**ADVANCED METROLOGY AND QUALITY ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: demonstrate the usage of laser principles in manufacturing metrology (K3)
CO2: analyze the role of laser based precision instruments in metrology (K4)
CO3: critically analyze the factors which causes the uncertainty in CMM measurement (K4,A3)
CO4: identify the applications of optoelectronic devices and machine vision techniques in production monitoring (K2)
CO5: analyze the tools for controlling the quality in manufacturing (K4,A3)

UNIT I LASER METROLOGY 8

Introduction – types of lasers – laser in engineering metrology – metrological laser methods for applications in machine systems – Interferometry applications – speckle interferometry – laser interferometers in manufacturing and machine tool alignment testing – calibration systems for industrial robots laser Doppler technique – laser Doppler anemometry.

UNIT II PRECISION INSTRUMENTS BASED ON LASER 9

Laser telemetric systems – detection of microscopic imperfections on high quality surface Pitter NPL gauge interferometer – classification of optical scanning systems – high inertia laser scan technique – rotating mirror technique – laser gauging – bar coding – laser dimensional measurement system.

UNIT III CO-ORDINATE MEASURING MACHINE 10

Co-ordinate metrology – CMM configurations – hardware components – software – Probe sensors – displacement devices – Performance Evaluations – Software – Hardware – Dynamic errors – Thermal effects diagram – temperature variations environment control – applications.

UNIT IV OPTO ELECTRONICS AND VISION SYSTEM 9

Opto electronic devices – CCD – On-line and in-process monitoring in production – applications image analysis and computer vision – Image analysis techniques – spatial feature – Image extraction – segmentation – digital image processing – Vision system for measurement – Comparison laser scanning with vision system.

UNIT V QUALITY IN MANUFACTURING ENGINEERING 9

Importance of manufacturing planning for quality – concepts of controllability – need for quality management system and models – quality engineering tools and techniques – statistical process control – six sigma concepts – Poka Yoke – Computer controlled systems used in inspection.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. John A. Bosch, Giddings and Lewis Dayton, "Co-ordinate Measuring Machines and Systems", Marcel Dekker, Inc, 1999.
2. Juran J.M. and Gyna F.M, "Quality Planning and Analysis", Tata-McGraw Hill, New Delhi
3. Zuech.Nello, "Understanding and Applying Machine Vision", Marcel Dekker, Inc, 2000
4. Elanchezhian.C, Vijaya Ramnath.B and Sunder Selwyn.T, "Engineering Metrology", Eswar Press, Chennai, 2004.

15MF17C	ADVANCED COMPUTING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: create a 2D &3D Model of simple machines(K6,S1)

CO2: generate CNC programs for simulating lathe and milling machine operations(K5,S2)

CO3: analyze a simple structures like beam, column, etc.(K4,A1,S2)

2D AND 3D GEOMETRIC MODELING

1. Excercise on 3D geometric modeling and assembly of Tail Stock.
2. Excercise on 3D geometric modeling and assembly of Screw Jack.
3. Excercise on 3D geometric modeling and assembly of Plummer Block.
4. Excercise on 3D geometric modeling and assembly of Machine Vice.
5. Excercise on 3D geometric modeling and assembly of Lathe Chuck.
6. Excercise on 3D geometric modeling and assembly of Flange Coupling.
7. Excercise on 2D geometric modeling of Sheet Metal Components.

COMPUTER AIDED MANUFACTURING

8. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving & canned cycle
9. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle.

DESIGN AND ANALYSIS

10. Exercises on analysis of Beams with different loading conditions.
11. Exercise on buckling analysis of beams.
12. Exercise on structural analysis with contact options.

P:60 TOTAL: 60 PERIODS

15MF21C	APPLIED HYDRAULICS AND PNEUMATICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explain the function and the purpose of various elements of pneumatic and hydraulic systems (K2)
CO2: design multiple actuator sequential circuits with suitable fringe modules (K6)
CO3: design pneumatic circuit to automate any simple machine (K6, S3)
CO4: read and understand Electro-Pneumatic circuit diagrams (K1)
CO5: construct a detailed hydraulic circuit diagram for any Industrial application (K6,A2)

UNIT I ELEMENTS OF PNEUMATIC SYSTEMS 9

Pneumatic Vs hydraulics, compressors - types, selection. Symbols of pneumatic elements. Cylinders - types, typical construction details. Valves – direction control, flow, pressure, types, typical construction details

UNIT II PNEUMATIC SYSTEMS DESIGN 9

General approach, travel step diagram. Sequential circuit design, step counter method. K.V. Mapping for minimization of logic equation, fringe condition modules, sizing of components in pneumatic systems.

UNIT III TYPICAL INDUSTRIAL APPLICATIONS OF PNEUMATIC SYSTEMS 9

Metal working, handling, clamping, application with counters.

UNIT IV ADVANCED TOPICS IN PNEUMATICS 9

Electro pneumatics, ladder diagram. Servo and proportional valves - types, operation, application, hydro-mechanical servo systems. PLC-construction, types, operation, programming

UNIT V DESIGN OF TYPICAL HYDRAULIC SYSTEMS 9

Total design of a fluid power system for an industrial application. Specifications of the circuit, circuit design, selection of elements based on force, speed, travel and time, sizing of pipes, design of power packs/selection of compressor, piping layout and accessories.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Werner Deppert and Kurt Stoll, “Pneumatic Controls: An Introduction to Principles“, Vogel-Druck Wurzburg, 1975.
2. Peter Rohner, “Fluid Power Logic Circuit Design – Analysis, Design Method and Worked Examples”, The Macmillan Press Limited, 1979.
3. Anthony Espisito, “Fluid Power with Application”, Pearson Education Private Limited, 5th Edition, First Indian Reprint, 2003.
4. Majumdar S R, “Oil Hydraulic Systems: Principles and Maintenance”, Tata McGraw Hill Publishing Company Limited, Fourth Reprint, 2003.
5. Majumdar S R, “Pneumatic Systems: Principles and Maintenance”, Tata McGraw Hill Publishing Company Limited, Fourth Reprint, 2003.

15MF22C PRODUCTION AND OPERATIONS MANAGEMENT

L	T	P	C
3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: explore the role of forecasting as a basis for supply chain planning and choose an appropriate method of forecasting for the given situation (K3)

CO2: analyze the different inventory systems and models (K4)

CO3: solve the sequencing and scheduling problems and minimize the make span (K5,A2)

CO4: construct a network model using PERT and CPM techniques for the given project (K6)

CO5: analyze the importance of materials requirement planning and master production scheduling in industries (K4,A4)

UNIT I FORECASTING 15

Introduction, types of forecasting, qualitative forecasting techniques, Time series analysis – Simple and weighted moving average, Exponential smoothing, seasonal and cyclic forecasting, measures of forecasting accuracy, decomposition of time series, limitations of time series.

UNIT II INVENTORY ANALYSIS AND CONTROL 15

Need for inventory, Definitions, EOQ model, EMQ model, continuous and periodic review policies, lot sizing techniques, inventory models with uncertain demand and lead times, risk pooling, ABC inventory system, vendor managed inventory, simulation of inventory systems.

UNIT III SEQUENCING AND SCHEDULING 15

Objectives in scheduling, single machine models – SPT and EDD sequences, mean flow time, weighted mean flow time, number of tardy jobs and mean tardiness, Parallel machine models – minimizing makespan and weighted mean flow time, Flow shop models – Johnson’s algorithm, Jobshop models – branch and bound approach.

UNIT IV PROJECT MANAGEMENT 15

PERT, Network stochastic considerations, CPM, time-cost trade off. Project monitoring, Line of balance.

UNIT V AGGREGATE PLANNING AND MASTER PRODUCTION SCHEDULING 15

Approaches to aggregate planning-graphical, empirical, optimization and parametric. Development of a master production schedule, Make-to-stock, assemble-to-order, make-to-order/engineer-to-order, materials requirement planning (MRP-I) manufacturing resource planning (MRP-II) and ERP.

