ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
REGULATIONS 2017
M.E. MANUFACTURING ENGINEERING
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I.   To prepare students to excel in research or to succeed in Manufacturing engineering profession through global, rigorous post graduate education.
II. To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve Manufacturing engineering problems
III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.
IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Manufacturing engineering issues to broader social context.
V.   To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career

PROGRAMME OUTCOMES:

On successful completion of the programme,

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

PEO / PO Mapping

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

Semester Course wise PO mapping

			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
YEAR 1	SEM 1	Applied Probability and Statistics	✓	✓							✓	
		Advanced in Manufacturing Technology				✓	✓	✓				
		Computer Integrated Manufacturing Systems	✓	✓				✓			✓	
		Advances in Casting and Welding		✓		✓		✓			✓	
		Metal Cutting Theory and Practice	✓	✓		✓		✓				
		Professional Elective I										
		Practical										
		CAD/CAM Laboratory					✓	✓	✓			
	SEM 2	Optimization Techniques in Manufacturing	✓	✓			✓	✓				
		Advances in Metrology and Inspection		✓	✓				✓			
		Theory of Metal Forming		✓	✓			✓			✓	
		Tooling for Manufacturing		✓	✓			✓			✓	
		Professional Elective II										
		Professional Elective III										
		Practical										
		Automation and Metal Forming Laboratory	✓				✓	✓	✓			
		Technical Seminar						✓	✓	✓		✓
YEAR 2	SEM 3	Professional Elective IV Professional Elective V Professional Elective VI										
		Practical										
		Project Work Phase I		✓		✓				✓	✓	✓
	SEM 4	Project Work Phase II		✓		✓				✓	✓	✓

List of Electives
MAPPING OF POS WITH SUBJECTS
Semester: I Electives

S.No.	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Fluid Power Automation	✓	✓		✓		✓		✓	✓	
2	Design for Manufacture and Assembly	✓	✓			✓				✓	
3	Micro Manufacturing	✓			✓		✓			✓	
4	Quality and Reliability Engineering	✓	✓	✓							

Semester: II Electives

S.No	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Finite Element Methods for Manufacturing Engineering	✓	✓	✓			✓				
2	Materials Management		✓	✓	✓	✓					
3	Industrial Ergonomics		✓		✓			✓			✓
4	Polymers and Composite Materials		✓		✓		✓				
5	Non-Destructive Testing and Evaluation		✓	✓			✓		✓		✓
6	Lean Manufacturing		✓	✓			✓		✓		
7	Robot Design and Programming	✓	✓	✓			✓			✓	
8	MEMS and Nanotechnology	✓					✓			✓	

Semester: III Electives

S.No	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1	Computer Aided Product Design		✓				✓				
2	Process Planning and Cost Estimation	✓	✓	✓			✓				
3	Manufacturing Management	✓	✓	✓			✓				
4	Research Methodology	✓	✓	✓					✓		
5	Nanotechnology	✓			✓		✓	✓			
6	Materials Testing and Characterization Techniques		✓	✓							
7	Mechatronics		✓		✓		✓				
8	Internet of Things for Manufacturing		✓					✓		✓	
9	Data Analytics	✓	✓	✓					✓		
10	Manufacturing System Simulation		✓	✓			✓		✓		✓
11	Product Lifecycle Management	✓	✓				✓	✓	✓	✓	
12	Additive Manufacturing		✓	✓							✓
13	Product Design and Development		✓		✓		✓	✓	✓		
14	Entrepreneurship Development		✓							✓	
15	Industrial Safety		✓							✓	✓

ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

REGULATIONS 2017

M.E. MANUFACTURING ENGINEERING

CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS (FULL TIME) CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	MA5160	Applied Probability and Statistics	FC	4	4	0	0	4
2.	MF5101	Advanced in Manufacturing Technology	PC	3	3	0	0	3
3.	MF5102	Computer Integrated Manufacturing Systems	PC	3	3	0	0	3
4.	MF5103	Advances in Casting and Welding	PC	3	3	0	0	3
5.	MF5104	Metal Cutting Theory and Practice	PC	4	4	0	0	4
6.		Professional Elective I	PE	3	3	0	0	3
PRACTICAL								
7.	MF5111	CAD/CAM Laboratory	PC	4	0	0	4	2
			TOTAL	**24**	**20**	**0**	**4**	**22**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MF5201	Optimization Techniques in Manufacturing	PC	5	3	2	0	4
2	CM5251	Advances in Metrology and Inspection	PC	3	3	0	0	3
3	MF5202	Theory of Metal Forming	PC	3	3	0	0	3
4	MF5203	Tooling for Manufacturing	PC	4	4	0	0	4
5		Professional Elective II	PE	3	3	0	0	3
6		Professional Elective III	PE	3	3	0	0	3
PRACTICAL								
7	MF5211	Automation and Metal Forming Laboratory	PC	4	0	0	4	2
8	MF5212	Technical Seminar	EEC	2	0	0	2	1
			TOTAL	**28**	**19**	**2**	**6**	**23**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective IV	PE	3	3	0	0	3
2		Professional Elective V	PE	3	3	0	0	3
3		Professional Elective VI	PE	3	3	0	0	3
PRACTICAL								
4	MF5311	Project Work Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICAL								
1	MF5411	Project Work Phase II	EEC	24	0	0	24	12
			TOTAL	**24**	**0**	**0**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 72

FOUNDATION COURSES (FC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA5160	Applied Probability and Statistics	FC	4	4	0	0	4

PROFESSIONAL CORE (PC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5101	Advanced in Manufacturing Technology	PC	3	3	0	0	3
2.	MF5102	Computer Integrated Manufacturing Systems	PC	3	3	0	0	3
3.	MF5103	Advances in Casting and Welding	PC	3	3	0	0	3
4.	MF5104	Metal Cutting Theory and Practice	PC	5	4	0	0	4
5.	MF5111	CAD/CAM Laboratory	PC	4	0	0	4	2
6.	MF5201	Optimization Techniques in Manufacturing	PC	5	3	2	0	4
7.	CM5251	Advances in Metrology and Inspection	PC	5	3	0	2	4
8.	MF5202	Theory of Metal Forming	PC	3	3	0	0	3
9.	MF5203	Tooling for Manufacturing	PC	5	3	2	0	4
10.	MF5211	Automation and Metal Forming Laboratory	PC	4	0	0	4	2

LIST OF ELECTIVES FOR M.E. MANUFACTURING ENGINEERING

SEMESTER I (Elective I)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5001	Fluid Power Automation	PE	3	3	0	0	3
2.	MF5002	Design for Manufacture and Assembly	PE	3	3	0	0	3
3.	MF5003	Micro Manufacturing	PE	3	3	0	0	3
4.	MF5004	Quality and Reliability Engineering	PE	3	3	0	0	3

SEMESTER II (Elective II & III)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5005	Finite Element Methods for Manufacturing Engineering	PE	3	3	0	0	3
2.	MF5006	Materials Management	PE	3	3	0	0	3
3.	MF5007	Industrial Ergonomics	PE	3	3	0	0	3
4.	MF5008	Polymers and Composite Materials	PE	3	3	0	0	3
5.	MF5009	Non-Destructive Testing and Evaluation	PE	3	3	0	0	3
6.	MF5071	Lean Manufacturing	PE	3	3	0	0	3
7.	MF5010	Robot Design and Programming	PE	3	3	0	0	3
8.	MF5011	MEMS and Nanotechnology	PE	3	3	0	0	3

SEMESTER III (Elective IV, V & VI)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5012	Computer Aided Product Design	PE	3	3	0	0	3
2.	MF5013	Process Planning and Cost Estimation	PE	3	3	0	0	3
3.	MF5014	Manufacturing Management	PE	3	3	0	0	3
4.	MF5072	Research Methodology	PE	3	3	0	0	3
5.	MF5015	Nanotechnology	PE	3	3	0	0	3
6.	MF5016	Materials Testing and Characterization Techniques	PE	3	3	0	0	3
7.	MF5017	Mechatronics	PE	3	3	0	0	3
8.	MF5073	Internet of Things for Manufacturing	PE	3	3	0	0	3
9	IL5091	Data Analytics	PE	3	3	0	0	3
10	CM5093	Manufacturing System Simulation	PE	3	3	0	0	3
11	PD5091	Product Lifecycle Management	PE	3	3	0	0	3
12	CM5091	Additive Manufacturing	PE	3	3	0	0	3
13	MF5018	Product Design and Development	PE	3	3	0	0	3
14	MF5074	Entrepreneurship Development	PE	3	3	0	0	3
15	MF5075	Industrial Safety	PE	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MF5212	Technical Seminar	EEC	2	0	0	2	1
2.	MF5311	Project Work Phase I	EEC	12	0	0	12	6
3.	MF5411	Project Work Phase II	EEC	24	0	0	24	12

MA5160   **APPLIED PROBABILITY AND STATISTICS**   **L T P C**
                                                                              4 0 0 4

OBJECTIVES :
This course is designed to provide the solid foundation on topics in applied probability and various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis and multivariate analysis.

UNIT I   PROBABILITY AND RANDOM VARIABLES   12
Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.

UNIT II   TWO DIMENSIONAL RANDOM VARIABLES   12
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT III   ESTIMATION THEORY   12
Unbiased estimators – Method of moments – Maximum likelihood estimation - Curve fitting by principle of least squares – Regression lines.

UNIT IV   TESTING OF HYPOTHESIS   12
Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.

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
OUTCOMES :
After completing this course, students should demonstrate competency in the following topics:
- Basic probability axioms and rules and the moments of discrete and continuous random variables.
- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.
- The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES :
1. Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 1998.
2. Devore, J. L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
3. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", Sultan and Sons, New Delhi, 2001.

