ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

M.E. COMPUTER INTEGRATED MANUFACTURING (FT/PT)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. 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.

II. To enhance the mathematical, scientific and engineering fundamentals the provide students with a solid foundation in required to solve analytical problems

III. To coach students with good design and engineering skills so as to comprehend, analyze, design, and produce novel materials, products and solutions for the contemporary manufacturing issues.

IV. 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.

V. To provide student with an academic environment conscious of research excellence, organizing capabilities, written ethical codes, discipline and guidelines, and the life-long learning needed for a successful professional career

PROGRAMME OUTCOMES (POs):

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.

Mapping of PEOs with POs

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

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Advanced Metrology and Computer Aided Inspection	✓	✓	✓		✓					
		Advances in Manufacturing Technology			✓	✓	✓					
		Applied Materials Engineering	✓		✓							
		Computer Applications in Design	✓									
		Statistical Methods for Engineers	✓	✓								
		CAD and CAE Laboratory	✓				✓	✓	✓			
		Elective I										
	SEM 2	Competitive Manufacturing Systems	✓		✓				✓		✓	
		Computer Aided Manufacturing			✓	✓					✓	
		Computer Integrated Production and Inventory Systems	✓					✓				
		Discrete System Simulation	✓	✓	✓	✓					✓	
		Elective II										
		Elective III										
		Technical Seminar						✓	✓			✓
		CAM Laboratory						✓	✓			✓
YEAR 2	SEM 1	Elective IV										
		Elective V										
		Elective VI										
		Project Work Phase I		✓		✓			✓			✓
	SEM 2	Project Work Phase II		✓		✓			✓			✓

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

M.E. COMPUTER INTEGRATED MANUFACTURING (FT/PT)

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7101	Advanced Metrology and Computer Aided Inspection	PC	3	3	0	0	3
2.	CI7102	Advances in Manufacturing Technology	PC	3	3	0	0	3
3.	CI7103	Applied Materials Engineering	PC	3	3	0	0	3
4.	ED7151	Computer Applications in Design	PC	3	3	0	0	3
5.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
6.		Elective I	PE	3	3	0	0	3
PRACTICAL								
7	CI7111	CAD and CAE Laboratory	PC	4	0	0	4	2
			TOTAL	**23**	**19**	**0**	**4**	**21**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7201	Computer Aided Manufacturing	PC	3	3	0	0	3
2.	CI7202	Computer Integrated Production and Inventory Systems	PC	3	3	0	0	3
3.	CI7252	Competitive Manufacturing Systems	PC	3	3	0	0	3
4.	QE7251	Discrete System Simulation	PC	3	3	0	0	3
5.		Elective II	PE	3	3	0	0	3
6.		Elective III	PE	3	3	0	0	3
PRACTICALS								
7.	CI7211	CAM Laboratory	PC	4	0	0	4	2
8.	CI7212	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICAL								
4.	CI7311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CI7411	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 DEGREE = 69

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI

M.E. COMPUTER INTEGRATED MANUFACTURING (PART TIME)

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7103	Applied Materials Engineering	PC	3	3	0	0	3
2.	ED7151	Computer Applications in Design	PC	3	3	0	0	3
3.	MA7160	Statistical Methods for Engineers	FC	4	4	0	0	4
PRACTICAL								
4.	CI7111	CAD and CAE Laboratory	PC	4	0	0	4	2
			TOTAL	**14**	**10**	**0**	**4**	**12**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7201	Computer Aided Manufacturing	PC	3	3	0	0	3
2.	CI7202	Computer Integrated Production and Inventory Systems	PC	3	3	0	0	3
3.	CI7252	Competitive Manufacturing Systems	PC	3	3	0	0	3
PRACTICAL								
4.	CI7211	CAM Laboratory	PC	4	0	0	4	2
			TOTAL	**13**	**9**	**0**	**4**	**11**

SEMESTER III

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CI7101	Advanced Metrology and Computer Aided Inspection	PC	3	3	0	0	3
2.	CI7102	Advances in Manufacturing Technology	PC	3	3	0	0	3
3.		Elective I	PE	3	3	0	0	3
			TOTAL	**9**	**9**	**0**	**0**	**9**

SEMESTER IV

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	QE7251	Discrete System Simulation	PC	3	3	0	0	3
2.		Elective II	PE	3	3	0	0	3
3.		Elective III	PE	3	3	0	0	3
PRACTICAL								
4.	CI7212	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**11**	**9**	**0**	**2**	**10**

SEMESTER V

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Elective IV	PE	3	3	0	0	3
2.		Elective V	PE	3	3	0	0	3
3.		Elective VI	PE	3	3	0	0	3
PRACTICAL								
4.	CI7311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER VI

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1.	CI7411	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 DEGREE = 69

FOUNDATION COURSES (FC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Statistical Methods for Engineers	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Advanced Metrology and Computer Aided Inspection	PC	3	3	0	0	3
2.		Advances in Manufacturing Technology	PC	3	3	0	0	3
3.		Applied Materials Engineering	PC	3	3	0	0	3
4.		Competitive Manufacturing Systems	PC	3	3	0	0	3
5.		Computer Aided Manufacturing	PC	3	3	0	0	3
6.		Computer Applications in Design	PC	3	3	0	0	3
7.		Computer Integrated Production and Inventory Systems	PC	3	3	0	0	3
8.		Discrete System Simulation	PC	3	3	0	0	3
9.		CAD and CAE Laboratory	PC	4	0	0	4	2
10.		CAM Laboratory	PC	4	0	0	4	2

