ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2017

M.E. COMPUTER INTEGRATED MANUFACTURING

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

i. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems
ii. To Impart knowledge to students in recent advances in the Computer Integrated Manufacturing Engineering to educate them to prosper in Manufacturing engineering and research related professions.
iii. To inculcate students with professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Computer Integrated Manufacturing engineering issues to broader engineering and social context.
iv. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Manufacturing engineering issues to broader social context.
v. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

PROGRAMME OUTCOMES:

On successful completion of the programme,

1. Graduates will demonstrate knowledge of mathematics, science and engineering.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.

PEO / PO Mapping

Programme Educational Objectives	Programme Outcomes									
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
I	✓	✓		✓						
II					✓	✓	✓			
III				✓	✓	✓	✓			
IV							✓	✓	✓	
V		✓	✓						✓	✓

Semester Course wise PO mapping

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Applied Mathematics for Engineers	✓	✓							✓	
		CNC Machines			✓	✓		✓			✓	
		Computer Applications in Design	✓	✓	✓	✓		✓				
		Advances in Manufacturing Technology				✓	✓	✓				
		Industrial Robotics	✓	✓	✓			✓			✓	
		Professional Elective I										
		Practical										
		CIM Laboratory I					✓	✓	✓			
	SEM 2	Competitive Manufacturing		✓		✓		✓	✓			
		Applied Materials Engineering		✓	✓	✓	✓					
		Advances in Metrology and Inspection		✓	✓				✓			
		Computer Integrated Production Systems	✓	✓				✓			✓	
		Professional Elective II										
		Professional Elective III										
		Practical										
		CIM Laboratory II					✓	✓	✓			✓
		Technical Seminar						✓	✓	✓		✓
YEAR 2	SEM 3	Professional Elective IV										
		Professional Elective V										
		Professional Elective VI										
		Practical										
		Project Work Phase I		✓		✓			✓	✓		✓
	SEM 4	Project Work Phase II		✓		✓			✓	✓		✓

List of Electives

MAPPING OF POS WITH SUBJECTS

Semester: I Electives

S.No.	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Additive Manufacturing			✓	✓		✓				
2	Computer Aided Process Planning		✓		✓		✓				
3	Design for Manufacturing				✓	✓	✓			✓	
4	Design of Cellular Manufacturing System				✓		✓				✓
5	Finite Element Analysis in Manufacturing Engineering	✓	✓	✓	✓		✓				

Semester: II Electives

S.No	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Electronics Manufacturing Technology		✓		✓					✓	
2	Environment Conscious Manufacturing		✓	✓			✓		✓	✓	
3	Evolutionary Computation			✓	✓					✓	
4	Intelligent Product Design and Manufacturing		✓		✓		✓				
5	Intelligent Manufacturing Systems		✓	✓	✓		✓				
6	Lean Manufacturing		✓	✓			✓		✓		
7	Micro and Nano Manufacturing	✓			✓		✓	✓			
8	Micro Electro Mechanical Systems	✓			✓		✓			✓	
9	Product Lifecycle Management			✓	✓		✓	✓	✓		
10	Manufacturing System Simulation		✓	✓			✓		✓		✓

Semester: III Electives

S.No	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Manufacturing Information Systems		✓				✓				
2	Management of Manufacturing Systems	✓	✓	✓			✓				
3	Mechatronics in Manufacturing Systems		✓		✓		✓			✓	
4	Design of Fluid Power Systems	✓	✓		✓		✓		✓	✓	
5	Project Management		✓	✓							✓

6	Reliability and Total Productive Maintenance	✓	✓	✓							
7	Sensors for Manufacturing and Condition Monitoring		✓		✓					✓	
8	Supply Chain Management		✓	✓				✓			✓
9	Green Manufacturing	✓	✓	✓			✓			✓	
10	Material Characterization Techniques	✓	✓	✓			✓		✓		
11	Tool Engineering	✓	✓		✓		✓			✓	
12	Total Quality Systems and Engineering		✓	✓							✓
13	Warehouse Layout Planning and Part Feeding Methods		✓	✓						✓	
14	Internet of Things for Manufacturing		✓					✓		✓	
15	Data Analytics	✓	✓	✓					✓		✓

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M.E. COMPUTER INTEGRATED MANUFACTURING

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I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4
2.	CM5101	CNC Machines	PC	3	3	0	0	3
3.	ED5151	Computer Applications in Design	PC	3	3	0	0	3
4.	CM5102	Advances in Manufacturing Technology	PC	3	3	0	0	3
5.	MR5391	Industrial Robotics	PC	3	3	0	0	3
6.		Professional Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	CM5111	CIM Laboratory I	PC	4	0	0	4	2
			TOTAL	**23**	**19**	**0**	**4**	**22**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CM5201	Competitive Manufacturing	PC	3	3	0	0	3
2.	CM5202	Applied Materials Engineering	PC	3	3	0	0	3
3.	CM5203	Computer Integrated Production Systems	PC	3	3	0	0	3
4.	CM5251	Advances in Metrology and Inspection	PC	3	3	0	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Professional Elective III	PE	3	3	0	0	3
PRACTICAL								
7.	CM5211	CIM Laboratory II	PC	4	0	0	4	2
8.	CM5212	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective IV	PE	3	3	0	0	3
2.		Professional Elective V	PE	3	3	0	0	3
3.		Professional Elective VI	PE	3	3	0	0	3
PRACTICAL								
4.	CM5311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	CM5411	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 70

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA5156	Applied Mathematics for Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CM5101	CNC Machines	PC	3	3	0	0	3
2.	ED5151	Computer Applications in Design	PC	5	3	0	0	3
3.	CM5102	Advances in Manufacturing Technology	PC	3	3	0	0	3
4.	MR5391	Industrial Robotics	PC	3	3	0	0	3
5.	CM5111	CIM Laboratory I	PC	4	0	0	4	2
6.	CM5201	Competitive Manufacturing	PC	3	3	0	0	3
7.	CM5202	Applied Materials Engineering	PC	3	3	0	0	3
8.	CM5203	Computer Integrated Production Systems	PC	3	3	0	0	3
9.	CM5251	Advances in Metrology and Inspection	PC	3	3	0	0	3
10.	CM5211	CIM Laboratory II	PC	4	0	0	4	2

LIST OF ELECTIVES FOR M.E. COMPUTER INTEGRATED MANUFACTURING
SEMESTER I (Elective I)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CM5091	Additive Manufacturing	PE	3	3	0	0	3
2.	CM5001	Computer Aided Process Planning	PE	3	3	0	0	3
3.	CM5002	Design for Manufacturing	PE	3	3	0	0	3
4.	CM5003	Design of Cellular Manufacturing System	PE	3	3	0	0	3
5.	CM5004	Finite Element Analysis in Manufacturing Engineering	PE	3	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CM5005	Electronics Manufacturing Technology	PE	3	3	0	0	3
2.	CM5092	Environment Conscious Manufacturing	PE	3	3	0	0	3
3.	CM5006	Evolutionary Computation	PE	3	3	0	0	3
4.	CM5071	Intelligent Product Design and Manufacturing	PE	3	3	0	0	3
5.	CM5007	Intelligent Manufacturing Systems	PE	3	3	0	0	3
6.	MF5071	Lean Manufacturing	PE	3	3	0	0	3
7.	CM5008	Micro and Nano Manufacturing	PE	3	3	0	0	3
8.	CM5072	Micro Electro Mechanical Systems	PE	3	3	0	0	3
9.	PD5091	Product Lifecycle Management	PE	3	3	0	0	3
10.	CM5093	Manufacturing System Simulation	PE	3	3	0	0	3

SEMESTER III (Elective IV, V & VI)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CM5009	Manufacturing Information Systems	PE	3	3	0	0	3
2.	CM5010	Management of Manufacturing Systems	PE	3	3	0	0	3
3.	CM5011	Mechatronics in Manufacturing Systems	PE	3	3	0	0	3
4.	CM5012	Design of Fluid Power Systems	PE	3	3	0	0	3
5.	CM5094	Project Management	PE	3	3	0	0	3
6.	CM5013	Reliability and Total Productive Maintenance	PE	3	3	0	0	3
7.	CM5014	Sensors for Manufacturing and Condition Monitoring	PE	3	3	0	0	3
8.	CM5015	Supply Chain Management	PE	3	3	0	0	3
9.	CM5073	Green Manufacturing	PE	3	3	0	0	3
10.	CM5016	Material Characterization Techniques	PE	3	3	0	0	3
11.	CM5017	Tool Engineering	PE	3	3	0	0	3
12.	CM5018	Total Quality Systems and Engineering	PE	3	3	0	0	3
13.	CM5019	Warehouse Layout Planning and Part Feeding Methods	PE	3	3	0	0	3
14.	MF5073	Internet of Things for Manufacturing	PE	3	3	0	0	3
15.	IL5091	Data Analytics	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CM5212	Technical Seminar	EEC	2	0	0	2	1
2.	CM5311	Project Work Phase I	EEC	12	0	0	12	6
3.	CM5411	Project Work Phase II	EEC	24	0	0	24	12

MA5156 APPLIED MATHEMATICS FOR ENGINEERS L T P C
4 0 0 4

OBJECTIVES :

This course is designed to enrich the knowledge in various advanced mathematical techniques such as matrix theory, calculus of variations, probability and random variables, Laplace transforms and Fourier transforms. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

UNIT I MATRIX THEORY 12

The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Least squares method - Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS 12

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems - Direct methods : Ritz and Kantorovich methods.

UNIT III PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT IV LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Laplace transform - Definitions - Properties – Transform error function - Bessel's function - Dirac delta function - Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation - Wave equation.

UNIT V FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Fourier transform : Definitions - Properties – Transform of elementary functions - Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations : Heat equation - Wave equation - Laplace and Poison's equations.

TOTAL : 60 PERIODS

OUTCOMES :

After completing this course, students should demonstrate competency in the following skills:

- Apply various methods in matrix theory to solve system of linear equations.
- Maximizing and minimizing the functional that occur in various branches of engineering disciplines.
- Computation of probability and moments, standard distributions of discrete and continuous random variables and functions of a random variable.
- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.

REFERENCES :

1. Andrews L.C. and Shivamoggi, B. "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Bronson, R. "Matrix Operations", Schaum's outline series, 2nd Edition, McGraw Hill, 2011.
3. James, G., "Advanced Modern Engineering Mathematics ", 3rd Edition, Pearson Education, 2004.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. O'Neil, P.V., "Advanced Engineering Mathematics ", Thomson Asia Pvt. Ltd., Singapore, 2003.
6. Sankara Rao, K., "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

CM5101 **CNC MACHINES** **L T P C**
3 0 0 3

OBJECTIVE:

- The students are expected to be knowledgeable in Engineering product specification, CAD/CAM integration, CNC machine tool building, CNC programming using manual method, generation of CNC codes using CAM software, Tooling and work holding devices.

UNIT I INTRODUCTION TO CAM 8

The evolution of product realization, CAM and its historical development, Engineering product specification– Engineering design, design drafting, tolerance graph analysis, relationship between product and process tolerance, statistical quality control, manufacturing reliability.
Geometric tolerancing- ASME standard, interpreting geometric specifications, multiple part features and datum.