4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers ", Pearson Education, Asia, 8th Edition, 2015.
5. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 5th Edition, Pearson Education, Asia, 2002.

MF5101   **ADVANCES IN MANUFACTURING TECHNOLOGY**   **L T P C**
                                                              3 0 0 3

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

UNIT I   UNCONVENTIONAL MACHINING   10
Introduction-Bulk processes - surface processes- Plasma Arc Machining- Laser Beam Machining-Electron Beam Machining-Electrical Discharge Machining – Electro chemical Machining-Ultrasonic Machining- Water Jet Machining-Electro Gel Machining-Anisotropic machining-Isotropic machining-Elastic Emission machining – Ion Beam Machining.

UNIT II   PRECISION MACHINING: 10
Ultra Precision turning and grinding: Chemical Mechanical Polishing (CMP) - ELID process – Partial ductile mode grinding-Ultra precision grinding- Binderless wheel – Free form optics. aspherical surface generation Grinding wheel- Design and selection of grinding wheel-High-speed grinding-High-speed milling- Diamond turning.

UNIT III   ADVANCES IN METAL FORMING   7
Orbital forging, Isothermal forging, Warm forging, Overview of Powder Metal techniques –Hot and Cold isostatic pressing - high speed extrusion, rubber pad forming, Hydroforming, Superplastic forming, Peen 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.-Diffusion coatings-Pulsed layer deposition.

                                                           TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
1. to produce useful research output in machining of various materials
2. use this knowledge to develop hybrid machining techniques
3. Application of this knowledge to manage shop floor problems

REFERENCES
1. Benedict,G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, SecondEdition, CRC Press (ISBN: 0849308267), 2006.
3. McGeough,J.A.,"Advanced methods of Machining",Springer,2011
4. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,1989.
5. Pandey, P.S. and Shah.N., "Modern Manufacturing Processes", Tata McGraw Hill, 1980.
6. Serope Kalpakjian., "Manufacturing Engineering and Technology" Pearson Education,2001

MF5102	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L T P C
		3 0 0 3

OBJECTIVES:
This course will enable the Student
- To gain knowledge about the basic fundamental of CAD.
- To gain knowledge on how computers are integrated at various levels of planning and manufacturing understand computer aided planning and control and computer monitoring.

UNIT I   COMPUTER AIDED DESIGN   9
Concept of CAD as drafting and designing facility, desirable features of CAD package, drawing features in CAD – Scaling, rotation, translation, editing, dimensioning, labeling, Zoom, pan, redraw and regenerate, typical CAD command structure, wire frame modeling, surface modeling and solid modeling (concepts only) in relation to popular CAD packages.

UNIT II   COMPONENTS OF CIM   9
CIM as a concept and a technology, CASA/Sme model of CIM, CIM II, benefits of CIM, communication matrix in CIM, fundamentals of computer communication in CIM – CIM data transmission methods – seriel, parallel, asynchronous, synchronous, modulation, demodulation, simplex and duplex. Types of communication in CIM – point to point (PTP), star and multiplexing. Computer networking in CIM – the seven layer OSI model, LAN model, MAP model, network topologies – star, ring and bus, advantages of networks in CIM

UNIT III   GROUP TECHNOLOGY AND COMPUTER AIDED PROCESS PLANNING   9
History Of Group Technology – role of G.T in CAD/CAM Integration – part families- classification and coding – DCLASS and MCLASS and OPTIZ coding systems – facility design using G.T – benefits of G.T – cellular manufacturing. Process planning - role of process planning in CAD/CAM Integration – approaches to computer aided process planning – variant approach and generative approaches – CAPP and CMPP systems.

UNIT IV   SHOP FLOOR CONTROL AND INTRODUCTION TO FMS   9
Shop floor control – phases – factory data collection system – automatic identification methods – Bar code technology – automated data collection system.
FMS – components of FMS – types – FMS workstation – material handling and storage system – FMS layout- computer control systems – applications and benefits.

UNIT V   COMPUTER AIDED PLANNING AND CONTROL AND
**   COMPUTER MONITORING   9**
Production planning and control – cost planning and control – inventory management – material requirements planning (MRP) – shop floor control. Lean and Agile Manufacturing. Types of production monitoring systems – structure model of manufacturing – process control and strategies – direct digital control.

OUTCOMES:
At the end of this course the students are expected
1. to produce useful research output in computer integrated manufacturing
2. use this knowledge to develop computer techniques
3. Application of this knowledge to functionalise computer aided planning.

TOTAL: 45 PERIODS

REFERENCES:
1. Chris McMahon and Jimmie Browne, "CAD CAM Principles, Practice and Manufacturing Management", Pearson Education second edition, 2005.Ranky, Paul G., "Computer Integrated Manufacturing", Prentice hall of India Pvt. Ltd.,2005.
2. James A. Regh and Henry W. Kreabber, "Computer Integrated Manufacturing", Pearson Education second edition, 2005.
3. Mikell. P. Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education 2001.
4. Mikell. P. Groover and Emory Zimmers Jr.,"CAD/CAM", Prentice hall of India Pvt.Ltd., 1998.
5. P N Rao, " CAD/CAM Principles and Applications", TMH Publications, 2007.
6. Yorem Koren, "Computer Integrated Manufacturing", McGraw Hill, 2005.

MF5103	ADVANCES IN CASTING AND WELDING	L T P C
		3 0 0 3

OBJECTIVES:
- To study the metallurgical concepts and applications of casting and welding process.
- To acquire knowledge in CAD of casting and automation of welding process.

UNIT I   CASTING DESIGN   8
Heat transfer between metal and mould — Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering

UNIT II   CASTING METALLURGY   8
Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification — Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys, Babbit alloy and Cu alloy.

UNIT III   RECENT TRENDS IN CASTING AND FOUNDRY LAYOUT   8
Shell moulding, precision investment casting, CO_2 moulding, centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry — Computer aided design of casting.

UNIT IV   WELDING METALLURGY AND DESIGN   10
Heat affected Zone and its characteristics – W eldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.

UNIT V   RECENT TRENDS IN WELDING   11

Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electroslag welding- narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water
welding.

OUTCOMES:

At the end of this course the students are expected to impart knowledge on basic concepts and advances in casting and welding processes.

TOTAL: 45 PERIODS

REFERENCES:
1. ASM Handbook vol.6, welding Brazing & Soldering, 2003
2. ASM Handbook, Vol 15, Casting, 2004
3. Carrry B., Modern Welding Technology, Prentice Hall Pvt Ltd., 2002
4. CORNU.J. Advanced welding systems – Volumes I, II and III, JAICO Publishers, 1994.
5. HEINELOPER & ROSENTHAL, Principles of Metal Casting, Tata McGraw Hill, 2000.
6. IOTROWSKI – Robotic welding – A guide to selection and application – Society of mechanical Engineers, 1987.
7. Jain P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003
8. LANCASTER.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980
9. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002
10. SCHWARIZ, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO), 1981
11. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002

MF5104   METAL CUTTING THEORY AND PRACTICE   L T P C
                                                               4 0 0 4

OBJECTIVES:
- To make the students familiar with the various principles of metal cutting, cutting tool materials and its wear mechanisms during the machining operation.

UNIT I   INTRODUCTION   12

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

UNIT II   SYSTEM OF TOOL NOMENCLATURE   12

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

UNIT III   THERMAL ASPECTS OF MACHINING   12

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

UNIT IV   TOOL MATERIALS, TOOL LIFE AND TOOL WEAR   12

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

UNIT V   WEAR MECHANISMS AND CHATTER IN MACHINING   12

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

OUTCOMES :

At the end of this course the students are expected to impart the knowledge and train the students in the area of metal cutting theory and its importance.

TOTAL: 60 PERIODS

REFERENCES

1. Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India, 1984.
2. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 1989.
3. Shaw.M.C.Metal cutting principles, oxford Clare don press, 1984.

MF5111   **CAD / CAM LABORATORY**   **L T P C**
                                                                         0 0 4 2

OBJECTIVES:

* To teach the students about the drafting of 3D components and analyzing the same using various CAD packages and programming of CNC machines
* To train them to use the various sensors

CAM LABORATORY

1. Exercise on CNC Lathe: Plain Turning, Step turning, Taper turning, Threading, Grooving canned cycle
2. Exercise on CNC Milling Machine: Profile Milling, Mirroring, Scaling & canned cycle. Study of Sensors, Transducers & PLC: Hall-effect sensor, Pressure sensors, Strain gauge, PLC, LVDT, Load cell, Angular potentiometer, Torque, Temperature & Optical Transducers.

CAD LABORATORY

2D modeling and 3D modeling of components such as

1. Bearing
2. Couplings
3. Gears
4. Sheet metal components
5. Jigs, Fixtures and Die assemblies.

TOTAL: 60 PERIODS

OUTCOMES :

At the end of this course the students are expected
* To impart the knowledge on training the students in the area of CAD/CAM

LIST OF EQUIPMENTS

S.NO	EQUIPMENT	QUANTITY
1.	Computer Server	1
2.	Computer nodes or systems (High end CPU with atleast 1 GB main memory) networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
5.	CNC Lathe	1
6.	CNC milling machine	1
SOFTWARE		
7.	Any High end integrated modeling and manufacturing CAD / CAM software	15 licenses
8.	CAM Software for machining centre and turning centre (CNC Programming and tool path simulation for FANUC / Sinumeric and Heidenhain controller)	15 licenses
9.	Licensed operating system	adequate
10.	Support for CAPP	adequate

MF5201   **OPTIMIZATION TECHNIQUES IN MANUFACTURING**   **L T P C**
                                                                 3 2 0 4

OBJECTIVES:
- To make use of the above techniques while modeling and solving the engineering problems of different fields.

