You Choose, We Do It
St. JOSEPH'S COLLEGE OF ENGINEERING
(An Autonomous Institution)
St. Joseph's Group of Institutions
Jeppiaar Educational Trust
OMR, Chennai - 119.

DEPARTMENT OF MECHANICAL ENGINEERING

M.E. MANUFACTURING ENGINEERING

REGULATIONS – 2021
(CHOICE BASED CREDIT SYSTEM)

PROPOSED CURRICULA AND SYLLABI

1. PROGRAMME EDUCATIONAL OBJECTIVES

Engineering graduates will be able to:

PEO1: Profession –Practice manufacturing engineering in a broad range of industries both core engineering and non-engineering fields such as medicine, space, law or business.

PEO2: Continuing Education–Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.

PEO3: Technophile– Conduct them in a responsible, professional, and ethical manner and attain professional maturity with deep understanding of the impact of the technological solutions in a societal and global context and a need for sustainable development.

PEO4: Service–Participate as leaders in their fields of expertise and in activities that support service and economic development nationally and throughout the world.

2. PROGRAMME OUTCOMES

Engineering graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solution for complex engineering problems and design systems components or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research- based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environmental and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-Long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. PROGRAMME SPECIFIC OUTCOMES

PSO 1: The students graduating in Manufacturing Engineering will have profound foundation in mathematical, scientific and engineering domains necessary to achieve professional and productive excellence in technical and non-technical problem solving and analyzing engineering problems.

PSO 2: The students graduating in Manufacturing Engineering will have the ability to synthesize the engineering data and apply scientific principles for applications involving manufacturing engineering using high end CAD/CAM/CAE computational packages such as CATIA, ANSYS and MATLAB.

PSO 3: The students graduating in Manufacturing Engineering will have the ability to pursue advanced careers and discharge his/her duties entrusted with high degree of commitment to address professional and ethical responsibilities, including a respect for diversity and provide cost effective engineering solutions.

4. PEO / PO MAPPING

Programme Educational Objectives	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PEO2	✓	✓	✓	✓	✓		✓		✓		✓	✓
PEO3	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
PEO4	✓		✓	✓	✓	✓		✓		✓		

5. SEMESTER, COURSE WISE PO, PSO MAPPING

YEAR	SEM	COURSE TITLE	PO												PSO		
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
YEAR 1	SEMESTER1	Applied Probability and Statistics	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓	✓
		Advanced in Manufacturing Technology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Computer Integrated Manufacturing Systems	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Advances in Materials Technology	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Research Methodology and IPR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Course – I															
		Audit Course *															
		CAD/CAM Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SEMESTER 2	Optimization Techniques	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓	✓
		Advances in Metrology and Inspection	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Tooling for manufacturing	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Professional Elective Course – II															
		Professional Elective Course – III															
		Modelling and Simulation Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Automation and Metal Forming Laboratory	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Mini Project with Seminar	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
YEAR 2	SEM3	Professional Elective Course – IV															
		Professional Elective Course – V															
		Open Elective Course															
		Project Work Phase I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SEM4	Project Work Phase II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

You Choose, We Do It
St. JOSEPH'S COLLEGE OF ENGINEERING
(An Autonomous Institution)
St. Joseph's Group of Institutions
Jeppiaar Educational Trust
OMR, Chennai - 119.

DEPARTMENT OF MECHANICAL ENGINEERING

M.E. MANUFACTURING ENGINEERING

REGULATIONS – 2021
(CHOICE BASED CREDIT SYSTEM)

CURRICULA AND SYLLABI

SEMESTER I

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
THEORY								
1	MA1154	Applied Probability and Statistics	FC	4	3	1	0	4
2	MF1101	Advanced in Manufacturing Technology	PCC	3	3	0	0	3
3	MF1102	Computer Integrated Manufacturing Systems	PCC	3	3	0	0	3
4	MF1103	Advances in Materials Technology	PCC	4	4	0	0	4
5		Professional Elective Course – I	PEC	3	3	0	0	3
6	RM 1101	Research Methodology and IPR	RMC	2	2	0	0	2
PRACTICALS								
7	MF1111	CAD/CAM Laboratory	PCC	4	0	0	4	2
			Total	**25**	**20**	**1**	**4**	**21**
8		Audit Course * **(*Audit Course is optional)**	AC	**Registration of any one of the Audit Courses is optional**				

SEMESTER II

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
THEORY								
1	MF1201	Optimization Techniques	PCC	4	3	1	0	4
2	MF1202	Advances in Metrology and Inspection	PCC	3	3	0	0	3
3	MF1203	Tooling for manufacturing	PCC	4	4	0	0	4
4		Professional Elective Course – II	PEC	3	3	0	0	3
5		Professional Elective Course – III	PEC	3	3	0	0	3
PRACTICALS								
6	MF1211	Modelling and Simulation Laboratory	PCC	4	0	0	4	2
7	MF1212	Automation and Metal Forming Laboratory	PCC	4	0	0	4	2
8	MF1213	Mini Project with Seminar	EEC	2	0	0	2	1
			Total	**27**	**16**	**1**	**10**	**22**

SEMESTER III

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
THEORY								
1		Professional Elective Course – IV	PEC	3	3	0	0	3
2		Professional Elective Course – V	PEC	3	3	0	0	3
3		Open Elective	OEC	3	3	0	0	3
PRACTICALS								
4	MF1311	Project Work Phase I	EEC	12	0	0	12	6
			Total	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
PRACTICALS								
1	MF1411	Project Work Phase II	EEC	24	0	0	24	12
			Total	**24**	**0**	**0**	**24**	**12**

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

FOUNDATION COURSES (FC)

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MA1154	Applied Probability and Statistics	FC	4	3	1	0	4

PROFESSIONAL CORE COURSES(PCC)

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1101	Advanced in Manufacturing Technology	PCC	3	3	0	0	3
2	MF1102	Computer Integrated Manufacturing Systems	PCC	3	3	0	0	3
3	MF1103	Advances in Materials Technology	PCC	4	4	0	0	4
4	MF1111	CAD/CAM Laboratory	PCC	4	0	0	4	2
5	MF1201	Optimization Techniques	PCC	4	3	1	0	4
6	MF1202	Advances in Metrology and Inspection	PCC	3	3	0	0	3
7	MF1203	Tooling for manufacturing	PCC	4	4	0	0	4
8	MF1211	Modelling and Simulation Laboratory	PCC	4	0	0	4	2
9	MF1212	Automation and Metal Forming Laboratory	PCC	4	0	0	4	2

PROFESSIONAL ELECTIVECOURSES (PEC)

SEMESTER I

PROFESSIONALELECTIVE COURSES – I

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1001	Design of Manufacturing Tools, Jigs and Fixtures	PEC	3	3	0	0	3
2	MF1002	Non-Destructive Testing and Evaluation	PEC	3	3	0	0	3
3	MF1003	Metal Cutting Theory and Practice	PEC	3	3	0	0	3
4	MF1004	Operations Management	PEC	3	3	0	0	3

SEMESTER II

PROFESSIONAL ELECTIVE COURSES – II

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1005	Advances in Casting and Welding	PEC	3	3	0	0	3
2	MF1006	Finite Element Methods for Manufacturing Engineering	PEC	3	3	0	0	3
3	MF1007	Manufacturing of Automotive Components	PEC	3	3	0	0	3
4	MF1008	Computer Aided Product Design	PEC	3	3	0	0	3