PROFESSIONAL ELECTIVES (PE)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	CI7001	Advances in Welding and Casting Technology	PE	3	3	0	0	3
2.	CI7002	Composite Materials	PE	3	3	0	0	3
3.	CI7003	Corrosion and Surface Engineering	PE	3	3	0	0	3
4.	CI7004	Design for Manufacturing	PE	3	3	0	0	3
5.	CI7005	Design of Cellular Manufacturing System	PE	3	3	0	0	3
6.	CI7006	Electronics Manufacturing Technology	PE	3	3	0	0	3
7.	CI7007	Finite Element Analysis in Manufacturing Engineering	PE	3	3	0	0	3
8.	CI7008	Intelligent Product Design and Manufacturing	PE	3	3	0	0	3
9.	CI7009	Lean Manufacturing	PE	3	3	0	0	3
10.	CI7010	Micro and Nano Manufacturing	PE	3	3	0	0	3
11.	CI7011	Precision Engineering	PE	3	3	0	0	3
12.	CI7012	Production Planning and Management	PE	3	3	0	0	3
13.	CI7013	Reliability and Total Productive Maintenance	PE	3	3	0	0	3
14.	CI7014	Sensors for Manufacturing and Condition Monitoring	PE	3	3	0	0	3
15.	CI7015	Sustainable Manufacturing	PE	3	3	0	0	3
16.	CI7016	Techniques of Material Characterization	PE	3	3	0	0	3
17.	CI7017	Tool Engineering	PE	3	3	0	0	3
18.	CI7018	Total Quality Systems and Engineering	PE	3	3	0	0	3
19.	CI7019	Warehouse Layout Planning and Part Feeding Methods	PE	3	3	0	0	3
20.	CI7071	Computer Aided Process Planning	PE	3	3	0	0	3

21.	CI7072	Industrial Robotics and Expert Systems	PE	3	3	0	0	3
22.	CI7073	Manufacturing Information Systems	PE	3	3	0	0	3
23.	CI7074	Mechatronics in Manufacturing	PE	3	3	0	0	3
24.	CI7075	Micro Electro Mechanical systems	PE	3	3	0	0	3
25.	CI7076	Supply Chain Management	PE	3	3	0	0	3
26.	CI7251	Additive Manufacturing	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.		Project Work Phase I	EEC	12	0	0	12	6
2.		Project Work Phase II	EEC	24	0	0	24	12
3.		Technical Seminar	EEC	2	0	0	2	1

CI7101 ADVANCED METROLOGY AND COMPUTER AIDED INSPECTION L T P C
3 0 0 3

OBJECTIVE:

- 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 - Clean room - behaviour - Maintenance and handling of equipments

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 - Engineering applications of interferometry

UNIT IV COMPUTER AIDED 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-Major applications of image processing.

TOTAL: 45 PERIODS

OUTCOME:

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

9. Sonka,M., Hlavac,V. and Boyle.R., “Image Processing, Analysis, and Machine Vision”, Cengage-Engineering, 2007.

WEB REFERENCES:

1. www.metrologytooling.com
2. www.iuk’tu-harburg.de

CI7102 ADVANCES IN MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

At the end of this course 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 - Hybrid 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

OUTCOME:

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. Franssila. S., “Introduction to Micro Fabrication”, John Wiley and sons Ltd., UK, 2004, ISBN: 978-0-470-85106-7
2. Benedict, G.F.,"Non Traditional manufacturing Processes", CRC press,2011
3. McGeough,J.A.,"Advanced methods of Machining",Springer,2011
4. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,1989.
5. Pandley, P.S. and Shah.N., “Modern Manufacturing Processes”, Tata McGraw Hill,1980.
6. HMT Manual, “Non – traditional Machining Methods”, 1975.
7. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267), 2006.
8. Madore, J, “fundamental of Micro fabrication”, CRC Press, 2002.
9. Jackson, M.J., “Micro fabrication and Nano manufacturing”, CRC Press, 2006.
10. Zant, P.V., “Microchip fabrication”, McGraw Hill, 2004.
11. Gad-el-Hak M, “The MEMS Handbook”, CRC Press, 2006.
12. Busnaina, A., “Nano manufacturing Handbook”, CRC Press, London, 2006

CI7103 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. Dieter, G.E., “Mechanical Metallurgy”, McGraw Hill, 1988.
2. Charles, J.A., Crane, F.A.A and Furness, J.A.G., “Selection and use of engineering Materials”, (3 rd Edition, Butterworth – Heiremann, 1977.
3. James, K.W., Wiley, Intersam, John, “The Hand book of Advance Materials”, Wilson Publishers., 2004.
4. Burakonsa, T.Z. and Wierzchan. T.,“Surface Engg of Meterials”- Principles of Equipment, Techniques.
5. Courtney, T.H.,“Mechanical Behavior of Materials” ,(2nd edition), McGraw Hill, 2000.
6. Flinn,R.A.and Trojan ,P.K.., “Engineering Materials and their Applications” (4^{th} Edition), Jaico, 1999.
7. Metals hand book, vol. 10, “Failure Analysis and Prevention”,(10th edition), 1994.

WEB REFERENCES:

1. www.astm.org/labs/pages/131350.htm
2. www.appliedmaterials.com/carrers/agu-ei.html

ED7151 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, rotators) windowing - view ports - clipping transformation.

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

MA7160 STATISTICAL METHODS FOR ENGINEERS L T P C

4 0 0 4

OBJECTIVE:

- This course aims at providing the necessary basic concepts of a few statistical methods and apply them to various engineering problems.

UNIT I ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency - Maximum Likelihood Estimation - Method of Moments.

UNIT II TESTING OF HYPOTHESIS 12

Tests based on Normal, t, χ^2 and F distributions for testing of means, variance and proportions - Analysis of r x c tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION 12

Multiple and Partial Correlation - Method of Least Squares- Plane of Regression - Properties of Residuals - Coefficient of Multiple Correlation - Coefficient of Partial Correlation - Multiple Correlation with total and partial correlations - Regression and Partial correlations in terms of lower order coefficients.