L:45 T:30 TOTAL: 75 PERIODS

REFERENCES

1. Johnson L A and D C Montgomery, “Operations Research in Production Planning, Scheduling, and Inventory Control”, John Wiley & Sons, 1974.
2. Bedworth D D, "Integrated Production Control Systems Management, Analysis, Design", John Wiley & Sons, 1987.
3. Richard B Chase, Nicholas J Aquilano and F Robert Jacobs, “Production and Operations Management – Manufacturing and Services, 8th Edition, Tata McGraw Hill Inc, 2000.
4. Elwood S Buffa, Rakesh K Sarin, “Modern Production and Operations Management”, John Wiley & Sons Inc, 2002.
5. Norman Gaither and Greg Frazier, “Operations Management”, Thomson Asia Private Limited, 2002.

6. Chary S N, "Production and Operations Management", 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2004.
7. Mukhopadhyay S K, "Production Planning and Control – Text and Cases", Prentice Hall of India Private Limited, 2004.
8. Baker K, "Introduction to Sequencing and Scheduling", John Wiley and Sons, 2004.
9. David Simchi-Levi, Philip Kaminsky and Edith Simchi-Levi, "Designing and Managing the Supply Chain – Concepts, Strategies and Case Studies", 3rd Edition, Tata McGraw Hill Publishing Company Limited, 2004.

15MF23C ADVANCED WELDING AND CASTING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: summarize the fundamental concepts of weld joint design and its characteristics (K2)
CO2: gain the knowledge about the recent trends in welding (K1,A1)
CO3: attain skill to use design principles in casting (K1,A1)
CO4: get aware on the solidification of various metals and alloys (K2)
CO5: gain the knowledge about the various methods of casting and specific products fabrication (K1,A1)

UNIT I WELDING METALLURGY AND DESIGN 8

Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing. Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

UNIT II RECENT TRENDS IN WELDING 8

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding – Plasma welding – Electroslag welding. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.

UNIT III CASTING DESIGN 8

Heat transfer between metal and mould –– Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering.

UNIT IV CASTING METALLURGY 10

Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification –– Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys , Babbit alloy and Cu alloy.

UNIT V CASTING PROCESSES 11

Shell moulding, precision investment casting, CO_2 moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes.

L:45 TOTAL: 45 PERIODS

REFERENCES

1. Schwariz, M.M. “Source book on innovative welding processes”, American Society for Metals (OHIO), 1981.
2. Lancaster.J.F, “Metallurgy of welding”, George Alien & Unwin Publishers, 1984.
3. Heineloper & Rosenthal, “Principles of Metal Casting”, Tata McGraw Hill, 2000.
4. Carrry B., “Modern Welding Technology”, Prentice Hall Pvt Ltd., 2002.
5. Parmer R.S., “Welding Engineering and Technology”, Khanna Publishers,2002.
6. Srinivasan N.K., “Welding Technology”, Khanna Tech Publishers, 2002.
7. ASM Handbook vol.6, Welding, Brazing & Soldering, 2003.
8. Jain P.L., “Principles of Foundry Technology”, Tata McGraw-Hill Pub, 2003.
9. ASM Handbook, Vol 15, Casting, 2004.

15MF24C	RESEARCH PAPER AND PATENT REVIEW - SEMINAR	L	T	P	C
		0	0	4	2

The student will make atleast two technical presentations on current topics related to the specialization. The same will be assessed by a committee appointed by the department. The students are expected to submit a report at the end of the semester covering the various aspects of his/her presentation together with the observation in industry visits.

P:60; TOTAL: 60 PERIODS

15MF25C METROLOGY AND MATERIALS TESTING LABORATORY

L	T	P	C
0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: choose an appropriate device/sensor to measure the linear & angular dimensions, speed, vibration and surface roughness(K3,S1,A1)

CO2: write programs to control the motion in AC, DC, servo & stepper motor and encoders(K5,S1)

CO3: predict and justify the mechanical properties of any ferrous or non-ferrous Materials(K5,S1)

METROLOGY

1. Study of Sensors and Transducer – Potentiometer, Strain gauge, Torque, LVDT, Hall – Effect, Speed, Vibration, Pressure, Optical transducer and Temperature transducer.
2. Study of various types of gauges.
3. Exercises on linear, angular and speed measurements
4. Exercises on Vibration measurements
5. Exercises on Motion controller using AC motor, DC motor, Servo motor and encoder.
6. Exercises on stepper motor.
7. Exercises on microprocessor based data acquisition system.
8. Exercise on measurements of surface finish parameters.
9. Experiment using pneumatic gauges.

MATERIALS TESTING

10. Study on various standards for testing.
11. Comparison of mechanical properties of any two materials (Metal or non-metal).
12. Exercise on preparation of samples for microstructure study.

P:60; TOTAL: 60 PERIODS

15MF01E ADVANCED MANUFACTURING PROCESSES

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the working of unconventional machining processes(K2)

CO2: discuss about the fabrication of micro devices.(K2)

CO3: discuss the technology about the fabrications and techniques used in micro fabrications.(K2,A2)

UNIT I NEWER MACHINING PROCESSES - I 9

(Non thermal energy) – Abrasive machining – water jet machining - ultrasonic machining– chemical machining – electro chemical machining – construction working principle – steps -types – process parameters – derivations – problems, merits, demerits and applications .

UNIT II NEWER MACHINING PROCESS – II 9

Wire cut EDM - Electro chemical machining – ECG - Electric discharge machining – construction – principle – types – control - circuits – tool design – merits, demerits & applications.

UNIT III NEWER MACHINING PROCESS – III 9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

UNIT IV FABRICATION OF MICRO DEVICES 9

Semiconductors – films and film de purification – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process – Solid free form fabrication.

UNIT V MICRO FABRICATION TECHNOLOGY 9

Wafer preparation – monolithic processing – moulding – PCB board hybrid & mcm technology – programmable devices & ASIC – electronic material and processing – stereo lithography SAW devices, Surface Mount Technology.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Pandey P.C. & Shan HS,“ Modern Machining Processes”, Standard Publishing Co.,1980
2. Jaeger R.C., “Introduction to microelectronic fabrication”, Addison Wesley, 1988.
3. Brahem T. Smith,”Advanced machining I.F.S.” UK, 1989.
4. Nario Taniguchi “Nano technology” Oxford University Press 1996.
5. More Madon, “Fundamentals of Micro fabrication”, CRC Press, 1997
6. Julian W.Hardner, “Micro senors Mems & smart devices”, 2002.
7. Serope Kelpekijian & Stevan R.Schmid, “Manufacturing process Engg Material” – 2003.

15MF02E	**ADVANCED METAL CUTTING THEORY AND PRACTICE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the basic mechanisms of chip formation and cutting force analysis in orthogonal cutting(K2)

CO2: describe the nomenclature of different cutting tools(K2,A1)

CO3: describe the measurement of temperature and heat distribution in machining(K2)

CO4: perform economics of machining and tool life estimation(K5)

CO5: analyze the different mechanisms of tool wear and chattering(K4,A2)

UNIT I INTRODUCTION 9

Need for rational approach to the problem of cutting materials-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.

UNIT II SYSTEM OF TOOL NOMENCLATURE 9

Nomenclature of single point cutting tool-System of tool nomenclature and conversion of rake angles-nomenclature of multi point tools like drills, milling-conventional Vs climb milling, mean cross sectional area of chip in milling-specific cutting pressure.

UNIT III THERMAL ASPECTS OF MACHINING 9

Heat distribution in machining-effects of various parameters on temperature-methods of temperature measurement in machining-hot machining-cutting fluids.

UNIT IV TOOL MATERIALS, TOOL LIFE AND TOOL WEAR 9

Essential requirements of tool materials-development in tool materials-ISO specification for inserts and tool holders-tool life-conventional and accelerated tool life tests - concept of mach inability index-economics of machining.