PROFESSIONALELECTIVE COURSES – III

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1009	Robotics and Industrial Automation	PEC	3	3	0	0	3
2	MF1010	Theory of Metal Forming	PEC	3	3	0	0	3
3	MF1011	Lean and Agile Manufacturing	PEC	3	3	0	0	3
4	MF1012	Surface Engineered Materials Technology	PEC	3	3	0	0	3

SEMESTER III

PROFESSIONAL ELECTIVE COURSES – IV

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1013	Industrial Design and Ergonomics	PEC	3	3	0	0	3
2	MF1014	MEMS and Nanotechnology	PEC	3	3	0	0	3
3	MF1015	Material Testing and Characterization	PEC	3	3	0	0	3
4	MF1016	Mechatronics in Manufacturing	PEC	3	3	0	0	3

PROFESSIONAL ELECTIVE COURSES – V

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1017	Micro Manufacturing	PEC	3	3	0	0	3
2	MF1018	Additive Manufacturing	PEC	3	3	0	0	3
3	MF1019	Design and Analysis of Experiments	PEC	3	3	0	0	3
4	MF1020	Product Design and Life Cycle Management	PEC	3	3	0	0	3

OPEN ELECTIVE COURSES (OEC)

(Out of 6 Courses one Course must be selected)

SEMESTER III

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	OCP101	Business Data Analytics	OEC	3	3	0	0	3
2	OMF101	Industrial Safety	OEC	3	3	0	0	3
3	OPE101	Renewable sources of Electrical Energy	OEC	3	3	0	0	3
4	OMB103	Cost Management of Engineering Projects	OEC	3	3	0	0	3
5	OMF102	Composite Materials	OEC	3	3	0	0	3
6	OCH105	Waste to Energy	OEC	3	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	MF1213	Mini Project with Seminar	EEC	2	0	0	2	1
2	MF1311	Project Work Phase I	EEC	12	0	0	12	6
3	MF1411	Project Work Phase II	EEC	24	0	0	24	12

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SEMESTER I

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	RM1101	Research Methodology and IPR	RMC	2	2	0	0	2

AUDIT COURSES (AC)

SEMESTER I

Registration for any of these courses is optional to students

Sl. No.	Subject Code	Subject Name	Category	Contact Periods	L	T	P	C
1	AX1001	English for Research Paper Writing	AC	2	2	0	0	0
2	AX1002	Disaster Management	AC	2	2	0	0	0
3	AX1003	Sanskrit for Technical Knowledge	AC	2	2	0	0	0
4	AX1004	Value Education	AC	2	2	0	0	0
5	AX1005	Constitution of India	AC	2	2	0	0	0
6	AX1006	Pedagogy Studies	AC	2	2	0	0	0
7	AX1007	Stress Management by Yoga	AC	2	2	0	0	0
8	AX1008	Personality Development Through Life Enlightenment Skills	AC	2	2	0	0	0

Credits Distribution

Sl. No.	Subject Area	CreditsPer Semester				Credits Total	Percentage %
		I	II	III	IV		
1	FC	04	-	-	-	04	5.7
2	PCC	12	15	-	-	27	38.6
3	PEC	03	06	06	-	15	21.4
4	RMC	02	-	-	-	02	2.9
5	OEC	-	-	03	-	03	4.3
6	EEC	-	01	06	12	19	27.1
7	AC	✓	-	-	-	-	
Total		**21**	**22**	**15**	**12**	**70**	**100**

FC – Foundation Courses
PCC – Professional Core Courses
PEC – Professional Elective Courses
RMC – Research Methodology and IPR Courses
OEC – Open Elective Courses
EEC – Employability Enhancement Courses
AC – Audit Courses / Non - Credit Courses(Optional).

Semester Wise Course Details

Sl. No.	Semester	Theory	Laboratory	Mini Project With Seminar	Project Work		Total
					Phase I	Phase II	
1	I	6 + 1 (*AC)	1	-	-	-	8
2	II	5	2	1	-	-	8
3	III	3	-	-	1	-	4
4	IV	-	-	-	-	1	1
Total		**15**	**3**	**1**	**1**	**1**	**21**

***AC – Audit Courses / Non – Credit Courses (Optional)**

FOUNDATION COURSES (FC)

		L	T	P	C
MA1154	**APPLIED PROBABILITY AND STATISTICS TECHNIQUES**	**4**	**0**	**0**	**4**

OBJECTIVES

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- It is framed to address the issues and the principles of estimation theory, testing of hypothesis and multivariate analysis.

COURSE OUTCOMES (CO)

CO1 The course gives exposure to random variables and well-founded knowledge of standard distributions which can describe real life phenomena.

CO2 The course paves ideas to handle situations involving more than one random variable and functions of random variables.

CO3 Students will gain fundamentals of estimation theory and regression

CO4 Students will gain the knowledge on testing of hypotheses on data. These concepts are very useful in biological, economical and social experiments and all kinds of generalizations based on information about a smaller sample and larger samples. Apply the appropriate test in the problems related with sampling.

CO5 Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

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 PERIODS: 60

REFERENCE BOOKS:

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.

PROFESSIONAL CORE COURSES (PCC)

MF1101	ADVANCED IN MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce to fundamentals of special machining processes.
- To understand unconventional machining processes.
- To introduce the micro machining process.
- To learn the nano fabrication processes and rapid prototyping

COURSE OUTCOMES (CO)

CO1	Discuss on fundamentals of unconventional machining processes
CO2	To produce useful research output in machining of various materials
CO3	Use this knowledge to develop hybrid machining techniques
CO4	Application of this knowledge to manage shop floor problems
CO5	To design of nano fabrication 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 10

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 PERIODS: 45

TEXT BOOKS:

1. Narayanaswamy, R., Theory of Metal Forming Plasticity, Narosa Publishers,1989.
2. Pandey, P.S. and Shah.N., "Modern Manufacturing Processes", Tata McGraw Hill, 1980.
3. Serope Kalpakjian., "Manufacturing Engineering and Technology" Pearson Education,2001

REFERENCE BOOKS:

1. Benedict,G.F.,"Non Traditional manufacturing Processes",CRC press,2011
2. Madou, M.J., Fundamentals of Micro fabrication: The Science of Miniaturization, Second Edition, CRC Press (ISBN: 0849308267), 2006.
3. McGeough,J.A.,"Advanced methods of Machining",Springer,2011

MF1102	COMPUTER INTEGRATED MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

- 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.

COURSE OUTCOMES (CO)

CO1 The students will be able to explain about various components of computer aided design and the fundamentals of parametric curves, surfaces and Solids.

CO2 The students will be able to explain about various components of computer integrated manufacturing and its applications.

CO3 The students will be able to explain about the features of group technology and computer aided process planning.

CO4 The students will be able to explain about the features of shop floor control and flexible manufacturing systems.

CO5 The students will be able to explain about various components of computer aided planning and control and computer monitoring.

UNIT - I COMPUTER AIDED DESIGN 9

Product cycle- Sequential and concurrent engineering- CAD system architecture- Computer graphics – Co-ordinate systems- 2D and 3D transformations - Line drawing -Clipping- viewing transformation, 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 – serial, 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.

TOTAL PERIODS: 45

TEXT BOOKS:

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. Mikell. P. Groover “Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education 2001.
3. James A. Regh and Henry W. Kreabber, “Computer Integrated Manufacturing”, Pearson Education second edition, 2005.