UNIT IV DESIGN OF EXPERIMENTS 12

Analysis of variance - One-way and two-way classifications - Completely randomized design - Randomized block design - Latin square design.

UNIT V MULTIVARIATE ANALYSIS 12

Random Vectors and Matrices - Mean vectors and Covariance matrices - Multivariate Normal density and its properties - Principal components: Population principal components – Principal components from standardized variables.

TOTAL: 60 PERIODS

OUTCOME:

- It helps the students to have a clear perception of the power of statistical ideas, tools and would be able to demonstrate the applications of statistical techniques to problems drawn from industry, management and other engineering fields.

REFERENCES:

1. Johnson, R. A. and Gupta, C. B., “Miller & Freund’s Probability and Statistics for Engineers”, Pearson Education, Asia, Seventh Edition, 2007.
2. Devore, J.L., “Probability and statistics for Engineering and the Sciences”, Thomson and Duxbury, Singapore, Fifth Edition, 2002.
3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Asia, Sixth Edition, 2007.
4. Gupta, S.C., and Kapoor, V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand and Sons, Eleventh Edition, 2002.
5. Spiegel, M.R. and Stephens, L.J., ”Schaum’s outlines,-Statistics”, Tata McGraw-Hill, Third Edition, 2000.
6. Freund, J.E., “Mathematical Statistics”, Prentice Hall of India, Fifth Edition, 2001.

CI7111 CAD AND CAE LABORATORY L T P C

0 0 4 2

OBJECTIVE:

- At the end of the course, the student should be able to: sketch, model, assemble and analyze mechanical components using CAD and CAE software package.

LIST OF EXPERIMENTS:

1. Sketching and Part modeling (Solid modeling, Surface modeling, Feature manipulation) of mechanical components using CAD software package

2. Assembly(Constraints, Exploded Views, Interference check) and Drafting(Layouts, GD & T Standard, Sectional Views, & Detailing) of mechanical components using CAD software package
3. Sheet Metal Design and Mould Design using CAD Software Package
4. Working with CAD Data Exchange formats: IGES,PDES,PARASOLID,DXF and STL
5. Finite Element Analysis (FEA) using Pre-processing (solid modeling, meshing, analysis setup) and post processing (graphical display and report) with CAE software package
6. Finite Element Analysis (FEA) for plastic deformation using nonlinear material models with CAE software package

TOTAL: 60 PERIODS

OUTCOME:

- With laboratory classes, it helps the students to get familiarized with the computer applications in design, Finite Element Analysis and to prepare drawings for components used industries.

LIST OF EQUIPMENTS REQUIRED:

1. Computers 25
2. CAD software Package- Unigraphics/CATIA/Solid Works/ PTC Creo
3. CAE Software package-ABAQUS/ LS-DYNA/ ANSYS/DEFORM/PATRAN/NASTRAN /MARC/ Hypermesh

CI7201 COMPUTER AIDED MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

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

CI7202 COMPUTER INTEGRATED PRODUCTION AND INVENTORY 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

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

REFERENCES:

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

6. Bauer, A., Browne, J., Bowden, R., and Duggan, J. ,"Shop Floor Control Systems From design to implementation", springer, 1994

CI7252 COMPETITIVE MANUFACTURING SYSTEMS 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

Five areas of competitive manufacturing: cost, quality, delivery, safety/environment, and morale. Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service – PLM.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Computer control and functions - Planning, scheduling and control of FMS - Knowledge based scheduling.

UNIT III COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS 9

System issues - Types of software - specification and selection - Trends - Simulation and Applications - 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 - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture – APQP – SOP – PPAP – Factories of the future.

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 for JIT – VSM - Kanban system - strategic implications - implementation issues.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course the student will be able to apply the knowledge to implement and work in competitive manufacturing systems. Student will be able to practice the principles of flexible manufacturing, Kaizen, 5S, Jidoka, Poka Yoke and Lean manufacturing.

REFERENCES:
1. Jha, N.K., “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
2. Bhat, S. K., “Total Quality Management", Himalaya Publishing House Pvt. Ltd., 2011.
3. Groover, M.P., “Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
4. Kalpakjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
5. Ohno, T.T., “Production System Beyond Large-Scale production", Productivity Press (India) Pvt. Ltd. 1992.
6. Dennis, P., “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.

QE7251 DISCRETE SYSTEM SIMULATION L T P C
3 0 0 3

OBJECTIVES :

- To understand the importance and advantages of applying simulation techniques for solving various problems on discrete event systems.
- To teach various random number generation techniques, its use in simulation, tests and validity of random numbers etc. development of simulation models, verification, validation and analysis.
- To understand the applications of random probability distributions in real time environments.
- Train students to solve discrete event problems through hand simulation and to develop simulation models using Extend simulation software.

UNIT I INTRODUCTION: 3

Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types of simulation.

UNIT II RANDOM NUMBERS: 5

Methods of generating random numbers, Pseudo random numbers and random variates, discrete and continuous random probability distributions, tests for random numbers.

UNIT III DESIGN OF SIMULATION: 8

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation.

UNIT IV SIMULATION SOFTWARE: 14

Study and selection of simulation languages, Use of simulation software such as GPSS, Extend, Matlab, Simulink, LabView etc., for simulation.

UNIT V CASE STUDIES IN SIMULATION: 15

Development of simulation models for queuing systems, production systems, inventory systems, Industrial scheduling problems.

TOTAL: 45 PERIODS

OUTCOMES :

Students will:

- Learn to simulate models matching real life scenarios and obtain superior results
- Develop capabilities of taking up consultancy projects.