UNIT V WEAR MECHANISMS AND CHATTER IN MACHINING 9

Processing and Machining – Measuring Techniques – Reasons for failure of cutting tools and forms of wear-mechanisms of wear-chatter in machining-factors effecting chatter in machining-types of chatter-mechanism of chatter.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Bhattacharya.A., "Metal Cutting Theory and practice", Central Book Publishers, India,1984.
2. Fryderyk E. Gorczyca, "Application of metal cutting theory", Industrial Press Inc., New York, 1987.
3. Boothroid D.G. & Knight W.A., "Fundamentals of machining and machine tools", Marcel Dekker, Newyork, 1989.
4. Shaw.M.C."Metal cutting principles", Cbs Publishers & Distributors Pvt. Ltd., 2002,
5. B. L. Juneja, Nitin Seth, "Fundamentals of metal cutting and machine tools", New Age International, New Delhi,2003

15MF03E	ADVANCED TOOL DESIGN	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: appropriate knowledge about the selection of tool and tool material for machining any type of material (K2)

CO2:describe different type of multipoint cutting tools used in conventional and CNC machines (K2)

CO3: design JIG and fixture fixtures for Machining simple components (K6)

CO4: design and manufacture tools for press work in addition to selection of the presses (K6)

CO5: describe the mould design concepts (K2)

UNIT I DESIGN OF SINGLE POINT TOOLS 15

Design of form tools, Selection of tool materials for different application, ISO standard for Inserts, tool holders, Selection of inserts and tool holders for specific examples.

UNIT II DESIGN OF MULTI POINT TOOLS 15

Design of Drills, Reamers, Milling cutters, Tapes and dies, Broaching tools, Gear cutting tools, Thread milling tools for CNC Machining Centers.

UNIT III DESIGN OF CHUCKING SYSTEMS 15

For CNC turning applications.

DESIGN OF JIGS AND FIXTURES: Design of drill jigs and milling fixtures. Welding fixtures, modular fixtures.

UNIT IV DESIGN OF TOOLS FOR PRESS WORK 15

Design of simple, compound and progressive tools, study of power presses and accessories, Application of EDM for tool making.

UNIT V DESIGN OF PLASTIC MOLD DESIGN 15

Design of Thermo plastic tools, two and three plate, design of runner, gate, cooling line, ejection.

DESIGN OF GAUGES: Plug, Ring, Snap, thread gauges, Application of Sine bar, Slip gauges and Air gauges, Toolings for Casting.

L:45; T:30: TOTAL: 75 PERIODS

REFERENCES

1. Arshinov V, “Metal Cutting Theory and Cutting Tool Design”, MIR, 1979.
2. HMT, “Production Technology”, Tata McGraw Hill, 1992.
3. Kempster M H A, “An Introduction to Jig and Tool Design”, Viva books, 1998.
4. Pye R G W, “Injection Mold Design”, East West Press, 2001.
5. E G Hoffman, “Jigs and Fixtures Design”, Thomson Learning, 2004.
6. Ostergaurd D. E, “Advanced Die Making”, Tata McGraw Hill.2006
7. C Donaldson, “Tool Design”, Tata McGraw Hill, 2008.

15MF04E	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe fuzzy logic principles (K2)
CO2: apply the concepts of fuzzy logic in industrial problems (K3,A2)
CO3: discuss the fundamental concepts of ANN (K2)
CO4: use various heuristic algorithms for simple and complex problems (K3,A3)

UNIT I INTRODUCTION TO FUZZY LOGIC 6

Basic concepts in Fuzzy Set theory – Operations of Fuzzy sets – Fuzzy relational equations – Propositional, Predicate Logic – Inference – Fuzzy Logic Principles – Fuzzy inference – Fuzzy Rule based systems – Fuzzification and defuzzification – Types.

UNIT II FUZZY LOGIC APPLICATIONS 9

Fuzzy logic controllers – Principles – Various industrial Applications of Fuzzy logic control – Adaptive Fuzzy systems – Fuzzy Decision making – Fuzzy classification – Fuzzy pattern Recognition – Image Processing applications – Fuzzy optimization.

UNIT III INTRODUCTION TO ARTIFICIAL NEURAL NETWORKS 9

Fundamentals of Neural networks – Neural network architectures – Learning methods – Taxonomy of Neural Network Architectures – Standard back propagation Algorithms – Selection of various parameters – Variations.

UNIT IV OTHER ANN ARCHITECTURES 9

Associative memory – Exponential Bidirectional Associative Memory – Adaptive Resonance Theory – Introduction – Adaptive Resonance Theory 1 – Adaptive Resonance Theory 2 – Applications – Kohen Self organizing maps – counter propagation networks – Industrial Applications.

UNIT V RECENT ADVANCES 12

Fundamentals of Genetic Algorithms – Hybrid systems – Meta heuristic techniques like simulated Annealing, Tabu Search, Ant colony optimization, Perpetual self organizing, Artificial immune systems – Applications in Design and Manufacturing.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Jacek M. Zurada, 'Introduction to Artificial Neural Systems", Jaico Publishing House, 1994
2. Laurene Fausett, "Fundamentals of Neural Networks, Architectures, Algorithms and Applications", Prentice Hall, Englewood cliffs, 1994.
3. Klir, G.J. Yuan Bo, 'Fuzzy sets and Fuzzy Logic: Theory and Applications", Prentice Hall of India Pvt. Ltd., 1997.
4. Simon Haykin, 'Neural Networks A comprehensive foundation", Prentice Hall, 2nd Edition, 1998.
5. S. Rajasekaran, GA Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003.

15MF05E	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the properties of fibers, matrices and smart materials.(K2)
CO2: analyze the characteristics of different fibers.(K4,A3)
CO3: select any of techniques to process metal matrix composites.(K2)
CO4: prepare the design procedure composite materials.(K3, A3)
CO5: perform various analysis of Composite Beams, Plates and Shells.(K4,A1)

UNIT I INTRODUCTION 15

Definition - Need - General characteristics, Applications, Fibers -Glass, Carbon, Ceramic and Aramid fibers. Matrices - Polymer, Graphite, Ceramic and Metal Matrices - Characteristics of fibers and matrices. Smart materials - Types and characteristics.

UNIT II MECHANICS AND PERFORMANCE 15

Characteristics of fibre - reinforced Lamina - Laminates - Interlaminar stresses - Static Mechanical Properties fatigue and Impact properties - Environmental effects - Fracture Behaviour and Damage Tolerance.

UNIT III MANUFACTURING 15

Bag Moulding - Compression Moulding - Pultrusion - Filament Winding - Other Manufacturing Processes, Quality Inspection methods, Processing of MMC's.

UNIT IV DESIGN 15

Failure Predictions - Laminate Design Consideration - Bolted and Bonded Joints Design Examples.

UNIT V ANALYSIS 15

Stress Analysis of Laminated Composite Beams, Plates, Shells - Vibration and Stability Analysis - Reliability of Composites - Finite Element Method of Analysis - Analysis of Sandwich structures.

L:45; T:30; TOTAL: 75 PERIODS

REFERENCES

1. Halpin, J.C., "Primer on Composite Materials, Analysis ", Techomic Publishing Co., 1984.
2. Agarwal B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites ", John Wiley and Sons, New York, 1990.
3. Mallick P.K. and Newman. S, " Composite Materials Technology: Processes and Properties ", Hansen Publisher, Munich, 1990.
4. Mallick, P.K., " Fiber-Reinforced composites: Materials, Manufacturing and Design ", Marcel Dekker Inc., 1993.

15MF06E COMPUTER AIDED PRODUCT DESIGN

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: identify the basics of engineering design and design software packages.(K2)
CO2: discuss about the fundamentals of computer graphics and geometric modelings. (K2)
CO3: describe the concepts of product design and its functions.(K2)
CO4: analyze various product design tools and techniques.(K4)
CO5: illustrate the important functions of product data management.(K3)

UNIT I INTRODUCTION 8

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting.

UNIT II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC MODEL 8

Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modeling – types – Wire frame surface and solid modeling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modeling – use of software packages.

UNIT III PRODUCT DESIGN CONCEPTS 8

Understanding customer needs – Product function modeling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – concept generation and selection.