UNIT I   INTRODUCTION   5
Optimization – Historical Development – Engineering applications of optimization – Statement of an Optimization problem – classification of optimization problems.

UNIT II   CLASSIC OPTIMIZATION TECHNIQUES   10
Linear programming - Graphical method – simplex method – dual simplex method – revised simplex method – duality in LP – Parametric Linear programming – Goal Programming.

UNIT III   NON-LINEAR PROGRAMMING   9
Introduction – Lagrangeon Method – Kuhn-Tucker conditions – Quadratic programming – Separable programming – Stochastic programming – Geometric programming

UNIT IV INTEGER PROGRAMMING AND DYNAMIC PROGRAMMING AND NETWORK TECHNIQUES 12

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

UNIT V ADVANCES IN SIMULATION 9

Genetic algorithms – simulated annealing – Neural Network and Fuzzy systems

TOTAL: 75 PERIODS

OUTCOME :

At the end of this course the students will be expected to introduce the various optimization techniques and their advancements.

REFERENCES:

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

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

OBJECTIVES:

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

UNIT I CONCEPTS OF METROLOGY: 8

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

UNIT II MEASUREMENT OF SURFACE ROUGHNESS: 9

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

UNIT III INTERFEROMETRY: 8

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

UNIT IV MEASURING MACHINES AND LASER METROLOGY: 10

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

UNIT V   IMAGE PROCESSING FOR METROLOGY: 10

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

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected to
1. Understand the advanced measurement principles with ease.
2. Operate sophisticated measurement and inspection facilities.
3. Design and develop new measuring methods.

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

MF5202   **THEORY OF METAL FORMING**   **L T P C**
                                                                            3 0 0 3

OBJECTIVES:
- To study the basic concepts of metal forming techniques and to develop force calculation in metal forming process.
- To study the thermo mechanical regimes and its requirements of metal forming

UNIT I   THEORY OF PLASTICITY   9
Theory of plastic deformation – Yield criteria – Tresca and Von-mises – Distortion energy – Stress-strain relation – Mohr's circle representation of a state of stress – cylindrical and spherical co-ordinate system – upper and lower bound solution methods – Overview of FEM applications in Metal Forming analysis.

UNIT II   THEORY AND PRACTICE OF BULK FORMING PROCESSES   8
Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

UNIT III   SHEET METAL FORMING   8
Formability studies – Conventional processes – H E R F techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application

UNIT IV   POWDER METALLURGY AND SPECIAL FORMING PROCESSES   9
Overview of P/M technique – Advantages – applications – Powder preform forging – powder rolling – Tooling, process parameters and applications. - Orbital forging – Isothermal forging – Hot and cold isostatic pressing – High speed extrusion – Rubber pad forming – Fine blanking – LASER beam forming

UNIT V   SURFACE TREATMENT AND METAL FORMING APPLICATIONS   9

Experiment techniques of evaluation of friction in metal forming selection – influence of temperature and gliding velocity – Friction heat generation – Friction between metallic layers – Lubrication carrier layer – Surface treatment for drawing, sheet metal forming, Extrusion, hot and cold forging.
Processing of thin Al tapes – Cladding of Al alloys – Duplex and triplex steel rolling – Thermo mechanical regimes of Ti and Al alloys during deformation – Formability of welded blank sheet – Laser structured steel sheet - Formability of laminated sheet.

OUTCOMES :

At the end of this course the students are expected to upgrade their knowledge on plasticity, surface treatment for forming of various types of metal forming process.

TOTAL: 45 PERIODS

REFERENCES:
1. Altan T., Metal forming – Fundamentals and applications – American Society of Metals, Metals park, 2003
2. ALTAN.T, SOO-IK-oh, GEGEL, HL – Metal forming, fundamentals and Applications, American Society of Metals, Metals Park, Ohio, 1995.
3. ASM Hand book, Forming and Forging, Ninth edition, Vol – 14, 2003
4. Dieter G.E., Mechanical Metallurgy (Revised Edition II) McGraw Hill Co., 1988
5. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes and Equipment, CRC publication press, 2012.
6. Marciniak,Z., Duncan J.L., Hu S.J., 'Mechanics of Sheet Metal Forming', Butterworth-Heinemann An Imprint of Elesevier, 2006
7. Nagpal G.R., Metal Forming Processes- Khanna publishers, 2005.
8. Proc. Of National Seminar on "Advances in Metal Forming" MIT, March 2000
9. SAE Transactions, Journal of Materials and Manufacturing Section 5, 1993-2007
10. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
11. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,2010

MF5203   TOOLING FOR MANUFACTURING   L T P C
**   4 0 0 4**

OBJECTIVES:
- To study the various design considerations for tooling.
- Develop knowledge in tooling and work holding devices

UNIT I   INTRODUCTION   12
Manufacturing Processes-objectives of manufacturing processes-classification of manufacturing process-Objectives of Tool design-tool design process-Nature and scope of Tool engineering-principles of economy for tooling-problems of economy in tooling-planning and tooling for economy-Manufacturing principles applicable to process and tool planning-tool control-tool maintenance-tool materials and its selection

UNIT II   TOOLING FOR METAL REMOVAL PROCESSES   12
Traditional machining processes -work and tool holding devices-tool nomenclatures-Mechanism of machining-force temperature and tool life of single point tool-multipoint tools -tool design-tool wear-special processes-capstan and turret lathe-tooling layout of automats-tooling in NC and CNC machines-tooling for machining centres-CAD in tool design-Jigs and fixtures-design-Non-traditional material removal processes-mechanical, electrical thermal and chemical energy processes-principles-operation-equipment-tooling parameters and limitations

UNIT III   TOOLING FOR METAL FORMING PROCESSES   12
Classification of Forming processes-Types of presses-design of -blanking and piercing dies-simple, compound, combination and progressive dies-Drawing dies-Bending dies-forging dies-plastic moulding dies

UNIT IV   TOOLING FOR METAL CASTING AND METAL JOINING PROCESSES   12
Tools and Equipment for moulding-patterns –pattern allowances – pattern construction-die casting tools- mechanization of foundries. Tooling for Physical joining processes Design of welding fixtures – Arc welding, Gas welding, Resistance welding, laser welding fixtures-Tooling for Soldering and Brazing Tooling for Mechanical joining processes

UNIT V   TOOLING FOR INSPECTION AND GAUGING   12
Survey of linear and angular measurements-standards of measurement-design and manufacturing of gauges- measurement of form-Inspection bench centre-co-ordinate measuring machine-tooling in CMM.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of this course the students are well versed in
1. State of Art in Tooling in Manufacturing and Inspection
2. Design and Develop tooling for Flexible Manufacturing

REFERENCES:
1. Cyril Donaldson Tool Design, Tata McGraw Hill, 1976
2. Hoffman E.G Fundamentals of tool design SME 1984.
3. Kalpak Jian S., Manufacturing Engineering and Technology Addison Wesley 1995.
4. L E Doyle Tool Engineering Prentice Hall 1950
5. Wellar, J Non-Traditional Machining Processes, SME, 1984

MF5211	**AUTOMATION AND METAL FORMING LABORATORY**	L T P C
		0 0 4 2

OBJECTIVE
- To train the students to have an hands on having the basic concepts of metal forming processes and to determine some metal forming parameters for a given shape.

EXPERIMENTS
1. Determination of strain hardening exponent
2. Determination of strain rate sensitivity index
3. Construction of formability limit diagram
4. Determination of efficiency in water hammer forming
5. Determination of interface friction factor
6. Determination of extrusion load
7. Study on two high rolling process

AUTOMATION LAB
1. Simulation of single and double acting cylinder circuits
2. Simulation of Hydraulic circuits
3. Simulation of electro pneumatic circuits
4. Simulation of electro hydraulic circuits
5. Simulation of PLC circuits
6. Software simulation of fluid power circuits using Automation studio.

TOTAL: 60 PERIODS

OUTCOMES:
At the end of this course the students are expected
* To impart practical knowledge on bulk metal forming and sheet metal forming processes

MF5212   **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

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

TOTAL: 30 PERIODS

MF5001   **FLUID POWER AUTOMATION**   **L T P C**
                                                                             3 0 0 3

OBJECTIVES:
* To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.
* To train the students in designing the hydraulics and pneumatic circuits using various design procedures.

UNIT I   INTRODUCTION   5
Need for Automation, Hydraulic & Pneumatic Comparison – ISO symbols for fluid power elements, Hydraulic, pneumatics – Selection criteria.

UNIT II   FLUID POWER GENERATING/UTILIZING ELEMENTS   8
Hydraulic pumps and motor gears, vane, piston pumps-motors-selection and specification-Drive characteristics – Linear actuator – Types, mounting details, cushioning – power packs – construction. Reservoir capacity, heat dissipation, accumulators – standard circuit symbols, circuit (flow) analysis.

UNIT III   CONTROL AND REGULATION ELEMENTS   8
Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and underlapped spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance.

UNIT IV   CIRCUIT DESIGN   10
Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade, method-truth table-Karnaugh map method-sequencing circuits-combinational and logic circuit.

UNIT V   ELECTRO PNEUMATICS & ELECTRONIC CONTROL OF HYDRAULIC
**   AND PNEUMATIC CIRCUITS   7**
Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, PLC ladder diagram for various circuits, motion controllers, use of field busses in circuits. Electronic drive circuits for various Motors.

TOTAL: 45 PERIODS

OUTCOMES :
At the end of this course the students are familiarized in the area of hydraulics, pneumatic and fluid power components and its functions.