UNIT II CAD/CAM INTEGRATION 9

Networking- networking techniques, LAN, components, wiring methods, network interface cards, network standards, Graphics standards – Data exchange format, evolution- features of various interfaces GKS, IGES, DXF, PDES, STEP etc., Process planning, Computer Aided Process Planning(CAPP) - variant, generative approaches.

UNIT III CONSTRUCTIONAL FEATURES OF CNC MACHINES 10

CNC Machine building, structural details, guide ways –Friction, Anti friction and other types of guide ways, elements used to convert the rotary motion to a linear motion – Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion, spindle assembly, torque transmission elements – gears, timing belts, flexible couplings, Bearings, Spindle drives and feed drives, open loop and closed loop control, Axis measuring system - Turn Mill Center - CNC VTL - Multi Axis (5 And 6 Axis) Machines With Live Tools - Axes & Spindle Cooling System - Through Coolant & Shower Coolant - Integral Spindle With HSK & Big Plus Spindle - Double Ball Screws - Linear Motors - Grease Lubricating System - Probing For Zero Offsets and First Off Inspection - Tool Breakage Detecting System - In Process Gauging System.

UNIT IV PART PROGRAMMING FOR CNC MACHINES 9

Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, do loop, mirroring features, Manual part programming for CNC turning and machining centre for popular controllers like Fanuc, Siemens, Generation of CNC program using CAM software.

UNIT V TOOLING AND WORK HOLDING DEVICES 9

Introduction to cutting tool materials – HSS, Carbides, Ceramics, CBN, PCD, classification of inserts-PMK, NSH, qualified, semi qualified and preset tooling, tooling system for CNC Machining centre and Turning centre, Automatic Tool changers, work holding devices for rotating and fixed work parts, Automatic Pallet changer, economics of CNC, maintenance of CNC machines. Feedback devices - Principles of Operation - Robots for loading jobs & material handling - Multi Pallets - Hydraulic and Pneumatic Fixtures - Anti Vibration Boring Bars - Hydro Gripping & Shrink Fit Adaptors for Drills and Reamers.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply knowledge in various fields of Computer Aided Manufacturing.

REFERENCES:
1. Chang,T.C., Wysk, R.A. and Wang,H.P., “Computer Aided Manufacturing”, Pearson Prentice Hall, 2009.
2. Jones, B.L., “Introduction to Computer Numerical Control”, Pitman, London, 1987.
3. “Mechatronics”, HMT, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
4. Radhakrishnan, P., “Computer Numerical Control ", New Central Book Agency, 1992.
5. Rao, P.N., “CAD/CAM”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2010.
6. Seamers, W.S., “Computer Numeric Control”, Fourth Edition – Thomson Delmar, 2002.
7. Singh, N., “Systems Approach to Computer-Integrated Design and Manufacturing”, Wiley India Pvt. Ltd., 2011.
8. Zeid,I., "CAD - CAM Theory and Practice ", Tata McGraw-Hill Publishing Co. Ltd., 2007.

ED5151 COMPUTER APPLICATIONS IN DESIGN

L	T	P	C
3	0	0	3

OBJECTIVE:
- To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

UNIT I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (Translation, scaling, rotation) windowing - view ports - clipping transformation.

UNIT II CURVES AND SURFACES MODELING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.
Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermite bicubic surface- Bezier surface and B-Spline surface-surface manipulations.

UNIT III NURBS AND SOLID MODELING 9

NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Regularized Boolean set operations - primitive instancing - sweep representations - boundary representations – constructive solid Geometry - comparison of representations - user interface for solid modeling.

UNIT IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software’s and their principles creation of prismatic and lofted parts using these packages.

UNIT V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc–Communication standards.

TOTAL : 45 PERIODS

OUTCOME:
- It helps the students to get familiarized with the computer graphics application in design.
- This understanding reinforces the knowledge being learned and shortens the overall learning curve which is necessary to solve CAE problems that arise in engineering.

REFERENCES:

1. David F. Rogers, James Alan Adams “Mathematical elements for computer graphics” second edition, Tata McGraw-Hill edition.2003
2. Donald Hearn and M. Pauline Baker “Computer Graphics”, Prentice Hall, Inc., 1992.
3. Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
4. Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
5. William M Neumann and Robert F.Sproull “Principles of Computer Graphics”, McGraw Hill Book Co. Singapore, 1989.

CM5102 ADVANCES IN MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- The students are expected to understand special machining processes, unconventional machining processes, micro machining process, nano fabrication processes and rapid prototyping.

UNIT I UNCONVENTIONAL MACHINING 10

Introduction-Bulk processes - surface processes- Plasma Arc Machining- Laser Beam Machining-Electron Beam Machining-Electrical Discharge Machining – Electro chemical Machining-Ultrasonic Machining- Water Jet Machining-Electro Gel Machining-Anisotropic machining-Isotropic machining-Elastic Emission machining – Ion Beam Machining.

UNIT II PRECISION MACHINING: 10

Ultra Precision turning and grinding: Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding-High-speed milling- Diamond turning.

UNIT III ADVANCES IN METAL FORMING 7

Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, micro blanking –Powder rolling – Tooling and process parameters

UNIT IV MICRO MACHINING AND NANO FABRICATION 10

Theory of micromachining-Chip formation-size effect in micromachining-microturning, micromilling, microdrilling- Micromachining tool design-Micro EDM-Microwire EDM-Nano fabrication: LIGA, Ion beam etching, Molecular manufacturing techniques –Atomic machining- Nano machining techniques – Top/Bottom up Nano fabrication techniques - Sub micron lithographic technique, conventional film growth technique, Chemical etching, Quantum dot fabrication techniques – MOCVD – Epitaxy techniques.

UNIT V RAPID PROTOTYPING AND SURFACE MODIFICATION TECHNIQUES 8

Introduction – Classification – Principle advantages limitations and applications- Stereo lithography – Selective laser sintering –FDM, SGC, LOM, 3D Printing-Surface modification Techniques: Sputtering-CVD-PVD-Diamond like carbon coating-Plasma Spraying Technique.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

1. to produce useful research output in machining of various materials
2. use this knowledge to develop hybrid machining techniques
3. Application of this knowledge to manage shop floor problems

REFERENCES

1. Benedict, G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2. Franssila. S., “Introduction to Micro Fabrication”, John Wiley and sons Ltd., UK, 2004, ISBN: 978-0-470-85106-7
3. Jackson, M.J., “Micro fabrication and Nanomanufacturing”, CRC Press, 2006.
4. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267), 2006.
5. McGeough, J.A.,"Advanced methods of Machining",Springer,2011
6. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,1989.
7. Pandley, P.S. and Shah.N., “Modern Manufacturing Processes”, Tata McGraw Hill, 1980.

MR5391 INDUSTRIAL ROBOTICS L T P C
3 0 0 3

OBJECTIVE:

- To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 10

Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors.

Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machine interference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 8

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

TOTAL: 45 PERIODS

OUTCOME:

The student will be able to design robots and robotic work cells and write program for controlling the robots. The student will be able to apply artificial intelligence and expert systems in robotics.

REFERENCES

1. Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
2. Groover,M.P., Weis,M., Nagel,R.N. and Odrey,N.G., "Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int., 1986.
3. Jordanides,T. and Torby,B.J., ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.
4. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
5. Klafter,R.D., Chmielewski, T.A. and Negin,M., "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
6. Koren,Y., "Robotics for Engineers", McGraw-Hill, 1987.
7. Kozyrey, Yu. "Industrial Robots", MIR Publishers Moscow, 1985.

CM5111	**CIM LABORATORY I**	**L T P C** **0 0 4 2**

OBJECTIVE:

- To impart knowledge in CAD software package for modeling, assembly, FEA of mechanical components and CNC programming for Milling/Turning.

OUTCOME:

At the end of this course the student will be able to model, assemble, FEA of mechanical components using CAD software and CNC programming for Milling/Turning.

1. Assembly of mechanical components using CAD software SolidWorks/CATIA/Pro-E.
2. Finite Element Analysis (FEA) using Pre-processing (solid modeling, meshing, analysis setup) and post processing (graphical display and report) with software PATRAN/ NASTRAN/ MARC/ ABAQUS/ LS-DYNA/ ANSYS/PAM-CRASH (Exercises include Simple Beam, Plane Stress, Strain, axi-symmetric, 3D Solids).
3. CNC code generation for CNC Milling.
4. CNC code generation for CNC Turning.
5. Demonstration of CNC Router Machine/ CNC Lathe/ CNC Milling (Students have to submit detailed reports on each demonstrations).

LIST OF EQUIPMENTS REQUIRED:

1. Computers 20
2. CAD software Solid Works/CATIA/Pro-E.
3. FEA Software PATRAN/NASTRAN/ MARC/ ABAQUS/ LS-DYNA/ ANSYS.
4. CAM Software for CNC machining/simulation (CAPS Mill, CAPS Turn and Edge CAM).

TOTAL: 60 PERIODS

CM5201 COMPETITIVE MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

UNIT IV LEAN MANUFACTURING: 9

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction – Overall efficiency - Kaizen – Common layouts - Principles of JIT - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture.

UNIT V JUST IN TIME 9

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

TOTAL: 45 PERIODS

OUTCOME:

OM Completion of this course the students are aware of the pace of changes in the manufacturing technology like FMS, Simulator, JIT etc.

REFERENCES:

1. Groover M.P., " Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
2. Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
3. Kalpkjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
4. Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
5. Taiichi Ohno, Toyota, " Production System Beyond Large-Scale production Productivity Press (India) Pvt.Ltd. 1992.

CM5202 APPLIED MATERIALS ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- This course provides knowledge in the areas of Industrial metallurgy, advanced materials and selection of materials for industrial applications.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 8

Mechanism of Elastic and Plastic deformation, Anelasticity and viscoelasticity- role of dislocations, yield stress, shear strength of perfect and real crystals –Strengthening mechanism, 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.

UNIT II FRACTURE BEHAVIOUR 8

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 – Residual Life Estimation- 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 8

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

UNIT IV MATERIAL PROCESSING 9

Processing of engineering materials – Primary and Secondary processes – astability, Weldability, forgeability and malleability Criteria – Process induced defects – Monitoring and control.

UNIT V MODERN MATERIALS AND TREATMENT 12

Dual phase steels, high strength low alloy steel, transformation included plasticity steel, maraging steel, smart materials, properties and applications of engineering plastics and composites materials - advanced structural ceramics – WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN, diamond – Plasma, PVD, CVD-thick and thin film deposition – Functionally Gradient Materials , Nano materials

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to select the materials for Engineering applications by understanding basic mechanical properties of materials, the relation of the microstructure and mechanical properties, processing techniques for controlling shape and properties in the final product and able to work in R&D activity in the field of materials science.

REFERENCES:

1. Burakonsa, T.Z. and Wierzchan. T.,"Surface Engg of Meterials"- Principles of Equipment, Techniques.
2. Charles, J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of engineering Materials", (3rd Edition, Butterworth – Heiremann, 1977.
3. Courtney, T.H., "Mechanical Behavior of Materials" ,(2nd edition), McGraw Hill, 2000.
4. Dieter, G.E., "Mechanical Metallurgy", McGraw Hill, 1988.
5. Flinn,R.A.and Trojan ,P.K.., "Engineering Materials and their Applications" (4th Edition), Jaico, 1999.
6. James, K.W., Wiley, Intersam, John, "The Hand book of Advance Materials", Wilson Publishers., 2004.
7. Metals hand book, vol. 10, "Failure Analysis and Prevention",(10th edition), 1994.