UNIT IV PRODUCT DESIGN TOOLS & TECHNIQUES 12

Product modeling – types of product models; product development process tools – TRIZ– Altshuller's inventive principles – Modeling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment – FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

UNIT V PRODUCT DATA MANAGEMENT 9

Product Data Management – concepts – Collaborative product design and commerce – Information Acquisition –Sourcing factor –manufacturing planning factor– Customization factor – Product life cycle management.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. David F.Rogers.J, Alan Adams, "Mathematical Elements for Computer Graphics", McGraw Hill, 1990.
2. Ibrahim Zeid, "CAD/CAM theory and Practice", Tata McGraw Hill, 1991.
3. James G.Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1994
4. Biren Prasad, "Concurrent Engineering Fundamentals Vol.11", Prentice Hall, 1997.

15MF07E	DESIGN FOR MANUFACTURING AND ASSEMBLY	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1: describe various approaches for tolerance design (K2)
- CO2: synthesis the assembly tolerance and allocate it to the components of assembly (K5)
- CO3: understand the fundamentals of geometric dimensioning and tolerancing (K2)
- CO4: prepare tolerance chart for the given application (K6,A2)
- CO5: discuss the statistical methods of tolerance analysis (K2)

UNIT I TOLERANCE ANALYSIS 15

Introduction – Concepts, definitions and relationships of tolerance – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi's Approach to tolerance design.

UNIT II TOLERANCE ALLOCATION 15

Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi's quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.

UNIT III GD & T 15

Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

UNIT IV TOLERANCE CHARTING 15

Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

UNIT V MANUFACTURING GUIDELINES 15

DFM guidelines for casting, weldment design – Formed metal components – Turned parts – Milled, Drilled parts – Non metallic parts – Computer Aided DFM software – Boothroyd and Dewhurst method of DFMA – DCS – Vis/VSA – 3D Dimensional control – Statistical tolerance Analysis Software – Applications.

L:45; T:30 ;TOTAL: 75PERIODS

REFERENCES

1. Oliver R. Wade, "Tolerance Control in Design and Manufacturing", Indus. Press,NY, 1967.
2. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1986.
3. James D. Meadows, "Geometric Dimensioning and Tolerancing", Marcel Dekker Inc., 1995.
4. C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 1997.
5. Alex Krulikowski, "Fundamentals GD&T", Delmar Thomson Learning, 1997.

15MF08E	**FINANCIAL MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**2**	**0**	**4**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: prepare a balance sheet based on profit and loss statement (K3,S2)
CO2: estimate the cost of manufacturing of a product and allocation of overhead cost (K2)
CO3: estimate the working capital requirements and inventory valuation(K2)
CO4: calculate the return on investment by different methods(K4,A2)
CO5: analyze the costing and profit planning methodologies for decision making(K4)

UNIT I FINANCIAL ACCOUNTING 15

Accounting principles - Basic records - Preparation and interpretation of profit and loss statement - balance sheet - Fixed assets - Current assets.

UNIT II COST ACCOUNTING 15

Elements of cost - cost classification - material cost - labour costs - overheads - cost of a product - costing systems - cost determination - process - costing - Allocation of overheads - Depreciation - methods.

UNIT III MANAGEMENT OF WORKING CAPITAL 15

Current assets - Estimation of working capital requirements - Management of accounts receivable - Inventory - Cash - Inventory valuation methods.

UNIT IV CAPITAL BUDGETING 15

Significance of capital budgeting - payback period - present value method - accounting rate of return method - Internal rate of return method.

UNIT V PROFIT PLANNING AND ANALYSIS 15

Cost - Volume profit relationship Relevant costs in decision making profit management analysis - Break even analysis.

L:45; T:30 ;TOTAL: 75PERIODS

REFERENCES

1. G.B.S. Narang, “Production and Costing”, Khanna Publishers, 1993.
2. C.James, Vanhorn, “Fundamentals of Financial Management” PHI, 1996
3. Presanna Chandra, “Financial Management”, Tata McGraw Hill, 1998.
4. R.Kesavan, C.Elanchezian, Vijayaramnath, “Process Planning and cost estimation”, New Age International Publishers, New Delhi 2004
5. R.Kesavan, C.Elanchezian, Sundar Selwyn, “Engineering Economics and Financial Accounting”, Laxmi Publications, New Delhi, 2005.
6. R.Kesavan, C. Elanchezian, B.Vijaramnath, “Engineering Economics and Cost Analysis”, Anuratha Publications, Chennai.

15MF09E	FINITE ELEMENT APPLICATION IN MANUFACTURING	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: understand the fundamental concepts of FEM (K2)
CO2: perform one dimensional analysis in solid mechanics and heat transfer (K3,A4)
CO3: solve structural and non-structural problem using FEM (K5,A2)
CO4: develop code for one dimensional analysis and validation using computer system (K6,A1)
CO5: perform finite element analysis of various production processes (K3,A2)

UNIT I INTRODUCTION 15

Fundamentals – Initial, boundary and eigen value problems – weighted residual, Galerkin and Raleigh Ritz methods - Integration by parts – Basics of variational formulation – Polynomial and Nodal approximation.

UNIT II ONE DIMENSIONAL ANALYSIS 15

Steps in FEM – Discretization. Interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 15

Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element Global and natural co-ordinates - Non linear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional, plane stress, plane strain and axisymmetric analysis.

UNIT IV COMPUTER IMPLEMENTATION 15

Pre Processing, mesh generation, elements connecting, boundary conditions, input of material and processing characteristics – Solution and post processing – Overview of application packages – Development of code for one dimensional analysis and validation

UNIT V ANALYSIS OF PRODUCTION PROCESSES 15

FE analysis of metal casting – special considerations, latent heat incorporation, gap element – Time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity and fracture – Solid and flow formulation – small incremental deformation formulation – Fracture criteria – FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency **–** FE analysis of welding.

L:45; T:30 ;TOTAL: 75 PERIODS

REFERENCES

1. Rao. S.S., “Finite Element method in engineering”, Pergammon press, 1989.
2. Kobayashi.S, Soo-ik-Oh and Altan,T, “Metal Forming and the Finite Element Methods”, Oxford University Press, 1989.
3. Bathe. K.J., “Finite Element procedures in Engineering Analysis”, 1990
4. Lewis R.W.Morgan, K. Thomas, H.R. and Seetharaman. K.N. “The Finite Element Method in Heat Transfer Analysis”, John Wiley, 1994.
5. Reddy.J.N.“ An Introduction to the Finite Element Method”, McGraw Hill,3rd Edition, 2006

15MF10E	INDUSTRIAL ERGONOMICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the concepts of human factor engineering.(K2)
CO2: analyze the human motions using anthropometry principle.(K4,S1)
CO3: design the workplace and process.(K6)
CO4: analyze the environmental factors in working location.(K4,A2)
CO5: discuss about the work physiology and its evaluation.(K2)

UNIT I INTRODUCTION 9

Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

UNIT II ANTHROPOMETRY 9

Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

UNIT III DESIGN OF SYSTEMS 9

Displays – Controls – Workplace – Seating – Work process – Duration and rest periods– Hand tool design – Design of visual displays – Design for shift work.

UNIT IV ENVIRONMENTAL FACTORS IN DESIGN 10

Temperature – Humidity – Noise – Illumination –Vibration – Measurement of 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 inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance – annoyance of noise and interference with communication – sources of vibration discomfort.

UNIT V WORK PHYSIOLOGY 8

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.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. E.J. McCormic, "Human factors in engineering design", McGraw Hill 1976
2. Rosatao, D.V. "Blow moulding HandBook", Hanser Publishers, 1989.
3. R.S. Bridger, "Introduction to Ergonomics", McGraw Hill, 1995.
4. Martin Helander, "A guide to the ergonomics of manufacturing", East West press, 1996
5. Rauwendaal,C., "Polymer extrusion", Hanser publishers, 2000.
6. Seamour, E.B. "Modern Plastics Technology", Prentice Hall, 2002
7. Mallick, P.K. and Newman.S., "Composite Materials Technology", Hanser Publishers, 2003

15MF11E	LEAN MANUFACTURING SYSTEM AND IMPLEMENTATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1: discuss the Principles and basic elements of lean manufacturing.(K2)
- CO2: identify the importance of cellular manufacturing, JIT, TPM and its implementations.(K2)
- CO3: describe the concepts of set up time reduction, TQM, 5S and VSM.(K2)
- CO4: analyze the factors for the implementation of six sigma concepts.(K4)
- CO5: illustrate the case studies about implementation of lean manufacturing at industries.(K3)

UNIT I INTRODUCTION 7

Conventional Manufacturing versus Lean Manufacturing – Principles Lean Manufacturing – Basic elements of lean manufacturing – Introduction to LM Tools.