REFERENCES:
1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 1988
2. Dudbey. A. Peace, Basic Fluid Power, Prentice Hall Inc, 1967.
3. E.C.Fitch and J.B.Suryaatmadyn. Introduction to fluid logic, McGraw Hill, 1978
4. Herbert R. Merritt, Hydraulic control systems, John Wiley & Sons, Newyork, 1967
5. Peter Rohner, Fluid Power Logic Circuit Design, Mcmelan Prem, 1994.
6. Peter Rohner, Fluid Power logic circuit design. The Macmillan Press Ltd.,London, 1979
7. W.Bolton, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education, 2003.

MF5002	DESIGN FOR MANUFACTURE AND ASSEMBLY	L T P C
		3 0 0 3

OBJECTIVES:
- To make the students learn about tolerance analysis, allocation and geometrical tolerances.
- Guidelines for design for manufacturing and assembly with examples.

UNIT I   TOLERANCE ANALYSIS   8
Introduction – Concepts, definitions and relationships of tolerancing – Matching design tolerances with appropriate manufacturing process – manufacturing process capability metrics – Worst care, statistical tolerance Analysis – Linear and Non-Linear Analysis – Sensitivity Analysis – Taguchi's Approach to tolerance design.

UNIT II   TOLERANCE ALLOCATION   8
Tolerance synthesis – Computer Aided tolerancing – Traditional cost based analysis – Taguchi's quality loss function – Application of the Quadratic loss function to Tolerancing – Principles of selective Assembly – Problems.

UNIT III   GD&T   10
Fundamentals of geometric dimensioning and tolerancing – Rules and concepts of GD&T – Form controls – Datum systems – Orientation controls – Tolerance of position – Concentricity and symmetry controls – Run out controls – Profile controls.

UNIT IV   TOLERANCE CHARTING   9
Nature of the tolerance buildup – structure and setup of the tolerance chart – piece part sketches for tolerance charts – Arithmetic ground rules for tolerance charts – Determination of Required balance dimensions – Determination of Mean working Dimensions – Automatic tolerance charting – Tolerance charting of Angular surfaces.

UNIT V   MANUFACTURING GUIDELINES   10

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

TOTAL: 45 PERIODS

OUTCOMES :
At the end of this course the students are expected
- To impart the knowledge about the significance of design for manufacturing and assembly

REFERENCES:
1. Alex Krulikowski, "Fundamentals GD&T", Delmar Thomson Learning, 1997.
2. C.M. Creveling, "Tolerance Design – A handbook for Developing Optimal Specifications", Addison – Wesley, 1997.
3. James D. Meadows, 'Geometric Dimensioning and Tolerancing", Marcel Dekker Inc., 1995.
4. James G. Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1986.
5. Oliver R. Wade, "Tolerance Control in Design and Manufacturing", Industrial Press, NY, 1967.

MF5003	MICRO MANUFACTURING	L T P C
		3 0 0 3

OBJECTIVE:
- The objective of the course is to acquaint the students with the principles, basic machine tools, and developments in the micro manufacturing process and research trends in the area of micro manufacturing process.

UNIT I   MICRO MACHINING I   10
Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT II   MICRO MACHINING II   10
Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining –Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT III   NANO POLISHING   9
Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemo-mechanical Polishining.

UNIT IV   MICRO FORMING AND WELDING   9
Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam for micro welding.

UNIT V   RECENT TRENDS AND APPLICATIONS   7
Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

TOTAL: 45 PERIODS

OUTCOMES :
At the end of this course the students are well experienced
- To impart the principles of various basic micro manufacturing process

REFERENCES:
1. Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN:8122422578.
2. Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010.
3. Jain V.K., 'Introduction to Micro machining' Narosa Publishing House, 2011
4. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi, 2002
5. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012
6. Janocha H., Actuators – Basics and applications, Springer publishers – 2012
7. Mcgeoug.J.A., Micromachining of Engineering Materials, CRC press 2001, ISBN-10:0824706447.
8. www.cmxr.com/industrial/
9. www.sciencemag.org.handbook

MF5004   **QUALITY AND RELIABILITY ENGINEERING**   **L T P C**
                                                                              3 0 0 3

OBJECTIVES:
To make the students to understand the various quality control techniques and to construct the various quality control charts for variables and attributes and also the design concepts for reliable system and maintenance aspects in industries.

UNIT I   QUALITY & STATISTICAL PROCESS CONTROL   8
Quality – Definition – Quality Assurance – Variation in process – Factors – process capability – control charts – variables X, R and X, - Attributes P, C and U-Chart tolerance design. Establishing and interpreting control charts – charts for variables – Quality rating – Short run SPC.

UNIT II   ACCEPTANCE SAMPLING   8
Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling plans – OC curves – Producer's risk and consumer's risk. AQL, LTPD, AOQL, Concepts – standard sampling plans for AQL and LTPD – use of standard sampling plans.

UNIT III   EXPERIMENTAL DESIGN AND TAGUCHI METHOD   9
Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

UNIT IV   CONCEPT OF RELIABILITY   9
Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covarient models, static models, dynamic models.

UNIT V   DESIGN FOR RELIABILITY AND MAINTAINABILITY   11
Reliability design process, system effectiveness, economic analysis and life cycle cost, reliability allocation, design methods, parts and material selection, derating, stress-strength and analysis, failure analysis, identification determination of causes, assessments of effects, computation of criticality index, corrective action, system safety – analysis of down-time – the repair time distribution, stochastic point processes system repair time, reliability under preventive maintenance state dependent system with repair. MTTR – mean system down time, repair vs replacement, replacement models, proactive, preventive, predictive maintenance maintainability and availability, optimization techniques for system reliability with redundancy heuristic methods applied to optimal system reliability.

                                                              TOTAL: 45 PERIODS

OUTCOMES :

At the end of this course the students are exposed to the various quality control techniques , to understand the importance and concept of reliability and maintainability in industries.

REFERENCES:
1. Amata Mitra "Fundamentals of Quality Control and improvement" Pearson Education, 2002.
2. Bester field D.H., "Quality Control" Prentice Hall, 1993.
3. Charles E Ebling, An Introduction to Reliability and Maintability Engineering, Tata-McGraw Hill, 2000.
4. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2002.
5. Dhillon, Engineering Maintainability – How to design for reliability and easy maintenance, PHI, 2008.
6. Patrick D To' corner, Practical Reliability Engineering, John-Wiley and Sons Inc, 2002

MF5005   **FINITE ELEMENT METHODS FOR MANUFACTURING   L T P C**
                ENGINEERING   3 0 0 3

OBJECTIVE:
- To study the fundamentals of one dimensional and two dimensional problems using FEA in manufacturing.

UNIT I   INTRODUCTION   6
Fundamentals – Initial, boundary and eigen value problems – weighted residual, Galerkin and Rayleigh Ritz methods - Integration by parts – Basics of variational formulation – Polynomial and Nodal approximation.

UNIT II   ONE DIMENSIONAL ANALYSIS   10
Steps in FEM – Discretization. Interpolation, derivation of elements characteristic matrix, shape function, assembly and imposition of boundary conditions-solution and post processing – One dimensional analysis in solid mechanics and heat transfer.

UNIT III   SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS   10
Shape functions for one and two dimensional elements- Three noded triangular and four nodded quadrilateral element Global and natural co-ordinates—Non linear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional, plane stress, plane strain and axisymmetric analysis.

UNIT IV   COMPUTER IMPLEMENTATION   9
Pre Processing, mesh generation, elements connecting, boundary conditions,   input of material and processing characteristics – Solution and post processing – Overview of application packages – Development of code for one dimensional analysis and validation

UNIT V   ANALYSIS OF PRODUCTION PROCESSES   10
FE analysis of metal casting – special considerations, latent heat incorporation, gap element – Time stepping procedures – Crank – Nicholson algorithm – Prediction of grain structure – Basic concepts of plasticity and fracture – Solid and flow formulation – small incremental deformation formulation – Fracture criteria – FE analysis of metal cutting, chip separation criteria, incorporation of strain rate dependency – FE analysis of welding.

                                                                TOTAL: 45 PERIODS

OUTCOMES :

At the end of this course the students are highly confident in
- Finite element methods and its application in manufacturing.

REFERENCES:
1. Bathe, K.J., Finite Element procedures in Engineering Analysis, 1990
2. Kobayashi,S, Soo-ik-Oh and Altan,T, Metal Forming and the Finite Element Methods, Oxford University Press, 1989.
3. Lewis R.W. Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite Element Method in Heat Transfer Analysis, John Wiley, 1994.
4. Rao, S.S., Finite Element method in engineering, Pergammon press, 2005.
5. Reddy, J.N. An Introduction to the Finite Element Method, McGraw Hill,2005.
6. Seshu P., Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd, 2004.
7. www.pollockeng.com
8. www.tbook.com

MF5006	MATERIALS MANAGEMENT	L T P C
		3 0 0 3

OBJECTIVE :
To introduce to the students the various concepts of materials management

UNIT I   INTRODUCTION   6
Introduction to materials management – Objectives – Functions – Operating Cycle – Value analysis – Make or buy decisions.

UNIT II   MANAGEMENT OF PURCHASE   7
Purchasing policies and procedures – Selection of sources of supply – Vendor development – Vendor evaluation and rating – Methods of purchasing – Imports – Buyer – Seller relationship – Negotiations.

UNIT III   MANAGEMENT OF STORES AND LOGISTICS   12
Stores function – Location – Layout – Stock taking – Materials handling – Transportation – Insurance – Codification – Inventory pricing – stores management – safety – warehousing – Distribution linear programming – Traveling Salesman problems – Network analysis – Logistics Management.

UNIT IV   MATERIALS PLANNING   10
Forecasting – Materials requirements planning – Quantity – Periodic – Deterministic models – Finite production.