REFERENCES:

1. Banks, J., Nelson, B.L., Nicol, D.M., Shahabudeen .P "Discrete event system simulation", 4th edition Prentice Hall, India, 2005.
2. Kalechman, M., "Practical MATLAB® basics for engineers", CRC press, Taylor and Francis group, First Indian reprint, 2012.
3. Shannon, R.E. "systems simulation – The art and Science", Prentice Hall, 1975.
4. Schriber, T.J., "simulation using GPSS", John Wiley, 1991.
5. Law, A.M. and Kelton, W.D., "Simulation Modeling and Analysis", McGraw Hill, 2000.

CI7211	CAM LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- Concepts of CNC programming and simulation on CNC turning center, Machining center and CNC Wire EDM
- Robot, PLC programming and Database Management Methods

LIST OF EXPERIMENTS

1. Study of different control systems and CNC codes.
2. Programming and simulation for turning, taper turning, circular interpolation, thread Cutting and facing operation.
3. Programming and simulation using Do-Loop and Sub-routine for CNC turning centre.
4. Programming and simulation for machining of internal surfaces in CNC turning centre
5. Programming and simulation for profile milling operation, circular interpolation
6. Programming and simulation for circular and rectangular pocket milling
7. Programming using canned cycles
8. CNC code generation using CAM software packages – Turning centre
9. CNC code generation using CAM software packages – Machining centre
10. Programming for CNC Wire cut EDM
11. Dimensional and geometric measurement of machined features using VMS and CMM
12. Robot programming for Material handling applications
13. PLC ladder logic programming.
14. Study on RDBMS and its application in problems like inventory control MRP etc

TOTAL: 60 PERIODS

OUTCOME:

At the end of this course

- The student will be able to use CNC machines for production
- Use this knowledge to program CNC machines
- Use this knowledge for Robot, PLC programming and Database Management method

LIST OF EQUIPMENTS REQUIRED:

1. Computers 25
2. CAM Software for 3 axis machining or more
3. CNC Production type turning or Machining center
4. CNC Wire Cut - EDM
5. Video Measuring System
6. Coordinate Measuring Machine
7. Surface Roughness tester
8. 5 -axis Robot
9. Programmable Logic Controller with ladder logic programming software
10. RDMBS Package with relevant modules like Inventory Control and MRP

CI7212	TECHNICAL SEMINAR	L T P C
		0 0 2 1

OBJECTIVE:

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

OUTCOMES:

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.

TOTAL: 30 PERIODS

CI7311	PROJECT WORK PHASE I	L T P C
		0 0 12 6

OBJECTIVES

- A research project topic may be selected either from published lists or from the creative ideas of the students themselves in consultation with their project supervisor.
- To improve the student research and development activities.

EVALUATION

Project work evaluation is based on Regulations of Credit system University Departments - Post graduate programmes of Anna University

TOTAL : 90 PERIODS

OUTCOME

The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated in their project work phase – II.

CI7411 PROJECT WORK PHASE II L T P C
0 0 24 12

OBJECTIVES

- The objective of the research project work is to produce factual results of their applied research idea in the thermal Engineering, from phase – I.
- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Division.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Division based on oral presentation and the project report
- To improve the student research and development activities.

EVALUATION

- Project work evaluation is based on Regulations of Credit system University Departments - Post graduate programmes of Anna University

TOTAL = 180 PERIODS

OUTCOME

The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

CI7001 ADVANCES IN WELDING AND CASTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on advances in welding and casting technology, cast design and advanced welding and casting processes.

UNIT I WELDING DESIGN AND METALLURGY: 10

Weld joint design- Heat Affected Zone (HAZ) - Weldability of steels - Cast iron - Stainless steels, aluminum, copper and titanium alloys - Hydrogen embrittlement - Pre and Post weld heat treatments - Weld defects.

UNIT II SPECIAL WELDING PROCESSES: 10

Friction welding process - effects of speed and pressure –Types- Explosive welding –Process Parameters-Plasma arc welding - Electron beam welding - High frequency induction welding - Diffusion bonding -Types- Cold pressure welding - Ultrasonic welding - Laser beam welding.

UNIT III CASTING DESIGN AND METALLURGY: 8

Design of gate, spruce, riser-design of patterns – design of thin and unequal sections- L,T,V,X,Y junctions-Solidification –Shrinkage – Rapid solidification processing(RSP)-Melt spinning-Roll quenching-Vibratory solidification-Splat cooling.

UNIT IV SPECIAL CASTING PROCESSES: 8

Evaporative Pattern Casting Process and full mould process –Vaccum sealed moulding-vacuum casting-Magnetic Moulding -Squeeze Casting-types- Plaster mould casting-Ceramic mould casting-Thixoforming or semi solid forming-Single crystal growing.

UNIT V AUTOMATION OF WELDING AND FOUNDRY: 9

Use of robots in welding- weld positioner and manipulators -weld seam tracking-arc sensing-vision system-automation of foundry-use of robots-moulding machines-Automation of sand plant, moulding and fettling sections of foundry-Dust and fume control.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the students are expected

- To produce useful research output in welding and casting.
- Use this knowledge in advancing the welding and casting process.
- Application of design knowledge to understand and to overcome defects in welding and casting.

REFERENCES:

1.Heine,R.W., Loper,C.R. and Rosenthal,P.C., "Principles of Metal casting", Tata McGraw- Hill, 1994.
2. Parmar,R.S., "Welding Processes and Technology", Khanna Publishers, 1997.
3. Jain,P.L., "Principles of Foundry Technology", Tata McGraw Hill, 2003.
4. Timings,R., " Fabrication and Welding Engineering", Elsevier Newnes,2008
5. Weman,K., "welding processes hand book", CRC press,2003.
6. Minkoff,J., "Solidification and cast structure",wiley.1986.
7. American Society of Metals, "Source Book on Electron beam and laser beam Welding",1987.
8. American Society of Metals, "Metals Hand Book", 9th Edition, Vol.V, 1989.
9. American Society of Welding, "Hand book of Welding", Vol.I to V.