REFERENCE BOOKS:

1. Mikell. P. Groover and Emory Zimmers Jr.,CAD/CAM”, Prentice hall of India Pvt.Ltd., 1998.
2. P N Rao, “CAD/CAM Principles and Applications”, TMH Publications, 2007.
3. Yorem Koren, “Computer Integrated Manufacturing”, McGraw Hill, 2005.

MF1103	ADVANCES IN MATERIALS TECHNOLOGY	L	T	P	C
		4	0	0	4

OBJECTIVES

- To understand the elastic and plastic behaviour of materials.
- To impart knowledge on fracture analysis.
- To familiarize on modern metallic materials.

- To review on polymeric and ceramics materials and their applications.
- To enable student to select material for specific applications.

COURSE OUTCOMES (CO)

CO1 Get knowledge of mechanism of failure of materials and methods.
CO2 Fully appreciate modification of material property to suit the specific requirements.
CO3 Express and appreciate the existing materials and development of upcoming new materials.
CO4 Have the knowledge to select the various non-metallic materials to suit required applications
CO5 Identify and select suitable material for relevant application.

UNIT - I ELASTIC AND PLASTIC BEHAVIOR 10

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

UNIT - II FRACTURE BEHAVIOUR 10

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

UNIT - III MODERN METALLIC MATERIALS 8

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

UNIT - IV NON METALLIC MATERIALS 7

Polymeric materials – Formation of polymer structure – Production techniques of fibres, foams, adhesives and coating – structure, properties and applications of Commodity and engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, applications as abrasives and cutting tool- Properties and applications of CNT – Graphene based Material

UNIT - V SELECTION OF MATERIALS 10

Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for Atmospheric, water, Soil and chemical, corrosion Selection for adhesive and abrasive wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery, chemical and nuclear applications.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Ashby M.F., Material Selection in Mechanical Design, 5th Edition, Butter Worth 2017.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, 10th Edition, ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, 3rd edition, Butterworth-Heiremann, 2001.
4. Thomas H. Courtney, Mechanical Behaviour of Materials, 2nd edition, McGraw Hill, 2000.

REFERENCE BOOKS:

1. Marc Andre, Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, 2ndEdition, Cambridge University Press, 2009.
2. George E.Dieter, Mechanical Metallurgy, 3rd Edition,McGraw Hill, 2014.10. SHIRO KOBAYASHI, SOO-IK-oh-ALTAN, T,Metal forming and Finite Element Method, Oxford University Press, 2001.
3. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,2010.

MF1111	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

CO1 Draw complex geometries of machine components in sketcher mode.

CO2 Ability to Develop 2D and 3D Part Models using Modeling Software.

CO3 Create complex engineering assemblies using appropriate assembly constraints.

CO4 Ability to Understand the CNC Control in Modern Manufacturing System.

CO5 Ability to Prepare CNC Part Programming and Perform Manufacturing.

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

MF1201 OPTIMIZATION TECHNIQUES

L	T	P	C
3	1	0	4

OBJECTIVES

- To introduce the various optimization techniques and their advancements.
- To make use of the above techniques while modeling and solving the engineering problems of different fields

COURSE OUTCOMES (CO)

CO1 The student has the basic knowledge about historical development of optimization problems, formulation of the problem, classification and application to various engineering domain.

CO2 Ability to approach and solve the linear equations of operational research problems which relates to the real engineering business problem.

CO3 Ability to approach and solve the Non-linear equations of operational research problems which relates to the real engineering business problem.

CO4 Ability to use the various optimization techniques for solving the various experimental studies to obtain the optimum objective function value.

CO5 The student has the knowledge about various simulation techniques and knows to relate these techniques to various experimental studies to obtain the optimum objective function value.

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 PERIODS: 60

TEXT BOOKS:

1. Singiresu S. Rao , "Engineering Optimization: Theory and Practice", Fourth Edition ,John Wiley & Sons, Inc., 2009
2. R. Panneerselvam, "Operations Research", Prentice Hall of India Private Limited, New Delhi 1 – 2005

REFERENCE BOOKS:

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. Ravindran, Philips and Solberg, Operations Research Principles and Practice, John Wiley & Sons, Singapore, 1992

MF1202	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.

COURSE OUTCOMES (CO)

C111.1 Ability to understand the concepts of metrology and errors in measurement
C111.2 Ability to understand the applications of measurement of surface roughness
C111.3 Ability to understand the basic study of interferometry and its importance
C111.4 Ability to understand measuring machines and laser metrology .
C111.5 Ability to apply image processing for metrology

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 PERIODS: 45

TEXT BOOKS:

1.Jain ,R.K.,"Engineering Metrology", Khanna Publishers, 2008.
2. Rajput,R.K., "Engineering Metrology and Instrumentations", Kataria & Sons Publishers, 2001.

REFERENCE BOOKS:

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. Smith,G.T., "Industrial Metrology", Springer, 2002
6. Sonka,M., Hlavac,V. and Boyle.R., "Image Processing, Analysis, and Machine Vision", Cengage Engineering, 2007.
7. Whitehouse,D.J., "Surface and their measurement", Hermes Penton Ltd, 2004.

MF1203	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.

COURSE OUTCOMES (CO)

CO1 Explain the fundamental concepts of tooling, tool engineering procedures, control and maintenance.
CO2 Discuss the mechanism in metal removal, tooling of automats, tooling in Non-traditional material removal processes
CO3 Explain the concept of tooling in metal forming processes.
CO4 Explain the concept of tooling in metal casting and metal joining processes
CO5 Explain the concept of inspection and gauging

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 PERIODS: 60

REFERENCE BOOKS:

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

MF1211	MODELLING AND SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- To study the fundamentals of finite element analysis from classical method to nodal approximation method in various fields of manufacturing applications.
- To make the students to design an element by Finite element analysis.
- To develop the knowledge related to modelling and simulation in field of manufacturing.

LIST OF EXERCISES

1. One Dimensional FEA Problem like beam, Truss etc.
2. Two Dimensional FEA Problems like plane stress, plane strain, axisymmetric and vibration.
3. Three Dimensional FEA Problems like shell and contact.
4. FEA Application in metal forming like superplastic forming, deep drawing etc
5. FEA Application in Metal cutting

6. FEA Application in Casting process
7. 3D Modelling and Assemble of Engine
8. Modelling of Crack Shaft
9. Modelling of Connecting Rod
10. Modelling of Cotter Joint
11. Modelling of Plummer Block and Coupling

(Any 10 for Conduct of end semester examination)

COURSE OUTCOMES (CO)

Students will be able to

CO1 : Apply the principles of Finite Element Analysis to solve problems in the field of production engineering.

CO2 : design and analyse various problems in field of manufacturing

CO3 : identify the problems and simulate using Finite element analysis

CO4 : Relate to Finite element analysis in various manufacturing applications.

CO5 : Develop skills in field of design and simulation using FEA.

MF1212	AUTOMATION & METAL FORMING LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES

- 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

COURSE OUTCOMES (CO)

CO1	Ability to Design pneumatic circuits with trainer kits and execute
CO2	Ability to understand the metal forming techniques and evaluate the related parameters.
CO3	Ability to design and execute pnuemo-hydraulic circuits using hydro-pneumatic Software.(case studies)
CO4	Ability to understand the strain hardening of material and evaluate.
CO5	Ability to understand the formability of sheet metal and forming methods.

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 PERIODS: 60

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Universal testing machine.
2. Hydraulic press.
3. Pipe surge and Water hammer apparatus.
4. Extrusion machine.
5. Two high mill roll apparatus.
6. Force sensor and motion sensor.