CM5203 COMPUTER INTEGRATED PRODUCTION SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the student with current trend in production management activities.
- To impress and prepare them to use modern technologies in future management systems.

UNIT I PRODUCTION PLANNING AND CONTROL AND FORECASTING: 9

Introduction :Production Planning and Control-Traditional Production Planning and Control - Problems with Traditional Production Planning and Control-Computer-Integrated Production Management System-Engineering and manufacturing data base –Forecasting - Qualitative methods: Delphi technique, Market research, Intrinsic methods-Time series-moving averages-exponential smoothing-Extrinsic methods-regression-forecast errors-numerical problems

UNIT II AGGREGATE PLANNING: 8

Planning hierarchy-Aggregate production planning (APP)-need-Alternatives for managing supply and demand-basic strategies-numerical problems-APP methods-Master Production Scheduling.

UNIT III RESOURCE PLANNING 10

Inventory Management - Inventory types and general control procedures-Order point systems-The inventory management module- -Material Requirements Planning- Basic MRP Concepts-capacity requirements planning-Distribution requirements planning-Independent versus dependent demand-Lumpy demand-Lead times-Common use items-Inputs to MRP-numerical problems- Manufacturing Resource planning-Enterprise planning.

UNIT IV SHOP FLOOR CONTROL: 9

Shop Floor Control -Functions of Shop Floor Control-Priority control and assignment of shop orders-Maintain information on work-in-process-Monitor shop order status-Production output data for capacity control-The Shop Floor Control System -Order release-Order scheduling-Order progress-Operation Scheduling-An overview of the scheduling problem-Priority rules for job sequencing-The Factory Data Collection System-Job traveler-Employee time sheet-Operation tear strips-Centralized shop terminal-Individual work center terminals-Voice data input

UNIT V COMPUTER PROCESS MONITORING AND CONTROL 9

Computer Process Monitoring: Data logging systems-Data acquisition systems-Multilevel scanning-Computer Control: Computer-Process Interfacing-Manufacturing Process Data-System Interpretation of Process Data-Interface Hardware Devices-Digital Input/Output Processing Interrupt system -Control programming-Computer Process Control-Structural Model of a Manufacturing Process-Process Control Strategies-Distributed Control versus Central Control- Supervisory Computer Control

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected

1. To manage efficiently various activities of production with the help of technology
2. Expected to use modern technologies in future management systems

REFERENCES:

1. Bauer, A., Browne, J., Bowden, R., and Duggan, J. ,"Shop Floor Control Systems From design to implementation", springer,1994
2. Chryssolouris G.,"Manufacturing Systems:Theory and Practice", Second Edition Springer,
3. Groover, M.P. and Zimmers, JR E.R.,"CAD/CAM: Computer-Aided Design and Manufacturing", Prentice Hall 1983
4. Mahadevan "Operations Management:Theory and practice",Pearson,2010
5. Mahapatra, P.B.," Computer-Aided Production Management", Prentice-Hall Of India Pvt. Limited, 2004
6. Singh, N., "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley & Sons, 1996.

CM5251 ADVANCES IN METROLOGY AND INSPECTION L T P C
3 0 0 3

OBJECTIVES:

- To teach the students basic concepts in various methods of engineering measurement techniques and applications, understand the importance of measurement and inspection in manufacturing industries.
- To make the students capable of learning to operate and use advanced metrological devices with ease in industrial environments.

UNIT I CONCEPTS OF METROLOGY: 8

Terminologies – Standards of measurement – Errors in measurement – Interchangeability and Selective assembly – Accuracy and Precision – Calibration of instruments – Basics of Dimensional metrology and Form metrology

UNIT II MEASUREMENT OF SURFACE ROUGHNESS: 9

Definitions – Types of Surface Texture: Surface Roughness Measurement Methods- Comparison, Contact and Non Contact type roughness measuring devices, 3D Surface Roughness Measurement, Nano Level Surface Roughness Measurement – Instruments.

UNIT III INTERFEROMETRY: 8

Introduction, Principles of light interference – Interferometers – Measurement and Calibration – Laser Interferometry.

UNIT IV MEASURING MACHINES AND LASER METROLOGY: 10

Tool Makers Microscope – Microhite – Coordinate Measuring Machines – Applications – Laser Micrometer, Laser Scanning gauge, Computer Aided Inspection techniques - In-process inspection, Machine Vision system-Applications.

UNIT V IMAGE PROCESSING FOR METROLOGY 10

Overview, Computer imaging systems, Image Analysis, Preprocessing, Human vision system, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Examples.

TOTAL: 45 PERIODS

OUTCOMES:

Students will:

1. Understand the advanced measurement principles with ease.
2. Operate sophisticated measurement and inspection facilities.
3. Design and develop new measuring methods.

REFERENCES

1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., 1992.
2. Bewoor, A.K. and Kulkarni,V.A.,"Metrology and Measurement", Tata Mc Graw-Hill, 2009.
3. Galyer, F.W. and Shotbolt, C.R., "Metrology for engineers", ELBS, 1990.
4. Gupta, I.C., "A Text Book of engineering metrology", Dhanpat Rai and Sons, 1996.
5. Jain ,R.K.,"Engineering Metrology", Khanna Publishers, 2008.
6. Rajput,R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.
7. Smith,G.T., "Industrial Metrology", Springer, 2002
8. Sonka,M., Hlavac,V. and Boyle.R., "Image Processing, Analysis, and Machine Vision", Cengage-Engineering, 2007.
9. Whitehouse, D.J., "Surface and their measurement", Hermes Penton Ltd, 2004.

CM5211 **CIM LABORATORY II** **L T P C**
0 0 4 2

OBJECTIVES:

- To impart knowledge in Programmable Logic Control, Robot, Matlab programming and inspection of mechanical components using Video Measurement System and Coordinate Measuring Machine.

OUTCOME:

At the end of this course the student will be able to programme in PLC, Robot, Matlab environment and they can also inspect mechanical components using VMS and CMM.

1. Programmable Logic Control (PLC) using PLC software Keyence ladder builder and working of PLC trainer kit.
2. Robot Programming.
3. Matlab Programming. (Matrix manipulations, plotting of functions and data, implementation of algorithms and creation of user interfaces).
4. Inspection of mechanical components using Video Measuring System (VMS).
5. Dimensional and Geometric measurements using Digital Height Gauge and Coordinate Measuring Machine (CMM).

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS REQUIRED:

1. Computers 20
2. PLC trainer kit
3. Video Measuring System (VMS)
4. Digital Height Gauge
5. Coordinate Measuring Machine (CMM)
6. Robot

CM5212 **TECHNICAL SEMINAR** **L T P C**
0 0 2 1

OBJECTIVES:

- To enrich the communication skills of the student through presentation of topics in recent advances in engineering/technology

OUTCOME:

Students will develop skills to read, write, comprehend and present research papers.
Students shall give presentations on recent areas of research in manufacturing engineering in two cycles. Depth of understanding, coverage, quality of presentation material (PPT/OHP) and communication skill of the student will be taken as measures for evaluation and as report.

TOTAL: 30 PERIODS

CM5091 **ADDITIVE MANUFACTURING** **L T P C**
3 0 0 3

OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology and the associated Aerospace, Architecture, Art, Medical and industrial applications.

UNIT I INTRODUCTION: 8

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELING: 10

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 10

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS: 10

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS: 7

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

OUTCOME:

On completion of this course, they will learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

REFERENCES:

1. Chua, C.K., Leong K.F. and Lim C.S., “Rapid prototyping: Principles and applications”, second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., “Rapid prototyping”, Hanser Gardener Publications, 2003.
3. Gibson, I., Rosen, D.W. and Stucker, B., “Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing”, Springer, 2010.
4. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
5. Kamrani, A.K. and Nasr, E.A., “Rapid Prototyping: Theory and practice”, Springer, 2006.
6. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications : A tool box for prototype development”, CRC Press, 2011.

CM5001 COMPUTER AIDED PROCESS PLANNING L T P C
3 0 0 3

OBJECTIVES:

- To familiarize the students with process planning in the manufacturing cycle, design, drafting, geometric modeling, systems in CAPP and report generation.

UNIT I INTRODUCTION: 8

Production Planning and Process Planning -The role of Process Planning in the Manufacturing cycle - Experience based planning -Need for computer aided process planning. –Process Planning and Concurrent Engineering, Group Technology

UNIT II PART DESIGN REPRESENTATION: 10

Basic part representation methods: CAD models-Feature based design-Design interface: syntactic pattern recognition-State transition diagram-Decomposition approach-Logic approach-Graph based approach.

UNIT III KNOWLEDGE REPRESENTATION: 7

Process knowledge-Dimensions and tolerances- Surface properties-Process constraints-Process economics-Process capability.

UNIT IV SYSTEM FORMULATION: 10

Logical Design of Process Planning – System structure-planning strategy-declarative knowledge of part-procedure knowledge of planning-other issues: process parameter selection, tool selection, machine selection, plan optimization , Implementation considerations – Decision table and Decision trees.

UNIT V COMPUTER AIDED PROCESS PLANNING SYSTEMS: 10

Computer aided Process Planning – Variant process planning – Generative process planning– Forward and Backward planning, input format - Totally Integrated process planning systems – Expert process planning-Commercial systems: CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP-

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected to use

1. Application of computers in the documentation
2. Creating database for the future use
3. Use of commercially available CAPP system in Industries

REFERENCES

1. Chang, T.C. and Wysk, R.A., “An Introduction to automated process planning systems”, Prentice Hall, 1985.
2. Chang, T.C., “An Expert Process Planning System”, Prentice Hall, 1985.
3. Halevi, G. and Weill, R.D., “Principles of Process Planning”, A logical approach – Springer, 2003.
4. Rao., “Computer Aided Manufacturing”, Tata McGraw Hill Publishing Co. 2002.
5. Singh, N., “Systems Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons, 1996.
6. Vollmann, T.E. and Bery, W.E., “Manufacturing Planning and Control Systems, 5th Edn., Galgotia Publications, 2004.

CM5002 DESIGN FOR MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- To apply the design for manufacturing principles in casting, welding, forming, machining and assembly, by considering various manufacturing constraints.

UNIT I INTRODUCTION: 6

Economics of Process selection – General design principles of manufacturability – Proper material selection – Strength and Mechanical factors- Application of form design.

UNIT II CASTING DESIGN AND WELDMENT DESIGN: 10

Factors affecting casting design- Strength aspects – Sand casting and die casting design-Factors affecting weldment design-Gas and arc welding design.

UNIT III FORMED METAL COMPONENTS AND NON METALLIC PARTS DESIGN: 10

Design considerations for the manufacture of extruded, cold headed metal parts – Tube and section bends – Powder metal parts-Thermo setting plastic parts-Reinforced – Plastic/Composite parts.

UNIT IV MACHINED COMPONENTS DESIGN: 10

Design considerations for the manufacture of turned parts-drilled parts-milled parts, planned, shaped and slotted parts-Ground parts-parts produced by EDM.