CI7002 COMPOSITE MATERIALS L T P C

3 0 0 3

OBJECTIVE:

- To impart knowledge of various manufacturing methods of different composite materials, their properties, machining characteristics and their applications.

UNIT I INTRODUCTION: 9

Introduction – Fibre reinforcements – Fabrication, properties and applications of Glass fibres, Boron fibres, Carbon fibres, Aramid fibres, Ceramic fibres – Whiskers – Comparison of fibres: particulate and whisker reinforcements – Matrix materials – Polymers, Metals, Ceramics and their properties.

UNIT II POLYMER MATRIX COMPOSITES: 9

Introduction – Processing of PMCs – Thermoset matrix composites: Hand layup, spray, filament winding, pultruion, resin transfer moulding, auctoclave moulding – Thermoplastic matrix composites : Film stacking, diaphragm forming, thermoplastic tape laying, Injection moulding – Interfaces in PMCs: Glass fibre/polymer interface, Aramid fibre/polymer interface – Structure, applications and mechanical properties of PMCs – Recycling of PMCs.

UNIT III METAL MATRIX COMPOSITES: 9

Introduction – Types, Metallic matrices: Aluminium, Titanium, Magnesium, copper Alloys – Processing of MMCs: Solid state, Liquid state, Vapour state , In-situ – Interface/Interphase in MMCs – Interfacial bonding in MMCs – Mechanical properties, coefficient of thermal expansion, environmental effects, moisture effects – Applications of MMCs – Recycling of MMCs.

UNIT IV CERAMIC MATRIX COMPOSITES: 9

Introduction – Types – Toughening Mechanism- Processing of CMCs: Cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – In-situ chemical reaction techniques: Chemical vapour deposition, Chemical vapour impregnation, Sol-gel, C-C Composites. Interface in CMCs. Mechanical Properties and Applications of CMCs – Fatigue behaviors and S-N curves of particle and whisker reinforced CMCs – Hybrid composites – Thermal fatigue – Creep.

UNIT V MACHINING OF COMPOSITES 9

Traditional (turning, milling, drilling, abrasive machining) and non-traditional (abrasive waterjet machining, electric discharge machining, ultrasonic, laser–assisted) machining of Composites – Characterisation and surface integrity studies on the machined surface.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of this course the student will be able to select appropriate composite materials for specific applications.

REFERENCES:

1. Chawla, K.K., “Composite Materials: Science and Engineering”, Springer, New York, ISBN: 978-0-387-74364-6, 2012.
2. Jahanmir, S., Ramulu, M. and Koshy, P., “Machining of Ceramics and Composites”, Marcel Dekker Inc, New York, 1999.
3. Sheikh-Ahmad, J.Y., “Machining of Polymer Composites”, Springer, USA, ISBN: 978-0-387-35539-9, 2009.
4. Mallick, P.K., “Fiber Reinforced Composites: Materials, Manufacturing and Design”, CRC Press, New Delhi, ISBN: 0849342058, 2010.
5. Hull, D. and Clyne, T.W., “An Introduction to Composite Materials”, Cambridge University Press, ISBN: 0-521-38190-8, 1988.
6. American Society of Metals, “Composites - ASM Handbook”, Volume -21, ISBN: 978-0-87170-703, 2001.
7. Vasiliev, V.V. and Morozov, E.V., “Advanced Mechanics of Composite Materials”, Elsevier Ltd., New Delhi, 2011.

CI7003 CORROSION AND SURFACE ENGINEERING L T P C

3 0 0 3

OBJECTIVES:

- To impart knowledge on the scientific principles and methods that underlie the cause, detection, measurement and prevention of corrosion problems in engineering practices.
- To impart knowledge on the hands-on approaches for matching surface treatments with design and performance requirements.

UNIT I MECHANISMS AND TYPES OF CORROSION : 9

Principles of Corrosion – classification of corrosion – form of corrosion, general, localized, metallurgical influenced, mechanically assisted, environmentally induced corrosions - Factors influencing corrosion- corrosion damage – corrosion cost.

UNIT II TESTING AND PREVENTION OF CORROSION: 9

Planning and preparation of corrosion tests – In-service monitoring, simulated service, laboratory testing – Evaluation of corrosion - Prevention of Corrosion, suitable designing and modifications of corrosive environment, corrosion inhibitors -Cathodic Protection - Anodic protection - Protective surface coatings.

UNIT III CORROSION BEHAVIOR OF MATERIALS: **9**

Selection of material for various corrosive environments - Corrosion of Steels, Stainless Steel, Aluminum alloys, Copper alloys, Nickel and Titanium alloys –Corrosion of Polymers, Ceramics and Composite materials.

UNIT IV SURFACE COATINGS: 9

Solid surface significance, surface properties, superficial layer – changing surface metallurgy, chemistry and adding a surface layer or coating - Diffusion coatings- Electro and Electro less Plating-Hot dip coating-Hard facing-Metal spraying, Plasma spraying

UNIT V THIN LAYER ENGINEERING PROCESSES: 9

Laser and Electron Beam hardening- Thermal evaporation, Arc Vaporization, Sputtering, Ion plating-Vapor deposition processes, Implantation technique – Coating of tools, TiC, TiN, Al_2O_3 and Diamond coating – Properties and applications of thin coating

TOTAL: 45 PERIODS

OUTCOMES:

- Students can able to provide solution for the typical Industrial corrosion problem.
- Students can able to provide solution for different types of Surface Engineering problem.