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

		L	T	P	C
MF1213	**MINI PROJECT WITH SEMINAR**	0	0	2	1

OBJECTIVES

- To prepare students to identify a problem for study.
- To do literature review of a problem.
- To enable to comprehend information in form of presentation both written and oral, to develop technical communication skills.
- To carry out modelling/ conduct experiments beyond regular laboratory exercises in developing solution to the identified problem.
- To cultivate spirit of team work in working as a group.

COURSE OUTCOMES (CO)

CO1 To critically observe the world around and identify a problem that can be solved.
CO2 To develop skills of read and comprehensively analysing the facts.
CO3 To exhibit skill of presentation both orally and in written form.
CO4 To get hands on experience to doing experimental/ theoretical analysis in synthesis of solution to the problem
CO5 Able to appreciate the importance of team work

TOTAL PERIODS: 30

		L	T	P	C
MF1311	**PROJECT WORK PHASE-I**	0	0	12	6

OBJECTIVES

- To enable students to select and define a problem/need for analysis in the field of manufacturing engineering.
- To review and analyse literature/ data of selected problem for study and propose objective and scope of dissertation work.
- To develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the field of problem
- To design, model and experiment/develop optimal solution for problem being investigated
- To analysis and interpretation of data, and synthesis of the information to provide valid conclusions and submit dissertation.

COURSE OUTCOMES (CO)

CO1 Identify a topic in advanced areas of Manufacturing Engineering. Identify methods and materials to carry out experiments
CO2 Review literature to identify gaps and define objectives & scope of the work

CO3 Generate and implement innovative ideas for social benefit
CO4 Analyze and discuss the results to draw valid conclusions
CO5 Reorganize the procedures with a concern for society, environment and ethics

EVALUATION

- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report
- Project work evaluation is based on the Regulations of the Credit system for Post graduate programmes.

OUTCOMES

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

TOTAL PERIODS: 24

MF1411	**PROJECT WORK PHASE-II**	**L**	**T**	**P**	**C**
		0	0	24	12

OBJECTIVES

- Based on practical experience in project work phase I, the students will be able to propose and define a problem/need for analysis in the field of manufacturing engineering.
- To comprehensively review and analyse literature/ data to develop hypothesis and identify methodology based on ethical, scientific and systematic application of knowledge in the field of problem
- To design experiments, develop model and conduct experiments/ simulations for development of sustainable and economical solution for problem being investigated
- To analyse and interpret data, and synthesize of the factual information's to arrive at valid conclusions
- To enable students to communicate technical information in form of oral presentation and technical report in form of dissertation.

COURSE OUTCOMES (CO)

CO1 Identify a topic in advanced areas of Manufacturing Engineering.Identify methods and materials to carry out experiments
CO2 Review literature to identify gaps and define objectives & scope of the work
CO3 Reorganize the procedures with a concern for society, environment and ethics
CO4 Generate and implement innovative ideas for social benefit
CO5 Analyze and discuss the results to draw valid conclusions

EVALUATION

- The progress of the project is evaluated based on a minimum of three reviews.
- The review committee may be constituted by the Head of the Department.
- A project report is required at the end of the semester. The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report
- Project work evaluation is based on the Regulations of the Credit system for Post graduate

programmes.

OUTCOMES

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

TOTAL PERIODS: 24

PROFESSIONAL ELECTIVE COURSES (PEC)

SEMESTER I

PROFESSIONAL ELECTIVE COURSES – I

		L	T	P	C
MF1001	**DESIGN OF MANUFACTURING TOOLS, JIGS AND FIXTURES**	3	0	0	3

OBJECTIVES

- To introduce to fundamentals of Jigs and Fixtures and tool materials.
- To understand geometrical features and design of cutting tools.
- To introduce the design steps of tools for metal forming operation.
- To learn the design process of clamping, locator and fixtures
- To familiarize the design process of Jigs and tool guides

COURSE OUTCOMES (CO)

CO1 Discuss on fundamentals Jigs and Fixtures and tool materials
CO2 Brief on geometrical features and design of cutting tools.
CO3 Understand the design steps of tools for metal forming operation.
CO4 Carryout design process for clamping, locator and fixtures.
CO5 To design of Jigs and tool guides

UNIT - I INTRODUCTION 9

Introduction, The design procedure, Drafting and design techniques in tooling drawing. Tooling Materials and Heat Treatment: Introduction, Properties of materials, Ferrous tooling materials, Non-ferrous tooling materials, Non-metallic tooling materials, Heat treatment and tool design. Introduction to Jigs and Fixtures: Definition, Differences between Jigs and Fixtures, principles of Jigs and Fixtures.

UNIT - II DESIGN OF CUTTING AND METROLOGY TOOLS 9

Introduction to metal cutting process and tools, Revision of metal cutting tools-Single point cutting tools, Milling cutters, Drills and Drilling, Reamers, Taps. Selection of carbide tools, determining the insert thickness for carbide tools. Introduction to Design of Tools for Inspection and Gauging, Geometrical Dimensioning and Tolerance, Work piece quality criteria, Principles of gauging, Types of gages and their applications, Amplification and magnification of error, Gage Tolerances, Indicating gages, Automatic gages, Gauging positional tolerance parts, problems.

UNIT - III DESIGN OF PRESS TOOLS 9

Design of Press-working Tools: Power presses, Cutting operations, Types of die-cutting operations - and their design, Evolution of blanking and progressive blanking. Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, Bending dies, Forming dies, and Drawing dies. Evolution

of a draw die, Progressive dies. Strip development for progressive dies, Examples of progressive dies. Extrusion dies, Drop forging dies and auxiliary tools

UNIT - IV DESIGN OF CLAMPS LOCATING METHODS AND FIXTURES 9

Locating and Clamping Methods: Introduction, Basic principle of location, Locating methods and devices, Basic principle of clamping. Principles of Location: Six degrees of freedom, Duty of the location system, Choice of location system, redundant location, 3-2-1 Location, Types and methods of location. Principles of Clamping: Requirements of the clamping system, Position of the clamps, Design of clamps, Types of clamps: Cam clamp, Toggle clamp. General Principles Of Milling, Lathe, Boring, Broaching And Grinding Fixtures – Assembly, Inspection And Welding Fixtures – Modular Fixturing Systems- Quick Change Fixtures.

UNIT - V DESIGN OF JIGS AND TOOL GUIDES 9

Types Of Jigs –plate Jig, Box Jig, Leaf Jig, Channel Jig, Post, Turnover, Channel, Latch, Pot, Angular Post Jigs – Indexing Jigs – Design of Drill Jigs: Introduction, Types of drill jigs, General considerations in the design of drill jigs, Drill bushings, Methods of construction. Guiding Elements: Introduction, Guiding the tools, Types of drill bushes.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Cyril Donaldson, Lecain, G.H. and Goold, V.C. Tool Design , 4th editions, TMH Publishing Co Ltd., New Delhi, 2012.
2. Donaldson, Lecain And Goold “Tool Design”, 3rdEdition, Tata McGraw Hill, 2000.
3. Hoffman “Jigs And Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
4. Joshi, P.H. “Jigs And Fixtures”, 2ndEdition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.

REFERENCE BOOKS:

1. Kempster, “Jigs And Fixture Design”, 3rd Edition, Hoddes And Stoughton, 1974.
2. Nagpal, G.R., “Tool Engineering and Design”, 6th edition, Khanna Publishers, , 2009.
3. Venkataraman. K., “Design Of Jigs Fixtures and Press Tools”, Tata McGraw Hill, New Delhi, 2005

MF1002	NON-DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To stress the importance of NDT in engineering.