UNIT V   INVENTORY MANAGEMENT   10
ABC analysis – Aggregate planning – Lot size under constraints – Just in Time (JIT) system.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are
- Familiarized with the various concepts and functions of material management, so that the students will be in a position to manage the materials management department independently.

REFERENCES
1. Dr. R. Kesavan, C.Elanchezian and T.SundarSelwyn, Engineering Management – Eswar Press – 2005.
2. Dr.R. Kesavan, C.Elanchezian and B.Vijaya Ramnath, Production Planning and Control, Anuratha Publications, Chennai, 2008.
3. G. Reghuram, N. Rangaraj, Logistics and supply chain management – cases and concepts, Macmillan India Ltd., 2006.
4. Gopalakrishnan.P, Handbook of Materials Management, Prentice Hall of India, 2005.
5. Guptha P.K. and Heera, Operations Research, Suttan Chand & Sons, 2007.
6. Lamer Lee and Donald W.Dobler, Purchasing and Material Management, Text and cases, Tata McGraw Hill, 2006.

MF5007   **INDUSTRIAL ERGONOMICS**   **L T P C**
                                                                                        3 0 0 3

OBJECTIVES :
To introduce the concepts of Ergonomics and to indicate the areas of Applications.

UNIT I   INTRODUCTION   9
Concepts of human factors engineering and ergonomics – Man – machine system and design philosophy – Physical work – Heat stress – manual lifting – work posture – repetitive motion.

UNIT II   ANTHROPOMETRY   9
Physical dimensions of the human body as a working machine – Motion size relationships – Static and dynamic anthropometry – Anthropometric aids – Design principles – Using anthropometric measures for industrial design – Procedure for anthropometric design.

UNIT III   DESIGN OF SYSTEMS   10
Displays – Controls – Workplace – Seating – Work process – Duration and rest periods – Hand tool design – Design of visual displays – Design for shift work.

UNIT IV   ENVIRONMENTAL FACTORS IN DESIGN   10
Temperature – Humidity – Noise – Illumination –Vibration – Measurement of illumination and contrast – use of photometers – Recommended illumination levels. The ageing eye – Use of indirect (reflected) lighting – cost efficiency of illumination – special purpose lighting for inspection and quality control – Measurement of sound – Noise exposure and hearing loss – Hearing protectors – analysis and reduction of noise – Effects of Noise on performance – annoyance of noise and interference with communication – sources of vibration discomfort.

UNIT V   WORK PHYSIOLOGY   8
Provision of energy for muscular work – Role of oxygen physical exertion – Measurement of energy expenditure Respiration – Pulse rate and blood pressure during physical work – Physical work capacity and its evaluation.

                                                              TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are updated with various concepts of Ergonomics, so that students will able to apply the concepts of ergonomics to Design of man – machine system

REFERENCES:
1. E.J. McCormic & Mark S. Sangers, Human factors in engineering design, McGraw Hill 2007
2. Martin Helander, A guide to the ergonomics of manufacturing, East West press, 2007
3. R.S. Bridger Introduction to Ergonomics, McGraw Hill, 1995.

MF5008   **POLYMERS AND COMPOSITE MATERIALS**   **L T P C**
                                                                           3 0 0 3

OBJECTIVES :
To impart knowledge on types, physical properties and processing of polymer matrix composites, metal matrix composites and ceramics matrix composites.

UNIT I   PROCESSING OF POLYMERS   9
Chemistry and Classification of Polymers – Properties of Thermo plastics – Properties of Thermosetting Plastics - Extrusion – Injection Moulding – Blow Moulding – Compression and Transfer Moulding – Casting – Thermo Forming. General Machining properties of Plastics – Machining Parameters and their effect – Joining of Plastics – Thermal bonding – Applications.

UNIT II   FIBERS AND MATRIX MATERIALS   9

Fibers – Fabrication, Structure, properties and applications – Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers - whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties – interfaces – Wettability – Types of bonding at the interface – Tests for measuring interfacial strength - Physical and chemical properties.

UNIT III   PROCESSING OF POLYMER MATRIX COMPOSITES   9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding - bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound – thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding – interfaces in PMCs - structure, properties and application of PMCs –recycling of PMCs.

UNIT IV   PROCESSING OF METAL MATRIX COMPOSITES   9

Metallic matrices: aluminium, titanium, magnesium, copper alloys – processing of MMCs: liquid state, Solid state, in situ fabrication techniques – diffusion bonding – powder metallurgy techniques- interfaces in MMCs – mechanical properties – machining of MMCs – Applications.

UNIT V   PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON
**   COMPOSITES   9**

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 – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course the students are expected
- To study matrix material, reinforcements of polymer matrix composites, MMC and ceramic matrix composites.
- To develop knowledge on processing, interfacial properties and application of composites.

REFERENCES:
1. ASM Handbook – Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
3. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0-387-35539-9.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012, ISBN:978-0-387-74364-6.
5. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
6. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003.
7. Said Jahanmir, Ramulu M. and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN: 0-8247-0178-x.
8. Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002

MF5009　　　　　**NON-DESTRUCTIVE TESTING AND EVALUATION**　　　　**L T P C**
　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　3 0 0 3

OBJECTIVES :
To stress the importance of NDT in engineering.

UNIT I　　　**NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION &**
　　　　　　　　LIQUID PENETRANT TESTING　　　　　　　　　　　　　　　　**6**
Introduction to various non-destructive methods, Comparison of Destructive and Non destructive
Tests, Visual Inspection, Optical aids used for visual inspection, Applications.
Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing
methods-water washable, Post – Emulsification methods, Applications

UNIT II　　　**EDDY CURRENT TESTING & ACOUSTIC EMISSION**　　　　　　　　**10**
Principles, Instrumentation for ECT, Absolute, differential probes, Techniques – High sensitivity
techniques, Multi frequency, Phased array ECT, Applications.
Principle of AET, Instrumentation, Applications - testing of metal pressure vessels, Fatigue crack
detection in aerospace structures.

UNIT III　　　**MAGNETIC PARTICLE TESTING & THERMOGRAPHY**　　　　　　　**10**
Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing
techniques, Applications.
Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications –
Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

UNIT IV　　　**ULTRASONIC TESTING**　　　　　　　　　　　　　　　　　　　**10**
Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A- scan, B-
Scan, C- Scan, Applications, Inspection Methods - Normal Incident Pulse-Echo Inspection, Normal
Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, TOFD Technique,
Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and
Intergranular cracks - Codes, standards, specification and procedures and case studies in ultrasonics
test.

UNIT V　　　**RADIOGRAPHY**　　　　　　　　　　　　　　　　　　　　　　**9**
Principle of Radiography, x-ray and gamma ray sources- safety procedures and standards, Effect of
radiation on Film, Radiographic imaging, Inspection Techniques – Single wall single image, Double
wall Penetration, Multiwall Penetration technique, Real Time Radiography - Codes, standards,
specification and procedures and case studies in Radiography test.
Case studies on defects in cast, rolled, extruded, welded and heat treated components - Comparison
and selection of various NDT techniques

　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　　TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected to have hands on experience on all types of NDT
and their applications in Engineering.

REFERENCES:
1. Baldev Raj, Jeyakumar,T., Thavasimuthu,M., "Practical Non Destructive Testing" Narosa
   publishing house, New Delhi, 2002
2. Krautkramer. J., "Ultra Sonic Testing of Materials", 1st Edition, Springer – Verlag Publication, New
   York, 1996.
3. Peter J. Shull "Non Destructive Evaluation: Theory, Techniques and Application" Marcel Dekker,
   Inc., New York, 2002
4. www.ndt.net

MF5071   **LEAN MANUFACTURING**   **L T P C**
                                                                              3 0 0 3

OBJECTIVE:
- To implement lean manufacturing concepts in the factories.

UNIT I   INTRODUCTION: 9
The mass production system – Origin of lean production system – Necessity – Lean revolution in
Toyota – Systems and systems thinking – Basic image of lean production – Customer focus – Muda
(waste).

UNIT II   STABILITY OF LEAN SYSTEM: 9
Standards in the lean system – 5S system – Total Productive Maintenance – standardized work –
Elements of standardized work – Charts to define standardized work – Man power reduction – Overall
efficiency - standardized work and Kaizen – Common layouts.

UNIT III   JUST IN TIME: 9
Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production
leveling – Pull systems – Value stream mapping**.**

UNIT IV   JIDOKA (AUTOMATION WITH A HUMAN TOUCH):   9
Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control –
Types and use of Poka-Yoke systems – Implementation of Jidoka.

UNIT V   WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY   9
Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion
Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin
Planning – Lean culture
                                                                     TOTAL: 45 PERIODS
OUTCOME:
The student will be able to practice the principles of lean manufacturing like customer focus, reduction
of MUDA, just in time, Jidoka and Hoshin planning.

REFERENCES
1. Dennis P.,” Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful
   Production System”, (Second edition), Productivity Press, New York,2007.
2. Liker, J., “ The Toyota Way : Fourteen Management Principles from the World's Greatest
   Manufacturer”,McGraw Hill, 2004.
3. Michael, L.G., “ Lean Six SIGMA: Combining Six SIGMA Quality with Lean   Production
   Speed”,McGraw Hill, 2002.
4. Ohno, T.,” Toyota Production System: Beyond Large-Scale Production”, Taylor &   Francis, Inc.,
   1988.
5. Rother, M., and Shook, J.,’ Learning to See: Value Stream Mapping to Add Value and Eliminate
   MUDA”, Lean Enterprise Institute, 1999.

MF5010   **ROBOT DESIGN AND PROGRAMMING**   **L T P C**

                                                                          3 0 0 3

OBJECTIVES :

- To impart knowledge in the area of Robot designing and programming in Robotic languages.