REFERENCES:

1. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985
2. Budinski, K.G., “Surface Engineering for Wear Resistance”, Prentice Hall, 1988.
3. Schweitzer, P.A.,”Fundamentals of corrosion, Mechanisms, causes and preventive methods”, Taylor and Francis, Indian reprint, 2012.
4. Review, R. U., “Corrosion”, Hand Book 2nd Edition, John Wiley ,2000.
5. Burakowski, T. and Wierzchon, T., “Surface Engineering of Metals”, CRC press,1999
6. ASM Metals Hand Book – Volume 13 , Corrosion, 1999
7. ASM Metals Hand book – Volume 5, Surface Engineering, 1999.

CI7004 DESIGN FOR MANUFACTURING L T P C

3 0 0 3

OBJECTIVE:

- At the end of this course the student should be able 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. Peck, H., “Designing for manufacture”, Sir Isaac Pitman & Sons Ltd., 1973.
3. chang,T.C., Wysk,R.A. and Wang, H.P.,"Computer-Aided Manufacturing", Second Edition, Prentice Hall, 1998.
4. Molloy, O., E. A. Warman, and S. Tilley, Design for Manufacturing and Assembly: Concepts, Architectures and Implementation, Kluwer, 1998.

CI7005 DESIGN OF CELLULAR MANUFACTURING SYSTEM 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

OUTCOME:

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

CI7006 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 packaging technology

REFERENCES:

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

CI7007 FINITE ELEMENT ANALYSIS IN MANUFACUTRING ENGINEERING L T P C

3 0 0 3

OBJECTIVE:

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

CI7008 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. Huang, G.Q. and Mak, K.L., “Internet Applications in Product design and Manufacturing”, Springer, 2003.
2. Parsaei, H.R. and Jamshidi, M., “Design and implementation of intelligent manufacturing systems”, Prentics Hall, 1995.
3. Kusiak, A., “Intelligent Design and Manufacturing”, Wiley-Interscience, 1992.
4. Dagli, C.H., “Intelligent systems in design and manufacturing”, ASME, 1994.

CI7009 **LEAN MANUFACTURING** **L T P C**

3 0 0 3

OBJECTIVE:

- At the end of this course the students should be able 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. Rother, M., and Shook, J.,' Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA", Lean Enterprise Institute, 1999.
3. Liker, J., " The Toyota Way : Fourteen Management Principles from the World's Greatest Manufacturer",McGraw Hill, 2004.
4. Michael, L.G., " Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production
   Speed",McGraw Hill, 2002.
5. Ohno, T.," Toyota Production System: Beyond Large-Scale Production", Taylor & Francis, Inc., 1988.

CI7010 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 forming, micro moulding, micro casting , micro joining. Applications of Micro and Nano products in IT and telecommunications, Automotives, Medicine

UNIT II MANUFACTURING METHODS 9

Material deposition – PVD, CVD, LIGA, Micro stereo lithography, Traditional micromachining-Theory of micromachining-Chip formation-size effect in micromachining, micro turning, micro drilling, micro milling, micro grinding, Diamond turn machining-types of DTM, components of DTM, materail removal mechanisms, tool geometry, applications

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. Jain, V.K, “Micro manufacturing Processes”, by CRC Press, ISBN: 9781439852903, 2013.
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, 2014.
4. McGeough, J.A. Micromachining of Engineering Materials h **,** CRC Press, ISBN-10: 0824706447, 2001.

5. Bandyopadhyay, A.K., “Nano Materials”, New Age International Publishers, New Delhi, SBN 8122422578, 2008.
6. Grundy, P.J. and Jones, G.A.,”Electron Microscopy in the Study of Materials”, Edward Arnold Limited, 1976.

CI7011 PRECISION ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

The student will be able to understand the striving need for precision and application.

- Motivate the students to learn about the advanced concepts of precision and ultra precision Machining methods
- In addition, the student will enhance his/her knowledge in Precision Engineering and its applications.

UNIT I INTRODUCTION: 8

Accuracy and Precision– Need for high precision –concept of accuracy - tolerance and fits system – Hole and shaft system – accuracy of manufacturing processes – types of fits – Selective assembly.

UNIT II MATERIALS FOR PRECISION ENGINEERING: 8

Diamond – types-single crystal- PCD – Natural-synthetic CBN - Ceramics – coated metals and non-metals–High performance polymer – alloys – refractory metals: cutting tools – performance – components of instruments – Jewels – self Lubrication – smart materials – properties – testing – applications.

UNIT III PRECISION MACHINING: 10

Precision grinding: IC chip manufacturing- ELID process – aspherical surface generation Grinding wheel- Designer and selection of grinding wheel-High-speed grinding-High-speed milling-Micro machining – Diamond turning-MEMS – micro finishing process – surface roughness measures – concept and non-concept method – comparison of features with machining process.

UNIT IV ERRORS: CAUSES AND REMEDIES: 10

Static stiffness - influence on machining accuracy – over all stiffness in a machine/instrument – errors due to variation of cutting forces – clamping forces – errors due to compliance while machining. Inaccuracy due to thermal effects: Heat sources and dissipation – Geometry of thermal deformation-influence of forced isstratics dimensional wear of elements – instruments; Machining tools and their

influence on accuracy- error due to clamping and setting location.

UNIT V PRECISION MACHINE ELEMENTS: 9

Introduction- guide ways- Drive systems; rolling element bearings-Principles, construction, classification, application etc., - Lubricated sliding bearings - construction – Principles etc.,- Hydrostatics bearings-types – aerostatic bearings – linear drive motors – magnetic bearings-applications-limitations - advantages.