UNIT II CELLULAR MANUFACTURING, JIT, TPM 9

Cellular Manufacturing – Types of Layout, Principles of Cell layout, Implementation. JIT – Principles of JIT and Implementation of Kanban. TPM – Pillars of TPM, Principles and implementation of TPM.

UNIT III SET UP TIME REDUCTION, TQM, 5S, VSM 10

Set up time reduction – Definition, philosophies and reduction approaches.TQM – Principles and implementation. 5S Principles and implementation - Value stream mapping - Procedure and principles.

UNIT IV SIX SIGMA 9

Six Sigma – Definition, statistical considerations, variability reduction, design of experiments – Six Sigma implementation

UNIT V CASE STUDIES 10

Various case studies of implementation of lean manufacturing at industries

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Rother M. and Shook J, “Learning to See: Value Stream Mapping to Add Value and Eliminate Muda”, Lean Enterprise Institute, 1999, Brookline, MA.
2. Mikell P. Groover ,‘Automation, Production Systems and CIM”, 2002.
3. Ronald G. Askin & Jeffrey B.Goldberg, “Design and Analysis of Lean Production Systems”, John Wiley & Sons, 2003

15MF12E	MANUFACTURING MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1:analyze the available plant layout types in practice and select the proper one for specific application(K4)

CO2:select an efficient methodology from alternatives by comparing their standard time for processing a specific product(K2)

CO3: prepare the route sheet for processing a product and use different tools and methods for estimating the future demand of products(K3)

CO4: apply machine scheduling and job sequencing methods to minimize the manufacturing lead time and increase the production rate of products(K3)

CO5: describe the managerial functions as they get in to senior managerial positions in industry (K2, A1)

UNIT I PLANT ENGINEERING 7

Plant location – Factors affecting plant location – Techniques – Plant layout - principles. Types – Comparison of layouts – Materials handling – Principles – Factors affecting selection of Materials handling system – Types of materials handling systems – Techniques.

UNIT II WORK STUDY 9

Method study – Principles of motion economy – steps in method study – Tool and Techniques – Work measurement – Purpose – stop watch time study – Production studies – work sampling – Ergonomics – Value analysis.

UNIT III PROCESS PLANNING AND FORECASTING 10

Process planning – Aims of process planning – steps to prepare the detailed work sheets for manufacturing a given component – Break even analysis – Forecasting – Purpose of forecasting – Methods of forecasting – Time series – Regression and Correlation – Exponential smoothing – Forecast errors.

UNIT IV SCHEDULING AND PROJECT MANAGEMENT 9

Scheduling – Priority rules scheduling – sequencing – Johnson's algorithm for job sequencing – n job M machine problems – Project Network analysis – PERT/CPM – Critical path – Floats – Resource leveling – Queuing analysis.

UNIT V PERSONNEL AND MARKETING MANAGEMENT 10

Principles of Management – Functions of personnel management – Recruitment – Training – Motivation – Communication – conflicts – Industrial relations – Trade Union – Functions of marketing – Sales promotion methods – Advertising – Product packaging – Distribution channels – Market research and techniques.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. R. Panneerselvam, "Production and Operations Management", Prentice Hall of India,2002
2. Martand T. Telsang, "Production Management", S.Chand & Co., 2005
3. Thomas E Mortan, "Production and Operations Management", Vikas Publican, 2003.
4. R. Kesavan, C. Elanchezian, and B.Vijayaramnath, "Principles of Management" Eswar Press – Chennai – 2004
5. R. Kesavan,C. Elanchezian and T.Sundar Selwyn, "Engineering Management", Eswar Press, Chennai – 2005
6. R. Kesavan, C.Elanchezian and B.Vijayaramnath, "Production Planning and Control", Anuratha Publications, Chennai – 2008

15MF13E	MANUFACTURING SYSTEM SIMULATION	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: recognize the important characteristics, key words, phrases, and concepts of simulation(K2)

CO2: generate random numbers based on discrete & continuous distribution and testing its randomness(K6)

CO3: describe the principles of experimental simulation design and apply the concepts in engineering industries(K2)

CO4: use computer simulation software to solve and interpret the results(K3)

CO5: develop simulation models for the defined cases(K6)

UNIT I INTRODUCTION 8

Basic concepts of system – elements of manufacturing system - concept of simulation – simulation as a decision making tool – types of simulation – Monte-Carlo simulation - system modeling – types of modeling – Limitations and Areas of application of simulation.

UNIT II RANDOM NUMBERS 10

Probability and statistical concepts of simulation – Pseudo random numbers – methods of generating random numbers – discrete and continuous distribution – testing of random numbers – kolmogorov-Smirnov test, the Chi-Square test - sampling - simple, random and simulated.

UNIT III DESIGN OF SIMULATION EXPERIMENTS 9

Problem formulation – data collection and reduction – time flow mechanical – key variables - logic flow chart starting condition – run size – experimental design consideration – output analysis, interpretation and validation – application of simulation in engineering industry.

UNIT IV SIMULATION LANGUAGE 9

Comparison and selection of simulation languages - Study of GPSS (Basic blocks only) Generate, Queue, Depart, Size, Release, Advance, Terminate, Transfer, Enter and Leave.

UNIT V CASE STUDIES 9

Development of simulation models using GPSS for queuing, production, inventory, maintenance and replacement systems – case studies.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Jerry Banks and John S.Carson, “Discrete event system simulation”, Prentice Hall 1991
2. John H.Mize and J.Grady Cox, “Essentials of simulation”–Prentice hall 1989
3. Averill M.Law and W.David Kelton, “Simulation Modeling and analysis”, McGraw Hill International Editions, 1991
4. Geoffrey Gordon “System simulation” – Prentice Hall of India, 1992
5. Jeffrey L.Written, Lonnie D, Bentley and V.M. Barice, “System analysis and Design Methods”, Galgotia publication, 1999

15MF14E MATERIALS MANAGEMENT AND LOGISTICS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

- CO1: discuss the concept of materials management and its functions.(K2)
- CO2: analyze the method of purchase, source of supply and buyer-seller relationship.(K4)
- CO3: discuss the importance of management of stores & logistics and its functions.(K2)
- CO4: use various tools for materials planning.(K3)
- CO5: analyze various tools of inventory management.(K4)

UNIT I INTRODUCTION 6

Introduction to materials management – Objectives – Functions – Operating Cycle – Value analysis – Make or buy decisions.

UNIT II MANAGEMENT OF PURCHASE 7

Purchasing policies and procedures – Selection of sources of supply – Vendor development – Vendor evaluation and rating – Methods of purchasing – Imports – Buyer – Seller relationship – Negotiations.

UNIT III MANAGEMENT OF STORES AND LOGISTICS 12

Stores function – Location – Layout – Stock taking – Materials handling – Transportation – Insurance – Codification – Inventory pricing – stores management – safety – warehousing – Distribution linear programming – Traveling Salesman problems – Network analysis – Logistics Management.

UNIT IV MATERIALS PLANNING 10

Forecasting – Materials requirements planning – Quantity – Periodic – Deterministic models – Finite production.