UNIT V DESIGN FOR ASSEMBLY: 9

Types of assembly – DFA –Index – evaluation of assembly – assembly cost reduction – case of assembly – impact on quality – related software usage – case studies.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to design castings, weldings, formed and machined components. He/She will be able to practice design for assembly principles.

REFERENCES

1. Bralla, J.G.,“Handbook of product design for manufacture”, McGraw Hill Book Co., 1986.
2. Chang,T.C., Wysk,R.A. and Wang, H.P.,"Computer-Aided Manufacturing", Second Edition, Prentice Hall, 1998.
3. Molloy, O., E. A. Warman, and S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Kluwer, 1998.
4. Peck, H., “Designing for manufacture”, Sir Isaac Pitman & Sons Ltd., 1973.

CM5003 DESIGN OF CELLULAR MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

UNIT I INTRODUCTION: 12

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

UNIT II CMS PLANNING AND DESIGN: 10

Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATION OF GT/CMS: 10

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL: 8

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V ECONOMICS OF GT/CMS: 5

Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the student should be able to plan and implement Cellular manufacturing systems, distinguish between traditional and non-traditional approaches of Problem solving, involve in performance measurement and determine human and economical aspects of CMS.

REFERENCES

1. Burbidge, J.L., “Group Technology in Engineering Industry", Mechanical Engineering pub.London, 1979.
2. Cleland.D.I. and Bidananda, B. (Eds), "The automated factory handbook: technology and management”, TAB Books , NY, 1991.
3. Irani, S.A., " Hand Book of Cellular Manufacturing Systems", John Wiley & Sons, 1999
4. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), "Planning, design and analysis of cellular manufacturing systems", Elsevier, 1995.

CM5004 FINITE ELEMENT ANALYSIS IN MANUFACTURING ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- The objective is to equip students with fundamentals of finite element principles so as to enable them to understand the behavior of various finite elements and to be able to select appropriate elements to solve physical and engineering problems with emphasis on structural and thermal engineering applications.

UNIT I GENERAL INTRODUCTION 10

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems –Variational Formulation of Boundary Value Problems – Ritz Technique –Natural and Essential Boundary conditions - Basic concepts of the Finite Element Method. One Dimensional Second Order Equations – Discretization – element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors - Assembly of Matrices - solution of problems from solid - Structural, stress, and strain analysis – Introduction to beam elements.

UNIT II PROBLEM IN 2D: 9

Second Order 2D Equations involving Scalar& Vector Variables – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors.

Application to Field Problems in Manufacturing Engineering - Quadrilateral elements. Introduction to elasticity equations – stress strain relations – plane problems of elasticity – element equations Plane stress, plane strain and axisymmetric problems – stress-strain-time or constitutive equations- Introduction to flow problems- solution of problems in fluid mechanics- numerical examples -plates and shell

UNIT III APPLICATIONS TO FIELD PROBLEMS 9

Higher Order Elements. Natural co-ordinate systems – Isoparametric elements – Shape functions for isoparametric elements – One, two and three dimensions – Serendipity elements – Numerical integration and application to plane stress problems transformation in $\xi, \eta \, and \, \zeta -$ coordinates- Jacobian of transformation-order of convergence- numerical integration –example problems- shape functions in natural coordinates- rectangular elements- Lagrange family- Serendipity family- rectangular prisms- tetrahedral elements

UNIT IV NON-LINEAR ANALYSIS 9

Introduction to Non-linear problems - some solution techniques- computational procedure- simple material nonlinearity- Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact- geometric non-linearity- modeling considerations- Impact analysis.

UNIT V ANALYSIS OF PRODUCTION PROCESSES 8

Application to Bulk forming, sheet metal forming, casting, metal cutting, welding- Features of software packages

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the students would have developed a thorough understanding of the basic principles of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving problems in Manufacturing Engineering

REFERENCES

1. Bathe, K.J., “Finite Element Procedures in Engineering Analysis, 1990.
2. Kobayashi, S., Soo-IK-Oh and Altan, T., “Metal forming and the Finite element Methods”, Oxford University Press, 1989.
3. Lewis, R.W., Morgan, K, Thomas, H.R., and Seetharaman, K.N., “The Finite Element Method in Heat Transfer Analysis”, John Wiley, 1994.
4. Rao, “Finite Element Method in Engineering”, Pergammon Press, 2005.
5. Reddy, J.N, “An Introduction to the Finite element Method”, McGraw – Hill, 2005.

CM5005 ELECTRONICS MANUFACTURING TECHNOLOGY L T P C

3 0 0 3

OBJECTIVE:

- To impart the knowledge in electronic packaging technology

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 9

History, definition, wafer preparation by growing, machining, and polishing, diffusion, microlithography, etching and cleaning, Printed Circuit Boards, types- single sided, double sided, multi layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)

UNIT II COMPONENTS AND PACKAGING 8

Through-hole components – axial, radial, multi leaded, odd form. Surface mount components- active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip

on board, multi chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III SOLDERING AND CLEANING 9

Soldering theory, effect of elemental constituents on wetting, microstructure and soldering, solder paste technology – fluxing reactions, flux chemistry, solder powder, solder paste composition and manufacturing, solder paste rheology, Wave soldering. Adhesive and solder paste application. solder system variables. soldering temperature profile. Reflow soldering - profile generation and control, soldering quality and defects. Post solder cleaning and selection. Measurement of cleanliness levels.

UNIT IV SURFACE MOUNT TECHNOLOGY: 11

SMT Equipment and Material Handling Systems, Handling of Components and Assemblies - Moisture Sensitivity and ESD, Safety and Precautions Needed, IPC and Other Standards, Stencil Printing Process, solder paste storage and handling, stencils and squeegees, process parameters, quality control - Component Placement, Equipment Type, Chip shooter, IC placer, Flexibility, Accuracy of Placement, Throughput, reflow soldering, adhesive, underfill and encapsulation process, applications, storage and handling, process & parameters.

UNIT V INSPECTION, TEST AND REWORK FOR PCB: 8

Inspection Techniques, Equipment and Principle – AOI, X-ray. stencil printing process- defects & corrective action, component placement process - defects & corrective action, Reflow Soldering Process- defects & corrective action, underfill and encapsulation Process- defects & corrective action, Testing of assemblies, In-circuit testing (ICT), functional testing, concept of yield, Rework and Repair, tools, rework criteria and process, Design for - Manufacturability, Assembly, Reworkability, Testing, Reliability and Environment.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply knowledge in various steps in electronics manufacturing and testings.

REFERENCES

1. Coombs, Jr. C.E., " Printed Circuits Handbook " Mc Graw-Hill Hand books Sixth Edition, 2008
2. Gurnett, K.W., "Surface Mount Handbook", Newnes Elsevier , 1999
3. Landers, T.L., "Electronics Manufacturing Processes", Prentice Hall, 1998
4. Lee, N.C., "Reflow Soldering Process and Trouble Shooting – SMT, BGA, CSP and Flip Chip Technologies", Newnes Elsevier, 2001
5. Prasad R.P., "Surface Mount Technology: Principles and Practice", New York: Chapman and Hall, 1997.
6. Seraphim, D., Lasky, R.C. and Che-Yu Li, "Principles of Electronic Packaging" Mcgraw Hill, 1989.
7. Strauss, R.," SMT Soldering Handbook", Newnes Elsevier , 1998
8. Zant, P.V., " Microchip Fabrication – a practical guide to semiconductor processing "McGraw Hill, 2000

CM5092 ENVIRONMENT CONSCIOUS MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- To impart the knowledge in sustainable manufacturing, ISO 14000 series standards, green manufacturing**,** recycling and life cycle assessment.

UNIT I SUSTAINABLE MANUFACTURING AND EMS: 9

Sustainable Manufacturing - Concepts and Methodologies to Help Promote Industrial Ecology - ISO 14000 series standards - Concepts of ISO 14001 - requirements of ISO 14001 – Environmental Management System benefits - Environmentally Conscious Manufacturing.

UNIT II GREEN MANUFACTURING: 9

Green Design and Quality Initiatives - Environmental Cost Accounting and Business Strategy - Accounting for an Environmentally Conscious Setting - The Development of Eco labelling Schemes

UNIT III RECYCLING: 9

Recycling as Universal Resource Policy - Innovation Towards Environmental Sustainability In Industry - A Systematic Framework for Environmentally Conscious Design

UNIT IV ENVIRONMENTAL ATTRIBUTES OF MANUFACTURING: 10

Environmental Attributes of Manufacturing Processes - Environmental Decision Support Systems - Decision Models for Reverse Production System Design - Environmentally Sound Supply Chain Management

UNIT V LIFE CYCLE ASSESSMENT 8

Life Cycle Assessment - Multipath way and Cumulative Risk Assessment - Reclamation And Recycling of Waste

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course the students will be able to follow the guidelines of ISO 14000, implement green design, follow environmental norms in manufacturing and do lifecycle assessment of products and processes.

REFERENCES

1. Besterfield, D.H., Besterfield, C.M., Besterfield, G.H. and Besterfield, M.S.,"Total Quality Management ", Pearson Education, 2002.
2. Gupta, S.M. and Lambert, A.J.D., "Environment Conscious Manufacturing", CRC Press, 2008.
3. Madu, C.N., "Handbook of Environmentally Conscious Manufacturing", Kluwer Academic Publisher, 2001.
4. Swamidass, P.M., "Encyclopedia of Production and Manufacturing Management", Kluwer Academic Publisher, 2000.

CM5006	EVOLUTIONARY COMPUTATION	L	T	P	C
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OBJECTIVES:

- To impart the knowledge in optimization, multi objective optimization, evolutionary algorithms, Multi-Objective Evolutionary Algorithms and programming.

UNIT I INTRODUCTION TO OPTIMIZATION: 9

Introduction to optimization - single and multi objective optimization - Evolutionary algorithms - principles of multi objective optimization.

UNIT II MULTI OBJECTIVE OPTIMIZATION: 9

Convex programming, Karush-Kuhn-Tucker conditions, Direct functional evaluation and derivative based optimization techniques;

UNIT III EVOLUTIONARY ALGORITHMS: 9

Simulated annealing, Tabu search; NFL theorem; Biological principles of evolution, General scheme of EAs, Representation, Selection schemes, Population evaluation, Variation operators; Constraint handling; Schema theorem; Binary coded genetic algorithm, Real coded genetic algorithm.

UNIT IV EVOLUTIONARY STRATEGIES AND EVOLUTIONARY PROGRAMMING 9

Evolutionary strategies, Evolutionary programming, genetic programming, Differential evolution, Particle swarm optimization;

UNIT V APPLICATIONS OF MULTI-OBJECTIVE EVOLUTIONARY ALGORITHMS: 9

Pareto-optimality, Multi-objective evolutionary algorithms; Statistical analysis of EC techniques; Customization in EAs; Applications of multi-objective evolutionary algorithms - Mechanical component design - Truss-structure design - Other applications.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course the students will be able to apply optimization using techniques like evolutionary strategies and evolutionary programming.