COURSE OUTCOMES (CO)

CO1 To introduce the basic principles, techniques, equipment, applications and limitations of NDT methods such as Visual inspection and liquid penetrant testing.
CO2 To learn the eddy current testing and acoustic emission NDT methods.
CO3 To know the magnetic particle and thermography testing methods.
CO4 To identify the defects by ultrasonic testing methods.
CO5 To make aware the developments and future trends in Radiography.

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 PERIODS: 45

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Peter J. Shull “Non Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002.
2. www.ndt.net.

MF1003	METAL CUTTING THEORY AND PRACTICE	L	T	P	C
		3	0	0	3

OBJECTIVES

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

To find the tool life in various machining operations by different machining condition.

COURSE OUTCOMES (CO)

CO1 To study the basic mechanism of chip formation, types of chips and other theories proposed by different scientists.
CO2 Have the detailed knowledge of single and multipoint cutting tool nomenclature.
CO3 Have the complete idea of heat distribution in cutting tool, influence of cutting fluid on tool.
CO4 To study the tool life calculation, machinability index.
CO5 To have the concept of tool wear mechanism, types of chatter and its mechanism.

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

TOTAL PERIODS: 60

TEXT BOOKS:

1. Bhattacharya.A., Metal Cutting Theory and practice, Central Book Publishers, India, 1984.

REFERENCE BOOKS:

1. Boothroid D.G. & Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, Newyork, 1989.
2. Shaw.M.C.Metal cutting principles, oxford Clare don press, 1984

MF1004	OPERATIONS MANAGEMENT	L	T	P	C
		3	0	0	0

OBJECTIVES

- To familiarize with various forecasting models.
- To impress upon the importance of sequencing problem in industries.
- To design and develop inventory control models for a given industry.
- To familiarize with project management techniques such as CPM and PERT.
- To train on plant engineering techniques such as plant location, plant layout, materials

handling and work study

COURSE OUTCOMES (CO)

CO1 Select an appropriate forecasting method for a given industry.
CO2 Obtain optimal solutions for sequencing problem in industry.
CO3 Design a suitable inventory system for any particular industry.
CO4 Use the project management techniques to minimize the project time.
CO5 Design plant layout and materials handling systems and can make use of the concepts of work study for work design.

UNIT - I FORECASTING 9

Forecasts-Types-Purpose- opinion and judgmental method-Time series methods – moving average - weighted moving average – method of least squares – Exponential smoothing method- Regression and correlation methods – simple and multiple regression – Linear and Nonlinear regression

UNIT - II SCHEDULING AND SEQUENCING 9

Scheduling – Single Criterion rules –Sequencing –n job 2 machine problem – Johnson's algorithm – 3 machine problem – M machine problem – Graphical method for 2 jobs M machine problems – Heuristic methods.

UNIT - III INVENTORY 9

Inventory – purpose of inventory – Basic EOQ Model –Quantity discount model – Reorder level – Fixed order quantity inventory system – Periodic review system – ABC analysis – Materials requirement planning – EOQ models under constraints – Purchasing management – Stores management – Just In Time inventory system – Vendor evaluation - Inventory pricing –Supply chain Management – Aggregate planning.

UNIT - IV PROJECT MANAGEMENT 9

Project network analysis – Activities – Events- critical path method – Method based on time estimates – Programme Evaluation Review Technique –Optimistic, pessimistic time, most likely time - Probability of completion of projects – Time crashing of Projects –Optimum duration and cost

UNIT - V PLANT ENGINEERING AND WORK STUD 9

Plant location – Factors affecting plant location – Break even analysis- Factors weighted rating method – Plant layout- Types- Selection – Plant layout Techniques – Travel chart method – Line balancing method– Work study – method study – Principles of Motion economy – steps in methods study - Charts – Micromotion study-memo motion study – multiple activity charts- therbligs – work measurement – stop watch time study – Production studies – PMTS – Work sampling – Materials handling – Principles – Selection

TOTAL PERIODS: 45

TEXT BOOKS:

1. Chary S.N Production and Operations Management, Tata McGraw Hill, 3rd Edition 2012.
2. Kanishka Bedi, Production and Operations Management, Oxford University Press,3rdEdition 2016.
3. Norma Gaither and Gregory Frazier, Operations Management, Cengage Learning, 9thEdition,2016.

REFERENCE BOOKS:

1. Pannerselvam R, Production and Operations Management, Prentice Hall of India, 2ndEdition, 2008.
2. Richard B. Chase, Ravi Shankar, F. Robert Jacobs, Nicholas J. Aquilano, Operations and Supply Management, McGraw Hill,14th edition, 2017.
3. William J Stevenson, Operations Management, McGraw Hill, 11th edition, 2012

SEMESTER II

PROFESSIONAL ELECTIVE COURSES – II

		L	T	P	C
MF1005	**ADVANCES IN CASTING AND WELDING**	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.

COURSE OUTCOMES (CO)

CO1 Ability to understand the concepts of casting design and casting principles
CO2 Ability to understand the concepts of casting metallurgy, casting effects and Castability
CO3 Ability to understand the basic study of foundry and the different technologies involved in casting
CO4 Ability to understand welding technique and technological aspects over welding design.
CO5 Ability to understand the unique characteristics of welding

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, CO2 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 – Weldability of steels, cast iron, stainless steel, aluminum, Mg , Cu , Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – 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

TOTAL PERIODS: 45

TEXT BOOKS:

1. Jain. P.L., Principles of Foundry Technology, Tata McGraw Hill Publishers, 2003
2. Parmer R.S., Welding Engineering and Technology, Khanna Publishers,2002

REFERENCE BOOKS:

1. ASM Handbook vol.6, welding Brazing & Soldering, 2003
2. ASM Handbook, Vol 15, Casting, 2004
3. Cary 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. Lancaster.J.F. – Metallurgy of welding – George Alien & Unwin Publishers, 1980
8. Schwariz, M.M. – Source book on innovative welding processes – American Society for Metals (OHIO), 1981
9. Srinivasan N.K., Welding Technology, Khanna Tech Publishers, 2002

MF1006	FINITE ELEMENT METHODS FOR MANUFACTURING ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES

- To study the fundamentals of one dimensional and two dimensional problems, higher order elements using FEA in manufacturing.
- Finite element methods and its application in manufacturing.

COURSE OUTCOMES (CO)

CO1 To understand the fundamentals of FEA and functional approximation method used to find the solution of engineering problems

CO2 To study the fundamentals of one dimensional problems using FEA in manufacturing.

CO3 To study the shape function of 1D, 2D finite elements and concepts of higher order elements which are useful for FEA in manufacturing.

CO4 To be familiar in utilization of analysis software and to get solution for manufacturing process

CO5 To understand and interpret the solutions obtained by software with respect to different types of manufacturing areas.