UNIT V INVENTORY MANAGEMENT 10

ABC analysis – Aggregate planning – Lot size under constraints – Just in Time (JIT) system.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Lamer Lee and Donald W.Dobler, "Purchasing and Material Management", Text and cases, Tata McGraw Hill, 1996.
2. Gopalakrishnan.P, "Handbook of Materials Management", Prentice Hall of India, 1996.
3. Guptha P.K. and Manmohan, "Problems in Operations Research", Suttan Chand & Sons, 2003.
4. R. Kesavan, C.Elanchezian and T.SundarSelwyn, "Engineering Management" Eswar Press – 2005.
5. R. Kesavan, C.Elanchezian and B.Vijaya Ramnath, "Production Planning and Control", Anuratha Publications, Chennai, 2008.
6. G. Reghuram, N. Rangaraj, "Logistics and supply chain management cases and concepts", Macmillan India Ltd., 2006.

15MF15E	MECHANICAL BEHAVIOUR OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe elastic and plastic behaviour of engineering materials(K2,A1)
CO2: explain the concepts of fatigue failure analysis(K2)
CO3: choose an appropriate material for the specific applications(K3,A2)
CO4: characterize the modern metallic materials(K5)
CO5: understand the properties, processing and applications of non metallic materials(K2)

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR 8

Elasticity in metals and polymers– Strengthening mechanisms, work hardening, solid solutioning, grain boundary strengthening, poly phase mixture, precipitation, particle, fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour–Super elasticity – Griffith's theory – Ductile, brittle transition in steel – High temperature fracture, creep – Larson Miller parameter – Deformation and fracture mechanism maps.

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES 10

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Safe life, Stress-life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS 9

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 – Computer aided materials selection.

UNIT IV MODERN METALLIC MATERIALS 9

Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel, Maraging steel, Nitrogen steel – Intermetallics, Ni and Ti aluminides – smart materials, shape memory alloys – Metallic glass and nano crystalline materials.

UNIT V NON METALLIC MATERIALS 9

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, processing and applications.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. George E.Dieter, "Mechanical Metallurgy", McGraw Hill, 1988
2. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., "Selection and use of engineering materials", 3rd edition, Butterworth-Heiremann, 1997.
3. Flinn, R.A., and Trojan, P.K., "Engineering Materials and their Applications", 4th Edition Jaico, 1999.
4. Metals Hand book, Vol.10, "Failure Analysis and Prevention", 10th Edition, Jaico, 1999.
5. Ashby M.F., "Materials selection in Mechanical Design" 2nd Edition, Butter worth, 1999.
6. Thomas H. Courtney, "Mechanical Behavior of Materials", 2nd Edition, McGraw Hill, 2000.

15MF16E	MECHANICAL PROCESSING AND PROPERTIES OF NANOSTRUCTURE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1:describe the mechanics and processes of rolling, forging, extrusion, wire drawing and sheet metal forming(K2)
CO2:describe the techniques for processing polymers.(K2, S1)
CO3:analyze various processing methods in powder metallurgy.(K4)
CO4:discuss about the properties and processing of structural and functional \ nanocrystalline materials.(K2,A3)
CO5:analyze the microstructure of nanostructure materials.(K4)

UNIT I PROCESSING OF METALS AND ALLOYS 6

Understanding the following processes from the viewpoints of mechanics and processes: rolling, forging, extrusion, wire drawing, sheet metal forming.

UNIT II PROCESSING OF POLYMERS 7

Special techniques like injection moulding, thermoforming, vacuum and pressure assisted forming.

UNIT III PROCESSING OF POWDERS OF METALS AND CERAMICS 12

Selection and characterization of powders, compacting and sintering; mechanical working. Production of Porous and Dense Composite Components: Metal- polymer- and ceramic- based composites.

UNIT IV PROCESSING OF STRUCTURAL AND FUNCTIONAL NANOCRYSTALLINE MATERIALS 10

Properties required of nanocrystalline materials used for structural, hydrogen storage, magnetic and catalytic applications; processing techniques; techniques for retaining the nanocrystalline structure in service.

UNIT V MICROSTRUCTURE AND PROPERTIES 10

Properties slightly dependent on temperature and grain size; properties strongly dependent on temperature and grain size; strengthening mechanisms; enhancement of available plasticity; grain size evolution and grain size control; Hall-Petch relation, microstructure – dislocation interactions at low and high temperatures; effects of diffusion on strength and flow of materials; methods of enhancing or retarding diffusion; grain boundary sliding and grain boundary migration; current limitations on approaches based on dislocation theory; possibilities for predictive design.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. H. Cottrell, “The Mechanical Properties of Matter”, John Wiley, London, 1964.
2. P. Haasen, “Physical Metallurgy”, Cambridge University , Cambridge, UK, 1978.
3. G. E. Dieter, adapted by D Bacon, “Mechanical Metallurgy”, SI Metric edition, MaGraw-Hill, Singapore, 1988.
4. K. A. Padmanabhan, “Mechanical Properties of Nanostructured Materials”, Materials Science and Engineering, A 304-306 (2001) 200-205.
5. C. C.Koch, “Nanostructured Materials: Processing, Properties and Applications”, 2nd Edition, 2007.

15MF17E	MEMS AND NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1:discuss the concepts of microelectronics and its applications.(K2)
CO2:describe the fabrication processes of different materials.(K2)
CO3: grasp ideas about various sensors.(K2,S1)
CO4: describe the fundamentals and properties of nanomaterials.(K2,A2)
CO5: analyze various microscopic techniques and its evaluation.(K4)

UNIT I OVERVIEW OF MEMS AND MICROSYSTEMS 6

Definition – historical development – fundamentals – properties, micro fluidics, design and fabrication micro-system, microelectronics, working principle and applications of micro system.

UNIT II MATERIALS, FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING 10

Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.Photolithography, photo resist applications, light sources, in implantation, diffusion process exudation – thermal oxidation, silicon diode, chemical vapour deposition, sputtering- deposition by epitoxy – etching – bulk and surface machining – LIGA process Micro system packaging – considerations packaging – levels of micro system packaging die level, device level and system level.

UNIT III MICRO DEVICES AND MATERIALS 8

Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands displacement sensors, pressure and flow sensors, micro actuators – smart materials – applications.

UNIT IV SCIENCE OF NANO MATERIALS 10

Classification of nano structures – effect of the nanometer length scale effects of nano scale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical and electronic properties – effect of nanoscale dimensions on biological systems. Fabrication methods – Top down processes – bottom up process.

UNIT V CHARACTERIZATION OF NANO MATERIALS 11

Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Julian W. Hardner “Micro Sensors, Principles and Applications”, CRC Press 1999.
2. Tai Ran Hsu, “MEMS and Microsystems Design and Manufacture”, Tata-McGraw Hill, New Delhi, 2002.
3. Norio Taniguchi, “Nano Technology”, Oxford University Press, New York, 2001
4. Charles P Poole, Frank J Owens, “Introduction to Nano technology”, John Wiley and Sons, 2003.
5. “The MEMS Hand book”, Mohamed Gad-el-Hak, CRC Press, N.Y, London, 2nd Edition, 2005
6. Mark Madou, “Fundamentals of Micro fabrication”, CRC Press, New York, 3rd Edition 2011.

15MF18E	NANO COMPOSITES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1:discuss the preparation techniques of metal-ceramic composites.(K2, S1)
CO2:identify the characteristics and properties of metal based nanocomposites.(K2)
CO3:design and improve the mechanical properties of super hard nanocomposites.(K6,A2)
CO4:design, dimension analysis and electrical properties of fractal based nanocomposites.(K6)
CO5:describe the properties of polymer based nanocomposites.(K2, A3)

UNIT I NANO CERAMICS 9

Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality.

UNIT II METAL BASED NANO COMPOSITES 9

Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties.

UNIT III DESIGN OF SUPER HARD MATERIALS 9

Super hard nanocomposites, its designing and improvements of mechanical properties.

UNIT IV NEW KIND OF NANOCOMPOSITES 9

Fractal based glass-metal nanocomposites, its designing and fractal dimension analysis. Electrical property of fractal based nanocomposites. Core-Shell structured nanocomposites.