REFERENCES

1. Back, T., Fogal, D. B. and Michalewicz, Z., “Handbook of Evolutionary Computation”, Oxford University Press, 1997.
2. Clerc, M.,”Particle Swarm Optimization”, ISTE, 2006.
3. Deb, K., “Multi-objective Optimization using Evolutionary Algorithms”, Wiley, 2001.
4. Fogel, D. B., “Evolutionary Computation, The Fossil Record”, IEEE Press, 2003.
5. Goldberg, D., “Genetic Algorithms in Search, Optimization, and Machine Learning”, Addison Wesley, 1989.
6. Price, K. , Storn, R. M. , and Lampinen, J. A. ,”Differential Evolution: A Practical Approach to Global Optimization”, Springer, 2005.

CM5071 INTELLIGENT PRODUCT DESIGN AND MANUFACTURING L T P C

3 0 0 3

OBJECTIVE:

- To teach the student the principles and practices of intelligent product design and manufacturing

UNIT I INTRODUCTION TO INTELLIGENT DESIGN AND MANUFACTURING: 9

Need - Internet technology and Manufacturing Industry - Digital enterprises - Manufacturing portals – Benefits.

UNIT II TECHNIQUES OF KNOWLEDGE REPRESENTATION 9

Artificial Neural Networks, Fuzzy Logic, Genetic Algorithms, Expert Systems with case studies.

UNIT III INTELLIGENT PRODUCT MODELING TECHNIQUES: 9

Intelligent CAD systems, integrating product and process design, manufacturing analysis and CAD/CAM integration, design methodology for automated manufacture, the impacts of intelligent process control on product design, and fuzzy knowledge-based controller design.

UNIT IV APPLICATION OF NEURAL NETWORKS: 9

Neural Networks for Intelligent Process Monitoring and Control : Applications to CNC machining, Metal Forming - Intelligent Manufacturing Planning, Scheduling and Control - Intelligent Assembly and Layout Planning.

UNIT V INTERNET BASED COLLABORATIVE CAD/CAM : 9

Applications to web based CAD, CAPP, CNC, Assembly planning, and Rapid Prototyping - Challenging issues of Collaborative CAD/CAM.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply Internet technology in manufacturing Industry and use techniques of Knowledge Representation.

REFERENCES

1. Dagli, C.H., "Intelligent systems in design and manufacturing", ASME, 1994.
2. Huang, G.Q. and Mak, K.L., "Internet Applications in Product design and Manufacturing" ,Springer, 2003.
3. Kusiak, A., "Intelligent Design and Manufacturing", Wiley-Interscience, 1992.
4. Parsaei, H.R. and Jamshidi, M., "Design and implementation of intelligent manufacturing systems", Prentics Hall, 1995.

CM5007 INTELLIGENT MANUFACTURING SYSTEMS L T P C

3 0 0 3

OBJECTIVES:

To know the concepts of Artificial Intelligence
To Practice the methods of solving problems using Artificial Intelligence
To build components of intelligent decision support system for Manufacturing

UNIT I INTRODUCTION 9

Components of manufacturing – Soft and Hard Automation – Flexible Manufacturing Cell – Flexible handling methods -Basic concepts of Artificial intelligence and expert systems – Intelligent System Components -System architecture and Data flow – System Operations.

UNIT II ARTIFICIAL INTELLIGENCE LANGUAGES 9

Heuristic search-logic programming and reasoning-automatic programming-scope of AI-in manufacturing components of intelligent manufacturing Aspects of intelligence and AI Requirements of AI languages, LISP & PROLOG – Simple programs

UNIT III BUILDING OF KNOWLEDGE BASED SYSTEMS 9

Knowledge engineering-protocol analysis -fuzzy logic -Semantic networks, Learning systems Knowledge Engineering Knowledge representation – Knowledge acquisition and optimization - Knowledge based approaches to design mechanical parts and mechanisms and design for automated assembly.

UNIT IV INTELLIGENT SYSTEMS 9

Knowledge based system for material selection – Intelligent process planning system. Intelligent system for equipment selection -Intelligent system for project management & factory monitoring. Inference engine Vision programmes-factory vision systems -machine learning

UNIT V FACTORIES OF FUTURE 9

The role of Artificial Intelligence in the factory of the future Features of Experts systems -applications in manufacturing planning and control – Intelligent systems. Scheduling in manufacturing – scheduling the shop floor – Diagnosis & trouble shooting.

TOTAL 45 PERIODS

OUTCOMES:

- Apply various knowledge based techniques
- Practice building of intelligent systems
- Adopt intelligent system for Manufacturing

REFERENCES

1. Andrew Kussiak, “Intelligent Manufacturing Systems”, Prentice Hall, 1990.
2. Kenneth R.Baker, “Introduction to sequencing and scheduling”, John Wiley & Sons, New York, 2000.
3. Richard W. Conway, William Maxwell and Louis W. Miller, “Theory of Scheduling”, Dover Publications, 2003.
4. Rich,E., “Artificial Intelligence”, McGraw Hill, 1986.
5. Simons, G.L, “Introducing Artificial Intelligence”, NCC Pub, 1990.

MF5071 LEAN MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- To implement lean manufacturing concepts in the factories.

UNIT I INTRODUCTION: 9

The mass production system – Origin of lean production system – Necessity – Lean revolution in Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Muda (waste).

UNIT II STABILITY OF LEAN SYSTEM: 9

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work – Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts.

UNIT III JUST IN TIME: 9

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production leveling – Pull systems – Value stream mapping**.**

UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH): 9

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka.

UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY 9

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture

TOTAL: 45 PERIODS

OUTCOME:

The student will be able to practice the principles of lean manufacturing like customer focus, reduction of MUDA, just in time, Jidoka and Hoshin planning.

REFERENCES

1. Dennis P.,” Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
2. Liker, J., “ The Toyota Way : Fourteen Management Principles from the World's Greatest Manufacturer”,McGraw Hill, 2004.

3. Michael, L.G., “Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed”,McGraw Hill, 2002.
4. Ohno, T.,” Toyota Production System: Beyond Large-Scale Production”, Taylor & Francis, Inc., 1988.
5. Rother, M., and Shook, J.,’ Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA”, Lean Enterprise Institute, 1999.

CM5008 MICRO AND NANO MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

- The purpose of this subject is to understand the principles of various micro and nano manufacturing methods**.**

UNIT I INTRODUCTION 9

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, micro casting, micro forming, micro joining.
Micro and Nano products

UNIT II MANUFACTURING METHODS 9

Material deposition – PVD, CVD, LIGA, Micro stereo lithography, Electro discharge deposition, Traditional micromachining- Theory of micromachining-Chip formation-size effect in micromachining, micro turning, micro drilling, micro milling, micro grinding, Diamond turn machining

UNIT III ADVANCED MACHINING / FINISHING PROCESSES 9

Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining , Micro/ Nano finishing processes- Abrasive Flow Machining, Magnetic Abrasive Finishing, Magneto Rheological Abrasive Flow Machining, Magneto Rheological Finishing. Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding

UNIT IV SYNTHESIS OF NANOMATERIALS 9

Introduction to nano materials, Methods of production of Nanoparticles, Sol-gel synthesis, Inert gas condensation, High energy Ball milling, Plasma synthesis, Electro deposition and other techniques. Synthesis of Carbon Nanotubes – Solid carbon source based production techniques, Gaseous carbon source based production techniques – Diamond Like Carbon coating. Nano wires

UNIT V CHARACTERISATION TECHNIQUES 9

Metrology for micro machined components-Optical Microscopy, White Light Interferrometry, Molecular Measuring Machine, Micro CMM
Scanning Probe Microscopy (SPM) – Scanning Electron Microscope, Transmission Electron Microscope, Scanning Thermal Microscopy, Tribological characteristics -Micro abrasion wear -Nano indentation- Ellipsometric Analysis

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply knowledge in micro and nano manufacturing methods, synthesis of nano materials and characterization techniques

REFERENCES

1. Bandyopadhyay, A.K., “Nano Materials”, New Age International Publishers, New Delhi, SBN 8122422578, 2008.
2. Bhushan, B., “Handbook of Nanotechnology”, Springer, Germany, ISBN-10: 3642025242, 2010.

3. Jain, V.K “Introduction to Micromachining”, Narosa publishing house, ISBN: 978-81-7319-915-8, 2010.
4. Jain, V.K, “Micro manufacturing Processes”, by CRC Press, ISBN: 9781439852903, 2012.
5. McGeoug, J.A. Micromachining of Engineering Materials h **,** CRC Press, ISBN-10: 0824706447, 2001.

CM5072 MICRO ELECTRO MECHANICAL SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge of design, fabrication and characterization of Micro Electro Mechanical systems.

UNIT I INTRODUCTION 9

Overview of MEMS and Microsystems: MEMS and Microsystems, Evolution of Micro fabrication, Microsystems and Microelectronics, Microsystems and miniaturization-Materials for MEMS and Microsystems: substrates and wafers, active substrate materials, Silicon, Gallium Arsenide, Piezoelectric Crystals, Polymers, Packaging materials-Working principles of Microsystems: micro sensors, micro actuation, MEMS with micro actuators, Micro accelerometers, micro fluidics-Applications of Microsystems in various industries.

UNIT II MECHANICS, SCALING AND DESIGN 9

Engineering Mechanics for Microsystems design: Introduction, Static bending of Thin Plates, Mechanical Vibration, Thermomechanics, Thermofluid, Engineering and micro system design, Laminar fluid flow, Incompressible fluid Flow, Heat conduction in solids-Scaling Laws in Miniaturization, Introduction to scaling, Scaling in (Electrostatic forces electromagnetic forces, Electricity, fluid mechanics, heat transfer)-Microsystems Design: Design Consideration, Process design, Mechanical Design, Design of Micro fluidic Network systems

UNIT III MICRO SYSTEM FABRICATION PROCESSES 11

Introduction- Photolithography- Ion implantation- Chemical Vapor Deposition-Physical Vapor Deposition - clean room- Bulk micromachining :etching, isotropic and anisotropic etching, wet and dry etching-Surface micro machining :process, mechanical problems associated with surface micro machining-LIGA process :general description, materials for substrates and photo resists-SLIGA process-Abrasive jet micro machining-Laser beam micro machining- Micro Electrical Discharge Micro Machining – Ultrasonic Micro Machining- Electro chemical spark micro machining- Electron beam micro machining-Focused Ion Beam machining

UNIT IV MICROSYSTEMS PACKAGING 8

Introduction - Microsystems Packaging-Interfaces in Microsystems Packaging-Essential Packaging Technologies- Die preparation, surface bonding, wire bonding, sealing- Three dimensional Packaging-Assembly of Microsystems, Signal Mapping and Transduction

UNIT V MICROMETROLOGY AND CHARACTERIZATION 8

Microscopy and visualization- Lateral and vertical dimension- optical microscopy, Scanning white light interferometry, Confocal Laser scanning microscopy, Molecular measuring machine, Micro coordinate measuring machine- Electrical measurements – Physical and chemical analysis – XRD- SEM - Secondary Ion mass spectrometry- Auger Electron Spectroscopy, SPM

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply the knowledge in mechanics, scaling, design, fabrication and characterization of micro systems.