TOTAL: 45 PERIODS

OUTCOME:

Students will:

- Operate high precision machineries with ease.
- Research and explore new areas of cutting tools.

REFERENCES:

1. Murthy, R.L., “Precision Engineering in Manufacturing”, New age International Publications, New Delhi, 2005.
2. Venkatesh, V.C. and Sudin, I., “Precision engineering”, Tata McGraw Hill Co., New Delhi, 2007.
3. James, D. and Meadow, S., “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc., 1995.

CI7012 PRODUCTION PLANNING AND MANAGEMENT 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. Chase, Aquilano and Jacobs, “Production and Operations Management”, eighth Edition, Tata McGraw Hill, 2010.

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

CI7013 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. Modarres,M., "Reliability and Risk Analysis ", Meral Dekker Inc., 1993.
3. Nakajima, S., “Introduction to TPM”, Productivity Press, 1988.
4. Kales, P., “ Reliability for technology Engineering and Management ", Prentice Hall, New Jersey, 1998.
5. Gopalakrishnan. P., and Banerji, A.K., “Maintenance and Spare Parts Management ", Prentice Hall of India, New Delhi, 1996.

CI7014	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. 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.
2. 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.
3. Sinclair, I.R., “Sensors and Transducers” Elsevier India Private Limited, New Delhi, India, ISBN: 978-0-7506-4932-1, 2001.
4. 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.
5. 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.

CI7015 SUSTAINABLE MANUFACTURING L T P C
3 0 0 3

OBJECTIVE:

To provide the student with the knowledge of sustainability in manufacturing, its evaluation, strategy to achieve sustainability, supply chain management and sustainable operations.

UNIT I ENVIRONMENTAL VALUATION: 9

Introduction to the environmental issues pertaining to the manufacturing sector - pressure to reduce costs - processes that minimize negative environmental impacts - environmental legislation and energy costs - acceptable practice in society - adoption of low carbon technologies - need to reduce the carbon footprint of manufacturing operations.
Techniques for non-market valuation: cost and income based approaches, demand estimation methods - expressed and revealed preference, choice modeling - Multi-criteria analysis- Stakeholder analysis - Environmental accounting at sector and national levels.

UNIT II EVALUATING SUSTAINABILITY: 9

Sustainability performance evaluators- Frameworks and techniques - environmental management systems - life cycle assessment - strategic and environmental impact assessments - carbon and water foot-printing.

UNIT III MANUFACTURING STRATEGY FOR SUSTAINABILITY: 9

Concepts of Competitive Strategy and Manufacturing Strategies and development of a strategic improvement programme - Manufacturing strategy in business success Strategy formation and formulation - Structured strategy formulation - Sustainable manufacturing system design options - Approaches to strategy formulation - Realization of new strategies/system designs.

UNIT IV SUPPLY CHAIN MANAGEMENT: 9

Challenges in logistics and supply chain - developing the right supply chain strategy for the products - need to align the supply network around the strategy - Tools that can be used systematically to identify areas for improvement in supply chains - Specific challenges and new thinking in the plan, source and delivering of sub-processes.

UNIT V SUSTAINABLE OPERATIONS: 9

Principles of sustainable operations - Life cycle assessment Manufacturing and service activities - Influence of product design on operations - Process analysis - Capacity management - Quality management -Inventory management - Just-In-Time systems - Resource efficient design - Consumerism and sustainable well-being - Sustainable manufacturing and practices.

TOTAL: 45 PERIODS

OUTCOME:

On completion of the course the students will be able to apply techniques of environmental valuation, formulate strategy for sustainable manufacturing and plan sustainable operations and supply chain management.

REFERENCES:

1. Seliger, G ,"Sustainable Manufacturing: Shaping Global Value Creation", Springer, 2012.
2. Seliger, G.,"Sustainability in Manufacturing: Recovery of Resources in Product and Material Cycles", 2007.
3. Jovane, F., Ęmper, W.E. and Williams, D. J., "The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing", Springer, 2009.
4. Kutz, M.," Environmentally Conscious Mechanical Design", John Wiley & Sons, 2007.
5. Davim, J.P., "Sustainable Manufacturing", John Wiley & Sons, 2010.

CI7016 TECHNIQUES OF MATERIAL CHARACTERIZATION L T P C

3 0 0 3

OBJECTIVE:

- On completion of the course the students are expected to be knowledgeable 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. Culity, B.D., Stock, S.R. and Stock, S., "Elements of X ray Diffraction", (3rd Edition). Prentice Hall, 2001.
2. Davis, H.E., Hauck, G. and Troxell, G.E., "The Testing of engineering Materials", (4th Edition), McGraw Hill, College Divn., 1982.
3. Cherepin and Malik, "Experimental Techniques in Physical Metallurgy", Asia Publishing Co. Bombay, 1968.
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. Newby, J., “Metals Hand Book- Metallography & Micro Structures”, (9th Edition), ASM International, 1989.
6. Grundy, P.J. and Jones, G.A.,”Electron Microscopy in the Study of Materials”, Edward Arnold Limited, 1976.
7. Morita, S., Wiesendanger, R. and Meyer, E., “Noncontact Atomic Force Microscopy” Springer, 2002

CI7017 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

OUTCOME:

At the end of this course

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

REFERENCES:

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

CI7018	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. Besterfield, D.H., Besterfield, C.M, Besterfield, G.H. and Besterfield, M.S., “Total Quality Management ", Pearson Education, 2002.
2. Noori, H. and Radford,R., " Production and Operations management - Total Quality and Responsiveness ", McGraw-Hill Inc, 1995.
3. Dalela, S. and Saurabh, “ISO 9000 A Manual for Total Quality Management ", S.Chand and

Company Ltd., 1997.
4. Bank, J., " The Essence of Total Quality Management ", Prentice Hall of India Pvt.Ltd., 1995.
5. Zairi, M., “Total Quality Management for Engineers ", Woodhead Publishing Limited 1991.
6. Baird, C.W., “The Six Sigma Manual for Small and Medium Businesses”, Atlantic Publishing Company (FL), Reprint 2011.