UNIT V POLYMER BASED NANOCOMPOSITES 9

Preparation and characterization of diblock Copolymer based nanocomposites; Polymercarbon nanotubes based composites, their mechanical properties, and industrial possibilities.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. “Physical Properties of Carbon Nanotubes”’ R. Saito,1999.
2. The search for novel, superhard materials- Stan Vepr¡ek (Review Article) JVST A, 1999
3. Nanometer versus micrometer-sized particles-Christian Brosseau,Jamal Ben,Youssef, Philippe Talbot, Anne-Marie Konn, (Review Article) J. Appl. Phys, Vol 93, 2003

15MF19E	OPTIMIZATION TECHNIQUES IN ENGINEERING	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: describe the need and practical applications of engineering optimization(K2)
CO2: solve linear programming problems by different methods(K3,A1)
CO3: solve non linear programming problems by various methods(K3)
CO4: work out the problems on integer & dynamic programming and construct the network for maximal flow & shortest path identification(K5)
CO5: define the concepts of non-traditional optimization techniques(K1,A2)

UNIT I INTRODUCTION 15

Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT II CLASSIC OPTIMIZATION TECHNIQUES 15

Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT III NON-LINEAR PROGRAMMING 15

Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming

UNIT IV INTEGER AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES 15

Integer programming - Cutting plane algorithm, Branch and bound technique, Zero-one implicit enumeration – Dynamic Programming – Formulation, Various applications using Dynamic Programming. Network Techniques – Shortest Path Model – Minimum Spanning Tree Problem – Maximal flow problem.

UNIT V ADVANCES IN SIMULATION 15

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

L:45; T:30 ;TOTAL: 75 PERIODS

REFERENCES

1. Ravindran, Philips and Solberg, "Operations Research Principles and Practice", John Wiley & Sons, Singapore, 1992.
2. P.K. Guptha & Man-Mohan, "Problems in Operations Research", Sultan chand & Sons, 1994
3. J.K.Sharma, "Operations Research Theory & Appln", Macmillan India Ltd., 1997
4. Hamdy A. Taha, "Operations Research An Introduction" , Prentice Hall of India, 1997
5. R.Panneerselvam, "Operations Research", Prentice Hall of India Pvt Ltd, New Delhi 1 – 2005

15MF20E	POLYMERS AND COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe structure, processing and property relationship of polymers.(K2)
CO2: apply the various processing techniques of Polymers.(K3)
CO3: explain the mechanical properties of various fibers.(K2)
CO4: signify the processing techniques of polymer matrix composites.(K2,S2)
CO5: discuss the fabrication techniques of metal and ceramic matrix composites.(K2,S3)

UNIT I PROPERTIES OF POLYMERS 8

Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics – Applications – Merits and Disadvantages.

UNIT II PROCESSING OF POLYMERS 9

Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Mechanical Fasteners – Thermal bonding – Press Fitting.

UNIT III INTRODUCTION TO FIBRES AND COMPOSITE MATERIALS 9

Fibres – Fabrication, Structure, properties and applications - Glass, Boron, carbon, organic, ceramic and metallic fibers whiskers – Matrix materials structure – polymers, – metals and ceramics – Physical and chemical properties

UNIT IV PROCESSING OF POLYMER MATRIX COMPOSITES 9

Open mould process, bag moulding, compression moulding with BMC and SMC filament winding – pultrusion – centrifugal casting – injection moulding – structure, properties and application of PMC's – Carbon Matrix Composites - Interfaces – Properties – recycling of PMC.

UNIT V PROCESSING OF METAL MATRIX COMPOSITES AND CERAMIC MATRIX COMPOSITES 10

Solid state fabrication techniques – diffusion bonding – powder metallurgy techniques plasma spray, chemical and physical vapour deposition of matrix on fibres Chemical vapour infiltration – Sol gel – liquid state fabrication methods – infiltration – squeeze, casting – rheo casting – compocasting - Interfaces properties– application of MMC and ceramic matrix composites.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Krishnan K Chawla, "Composite Materials Science and Engineering", International Edition, Springer, 2006
2. Harold Belofsky, "Plastics, Product Design and Process Engineering", Hanser Publishers, 2002.
3. Bera.E and Moet.A, "High performance polymers", Hanser Publishers, 2001.

15MF21E	**RAPID MANUFACTURING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: understand the AI concepts and expert systems.(K2)
CO2: apply the concurrent engineering design in real time applications.(K3)
CO3: describe various advanced manufacturing concepts.(K2)
CO4: attain knowledge on product development.(K2)
CO5: define the principles of modular and rapid tooling.(K1)

UNIT I INTRODUCTION TO CONCURRENT ENGINEERING 9

Extensive definition of CE – CE design methodologies organizing for CE – CE tool box collaborative product development – IT support – Solid modeling – Product data management – collaborative product – Artificial intelligence – Expert systems – software hardware co – design.

UNIT II DESIGN STATE 9

Life cycle design of products – opportunity for manufacturing enterprises – modality of concurrent engineering design – Automated Analysis Idealization control – concurrent Engineering in optimal structural design – Real time constraints.

UNIT III MANUFACTURING CONCEPTS AND ANALYSIS 9

Manufacturing competitiveness – checking design process – conceptual design mechanism – qualitative physical approach – An intelligent design for manufacturing system – JIT system – low inventory – modular fixtures modeling and Reasoning for computer based Assembly planning – Design of Automated Manufacturing systems.

UNIT IV RAPID PROTO TYPE TOOLING PROCESSES 9

Ed for coessiomn in product development classification of RP systems – Fused deposition modeling selective laser sintering – stereo lithography systems – laminated object manufacturing. Solid ground curing – laser engineered net shaping (LENS).

UNIT V MODULAR AND RAPIDTOOLING 9

Principle – Thermojet printer, Sander's model 3D printer, Genisys Xs printer, JP system object yudra system – In direct rapid tooling , silicon rubber tooling – aluminium fitted epoxy tooling – spray metal tooling, direct rapid tooling – quick cast process – copper polyamide, rapid tools sand casting tooling laminated tooling soft tooling Vs hard tooling.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Anderson M.M and Hein L. Berlin "Integrated Product Development", Springer Ver Log 1987.
2. Cleetus. J,"Design for concurrent Engineering", Concurrent Engineering Research Center, and Mongantown W.V.1992.
3. Andrew Kusaik, "Concurrent Engineering Automation tools and technology", Wiley John and Sons Inc 1992.
4. Prasad, "Concurrent Engineering Fundamentals Integrated Product Development", 1996.
5. Paul P.Jacob, Stereo Lithography and other Rapid Prototyping &Manufacturing Technologies, SME. New York, 1996.
6. Pham. D.T. and Dimov. S.S. "Rapid Manufacturing", Verlag London, 2001.

15MF22E	RELIABILITY ENGINEERING	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: discuss the basic concepts of reliability and the aspects of the reliability optimization of systems subjected to failure(K2)

CO2: design for reliability process by taking into account the maintainability considerations that arise at each phase in the life cycle of the system. (K6)

CO3: discuss the considerations and requirements for designing equipment and and systems to facilitate maintenance(K2)

CO4: describe the various techniques used to optimize the system relaiability(K2)

CO5: discuss objectives of packaging, transportation and subsequent storage and and the reliability management(K2)

UNIT I CONCEPTS OF RELIABILITY 15

Definition of reliability, reliability Vs quality, reliability function, MTTF, hazard rate function, bathtub curve, derivation of the reliability function, constant failure rate model, time dependent failure models, Weibull distribution, normal distribution- the lognormal distribution.

RELIABILITY OF SYSTEM AND MODELS: Serial configuration, parallel configuration, combined series parallel systems, system structure function, minimal cuts and minimal paths, Markov analysis, load sharing systems, standby system, degraded systems, three state devices, covariate models, static models, dynamic models, physics of failure models.

UNIT II DESIGN FOR RELIABILITY & MAINTAINABILITY 15

Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, optimal, Arinc, Agree, design methods, parts and material selection, derating, stress-strength analysis, failure analysis, identification of failure mode, determination of causes, assessment of effects, classification of severity, computation of criticality index, corrective action, system safety and FTA.