UNIT I   INTRODUCTION   9
Definition, Need Application, Types of robots – Classifications – Configuration, work volume, control loops, controls and intelligence, specifications of robot, degrees of freedoms, end effectors – types, selection applications.

UNIT III   ROBOT KINEMATICS   9
Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

UNIT III   ROBOT DYNAMICS AND TRAJECTORY PLANNING   9
Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

UNIT IV   ROBOT PROGRAMMING & AI TECHNIQUES   9
Types of Programming – Teach Pendant programming – Basic concepts in A1 techniques – Concept of knowledge representations – Expert system and its components.

UNIT V   ROBOT SENSORS AND ACTUATORS   9
Design of Robots – characteristics of actuating systems, comparison, microprocessors control of electric motors, magnetostrictive actuators, shape memory type metals, sensors, position, velocity, force, temperature, pressure sensors – Contact and non contact sensors, infrared sensors, RCC, vision sensors.

                                                                    TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
- To introduce the kinematic arrangement of robots and its applications in the area of manufacturing sectors
- To expose to build a robot for any type of application

REFERENCES

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

MEMS AND NANOTECHNOLOGY **L T P C**
3   0   0   3

OBJECTIVES :
- To inspire the students to expect to the trends in manufacturing of micro components and measuring systems to nano scale.

UNIT I   OVER VIEW OF MEMS AND MICROSYSTEMS   6
Definition – historical development – properties, design and fabrication micro-system, microelectronics, working principle ,applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers.

UNIT II   FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING   10
Photolithography, photo resist applications, light sources, ion implantation, diffusion–Oxidation - thermal oxidation, silicon dioxide, chemical vapour deposition, sputtering - deposition by epitaxy – etching – bulk and surface machining – LIGA process – LASER, Electron beam ,Ion beam processes – Mask less lithography. Micro system packaging –packaging design– levels of micro system packaging -die level, device level and system level – interfaces in packaging – packaging technologies- Assembly of Microsystems

UNIT III   MICRO DEVICES   8
Sensors – classification – signal conversion ideal characterization of sensors micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer , chemical and bio sensor - sensitivity, reliability and response of micro-sensor - micro actuators – applications.

UNIT IV   SCIENCE AND SYNTHESIS OF NANO MATERIALS   10
Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture
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. Top down and bottom up processes.

UNIT V   CHARACTERIZATION OF NANO MATERIALS   11
Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.
TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
- To expose the evolution of micro electromechanical systems, to the various fabrication techniques and to make students to be aware of micro actuators. Also to impart knowledge to nano materials and various nano measurements techniques.

REFERENCES:
1. Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003
2. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
3. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.

4. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
5. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
6. Sami Franssila, Introduction to Micro fabrication, John Wiley & sons Ltd, 2004. ISBN:470-85106-6
7. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
8. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc.,2013,ISBN : 978-93-82291-39-8

MF5012   **COMPUTER AIDED PRODUCT DESIGN**   **L T P C**
                                                         3 0 0 3

OBJECTIVES :
To introduce the computer aided modeling and various concepts of product design.

UNIT I   INTRODUCTION   8
Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – Computer hardware & Peripherals – software packages for design and drafting.

UNIT II   COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC MODEL   8
Computer graphics – applications – principals of interactive computer graphics – 2D 3D transformations – projections – curves - Geometric Modeling – types – Wire frame surface and solid modeling – Boundary Representation, constructive solid geometry – Graphics standards – assembly modeling – use of software packages

UNIT III   PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT   10
Understanding customer needs – Product function modeling – Function trees and function structures – Product tear down methods – Bench marking – Product port folio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle management.

UNIT IV   PRODUCT DESIGN TOOLS & TECHNIQUES   10
Product modeling – types of product models; product development process tools – TRIZ – Altshuller's inventive principles – Modeling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment

UNIT V   PRODUCT DESIGN TECHNIQUES   9
FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
- To model a product using CAD software.
- To apply the various design concepts and design tools and techniques while designing a product.

REFERENCES:
1. Biren Prasad, "Concurrent Engineering Fundamentals Vol.11", Prentice Hall, 1997.
2. David F.Rogers.J, Alan Adams, "Mathematical Elements for Computer Graphics", McGraw Hill, 1990
3. Ibrahim Zeid, "CAD/CAM theory and Practice", Tata McGraw Hill, 1991.
4. James G.Bralla, "Handbook of Product Design for Manufacturing", McGraw Hill, 1994
5. Kevin Otto, Kristin Wood, "Product Design", Pearson Education, 2000

MF5013   **PROCESS PLANNING AND COST ESTIMATION**   **L T P C**
                                                                                              3 0 0 3

OBJECTIVES:
To introduce the process planning concepts to make cost estimation for various products after
process planning

UNIT I   INTRODUCTION TO PROCESS PLANNING   10
Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in
process selection-.Production equipment and tooling selection

UNIT II   PROCESS PLANNING ACTIVITIES   10
Process parameters calculation for various production processes-Selection jigs and fixtures election
of quality assurance methods – Set of documents for process planning-Economics of process
planning- case studies

UNIT III   INTRODUCTION TO COST ESTIMATION   8
Importance of costing and estimation –methods of costing-elements of cost estimation –Types of
estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head
charges- Calculation of depreciation cost

UNIT IV   PRODUCTION COST ESTIMATION   8
Estimation of Different Types of Jobs – Estimation of Forging Shop, Estimation of Welding Shop,
Estimation of Foundry Shop

UNIT V   MACHINING TIME CALCULATION   9
Estimation of Machining Time – Importance of Machine Time Calculation- Calculation of Machining
Time for Different Lathe Operations ,Drilling and Boring – Machining Time Calculation for Milling,
Shaping and Planning -Machining Time Calculation for Grinding

                                                                          TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course the students are expected to use the concepts of process planning and cost
estimation for various products.

REFERENCES:
1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002.
2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley,
     1998.
3. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology
     Books, Dec 2002.
4. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003.

MF5014   **MANUFACTURING MANAGEMENT**   **L T P C**
                                                                              3 0 0 3

OBJECTIVES :
To introduce the concepts of manufacturing management and various manufacturing management functions to the students.

UNIT I   PLANT ENGINEERING   7
Plant location – Factors affecting plant location – Techniques – Plant layout - principles - Types – Comparison of layouts – Materials handling – Principles – Factors affecting selection of Materials handling system – Types of materials handling systems – Techniques.

UNIT II   WORK STUDY   8
Method study – Principles of motion economy – steps in method study – Tool and Techniques – Work measurement – Purpose – stop watch time study – Production studies – work sampling – Ergonomics – Value analysis.

UNIT III   PROCESS PLANNING AND FORECASTING   9
Process planning – Aims of process planning – steps to prepare the detailed work sheets for manufacturing a given component – Break even analysis – Forecasting – Purpose of forecasting – Methods of forecasting – Time series – Regression and Correlation – Exponential smoothing.

UNIT IV   SCHEDULING AND PROJECT MANAGEMENT   12
Scheduling – Priority rules for scheduling – sequencing – Johnson's algorithm for job sequencing – n job M machine problems – Project Network analysis – PERT/CPM – Critical path –Floats – Resource leveling – Queuing analysis.

UNIT V   PERSONNEL AND MARKETING MANAGEMENT   9
Principles of Management – Functions of personnel management – Recruitment – Training – Motivation – Communication – conflicts – Industrial relations – Trade Union – Functions of marketing – Sales promotion methods – Advertising – Product packaging – Distribution channels – Market research and techniques.

                                                                    TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course the students are trained in the various functions of manufacturing management so that the students will be able to take up these functions as they get in to senior managerial positions.

REFERENCES
1.   Dr. R. Kesavan, C. Elanchezian, and B.Vijayaramnath, Principles of Management – Eswar Press – Chennai – 2004
2.   Dr. R. Kesavan, C.Elanchezian and B.Vijayaramnath, Production Planning and Control, Anuratha Publications, Chennai – 2008
3.   Dr. R. Kesavan,C. Elanchezian and T.Sundar Selwyn, Engineering Management – Eswar Press, Chennai – 2005
4.   Martand T. Telsang, Production Management, S.Chand & Co., 2007

OBJECTIVES

- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.

UNIT I   INTRODUCTION TO RESEARCH   9

The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

UNIT II   EXPERIMENTAL DESIGN   9

Laboratory and the Field Experiment – Internal and External Validity – Factors affecting Internal validity. Measurement of variables – Scales and measurements of variables. Developing scales – Rating scale and attitudinal scales – Validity testing of scales – Reliability concept in scales being developed – Stability Measures.

UNIT III   DATA COLLECTION METHODS   9

Interviewing, Questionnaires, etc. Secondary sources of data collection. Guidelines for Questionnaire Design – Electronic Questionnaire Design and Surveys. Special Data Sources: Focus Groups, Static and Dynamic panels. Review of Advantages and Disadvantages of various Data-Collection Methods and their utility. Sampling Techniques – Probabilistic and non-probabilistic samples. Issues of Precision and Confidence in determining Sample Size. Hypothesis testing, Determination of Optimal sample size.

UNIT IV   MULTIVARIATE STATISTICAL TECHNIQUES   9

Data Analysis – Factor Analysis – Culster Analysis -Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation – Application of Statistical(SPSS) Software Package in Research.

UNIT V   RESEARCH REPORT   9

Purpose of the written report – Concept of audience – Basics of written reports. Integral parts of a report – Title of a report, Table of contents, Abstract, Synopsis, Introduction, Body of a report – Experimental, Results and Discussion – Recommendations and Implementation section – Conclusions and Scope for future work.

                                                                      TOTAL = 45 PERIODS
OUTCOME

- After completion of the syllabus students will able to get knowledge about the different research techniques and research report.