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 PERIODS: 45

TEXT BOOKS:

1. Bathe, K.J., Finite Element procedures in Engineering Analysis, 1990 , Latest Edition
2. Reddy, J.N. An Introduction to the Finite Element Method, McGraw Hill,2017, Latest Edition

REFERENCE BOOKS:

1. Kobayashi,S, Soo-ik-Oh and Altan,T, Metal Forming and the Finite Element Methods, Oxford University Press, 1989.
2. Lewis R.W. Morgan, K, Thomas, H.R. and Seetharaman, K.N. The Finite Element Method in Heat Transfer Analysis, John Wiley, 1994.
3. Rao, S.S., Finite Element method in engineering, Pergamon press, 2005.
4. Seshu P., Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd, 2004.
5. www.pollockeng.com
6. www.tbook.com

MF1007	MANUFACTURING OF AUTOMOTIVE COMPONENTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To introduce the students about the requirement of materials for automobile components
- To familiarize students on typical materials used in manufacturing of automobile components
- To impart knowledge on material and manufacturing techniques of piston, valves and battery parts
- To impart knowledge on material and manufacturing techniques of engine blocks, cables and locks in automobile.
- To impart knowledge on material and manufacturing techniques of general transmission parts of automobile

COURSE OUTCOMES (CO)

CO1 Have the knowledge about material requirements, its recycling and life cycle aspects.
CO2 Gain an insight over the latest materials adopted in automobile manufacture.
CO3 Have the knowledge of methods adopted in manufacture of piston, valves and battery parts.
CO4 Know the methods of manufacturing engine block, cables and locks in automobile.
CO5 Have the idea of various manufacturing methods of automobile structure, transmission parts.

UNIT - I MATERIAL NEEDS IN AUTOMOBILE 9

Requirements of materials in automotive tests – recycling and life cycle consideration. Current materials in use and their future. Advanced in manufacturing and joining techniques. Technical problems and solutions for use of magnesium alloys in automotive industry. Most commonly used composite moulding processes. Renewable materials, barriers and incentives in use of bio-composites - composite materials and their automotive applications.

UNIT - II MATERIALS AND TECHNOLOGIES FOR AUTOMOBILE 8

Introduction – steel sheets – high strength steel sheet – "Nano-Hilen" – "BHT" – high strength galvannealed steel sheets – development of inorganic type high lubrication galvannealed steel sheets – organic solid lubricant technology – uses of aluminium in automobiles – uses of plastics in automobiles.

UNIT – III MANUFACTURING OF PISTON, VALVES AND BATTERY PARTS 10

Introduction – manufacturing of auto piston – manufacturing of pins for automobiles – manufacturing of piston rings – manufacturing of lead storage battery. Manufacturing of valve and valve set – manufacturing of automobile silencer.

UNIT - IV MANUFACTURING OF ENGINE BLOCK, CABLES AND LOCKS 8

Manufacturing of automobile chain – manufacturing of cylindrical block. Manufacturing of cylinder liner – manufacturing of automobile control cable – manufacturing of engine moulding pad – manufacturing of auto locks.

UNIT - V MANUFACTURING OF TRANSMISSION PARTS 10

Manufacturing of automobile chassis and other technologies. Manufacturing of automobile body – Manufacturing of disc brake – Manufacturing of brake drum – Manufacturing of gear blank – Manufacturing of gear – casting method – forming method – powder metallurgy – Manufacturing of gear box housing – Manufacturing process of leaf spring – Manufacturing process of automotive tyres – Manufacturing of auto tubes and flaps. Heat treatment of automobile components – forging technologies of automobile parts – Manufacturing of Torque Converters- painting technology of automobiles - Role of Nanotechnology in Automotive Industries.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Gupta K.M, Automobile Engineering Vol.I and II, Umesh Publishers, 2000.
2. Kirpal Singh, Automobile Engineering, Vol.I and II, Standard Publishers, New Delhi, 1997.
3. Ramalingam K K, Automobile Engineering: Theory and Practice, 2nd Edition, Scitech Publications (India), 2001.

REFERENCE BOOKS:

1. Joao Paulo Carmo, New Advances in Vehicular Technology and Automotive Engineering, JanezaTrdine publisher, 2012.
2. Ahmed Elmarkkbi, Advanced Composite Materials for Automotive Applications, Wiley publications, 2014.
3. Brian Cartor, Patric Grant, Automotive Engineering Light Weight, Functional and Novel materials, Taylor and Francis, CRC Press, 2008.

MF1008	COMPUTER AIDED PRODUCT DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To review the basics of Computer aided design
- To familiarize students on use of modelling tools of CAD software.
- To apply the various design concepts and design tools and techniques while designing a product.
- To understand the product modelling method and its relationship with computer graphics.
- To create awareness on product life cycle management.

COURSE OUTCOMES(CO):

Students will be able to

1. Understand the design phases and various design hardware and software.
2. Relating basics of various geometrical feature creation.
3. Systematically work on each stages in the development of a new product and its management.
4. Predicting on various factors for various design applications.
5. Mixing the techniques in the design of new product.

UNIT I INTRODUCTION 8

Introduction to Engineering Design – Various phases of systematic design – sequential engineering and concurrent engineering – CAD/CAM hardware and Softwares – software packages for design and drafting.

UNIT II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC 8

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

UNIT III PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT 10

Understanding customer needs – Product function modelling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – 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 AND TECHNIQUES 10

Product modelling – types of product models; product development process tools – TRIZ – Altshuller‘s inventive principles – Modelling 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.

TOTALPERIODS: 45

REFERENCES:

1. Biren Prasad, ―Concurrent Engineering Fundamentals Vol.II, Prentice Hall,1st Edition, 1996..
2. David F.,Rogers.J, Alan Adams, Mathematical Elements for Computer Graphics, McGraw Hill, 2ndEdition,2002.
3. Ibrahim Zeid, Sivasubramanian R, CAD/CAM theory and Practice, McGraw Hill, 2ndEdition, 2009.
4. James G.Bralla, Handbook of Product Design for Manufacturing, McGraw Hill, 1998
5. Kevin Otto, Kristin Wood, Product Design, Pearson Education, 2004.

PROFESSIONAL ELECTIVE COURSES – III

MF1009	ROBOTICS AND INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

To make the student to be familiar with
- Classification and construction of robots
- Serial and parallel Manipulators
- Programming method of robots
- Understand various control systems

COURSE OUTCOMES (CO):

Students will be able to
CO1 Understand the basics of robotics.
CO2 Relating basics of robot arm kinematics and dynamics.
CO3 Understand the basics of robot programming methods.
CO4 Understanding the basics of sensing elements.
CO5 Understand the control system and components.

Unit I INTRODUCTION TO ROBOTICS 9

Introduction to Robotics: Definitions, historical development, classification, work volume, Control systems and dynamic performance. – Grippers

Unit II ROBOT ARM KINEMATICS AND DYNAMICS 9

Robot Arm Kinematics and Dynamics: Frame transformation, D-H parameters, Forward kinematics, Inverse kinematics, - Rotation matrix - Homogeneous coordinates and transformation matrix

Unit III ROBOT PROGRAMMING METHODS 9

Robot Programming Methods: Manual teaching, Lead-through teaching, VAL programming. – Introduction to trajectory Planning - Introduction to Automation.

Unit IV SENSING 9

Sensing: Range sensing, proximity sensing, touch sensors, force and torque sensing, Robot Vision: System: Sensing & Digitizing, Image processing & Analysis, Application.

Unit VCONTROL SYSTEM AND COMPONENTS 9

Control system and components: Control system concepts and models, controllers, Control system analysis, Robot Activation and Feedback componens – position control - velocity control – Actuation.

TOTALPERIODS: 45

REFERENCES:

1.Mikell P. Groover, "Industrial Robots", McGraw Hill, 2005
2.S.K. Saha, Introductions to Robotics, McGraw Hill, 2009
3.L.K. Huat, Industrial Robotics: Programming, Simulation and Applications, Tata McGraw Hill, 2003.
4.Ganesh Hegde, A textbook of Industrial Robotics, Lakshmi Publication, 2006.