REFERENCES
1. Franssila, S., “Introduction to Micro Fabrication” John Wiley & sons Ltd, 2004.ISBN:470-85106-6
2. Hak M.G., “MEMS Handbook”, CRC Press, ISBN: 8493-9138-5, 2006.
3. Hsu, T.R., “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill, 2002,ISBN: 9780070487093.
4. Jackson, M.J., “Microfabrication and Nanomanufacturing” Taylor and Francis 2006.
5. Jain, V.K., “Introduction to Micromachining” Narosa Publishing House, 2010.
6. McGeough, J.A., “Micromachining of Engineering Materials”, CRC Press, ISBN: 0824706447, 2001.

PD5091 PRODUCT LIFECYCLE MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:
To understand history, concepts and terminology of PLM
To understand functions and features of PLM/PDM
To understand different modules offered in commercial PLM/PDM tools
To understand PLM/PDM implementation approaches
To understand integration of PLM/PDM with other applications

UNIT I HISTORY, CONCEPTS AND TERMINOLOGY OF PLM 9
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II PLM/PDM FUNCTIONS AND FEATURES 9
User Functions –Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III DETAILS OF MODULES IN A PDM/PLM SOFTWARE 9
Case studies based on top few commercial PLM/PDM tools

UNIT IV ROLE OF PLM IN INDUSTRIES 9
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organisation, users, product or service, process performance.

UNIT V BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE 9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

TOTAL: 45 PERIODS

OUTCOMES:
The students will be able to
1. Understand history, concepts and terminology of PLM.
2. Apply the functions and features of PLM/PDM.
3. Understand different modules offered in commercial PLM/PDM tools.
4. Understand PLM/PDM implementation approaches.
5. Integrate PLM/PDM with other applications.
6. Analyse the case studies.

REFERENCES
1. Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
2. International Journal of Product Lifecycle Management, Inderscience Publishers
3. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
4. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
5. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
6. Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

CM5093 MANUFACTURING SYSTEM SIMULATION L T P C
3 0 0 3

OBJECTIVE:
- To introduce computer simulation technologies and techniques
- To introduce concepts of modeling layers of society's critical infrastructure networks
- To build tools to view and control simulations and their results

UNIT I INTRODUCTION 9

Systems and modeling – statistical models in simulation -discrete and continuous system -Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

UNIT II RANDOM NUMBERS 9

Random number generation -Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers

UNIT III RANDOM VARIATES 9

Random variate generation-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation, Testing -Analysis of simulation data.

UNIT IV ANALYSIS OF SIMULATION DATA 9

Input modelling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.

UNIT V SIMULATION LANGUAGES 9

Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK-Simulation based optimization-Modelling and Simulation with Petrinets -Case studies in manufacturing and material handling system.

TOTAL: 45 PERIODS

OUTCOMES
- At the end of this course the students are expected to
- Develop Manufacturing Models of Discrete event systems
- Generation of Uncertainty using Random numbers and Random Variates
- Input, Output Analysis: Verification & Valediction of Models and Optimization

REFERENCES

1. Geoffrey Gordon, "System Simulation", 2nd Edition, Prentice Hall, India, 2002.
2. Jerry Banks & John S.Carson, Barry L Nelson, “Discrete event system simulation”, Prentice Hall
3. Law A.M, “Simulation Modelling and Analysis”, Tata Mc Graw Hill
4. NarsinghDeo, “System Simulation with Digital Computer”, Prentice Hall
5. Pidd, M, “Computer Simulation in Management Science”, John Wiley & Sons, Inc.

CM5009 MANUFACTURING INFORMATION SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- The purpose of the course is to provide an importance of databases and its application in manufacturing systems that prepare students for their engineering practice by organization by conversant with order policies, data base terminologies, designing, manufacturing considerations

UNIT I INTRODUCTION: 7

The Evolution of order policies, from mrp to MRP II to ERP – Agile Manufacturing Information Systems, Manufacturing Database Integration.

UNIT II DATABASE: 9

Terminologies – Entities and attributes – Data models, schema and subschema - Data Independence – ER Diagram – UML notation for describing the enterprise–wide data objects- Trends in database.

UNIT III DESIGNING DATABASE: 9

Hierarchical model – Network approach- Relational Database concepts, principles, keys,– functional dependency – Normalization types – relational operations- Query Languages-Case studies.

UNIT IV MANUFACTURING CONSIDERATION: 10

The product and its structure, inventory and process flow – Shop floor control Data structure and procedure – various models – the order scheduling module, Input/output analysis module, and stock status database – the complete IOM database.

UNIT V INFORMATION SYSTEM FOR MANUFACTURING: 10

Parts oriented production information system – concepts and structure – Computerized production scheduling, online production control systems, Computer based production management system, computerized manufacturing information system -RFID-Telecommunication– case study.

TOTAL: 45 PERIODS

OUTCOME:

On completion of this course, the students are expected to create simple to moderately complex manufacturing information systems for manufacturing industry.

REFERENCES

1. Date, C.J., ”An Introduction to Database Systems” Addison Wesley”, 8th Edn,. 2003
2. Franjo, C., “Manufacturing Information & Data Systems Analysis, Design & Practice”, Butterworth-Heinemann, 2002.
3. Kerr, R., “Knowledge based Manufacturing Management”, Addison-Wesley, 1991.
4. Oliver, G. and Wolfhard, K., “RFID in Manufacturing”, Kubach.vwe.,2008
5. Orlicky, G., “Material Requirements Planning”, McGraw-Hill, 1994.
6. Sartori, L.G., “Manufacturing Information Systems”, Addison-Wesley Publishing Company, 1988.
7. Weiming S, “Information Technology for Balanced Manufacturing Systems”, Springer, 2006.
8. www.ist.psu.edu
9. www.cse.wustl.edu (UML Notation Guide)

CM5010 MANAGEMENT OF MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To provide the student with the knowledge of how to manage different aspects of manufacturing including design, facilities, jobs, inventory, MRP and reengineering.

UNIT I INTRODUCTION: 6

Elements – Manufacturing Strategies and competitiveness-Meeting the competitive Project management.

UNIT II DESIGNING OF PRODUCTS: 9

Process selection-Process flow Design – Operations Technology -Waiting line management-Computer simulation of waiting lines – Quality management.

UNIT III DESIGN OF FACILITIES AND JOBS: **10**

Capacity planning – Strategies – Planning service capacity - JIT – Facility location and layout - Job Design and Work measurement.

UNIT IV INVENTORY SYSTEMS AND MRP: 10

Definition-Purposes of Inventory-Inventory models-Fixed order Quantity models and Fixed-time period models.MRP Systems-MRP system structures- Improvements for MRP system-Advanced MRP-type systems.

UNIT V REVISING THE SYSTEM: 10

Operations consulting – BPR - Synchronous Manufacturing and theory of Constraints.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student should be able to design products, facilities, jobs, inventory systems and embark on business process reengineering.

REFERENCES:

1. Chary, S.N., “Production and Operations Management”, Tata McGraw-Hill, 3rd Edition 2006.
2. Chase, Aquilano and Jacobs, “Production and Operations Management”, eighth Edition, Tata McGraw Hill, 2010.
3. Jay, H. and Render, B.,“Production and Operations Management: Strategic and Tactical Decisions”, Business & Economics – 1996.
4. Operations Management, Jae K. Shim, Joel G. Siegel - Business & Economics, 1999.
5. Robert, A.O., “Manufacturing management: a quantitative approach”, International Textbook Co, 1968.

CM5011 MECHATRONICS IN MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVE:

- To provide the student with the knowledge of sensors, transducers, various types of actuators used in mechatronics systems and also the use of PLCs and mechatronics design.

UNIT I INTRODUCTION : 5

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems - Control Systems.

UNIT II SENSORS AND TRANSDUCERS: 12

Introduction - Performance Terminology – Potentiometers - LVDT - Capacitance sensors - Strain gauges - Eddy current sensor - Hall effect sensor - Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III ACTUATORS: 10

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 8

Introduction - Basic structure - Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS CASE STUDIES: 10

Steps in mechatronics design - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine – Mechatronics Control in automated Manufacturing – Data Acquisition - Case studies.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student should be able to apply Mechatronics in design and practical requirements.

REFERENCES:

1. Bolton, W., “Mechatronics”, Pearson education, second edition, fifth Indian Reprint, 2003
2. Bradley, D.A., Dawson. D., Buru, N.C. and Loader, A.J., “Mechatronics” Nelson Thornes Ltd, Eswar press, Indian print, 2004.
3. Histand, M.B. and Alciatore,D.G., “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 1999.
4. Mahalik,N.P., “Mechatronics Principles, Concepts and applicatlions” Tata McGraw-Hill Publishing Company Limited, 2003.
5. Onwubolu, G.C., "Mechatronics Principles and Applications", Elsevier, 2006.
6. Shetty, D. and Kolk, O. A., “Mechatronics systems design”, PWS Publishing company, 2007.
7. Sinclair, I., “Sensors and Transducers”, Elsevier, Newnes, Reprint 2012.
8. Smaili, .A. and Mrad, F., "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.

CM5012 DESIGN OF FLUID POWER SYSTEMS L T P C

3 0 0 3

OBJECTIVE:

- To study the principles, practices and techniques of Design of Hydraulic and Pneumatic Systems.

UNIT I OIL HYDRAULIC SYSTEMS: 10

Hydraulic Power Generators - Selection and specification of pumps, pump characteristics - Linear and Rotary Actuators - selection, specification and characteristics - Pressure - direction and flow control valves - relief valves, non-return and safety valves - Hydraulic actuation systems.

UNIT II HYDRAULIC CIRCUIT DESIGN: 10

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits – press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits –

Design and methodology-Sequential circuits, cascade, circuits - Compound and combination circuit design - selection of components - safety and emergency mandrels.

UNIT III PNEUMATIC SYSTEMS AND CIRCUITS: 8

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions - modules and their integration.

UNIT IV PNEUMATIC CIRCUIT DESIGN: 9

Sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design - hydro pneumatic circuits - Pneumatic equipments - selection of components - design calculations –application.

UNIT V COMPUTER CONTROL AND MAINTENANCE OF FLUID POWER CIRCUITS: 8

Fuzzy logic in fluid power circuits- PLC in fluid powers- PLC ladder diagram – Low cost automation - Robotic circuits - Installation -Fault finding in fluid power circuits.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply these innovations to design Hydraulic and Pneumatic Systems for industrial applications.

REFERENCES

1. Bolton W., “Pneumatic and Hydraulic Systems ", Butterworth - Heineman, 1997.
2. Esposito. A., “Fluid power with Applications ", Prentice Hall, 2009.
3. Majumdar, S., “Oil Hydraulic Systems: Principles And Maintenance”, Tata McGraw-Hill Education, 2001.
4. Majumdar, S.R., “Pnuematic Systems: Principles And Maintenance”, Tata McGraw-Hill Education, 2001.
5. Parr, A., “Hydraulics and Pneumatics ", (HB), Jaico Publishing House, 1999.
6. Pease D.A. and Pippenger J.J., “Basic Fluid Power ", Prentice Hall, 1987.
7. Pessen, D.W., “Industrial Automation Circuit Design and Components”, Wiley India Pvt. Ltd., Reprint 2011.

CM5094 PROJECT MANAGEMENT L T P C

3 0 0 3

OBJECTIVE:

- To develop the skills that professionals need to become effective project managers. With a specific focus on developing practical project management skills for the students to apply proven methodologies to projects within their individual fields.