CI7019 WAREHOUSE LAYOUT PLANNING AND PART FEEDING METHODS L T P C
3 0 0 3

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

OUTCOME:

Students will be able to:

- Design and plan warehouse layouts
- 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. Richards, G., "Warehouse Management: A complete guide to improving efficiency and minimizing costs in the modern warehouse", London Philadelphia, 2011.
5. Tompkins, J.A., and Smith, J.D., "The Warehouse Management Handbook", Tompkins press, 1998.
6. IS 1893(Part 1): 2002, Indian Standard, Criteria For Earthquake Resistant Design Of Structures, Part 1 General provisions and buildings, (Fifth Revision).

CI7071 COMPUTER AIDED PROCESS PLANNING L T P C

3 0 0 3

OBJECTIVE:

- 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

- Application of computers in the documentation
- Creating database for the future use
- Use of commercially available CAPP system in Industries

REFERENCES:

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

WEB REFERENCES:

1. http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm
2. http://Estraj.ute.sk/journal/englo/027/027.htm

CI7072 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS 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.

TEXT BOOK:

1. K.S.Fu, Gonzalez, R.C. and Lee, C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.

REFERENCES:

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

CI7073 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 system for manufacturing industry.

REFERENCES:

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

WEB REFERENCES:

1. www.ist.psu.edu
2. www.cse.wustl.edu(UML Notation Guide)

CI7074 MECHATRONICS IN MANUFACTURING 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. Smaili, .A. and Mrad, F., "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
3. Shetty, D. and Kolk, O. A., “Mechatronics systems design”, PWS Publishing company, 2007.
4. Onwubolu, G.C., "Mechatronics Principles and Applications", Elsevier, 2006.
5. Mahalik,N.P., “Mechatronics Principles, Concepts and applicatlions” Tata McGraw-Hill Publishing Company Limited, 2003.
6. Histand, M.B. and Alciatore,D.G., “Introduction to Mechatronics and Measurement systems”, McGraw Hill International edition, 1999.
7. Bradley, D.A., Dawson. D., Buru, N.C. and Loader, A.J., “Mechatronics” Nelson Thornes Ltd, Eswar press, Indian print, 2004.
8. Sinclair, I., “Sensors and Transducers”, Elsevier, Newnes, Reprint 2012.

CI7075 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. Hsu, T.R., “MEMS & Microsystems Design and Manufacture”, Tata McGraw Hill, 2002,ISBN: 9780070487093.

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

CI7076 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- The objective of this module is to provide the participants with a good knowledge on logistics and supply chain management and how these topics can be related with the organization and their business needs.

UNIT I INTRODUCTION TO SUPPLY CHAIN MANAGEMENT 8

Supply chain stages and decision phases process view of a supply chain. Supply chain flows. Examples of supply chains. Competitive and supply chain strategies. Achieving strategic fit. Expanding strategic scope. Drivers of supply chain performance. Framework for structuring drivers - Obstacles to achieving fit.Case discussions.

UNIT II DESIGNING THE SUPPLY CHAIN NETWORK 9

Distribution Networking – Role, Design. Supply Chain Network (SCN) – Role, Factors, Framework for Design Decisions. Models for facility location and capacity allocation. Impact of uncertainty on SCN – discounted cash flow analysis, evaluating network design decisions using decision using decision trees.

UNIT III SOURCING, TRANSPORTATION AND PRICING 10

Role of sourcing, supplier – scoring and assessment, selection and contracts. Design collaboration. Role of transportation, Factors affecting transportation decisions. Modes of transportation and their performance characteristics. Designing transportation network. Trade-off in transportation design. Tailored transportation, Routing and scheduling in transportation. International transportation. Analytical problems. Role Revenue Management in the supply chain, Revenue management for: Multiple customer segments, perishable assets, seasonal demand, bulk and spot contracts.

UNIT IV COORDINATION AND TECHNOLOGY 10

Co-ordination in a supply chain: Bullwhip effect. Obstacles to coordination. Managerial levers to achieve co-ordination, Building strategic partnerships. The role of IT supply Chain, The Supply Chain IT framework, CRM, Internal SCM, SRM. The role of E-business in a supply chain, The E-business framework, E-business in practice. Case discussion.

UNIT V EMERGING CONCEPTS 8

3PL- 4PL- Global Logistics -Reverse Logistics; Reasons, Activities, Role. Ware house Management-RFID Systems; Components, applications, implementation. Lean supply Chains-Sustainable supply Chains

TOTAL: 45 PERIODS

OUTCOMES:

- The objective of this module is to provide the participants with a good knowledge on logistics and supply chain management and how these topics can be related with the organization and their business needs.

REFERENCES

1. Sunil Chopra, Peter Meindl and Kalra, Supply Chain Management, Strategy, Planning, and operation,Pearson Education, 2013.
2. Robert B Handfield, Ernest L Nichols, Jr.,Supply Chain Redesign – Transforming Supply Chains into Integrated Value Systems , Pearson Education , 2002.
3. Jeremy F.Shapiro, Modeling the supply chain, Thomson Duxbury, 2006.
4. David Simchi Levi,Philip Kaminsky and Edith Simchi Levi, Designing and Managing the Supply Chain, Mc Graw Hill, 2009.

CI7251 ADDITIVE MANUFACTURING L T P C

3 0 0 3

OBJECTIVE:

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