MF1010	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

COURSE OUTCOMES (CO):

Students will be able to
CO1 Understand the basics of theory of plasticity.
CO2 Relate the theory and practicing methods of Bulk Forming Processes
CO3 Understand the basics of sheet metal forming.
CO4 Understanding the basics of powder metallurgy and special forming processes.
CO5 Understand the surface treatment and metal forming applications.

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.

TOTALPERIODS: 45

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.

MF1011	LEAN AND AGILE MANUFACTURING	L	T	P	C
		3	0	0	0

OBJECTIVES

- To provide basic understanding on the concepts of Lean and Agile Manufacturing.

COURSE OUTCOMES (CO)

CO1	The student will be able to practice the principles of lean manufacturing
CO2	The student will be able to practice the principles of lean manufacturing like customer focus, reduction of MUDA.
CO3	The student will be able to practice the principles of lean manufacturing and lean tools,
CO4	The students will obtain knowledge to try the relevant technique for manufacturing.
CO5	The student will be able to practice the principles of new organisation culture.

UNIT - I INTRODUCTION 9

Origins and objectives of lean manufacturing-Lean process,3M concept, key principles and implications of lean manufacturing-traditional vs lean manufacturing characteristics–roadmap for lean implementation and lean benefits. Study of Ford and Toyota production system, JIT manufacturing, Lean building blocks.

UNIT - II LEAN TOOLS I 9

Value creation and waste elimination – seven types of waste- pull production - different models of pull production -The Kanban system - continuous flow-The continuous improvement process / Kaizen, Worker involvement. Design of Kanban quantities, levelled production, tools for continuous improvement.

UNIT - III LEAN TOOLS II 9

The value stream – benefits, mapping process. The current state map–mapping icons, mapping steps. VSM exercises, Takt time calculations Standardized work – standard work sequence, timing and working progress. Quality at source - Automation/Jidoka, Visual management system, Mistake

proofing/Poka-Yoke. 5S technique – Elements and waste elimination thro 5S, advantages and benefits, 5S audit. Visual control aids for improvement, Flexible work force

UNIT - IV AGILE PRODUCTION SYSTEM AND PRACTICES 9

Agile production system – the task aligned organization – agile manufacturing production system – production planning and control, quality assurance, purchasing, maintenance, overview of production support, business operation, engineering, human resource, finance and accounting. Agile practices – Agile practice for product development – manufacturing agile practice – understanding the value of investing in people, removing inappropriate fear from the shop floor – not scarifying agility for perfectionism

UNIT - V MANAGEMENT IN THE AGILE ORGANIZATION 9

Old management styles, role of manager in an agile organization – vision champion, team leader, coach, business analyzer, supporting the new culture – performance appraisal systems, selection systems, reward and recognition systems, organizational measurement, organizational learning processes

TOTAL PERIODS: 45

TEXT BOOKS:

1. Micheal Wader, "Lean Tools: A Pocket guide to Implementing Lean Practices", Productivity and Quality Publishing, 2002.
2. William M Feld, "Lean Manufacturing: Tools, Techniques and How to Use Them", APICS, 2001.
3. S.R.Devadasan, V.Mohan Sivakumar, V.Murugesh, P.R.Shalij, 'Lean and Agile Manufacturing', Prentice Hall India, 2012.

REFERENCE BOOKS:

1. Taiichi Ohno, "Toyoto Production Systems: Beyond Large Scale Production", Productivity Press,1988.
2. Askin RG and GoldbergJB, "Design and Analysis of Lean Production Systems", John Wiley and Sons, 2003.
3. Goldman S L, Nagal R N and Preiss K, "Agile Competitors and Virtual Organization", Van Nostrand Reinhold, 1995.

MF1012	SURFACE ENGINEERED MATERIALS TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To teach students the basic concepts of surface engineering and its development
- To provide students the knowledge of coatings and the formation of technological surface layers
- To enable the students, understand the basic principles of Laser Technology and Plasma Coating Technology

COURSE OUTCOMES (CO)

CO1 Able to understand the basic concepts in surface coating, wear and corrosion
CO2 Explain the concepts of coating in metallic and non- metallic materials. Measurement of roughness
CO3 Explain the concepts on formation of Surface Layers in coating techniques
CO4 Ability to understand the laser techniques and tribological properties
CO5 Explain the concept of coating by using Plasma coating technology

UNIT - I DEVELOPMENT OF SURFACE ENGINEERING 12

Development of surface Engineering – Solid surface – Geometrical and mechanical concepts- Wear- Abrasive wear- Erosion wear – Erosion – Corrosion- Surface roughness-Metallographic structure – Need for surface coatings- Enhancement of wear and prevention of corrosion.

UNIT - II CONCEPTS OF COATING 12

Coatings- Concepts of coatings – Metallic and non- metallic coatings- Galvanizing – Spray and cladded coatings- Principles parameters of coatings – Thickness measurement – Physico and chemical parameters of coatings – Surface characterization – GIXRD - microstructure - SIMS – Roughness measurement – Profilometer.

UNIT - III FORMATION OF TECHNOLOGICAL SURFACE LAYERS 12

Formation of technological surface layers – Techniques – Physical vapor deposition –Chemical vapor deposition - electron beam technology – Principles underlying the electron beam impingement – Acceleration of electrons – Electron guns – Interaction of electron beam with treated material – Applications of electron beam coating in surface engineering

UNIT - IV LASER TECHNOLOGY 12

Laser technology – CO2 and Nd: YAG lasers - processing parameters – Continuos and pulsed operations – Properties of laser – Temperature distribution in laser treated material – Depth of penetration of photons – Hard coatings – Applications of laser in surface engineering - Ion implantation techniques – Physical principal of ion beam implantation – Pulsed and continuos ion beam implantation – Tribological properties of ion implanted materials – Strength –Hardness and adhesion of implanted materials- Advantages and disadvantages

UNIT - V PLASMA COATING TECHNOLOGY 12

Plasma coating technology – Processing parameters- Plasma nitriding – Oxy nitriding – Nitro carburizing - boriding- Characterization of Cr –N coatings – Plasma nitrided steels and titanium alloys – Corrosion and wear behavior – Super hard biocompatible coating for medical implants – Carbon like diamond coating- -Nano surface coatings- Comparative study of various coating process in industry

TOTAL PERIODS: 60

TEXT BOOKS:

1. Plasma surface engineering, (2004), Proceedings of DAE-BRNS workshop

REFERENCE BOOKS:

1.D.Setas , A.Tacton, Mercel –Dekker, (2001), Coatings technology handbook I Editors: Bharat Bhushan, (2000), Principles and application of tribology, John Wiley Sons
2. Surface Modification Technologies Vol. XI and XII, Ed: T. Sudarshan et al – TMS Conference Proceedings

SEMESTER III

PROFESSIONAL ELECTIVE COURSES – IV

		L	T	P	C
MF1013	**INDUSTRIAL DESIGN AND ERGONOMICS**	3	0	0	3

OBJECTIVES

- To introduce to industrial design based on ergonomics.
- To consider ergonomics concept in manufacturing
- To apply ergonomics in design of controls and display.
- To apply environmental factors in ergonomics design
- To understand aesthetics applicable to manufacturing and product

COURSE OUTCOMES (CO)

CO1 Appreciate ergonomics need in the industrial design.
CO2 Apply ergonomics in creation of manufacturing system
CO3 Discuss on design of controls and display.
CO4 Consider environmental factors in ergonomics design.
CO5 Report on importance of aesthetics to manufacturing system and product

UNIT - I INTRODUCTION 9

An approach to industrial design, Elements of design structure for industrial design in engineering application in modern manufacturing systems- Ergonomics and Industrial Design: Introduction to Ergonomics, Communication system, general approach to the man-machine relationship, Human component of work system, Machine component of work system, Local environment-light, Heat, Sound.