UNIT I PROJECT SELECTION AND PROJECT ORGANISATION: 9

Project selection and nature of selection, project portfolio process, Analysis under uncertainty, Project organisation, Matrix organisation, Mixed organisational systems.

UNIT II PROJECT PLANNING: 9

Project Co-ordination, sorting out the projects, Work breakdown structure, system integration, Interface co-ordination, Project life cycle, Conflict and negotiation.

UNIT III PROJECT IMPLEMENTATION: 12

Estimating project budgets, Process of cost estimation, Scheduling : Network techniques PERT and CPM, crashing a project, Resource loading and leveling, Multiproduct scheduling and resource allocation.

UNIT IV MONITORING AND INFORMATION SYSTEMS: 9

Planning-Monitoring-Controlling cycle, Information needs and the reporting process, Computerized PMIS, Earned value analysis, Types of project control processes, control as a function of management, control of change and scope.

UNIT V PROJECT TERMINATION: 6

Construction and use of audit report, Project audit life cycle, Essentials of audit and evaluation, Varieties of project termination, termination process, Final report – A project history.

TOTAL: 45 PERIODS

OUTCOME:

Students will gain a solid understanding of current Project Management methodologies and techniques that are being applied worldwide. They will also learn relevant management skills to ensure success in working with teams and entire organization

REFERENCES:

1. Cleland, D.I. and Ireland, L.R., "Project Management – Design & Implementation", McGraw Fills, 2007
2. Kerzner, H., "Project Management – A Systems Approach Planning, Scheduling and Controlling", John Wiley and Sons, 2009.
3. Meredith, J.R. and Mantel, Jr. S.J., "Project Management – A Managerial Approach, John Wiley and Sons, 2011

CM5013 RELIABILITY AND TOTAL PRODUCTIVE MAINTENANCE L T P C

3 0 0 3

OBJECTIVE:

- To provide the student with the knowledge of reliability, failure analysis, reliability prediction, management and also the principles and practices of TPM.

UNIT I INTRODUCTION 9

Reliability function - MTBF - MTTF - mortality curve - availability -Maintainability.

UNIT II FAILURE DATA ANALYSIS: 9

Repair time distributions - exponential, normal, log normal, gamma, and Weibull - reliability data requirements - Graphical evaluation.

UNIT III RELIABILITY PREDICTION: 9

Failure rate estimates - Effect of environment and stress - Series and Parallel systems - RDB analysis – Standby Systems - Complex Systems.

UNIT IV RELIABILITY MANAGEMENT: 9

Reliability demonstration testing - Reliability growth testing - Duane curve -Risk assessment - FMEA, Fault tree.

UNIT V TOTAL PRODUCTIVE MAINTENANCE: 9

Causes of Machine Failures - Downtime - Maintenance policies - Restorability predictions - Replacement models - Spares provisioning -Maintenance management – Total Productive Maintenance – Maximizing equipment effectiveness – Organizing for TPM implementation – Implementation – TPM small group activities.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student should be able to do all calculations relating to reliability of a product or a system. The student should be able to predict reliability and implement total productive maintenance in factories.

REFERENCES
1. Birolini, A., “Reliability Engineering: Theory and Practice”, Springer, 2010.
2. Gopalakrishnan. P., and Banerji, A.K., “Maintenance and Spare Parts Management ", Prentice Hall of India, New Delhi, 1996.
3. Kales, P., “Reliability for technology Engineering and Management ", Prentice Hall, New Jersey, 1998.
4. Modarres,M., "Reliability and Risk Analysis ", Meral Dekker Inc., 1993.
5. Nakajima, S., “Introduction to TPM”, Productivity Press, 1988.

CM5014 SENSORS FOR MANUFACTURING AND CONDITION MONITORING

L	T	P	C
3	0	0	3

OBJECTIVE:
- To impart knowledge of sensor technologies used in the manufacturing industry for monitoring workpieces, machine tools, machining processes and advanced sensors.

UNIT I INTRODUCTION TO SENSORS **9**

Role of sensors in manufacturing and condition monitoring – Principles – Classification Applications – Basic requirements of sensor – Signal processing and decision making.

UNIT II SENSORS FOR WORKPIECE MONITORING **9**

Mechanical, Electrical, Electro-mechanical, Opto-electrical, Optical, Pneumatic, Capacitance, Eddy-current and Magnetic sensors.

UNIT III SENSORS FOR MACHINE TOOL MONITORING **9**

Position measurements: Linear, angular and velocity sensors – Calibration of machine tools – Collision detection measurements.

UNIT IV SENSORS FOR MACHINING PROCESSES **9**

Sensors for condition monitoring: Force, torque, power, temperature, vibration, acoustic emission, tool sensors, chip control sensors – Adaptive control system – Intelligent systems for machining processes.

UNIT V ADVANCED SENSORS **9**

Optical and machine vision sensors – Smart/Intelligent sensors – Integrated sensors – Robot sensors – Micro-sensors – Nano-sensors.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply appropriate sensors for monitoring work pieces, machine tools, machining processes and advanced sensors in manufacturing industries.

REFERENCES
1. Considine, D.M. and Glenn, D., “Standard Handbook of Industrial Automation: Advanced Industrial Technology 01”, Chapman and Hall, New York, DOI: 10.1017/S0263574700004392, 1987.
2. Sinclair, I.R., “Sensors and Transducers” Elsevier India Private Limited, New Delhi, India, ISBN: 978-0-7506-4932-1, 2001.
3. Tönshoff, H.K. and Inasaki, I., “Sensors in Manufacturing: Sensors Applications- Volume1”, Wiley-VCH Verlag GmbH, Weinheim, ISBNs: 3-527-29558-5 (Hardcover); 3-527-60002-7 (Electronic), 2001.
4. Venkatesh, V.C. and Chandrasekaran, H., “Experimental Techniques in Metal Cutting”, Prentice-Hall of India Private Limited, New Delhi, India, ISBN: 0-87692-449-6, 1987.
5. Wang, L. and Gao, R.X., “Condition Monitoring and Control for Intelligent Manufacturing”, Springer-Verlog London Limited, ISBN-13:978-1-84628-263-3, 2006.

CM5015 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To provide the student with the knowledge of logistics management, network design, sourcing, pricing, coordination and technology in supply chain management.

UNIT I INTRODUCTION: 6

Definition of Logistics and SCM: Evaluation, Scope Importance & Decision phases – Drivers of SC performance and Obstacles.

UNIT II LOGISTICS MANAGEMENT: 10

Factors – Modes of transportation – Design options for transportation Networks - Routing and Scheduling – Inbound and outbound logistics –Reverse Logistics – 3PL – Integrated Logistics concepts-Integrated Logistics Model – Activities – Measuring logistics cost and performance – Warehouse Management – Case Analysis.

UNIT III SUPPLY CHAIN NETWORK DESIGN: 10

Distribution in supply chain – Factors in Distribution network design – design Options – Network Design in supply chain – Framework for network Decisions – Managing cycle inventory and safety.

UNIT IV SOURCING AND PRICING IN SUPPLY CHAIN: 9

Supplier Selection and contracts – design collaboration – Procurement process. Revenue management in supply chain.

UNIT V COORDINATION AND TECHNOLOGY IN SUPPLY CHAIN : 10

Supply Chain Coordination – Bullwhip effect of lack of Coordination and obstacles – IT and SCM – supply Chain IT frame work. E Business & SCM. Metrics for SC performance – Case Analysis.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student should be able to manage logistics and supply chain of a factory or an organization.

REFERENCES

1. Ayers, J.B., “Handbook of Supply Chain Management”, Taylor and Francis Group, 2006.
2. Bloomberg, D.J., Lemay, S. and Hanna, J.B.,’Logistics”, PHI 2002.
3. Chopra, S. and Meindl, P., “Supply chain management, Strategy, Planning, and Operation “, PHI, Second edition, 2004.
4. Christopher, M., “Logistics and Supply Chain Management – Strategies for Reducing Cost and Improving Service”, Pearson Education Asia, Second Edition.
5. Shapiro, J.F. and Duxbury, T., “Modeling the supply Chain”, 2002.

CM5073 GREEN MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

To introduce the concept of Green Manufacturing Design to the students

UNIT I INTRODUCTION 9

Environmental effects of design – Environmental damage – In efficient energy use – Design for recycling.

UNIT II ENVIRONMENTAL LIFE CYCLE ASSESSMENT 9

Material flow and cycles – Material recycling – Emissionless manufacturing.

UNIT III GREEN DESIGN METHODS 9

Mass balance analysis – Green indicate – Design for disassembly design for recycle – Rist analysis – Material selection.

UNIT IV DESIGN FOR ENVIRONMENT 9

Eco design – Industrial Ecology – Pollution prevention – Reduction of toxic emission.

UNIT V SUSTAINABLE ECONOMIC ENVIRONMENT 9

Solar energy devices – wind energy resources – Full cost accounting methodology – Selection of natural friendly materials.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will understand the concepts of Green Manufacturing Design
- It will impart green design methods and to assess the life cycle of the product

REFERENCES:

1. Cairn and Francis – Costing the earth – Harvard Business School Press - 2009
2. Gradel.T.E. and B.R. Allenby – Industrial Ecology – Prentice Hall – 2010
3. World commission on Environment and Development (WCED), Our Common Future, Oxford University Press, 2005.

CM5016 MATERIAL CHARACTERIZATION TECHNIQUES L T P C

3 0 0 3

OBJECTIVE:

- To impart knowledge in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical, Thermal analysis and mechanical testing methods.

UNIT I MICRO STRUCTURAL EVALUATION: 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials.

UNIT II CRYSTAL STRUCTURE ANALYSIS: 9

Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction.

UNIT III ELECTRON MICROSCOPY: 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF & DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction & working of SEM – various Imaging Techniques – Applications- Atomic Force Microscopy- Construction & working of AFM - Applications .

UNIT IV CHEMICAL AND THERMAL ANALYSIS: 9

Basic principles, practice and applications of X-ray spectrometry, Wave dispersive X- ray spectrometry, Auger spectroscopy, Secondary ion mass spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR) – proton induced X-ray Emission spectroscopy, Differential thermal analysis, Differential Scanning Calorimetry (DSC) and Thermo Gravimetric Analysis (TGA)

UNIT V MECHANICAL TESTING: 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Ductility Measurement – Impact Test – Charpy & Izod. Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – Applications of Dynamic Tests.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the student will be able to apply various material characterization techniques for research and analysis.

REFERENCES

1. Cherepin and Malik, "Experimental Techniques in Physical Metallurgy", Asia Publishing Co. Bombay, 1968.
2. Culity, B.D., Stock, S.R. and Stock, S., "Elements of X ray Diffraction", (3rd Edition). Prentice Hall, 2001.
3. Davis, H.E., Hauck, G. and Troxell, G.E., "The Testing of engineering Materials", (4th Edition), McGraw Hill, College Divn., 1982.
4. Goldsten, I.J., Dale, E., Echin, N.P. and Joy, D.C., "Scanning Electron Microscopy & X ray- Micro Analysis", (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
5. Grundy, P.J. and Jones, G.A.,"Electron Microscopy in the Study of Materials", Edward Arnold Limited, 1976.
6. Morita, S., Wiesendanger, R. and Meyer, E., "Noncontact Atomic Force Microscopy" Springer, 2002
7. Newby, J., "Metals Hand Book- Metallography & Micro Structures", (9th Edition), ASM International, 1989.