REFERENCES
1. C.R.Kothari, Research Methodology, WishvaPrakashan, New Delhi, 2001.
2. Donald H.McBurney, Research Methods, Thomson Asia Pvt. Ltd. Singapore, 2002.
3. Donald R. Cooper and Ramela S. Schindler, Business Research Methods, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2000
4. G.W.Ticehurst and A.J.Veal, Business Research Methods, Longman, 1999.
5. Ranjit Kumar, Research Methodology, Sage Publications, London, New Delhi, 1999.
6. Raymond-Alain Thie'tart, *et.al.,* Doing Management Research, Sage Publications, London, 1999
7. Uma Sekaran, Research Methods for Business, John Wiley and Sons Inc., New York, 2000.

MF5015	NANOTECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES :
To inspire the students to expect to the trends in development and synthesizing of nano systems and measuring systems to nano scale.

UNIT I   OVER VIEW OF NANOTECHNOLOGY   6
Definition – historical development – properties, design and fabrication Nanosystems, , working principle ,applications and advantages of nano system. Nanomaterials – ordered oxides – Nano arrays – potential health effects

UNIT II   NANODEFECTS, NANO PARTILES AND NANOLAYERS   8
Nanodefects in crystals – applications – Nuclear Track nano defects. Fabrication of nano particles – LASER ablation – sol gels – precipitation of quantum dots.Nano layers – PVD,CVD ,Epitaxy and ion implantation – formation of Silicon oxide- chemical composition – doping properties – optical properties

UNIT III   NANOSTRUCTURING   8
Nanophotolithography – introduction – techniques – optical – electron beam – ion beam – X-ray and Synchrotron – nanolithography for microelectronic industry – nanopolishign of Diamond – Etching of Nano structures – Nano imprinting technology –   Focused ion beams - LASER interference Lithography nanoarrays –Near-Field Optics - case studies and Trends

UNIT IV   SCIENCE AND SYNTHESIS OF NANO MATERIALS   12
Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture
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. Top down and bottom up processes.

UNIT V   CHARACTERIZATION OF NANO MATERIALS   11
Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunneling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course the students are expected
- To evaluate Nano systems, to the various fabrication techniques.
- Also to have deep knowledge in nano materials and various nano measurements techniques.

REFERENCES:
1. Charles P Poole, Frank J Owens, Introduction to Nano technology, John Wiley and Sons, 2003
2. Fahrner W.R.,Nanotechnology and Nanoelectronics, Springer (India) Private Ltd., 2011.
3. Julian W. Hardner Micro Sensors, Principles and Applications, CRC Press 1993.
4. Mark Madou , Fundamentals of Microfabrication, CRC Press, New York, 1997.
5. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006, ISBN : 8493-9138-5
6. Norio Taniguchi, Nano Technology, Oxford University Press, New York, 2003
7. Sami Franssila, Introduction to Micro fabrication , John Wiley & sons Ltd, 2004. ISBN:470-85106-6
8. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2002.
9. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc.,2013,ISBN : 978-93-82291-39-8

MF5016   MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES   L T P C
                                                                    3 0 0 3

OBJECTIVE:
This course aims to impart knowledge on various techniques of material characterization.

UNIT I   MICRO AND CRYSTAL STRUCTURE ANALYSIS   10
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 - 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 II   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 III   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 Infra Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravitymetric Analysis (TGA)

UNIT IV   MECHANICAL TESTING – STATIC TESTS   8
Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy & Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT V   MECHANICAL TESTING – DYNAMIC TESTS   9
Fatigue – Low & High Cycle Fatigues – Rotating Beam & Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests.

                                                                TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course the students are expected to be knowledgeable in microstructure evaluation, crystal structure analysis, electron microscopy, Chemical Thermal Analysis, static and dynamic mechanical testing methods.

REFERENCES:
1. ASM Hand book-Materials characterization, Vol – 10, 2004.
2. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
3. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
4. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
5. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill, 1988.
6. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
7. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
8. Morita.S, Wiesendanger.R, and Meyer.E, "Non-contact Atomic Force Microscopy" Springer, 2002,
9. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.
10. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.

MF5017   **MECHATRONICS**   **L T P C**
                                                                              3 0 0 3

OBJECTIVES:
This syllabus is formed to create knowledge in Mechatronics systems and impart the source of concepts and techniques, which have recently been applied in practical situation. It gives the frame work of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

UNIT I   INTRODUCTION   6
Introduction to Mechatronics-systems – Mechatronics approach to modern engineering and design – Need of Mechatronics – Emerging areas of Mechatronics – Classification of Mechatronics – Mechatronics elements.

UNIT II   SENSORS AND TRANSDUCERS   12
Introduction – Performance Terminology – Potentiometers – Strain gauges – I VDT – Eddy current sensor – Hall effect sensor – Capacitance sensors – Digital transducers – Temperature sensors – Optical sensors – Piezo electric sensor-ultrosonic sensors – Proximity sensors – Signal processing techniques.

UNIT III   MICROPROCESSORS AND MICROCONTROLLERS   12
Introduction – Architectures of 8 – bitmicrocontrollers (8051) series, PIC Microcontrollers (16f xxx) series – Assembly language programming instruction format, addressing modes, instruction sets, Basic program examples interface of keypads, leds, leds, A/D and D/A Converters, RS 232 serial communication interface, classification of memories.

UNIT IV   ACTUATORS   8
Switching Devices, Classification of actuators – Electrical actuators – Solid state relays, solenoids, D.C. motors, Servo motors, Stepper motors – Interfacing with microcontroller through H-bridge Circuits – Piezoelectric actuators.

UNIT V   MECHATRONIC SYSTEMS   7
Design process-stages of design process – Traditional and Mechatronics design concepts – Case studies – Engine management system, Automatic camera, Automatic wishing machine, Pick and place robots.

                                                              TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course the students are experts in designing Mechatronics components.

REFERENCES:
1. Devadas shetty, Richard A. Kolk, "Mechatronics System Design", PWS Publishing Company, 2001.
2. M.A. Mazidi & J.G. Mazidi, 8051 Micrcontroller and embedded systems, 2002
3. R.K.Rajput.A Text Book of Mechatronics, Chand &Co, 2007
4. W.Bolton, "MICHATRONICS" Pearson Education Limited, 2004

MF5073   **INTERNET OF THINGS FOR MANUFACTURING**   **L T P C**
                                                                       3 0 0 3

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

UNIT I   INTRODUCTION   9
Technology of the IoT and applications,. IoT data management requirements, Architecture of IoT, Security issues Opportunities for IoT -Issues in implementing IoT. Technological challenges, RFID and the Electronic Product Code (EPC) network, the web of things.

UNIT II   DESIGN OF IoT   9
Design challenges in IoT -Standardization, Security and privacy, Infrastructure, Analytics. Design steps for implementing IoT.

UNIT III   PROTOTYPING OF IoT   9
Design principles for connected devices -Embedded devices, physical design, online components, embedded coding system. Informed Manufacturing plant – Elements, IoT implementation in Transportation and logistics, Energy and utilities, Automotive Connected supply chain, Plant floor control automation, remote monitoring, Management of critical assets, Energy management and resource optimization, proactive maintenance.

UNIT IV   PREREQUISITES FOR IoT   9
IOT Technologies Wireless protocols low-power design (Bluetooth Low Energy), range extension techniques (data mining and mesh networking), and data-intensive IoT for continuous recognition applications Data storage and analysis Localization algorithms Localization for mobile systems

UNIT V   APPLICATION IN MANUFACTURING   9
Applications HCI and IoT world -Multilingual interactions Robotics and Autonomous Vehicles Sensing and data processing-Simultaneous mapping and localization-Levels of autonomy, Smart factories, Future research challenges
                                                                       TOTAL : 45 PERIODS
OUTCOMES:
- At the end of this course the students are expected to
- Utilizing sensors to gain greater visibility and real-time situational awareness
- Vertical applications that provide a clear business case and a pressing opportunity
- Emerging technologies to address IoT challenges

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

IL5091   **DATA ANALYTICS**   **L T P C**
                                                                      3 0 0 3
OBJECTIVES:
The Student should be made to:
- Be exposed to big data
- Learn the different ways of Data Analysis
- Be familiar with data streams
- Learn the mining and clustering
- Be familiar with the visualization

UNIT I   INTRODUCTION TO BIG DATA   8
Introduction to Big Data Platform – Challenges of conventional systems - Web data – Evolution of
Analytic scalability, analytic processes and tools, Analysis vs reporting – Modern data analytic tools,
Stastical concepts: Sampling distributions, resampling, statistical inference, prediction error.

UNIT II   DATA ANALYSIS   12
Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks,
Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear
dynamics – Rule induction – Neural networks: learning and generalization, competitive learning,
principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data,
fuzzy decision trees, Stochastic search methods.

UNIT III   MINING DATA STREAMS   8
Introduction to Streams Concepts – Stream data model and architecture – Stream Computing,
Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating
moments – Counting oneness in a window – Decaying window – Realtime Analytics
Platform(RTAP) applications - case studies – real time sentiment analysis, stock market predictions.

UNIT IV   FREQUENT ITEMSETS AND CLUSTERING   9
Mining Frequent itemsets – Market based model – Apriori Algorithm – Handling large data sets in
Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering
Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and
PROCLUS – Frequent pattern based clustering methods – Clustering in non-euclidean space –
Clustering for streams and Parallelism.