UNIT III DESIGN FOR MAINTAINABILITY 15

Analysis of downtime- the repair time distribution, stochastic point processes, system repair time, reliability under preventive maintenance, state dependent systems with repair, MTTR-mean system downtime, MTR – MH/OH, cost model, fault isolation and self diagnostics, repair Vs replacement, replacement model, proactive, preventive, predictive maintenance, maintenance and spares provisioning, maintainability prediction and demonstration, concepts and definition of availability.

UNIT IV OPTIMIZATION OF SYSTEM RELIABILITY 15

Optimization techniques for system reliability with redundancy, heuristic methods applied to optimal system reliability, redundancy allocation by dynamic programming, reliability optimization by non linear programming.

THE ANALYSIS OF FAILURE DATA AND RELIABILITY TESTING: Data collection, empirical methods, ungrouped and grouped complete, censored data, static life estimation, test time calculation, burn in testing, acceptance, sequential, binomial testing, accelerated life testing, other acceleration models, experimental design, reliability growth process, idealized growth curve, various growth models, identifying failure and repair distributions.

UNIT V PACKAGING AND TRANSPORTATION FOR RELIABILITY 15

Objectives, preservation-packaging, transportation and subsequent storage, reliability and the customer. Purchase of equipment, installation, commissioning a new system, reliability prediction and control, reliability management, the people concerned with reliability, coordination, training.

L:45; T:30; TOTAL: 75 PERIODS

REFERENCES

1. Approach", Hemisphere Publications, 1991.
2. Srinath l S, "Engineering Design and Reliability", ISTE, 1999.
3. Charles E Ebling, "An introduction to Reliability and Maintainability Engineering", Tata McGraw Hill, 2000.
4. Way kuo, Rajendra Prasad V, Frank A, Tillman and Ching-Lai Hwang, "Optimal Reliability Design and Applications", Cambridge University Press Private Limited, 2001.
5. David J Smith, "Reliability, Maintainability and Risk: Practical Methods for Engineers", Butterworth, 2002.
6. Patrick D T o'connor, "Practical Reliability Engineering", John-Wiley and Sons Inc, 2002.

15MF23E	**ROBOT DESIGN AND PROGRAMMING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

Upon completion of this course, the student will be able to

CO1: discuss the working principle, characteristics and applications of robots.(K2)
CO2: discuss various robot kinematic principles.(K2)
CO3: understand the robot dynamics, static force analysis of robots and trajectory planning.(K2)
CO4: understand the basics of robot programming and AI techniques.(K2)
CO5: illustrate the various functions and applications of robot sensors and actuators.(K3)

UNIT I INTRODUCTION 9

Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

UNIT II ROBOT KINEMATICS 9

Introduction – Matrix representation Homogeneous transformation, forward and inverse– Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 9

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order – Polynomial trajectory planning

UNIT IV ROBOT PROGRAMMING & AI TECHNIQUES 9

Types of Programming – Teach Pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOT SENSORS AND ACTUATORS 9

Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non-contact sensors, infrared sensors, RCC, vision sensors.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. Gordon Mair, ‘Industrial Robotics’, Prentice Hall (U.K.),354pp, 1988
2. Wesley E Snyder R, ‘Industrial Robots, Computer Interfacing and Control’, Prentice Hall International Edition, 1988.
3. Groover.M.P. “Industrial Robotics”, McGraw – Hill, International edition, 1996.
4. Saeed.B.Niku, “Introduction to Robotics Analysis, system, Applications ”, Pearson educations, 2002.

15MF24E	STATISTICAL QUALITY CONTROL	L	T	P	C
		3	2	0	4

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: describe the principles underlying sampling as a means of making inferences about a population(K2)

CO2: construct a control chart to identify the capability of manufacturing process(K6)

CO3: choose proper sampling plan to accept or reject a product lot (K3)

CO4: use statistical tools to characterize the reliability of an item(K3,A1)

CO5: suggest a suitable experimental design to identify the contribution of parameters any process (K6)

UNIT I SAMPLING THEORY AND TESTING OF HYPOTHESIS 15

Population, sample – influence of sample size – Estimation of population parameter from sample – mean and variance, difference of means, variances and ratios of variances – Tests of hypothesis – large and small samples – Chi-square distribution – F distribution.

UNIT II STATISTICAL PROCESS CONTROL 15

Variation in process – Factors – control charts – variables X R and X,C, - Attributes P, C and U-Chart Establishing and interpreting control charts process capability – Quality rating – Short run SPC.

UNIT III ACCEPTANCE SAMPLING 15

Lot by lot sampling types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer's risk and consumer's risk. AQL, LTPD, AOQL, Concepts Design of single sampling plan – standard sampling plans for AQL end LTPD – use of standard sampling plans – Sequential sampling plan.

UNIT IV RELIABILITY AND QUALITY 15

Life testing – failure characteristics – meantime to failure – maintainability and availability – reliability – system reliability – OC curves – reliability improvement techniques – Reliability testing techniques Pareto analysis.

UNIT V EXPERIMENTAL DESIGN AND TAGUCHI METHOD 15

Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

L:45; T:30; TOTAL: 75 PERIODS

REFERENCES

1. Manohar Mahajan, "Statistical Quality Control", Dhanpal Rai & Sons, 2001.
2. Amitava Mitra "Fundamentals of Quality Control and improvement",Pearson Education, 2002.
3. Bester field D.H., "Quality Control" Prentice Hall, 7th edition, 2003
4. Sharma S.C., "Inspection Quality Control and Reliability", Khanna Publications, 2004.

15MF25E	SYNTHESIS AND APPLICATIONS OF NANOMATERIALS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

Upon completion of this course, the students will be able to

- CO1: describe the synthesis methods of bulk and nano composite materials. (K2,S1)
- CO2: analyze various chemical approaches in synthesizing of bulk and nano composite materials(K4)
- CO3: discuss various physical approaches in synthesizing of bulk and nano composite materials(K2)
- CO4: explain the fundamentals of nano porous materials(K2)
- CO5: apply nano materials in various engineering fields(K3,A2)

UNIT I BULK SYNTHESIS 9

Synthesis of bulk nano-structured materials –sol gel processing –Mechanical alloying and mechanical milling- Inert gas condensation technique – Nano polymers – Bulk and nano composite materials.

UNIT II CHEMICAL APPROACHES 9

Self-assembly, self-assembled mono layers (SAMs). Langmuir-Blodgett (LB) films, clusters, colloids, zeolites, organic block copolymers, emulsion polymerization, templated synthesis, and confined nucleation and/or growth. Biomimetic Approaches: polymer matrix isolation, and surface-templated nucleation and/or crystallization. Electrochemical Approaches: anodic oxidation of alumina films, porous silicon, and pulsed electrochemical deposition.

UNIT III PHYSICAL APPROACHES 9

Vapor deposition and different types of epitaxial growth techniques- pulsed laser deposition, Magnetron sputtering - Micro lithography (photolithography, soft lithography, micromachining, e-beam writing, and scanning probe patterning).

UNIT IV NANOPOROUS MATERIALS 9

Nano porous Materials – Silicon - Zeolites, mesoporous materials – nano membranes and carbon nano tubes - AgX photography, smart sunglasses, and transparent conducting oxides –molecular sieves – nano sponges.

UNIT V APPLICATION OF NANOMATERIALS 9

Molecular Electronics and Nano electronics – Nanobots- Biological Applications – Quantum Devices – Nano mechanics - Carbon Nanotube – Photonics- Nano structures as single electron transistor –principle and design.

L:45; TOTAL: 45 PERIODS

REFERENCES

1. S.P. Gaponenko, “Optical Properties of semiconductor nanocrystals”, Cambridge Univ Press, 1980.
2. K. Barriham, D.D. Vvedensky, “Low dimensional semiconductor structures: fundamental and device applications”, Cambridge University Press, 2001.
3. W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate (Eds.), “Handbook of NanoScience, Engg. and Technology”, CRC Press, 2002.
4. G. Cao, “Nanostructures & Nanomaterials: Synthesis, Properties & Applications”, Imperial College Press, 2004.
5. J.George, “Preparation of Thin Films, Marcel Dekker, Inc., New York. 2005.