CM5017 TOOL ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

- This course provides knowledge in the areas of design of single point and multi point cutting tools, dies, jigs, fixtures and limit gauges and toll design for CNC machines.

UNIT I INTRODUCTION: 7

Broad Classification of Tools-Cutting tools, Dies , Holding and Measuring tools, Tool materials and heat treatment- Ferrous, Non-ferrous and Non metallic materials, tool making practices.

UNIT II DESIGN OF CUTTING TOOLS: 11

Single Point Cutting Tools: Classification, Nomenclature, geometry, design of single point tools for lathes, shapers, planers etc. Chip breakers and their design. Multipoint Cutting Tools: Classification and specification, nomenclature, Design of drills, milling cutters, broaches, taps etc. Design of Form Tools: Flat and circular form tools, their design and applications.

UNIT III DESIGN OF DIES: 10

Classification of dies, Design of Dies for Bulk metal Deformation-Wire Drawing, Extrusion, Forging and Rolling; Design of Dies for Sheet metal: Blanking and Piercing, Bending and Deep-drawing; Design of Dies used for Casting and Moulding, Powder Metallurgy die design.

UNIT IV DESIGN OF JIGS AND FIXTURES: 9

Classification of Jigs and Fixtures, Fundamental Principles of design of Jigs and Fixtures, Location and Clamping in Jigs and fixtures, Simple design for drilling Jigs, Milling fixtures etc. Indexing Jigs and fixtures.

UNIT V DESIGN OF LIMIT GAUGES AND TOOL DESIGN FOR CNC MACHINES: 8

Fixed gauges, gauge tolerances, indicating gauges, automatic gauges, selection of materials, tool design for CNC machines- fixture design, cutting tools, tool holding, tool pre-setter, automatic tool changers and positioners.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course

1. This domain knowledge will increase their employability skills
2. Use this knowledge to develop innovative ideas work holding methods
3. Encourages to involve in research in the area of machining

REFERENCES

1. Donaldson, C., "Tool Design", Tata Mc-Graw Hill, 2006
2. Grant, H,E., "Jigs and Fixtures, Tata Mc-Graw Hill, 2006
3. Joshi, P.H., "Jigs and Fixtures, Tata Mc-Graw Hill, 2003
4. Kempster, M.H.A., "Principles of Jig and Tool Design", English University Press Ltd.,1968.
5. Pollack, H.W., "Tool Design" Reston Publishing Company, Inc. 1976.

CM5018 TOTAL QUALITY SYSTEMS AND ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- This course provides knowledge in the areas of quality management, its pioneers, practices and techniques. It also provides knowledge in quality by design and product liability.

UNIT I INTRODUCTION: 10

Principles of Quality Management - Pioneers of TQM - Quality costs - Customer Orientation - Benchmarking - Re-engineering - Concurrent Engineering.

UNIT II PRACTICES OF TQM: 10

Quality system - ISO 9001:2000 - QS 9000, ISO 14000 - Quality Auditing - Leadership - Organisational Structure - Team Building - Information Systems and Documentation.

UNIT III TECHNIQUES OF TQM: 10

Single Vendor Concept - JIT - Quality Function deployment - Quality Circles - KAIZEN - SGA - POKA YOKE - Taguchi Methods.

UNIT IV QUALITY BY DESIGN: 8

Introduction – Rationale for implementation – Benefits– Teams – Communication models – Implementation – Tools – Misconceptions and Pitfalls.

UNIT V PRODUCTS LIABILITY: 7

Introduction – Product safety law – products liability law – defenses – Proof and the expert witness – Financial Loss – The future of products liability – Prevention.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course the student should be able to apply the principles, practices and techniques of quality systems and engineering in factories.

REFERENCES

1. Baird, C.W., “The Six Sigma Manual for Small and Medium Businesses”, Atlantic Publishing Company (FL), Reprint 2011.
2. Bank, J., " The Essence of Total Quality Management ", Prentice Hall of India Pvt.Ltd., 1995.
3. Besterfield, D.H., Besterfield, C.M, Besterfield, G.H. and Besterfield, M.S., “Total Quality Management ", Pearson Education, 2002.
4. Dalela, S. and Saurabh, “ISO 9000 A Manual for Total Quality Management ", S.Chand and Company Ltd., 1997.
5. Noori, H. and Radford,R., " Production and Operations management - Total Quality and Responsiveness ", McGraw-Hill Inc, 1995.
6. Zairi, M., “Total Quality Management for Engineers ", Woodhead Publishing Limited 1991.

CM5019 WAREHOUSE LAYOUT PLANNING AND PART FEEDING METHODS

L	T	P	C
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OBJECTIVE:

- Students will learn various part feeding methods, optimum design of feeding routes and feeding methods and develop knowledge on warehouse management systems, safety requirements of ware house panning

UNIT I LAYOUT PLANNING: 8

Layout Planning - Importance of Layout Planning - General Steps in Layout and Space Requirements Planning - Warehouse Activities - Determining Space Requirements – Develop realistic and Ideal Layout for Storage and Retrieval – Material storage methods for each part

UNIT II RACKING SYSTEMS FOR WAREHOUSE: 9

Selection of Ware House Equipments and Material Handling Systems - Racking and Shelving Systems - Rack Planning Considerations - General Categories of Rack Systems - Large Products Storage System - Pallet Storage Systems Selection - Selection of Racking Systems - Technical Specification of the High Rack System - Design Standard for Racking Systems - Layout of High Rack Storage - Warehouse Floors - Industrial Floorings - Floor Loading and Preparation – Calculations.

UNIT III MATERIAL HANDLING SYSTEMS FOR WAREHOUSE: 9

Material Handling System - Material Flow Path - Selection Criteria to Determine Equipment - Material Handling Equipment Classification – MHE Manufacturer's Worldwide Ranking - Comparison of Fork Lift, Reach Truck and Narrow Aisle Truck - MHE Service and Battery Charging - Crane Design Requirements

UNIT IV PART FEEDING: 10

Part feeding - Number of Tow Truck Requirements - Calculations - Kitting Trolley Route Map - Kitting Time Estimation - Kitting Trolley Feeding Man Power Calculation - Kitting Trolley Design Methodology - Assumptions in Kitting Design - Kit Trolley Design - Key Ware House Planning- Issues to be Considered during Ware Housing Planning - Check List for Warehouse Layout Planning - Return on Assets

UNIT V WAREHOUSE MANAGEMENT SYSTEMS, SAFETY AND STAFFING 9

WMS Support in Ware House Management - Benefits of a WMS - Components of a WMS - WMS Data - WMS Functions - WMS Reports - Ware House Safety Requirements, Warehouse Staffing - Personnel Requirements for a Typical Warehouse.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. Design and plan warehouse layouts
2. Plan racking systems and Material handling systems for warehouse requirements.

REFERENCES

1. Bartholdi, J.J. and Hackman, S.T., "Warehouse & Distribution science", Release 0.89, The Supply chain and logistics Institute, School of Industrial and systems Engineering, Georgia Institute of technology, Atlanta, GA 30332-0205 USA, Revised August 20, 2008.
2. Frazelle, E.H.,"World-Class warehousing and Material handling", TATA McGraw-Hill Edition 2004.
3. Hanson, R., "In-plant materials supply: Supporting the choice between kitting and continuous supply", Department of Technology Management and Economics, Chalmers University of Technology, Gothenburg, Sweden 2012. (http://publications.lib.chalmers.se/records/fulltext/155418.pdf)
4. IS 1893(Part 1): 2002, Indian Standard, Criteria For Earthquake Resistant Design Of Structures, Part 1 General provisions and buildings, (Fifth Revision).
5. Richards, G., "Warehouse Management: A complete guide to improving efficiency and minimizing costs in the modern warehouse", London Philadelphia, 2011.
6. Tompkins, J.A., and Smith, J.D., "The Warehouse Management Handbook", Tompkins press, 1998.

MF5073 INTERNET OF THINGS FOR MANUFACTURING L T P C

3 0 0 3

OBJECTIVES:

- To discover key IoT concepts including identification, sensors, localization, wireless protocols
- To explore IoT technologies, architectures, standards, and regulation
- To realize the value created by collecting, communicating, coordinating, and leveraging data
- To examine developments that will likely shape the industrial landscape in the future;

UNIT I INTRODUCTION 9

Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II DESIGN OF IoT 9

Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III PROTOTYPING OF IoT 9

Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV PREREQUISITES FOR IoT 9

IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V APPLICATION IN MANUFACTURING 9

Applications HCI and IoT world - Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges

TOTAL : 45 PERIODS

OUTCOME:

- Utilizing sensors to gain greater visibility and real-time situational awareness
- Vertical applications that provide a clear business case and a pressing opportunity
- Emerging technologies to address IoT challenges

REFERENCES:

1. Adrian McEwan and Hakim Cassimally, “Designing the internet of things”, Wiley, 2013
2. Code Halos: How the Digital Lives of People, Things, and Organizations are Changing the Rules of Business, by Malcolm Frank, Paul Roehrig and Ben Pring, published by John Wiley & Sons.
3. Internet of Things: A Hands-On Approach by Vijay Madisetti, Arshdeep Bahga, VPT; 1st edition 2014.
4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis Karnouskos, Stefan Avesand, David Boyle, “From Machine-to-Machine to the Internet of Things -Introduction to a New Age of Intelligence” Elsevier
5. Meta Products -Building the Internet of Things by Wimer Hazenberg, Menno Huisman, BIS Publishers 2014.

IL5091 DATA ANALYTICS L T P C

3 0 0 3

OBJECTIVES:

The Student should be made to:

- Be exposed to big data
- Learn the different ways of Data Analysis
- Be familiar with data streams
- Learn the mining and clustering
- Be familiar with the visualization

UNIT I INTRODUCTION TO BIG DATA 8

Introduction to Big Data Platform – Challenges of conventional systems - Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting - Modern data analytic tools, Stastical concepts: Sampling distributions, resampling, statistical inference, prediction error.

UNIT II DATA ANALYSIS 12

Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics - Rule induction - Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods.

UNIT III MINING DATA STREAMS 8

Introduction to Streams Concepts – Stream data model and architecture - Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window - Realtime Analytics Platform(RTAP) applications - case studies - real time sentiment analysis, stock market predictions.

UNIT IV FREQUENT ITEMSETS AND CLUSTERING 9

Mining Frequent itemsets - Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-euclidean space – Clustering for streams and Parallelism.

UNIT V FRAMEWORKS AND VISUALIZATION 8

MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed file systems – Visualizations - Visual data analysis techniques, interaction techniques; Systems and applications:

TOTAL : 45 PERIODS

OUTCOMES:

The student should be made to:

- Apply the statistical analysis methods.
- Compare and contrast various soft computing frameworks.
- Design distributed file systems.
- Apply Stream data model.
- Use Visualisation techniques

REFERENCES:

1. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
2. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
3. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O"Reilly, 2011.
4. Jiawei Han, Micheline Kamber “Data Mining Concepts and Techniques”, Second Edition, Elsevier, Reprinted 2008.
5. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.