UNIT V   FRAMEWORKS AND VISUALIZATION   8
MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file
systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and
applications:

                                                              TOTAL : 45 PERIODS

OUTCOMES:
At the end of this course the students are expected to
- Apply the statistical analysis methods.
- Compare and contrast various soft computing frameworks.
- Design distributed file systems.
- Apply Stream data model.
- Use Visualisation techniques

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

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

OBJECTIVES:
- Introduce computer simulation technologies and techniques
- Introduce concepts of   modeling layers of society's critical infrastructure networks
- Build tools to view and control simulations and their results

UNIT I   INTRODUCTION   9
Systems and   modeling – statistical models in simulation –discrete and continuous system –Monte Carlo Simulation. Simulation of Single Server Queuing System. Simulation of manufacturing shop Simulation of Inventory System

UNIT II   RANDOM NUMBERS   9
Random number generation –Properties of Random Numbers –Generation of Pseudo Random Numbers – Techniques –Tests for Random Numbers

UNIT III   RANDOM VARIATES   9
Random variate generation-Inverse Transform Technique –Direct Transform Techniques Convolution Method Acceptance Rejection Technique– Routines for Random Variate Generation, Testing – Analysis of simulation data.

UNIT IV   ANALYSIS OF SIMULATION DATA   9
Input   odeling-Fitness tests – verification and validation of simulation models – output analysis for a single model, Comparison and evaluation of alternate system design, Optimization using simulation.

UNIT V   SIMULATION LANGUAGES   9
Simulation languages and packages-Case studies in WITNESS; FLEXSIM, ARENA, SIMQUICK-Simulation based optimization-Modelling and Simulation with Petrinets – Case studies in manufacturing and material handling system.

                                                        TOTAL : 45 PERIODS
OUTCOMES:
- At the end of this course the students are expected to
- Develop Manufacturing Models of Discrete event systems
- Generation of Uncertainty using Random numbers and Random Variates
- Input, Output Analysis: Verification & Valediction of Models and Optimization

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

PD5091   **PRODUCT LIFECYCLE MANAGEMENT**   **L T P C**
                                                                                      3 0 0 3
OBJECTIVE:
To understand history, concepts and terminology of PLM
To understand functions and features of PLM/PDM
To understand different modules offered in commercial PLM/PDM tools
To understand PLM/PDM implementation approaches
To understand integration of PLM/PDM with other applications

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

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

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

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

UNIT V   BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE   9
PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD,
SLM and ERP
                                                                        TOTAL: 45 PERIODS
OUTCOMES:
The students will be able to
    1. Understand history, concepts and terminology of PLM.
    2. Apply the functions and features of PLM/PDM.
    3. Understand different modules offered in commercial PLM/PDM tools.
    4. Understand PLM/PDM implementation approaches.
    5. Integrate PLM/PDM with other applications.
    6. Analyse the case studies.

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

CM5091   **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
OUTCOMES:
On completion of this course the students are expected to learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing, case studies relevant to mass customized manufacturing, and some of the important research challenges associated with AM and its data processing tools

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

MF5018   **PRODUCT DESIGN AND DEVELOPMENT**   **L T P C**
                                                                                    3 0 0 3

OBJECTIVES:
Understand the application of product design methods to develop a product

UNIT I   PRODUCT DEVELOPMENT AND CONCEPT SELECTION   10
Product development process – Product development organizations- Identifying the customer needs –
Establishing the product specifications – concept generation – Concept selection.

UNIT II   PRODUCT ARCHITECTURE   7
Product architecture – Implication of the architecture – Establishing the architecture – Related system
level design issues.

UNIT III   INDUSTRIAL AND MANUFACTURING DESIGN   10
Need for industrial design – Impact of industrial design – Industrial design process. Assessing the
quality of industrial design- Human Engineering consideration - Estimate the manufacturing cost –
Reduce the component cost – Reduce the assembly cost – Reduce the support cost – Impact of DFM
decisions on other factors

UNIT IV   PROTOTYPING AND ECONOMIC ANALYSIS   9
Principles of prototyping – Planning for prototypes - Elements of economic analysis – Base case
financial model – Sensitivity analysis – Influence of the quantitative factors

UNIT V   MANAGING PRODUCT DEVELOPMENT PROJECTS   9
Sequential, parallel and coupled tasks - Baseline project planning – Project Budget Project execution
– Project evaluation- patents- patent search-patent laws International code for patents.
                                                                    TOTAL: 45 PERIODS
OUTCOMES:
At the end of this course the students are expected to design and develop various products

REFERENCES:
1. Charles Gevirtz, Developing New products with TQM, McGraw – Hill International editions, 1994
2. Karal .T. Ulrich, Steven D.Eppinger, Product Design and Development, McGRAW- HILL
   International Editions.2003.
3. S.Rosenthal, Effective product design and development, Irwin 1992.

MF5074   **ENTREPRENEURSHIP DEVELOPMENT**   **L T P C**
                                                                                 3 0 0 3
OBJECTIVE:
- To develop and strengthen entrepreneurial quality and motivation in students. To impart basic
  entrepreneurial skills and understandings to run a business efficiently and effectively.

UNIT I   ENTREPRENEURAL COMPETENCE   6
Entrepreneurship concept – Entrepreneurship as a Career – Entrepreneurial   Personality -
Characteristics of Successful, Entrepreneur – Knowledge and Skills of Entrepreneur.

UNIT II   ENTREPRENEURAL ENVIRONMENT   12
Business Environment - Role of Family and Society - Entrepreneurship Development Training and
Other Support Organisational Services - Central and State Government Industrial Policies and
Regulations - International Business.

UNIT III   BUSINESS PLAN PREPARATION   12

Sources of Product for Business - Prefeasibility Study - Criteria for Selection of Product - Ownership - Capital - Budgeting Project Profile Preparation - Matching Entrepreneur with the Project - Feasibility Report Preparation and Evaluation Criteria.

UNIT IV   LAUNCHING OF SMALL BUSINESS   10

Finance and Human Resource Mobilization Operations Planning - Market and Channel Selection - Growth Strategies - Product Launching – Incubation, Venture capital, IT startups.

UNIT V   MANAGEMENT OF SMALL BUSINESS   5

Monitoring and Evaluation of Business - Preventing Sickness and Rehabilitation of Business Units- Effective Management of small Business.

TOTAL: 45 PERIODS

OUTCOME:
- Students will gain knowledge and skills needed to run a business.

REFERENCES:
1. Hisrich, Entrepreneurship, Edition 9, Tata McGraw Hill, New Delhi, 2014
2. S.S.Khanka, Entrepreneurial Development, S.Chand and Company Limited, New Delhi, (Revised Edition) 2013.
3. Mathew Manimala, Entrepreneurship Theory at the Crossroads, Paradigms & Praxis, Biztrantra, 2nd Edition ,2005
4. Prasanna Chandra, Projects – Planning, Analysis, Selection, Implementation and Reviews, Tata McGraw-Hill, 1996.
5. P.Saravanavel, Entrepreneurial Development, Ess Pee kay Publishing House, Chennai 1997.
6. Arya Kumar. Entrepreneurship. Pearson, 2012.
7. Donald F Kuratko, T.V Rao. Entrepreneurship: A South Asian perspective. Cengage, 2012

MF5075	INDUSTRIAL SAFETY	L T P C
		3 0 0 3

OBJECTIVE:
To develop and strengthen the safety ideas and motivate the students to impart basic safety skills and understandings to run an industry efficiently and effectively

UNIT I   OPERATIONAL SAFETY   9

Hot metal operation, boiler, pressure vessels – heat treatment shop – gas furnace operation – electroplating – hot bending pipes – safety in welding and cutting, Cold – metal operation – safety in machine shop – cold bending and chamfering of pipesmetal cutting – shot blasting, grinding, painting – power press and other machines. Management of toxic gases and chemicals – industrial fires and prevention – road safety – highway and urban safety – safety of sewage disposal and cleaning – control of environmental pollution – managing emergencies in industries – planning security and risk assessments, on – site and off site. Control of major industrial hazards.

UNIT II   SAFETY APPRAISA L AND ANALYSIS   9

Human side of safety – personal protective equipment – causes and cost of accidents. Accidents prevention program – specific hazard control strategies – HAZOP training and development of employees – first aid – fire fight devices – accident reporting, investigation. Measurement of safety performance, accident reporting and investigation – plant safety inspection, job safety analysis – safety permit procedures. Product safety – plant safety rules and procedures – safety sampling – safety inventory systems. Determining the cost effectiveness of safety measurement.

UNIT III   OCCUPATIONAL HEALTH   9

Concept and spectrum of health functional units and activities of operational health service – occupational and related disease – levels of prevention of diseases – notifiable occupational diseases Toxicology Lead – Nickel, chromium and manganese toxicity – gas poisoning (such as CO, Ammonia Chlorise, So2, H2s.) their effects and prevention – effects of ultra violet radiation and infrared radiation on human system.

UNIT IV   SAFETY AND HEALTH REGULATIONS   9

Safety and health standards – industrial hygiene – occupational diseases prevention welfare facilities. The object of factories act 1948 with special reference to safety provisions, model rules 123a, history of legislations related to safety – pressure vessel act – Indian boiler act – the environmental protection act – electricity act – explosive act.

UNIT V   SAFETY MANAGEMENT   9

Evaluation of modern safety concepts – safety management functions – safety organization, safety department- safety committee, safety audit – performance measurements and motivation – employee participation in safety - safety and productivity.

TOTAL: 45 PERIODS

OUTCOME:

At the end of this course the students are expected to gain knowledge and skills needed to run an industry with utmost safety precautions.

REFERENCES:

1. John V Grimaldi, Safety Management. AITB publishers, 2003.
2. John.V .Grimaldi and Rollin. H Simonds, "Safety Managenent", All India traveler book seller, New Delhi – 1989.
3. Krishnan N.V, "Safety in Industry", Jaico Publisher House, 1996.
4. Singh, U.K and Dewan, J.M., "Sagety, Security And Risk Management", APH publishing company, New Delhi, 1996.