UNIT - II ERGONOMICS AND PRODUCTION 9

Introduction, Anthropometric data and its applications in ergonomic, working postures, Body Movements, Work Station Design, Chair Design. Visual Effects of Line and Form: The mechanics of seeing, Psychology of seeing, Figure on ground effect, Gestalt's perceptions - Simplicity, Regularity, Proximity, Wholeness. Optical illusions, Influences of line and form.

UNIT - III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9

Displays: Design Principles of visual Displays, Classification, Quantitative displays, Qualitative displays, check readings, Situational awareness, Representative displays, Design of pointers, Signal and warning lights, colour coding of displays, Design of multiple displays Controls: Design considerations, Controls with little efforts – Push button, Switches, rotating Knobs. Controls with muscular effort – Hand wheel, Crank, Heavy lever, Pedals. Design of controls in automobiles, Machine Tools

UNIT - IV ENVIRONMENTAL FACTORS 9

Colour: Colourand light, Colour and objects, Colour and the eye – after Image, Colour blindness, Colour constancy, Colour terms – Colour circles, Munsel colour notation,reactions to colour and colour combination – colour on engineering equipments, Colour coding, Psychological effects, colour and machine form, colour and style

UNIT - V AESTHETIC CONCEPTS 9

Concept of unity, Concept of order with variety, Concept of purpose, Style and environment, Aesthetic expressions - Symmetry, Balance, Contrast, Continuity, Proportion. Style - The components of style, House style, Style in capital good. Introduction to Ergonomic and plant layout softwares

TOTAL PERIODS: 45

TEXT BOOKS:

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7thEdition, 2002
2. Bridger, R.C., Introduction to Ergonomics, 2ndEdition, 2003, McGraw Hill Publications.

REFERENCE BOOKS:

1. Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988
2. Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.

MF1014	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.

COURSE OUTCOMES (CO)

CO1 Understand MEMS and Microsystems working principle and applications
CO2 Understand MEMS manufacturing and micro system packaging
CO3 Ability to select and use micro devices in various applications.
CO4 Understand the science and synthesis of Nano materials
CO5 Ability to characterize nano materials

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 tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL PERIODS: 45

REFERENCE BOOKS:

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 Micro fabrication, 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

MF1015	MATERIAL TESTING AND CHARACTERIZATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To provide understanding of techniques of microstructure and crystal structure evaluation of materials.
- To introduce tools for analysis of microstructure and surface topography of materials.
- To understand the techniques of chemical and thermal analysis of materials.
- To gain knowledge in various static mechanical testing methods.
- To gain knowledge in various dynamic mechanical testing methods.

COURSE OUTCOMES (CO)

CO1 To characterize the engineering materials.
CO2 Know the fundamental principle of Top-notch characterization tools.
CO3 Choose appropriate mechanical static testing methods.
CO4 Choose appropriate mechanical dynamic testing methods.
CO5 Identify the crystal structure and analysis can be made.

UNIT - I MICRO AND CRYSTAL STRUCTURE ANALYSIS 9

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

UNIT - II ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials – Transmission Electron Microscopy – Specimen Preparation – Imaging Techniques – BF and DF – SAD – Electron Probe Microanalysis – Scanning Electron Microscopy – Construction and working of SEM and FESEM Back scattered and Secondary Electron Imaging Techniques – Applications- Atomic Force Microscopy- Construction and working of AFM - Contact and Non-Contact modes Applications.

UNIT - III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Energy dispersive and 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 Gravity metric Analysis (TGA) - Dynamic Mechanical Analysis (DMA).

UNIT - IV MECHANICAL TESTING – STATIC TESTS 9

Hardness – Brinell, Vickers, Rockwell and Micro Hardness Test, Rebound hardness and Indendation – Tensile Test – Stress – Strain plot – Proof Stress – Torsion Test - Ductility Measurement – Impact Test – Charpy and Izod – DWTT - Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT - V MECHANICAL TESTING – DYNAMIC TESTS 9

Fatigue – Low and High Cycle Fatigues – Rotating Beam and Plate Bending HCF tests – S-N curve – LCF tests – Crack Growth studies – Creep Tests – LM parameters – AE Tests-modal analysis - Applications of Dynamic Tests – Fatigue life estimation.

TOTAL PERIODS: 45

REFERENCE BOOKS:

1. Angelo P C, Material characterization, Cengage Learning India, 2016.
2. Cullity B.D., Stock S.R and Stock S., Elements of X ray Diffraction, 3rdEdition. Prentice Hall, 2018.
3. Skoog, Holler and Nieman, Principles of Instrumental Analysis, 7thedition, Cengage Learning, 2017.
4. Suryanarayana A. V. K., Testing of metallic materialism's publications, 2ndEdition, 2007.
5. Suryanarayana C, Experimental Techniques in materials and Mechanics, CRC Press, 1stEdition,2011.
6. Yang Leng, Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, Hong Kong University of Science and Technology, John Wiley and Sons (Asia) Pvt. Ltd., 2ndEdition, 2013.

MF1016	MECHATRONICS IN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

•To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.

• To know the basic working principle of sensors and transducers of use for manufacturing systems

• To know the basic working principle of drives and actuators of use for manufacturing systems

• To know the features, modules and interfaces of microcontrollers and microprocessors

• To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

COURSE OUTCOMES (CO)

CO1 Imply the knowledge to study the mechatronics in modern manufacturing systems.

CO2 Identify and select the sensors and transducers based on the application.

CO3 Identify the principles and functions of drives and actuators.

CO4 Get knowledge of microprocessor and microcontrollers and its functions.

CO5 Apply the knowledge about integration of mechatronic systems in manufacturing.

UNIT - I INTRODUCTION TO MECHATRONICS IN MODERN MANUFACTURING 12

Introduction to Process Parameters in Conventional Manufacturing – Assembly – Inspection – Transportation - Introduction to Systems - Subsystems of Mechatronics - Identification of Mechatronics' Entities in Modern Manufacturing - Mechanical, Fluid, Thermal, Electrical, Electronics, Communication, Control systems and Software Integration for Manufacturing - Classification of Manufacturing based on Mechatronics – CNC based Subtractive Manufacturing – Rapid Prototyping based Additive Manufacturing- Automated Assembly Stations – Modern Quality Inspection and Transportation Systems.

UNIT - II SENSORS AND TRANSDUCERS 8

Introduction – Performance Terminology – Resistive Transducers – Inductive Transducers - Capacitance Transducers – Optical Sensors – Contact and Non-Contact Temperature Sensors – Eddy Current Sensor – Hall Effect Sensor – Piezo Electric Sensor - Ultrasonic Sensors – Proximity Sensors – Chemical and Gas Sensors - Signal Conditioning - Condition Monitoring

UNIT - III DRIVES AND ACTUATORS 8

Role of Linear and Rotary Actuators - Electrical Actuators- Servo Concepts and Stepper Motors - Fluid Power – Piezo Actuators – Solenoids - Function of Drives - Mechanical Switching Devices – Solid State drives for various actuators.

UNIT - IV MICROPROCESSORS AND MICROCONTROLLERS 8

Requirement for Processor – Comparison of 8085 Microprocessor and 8051 Microcontrollers– 8051 Microcontrollers Architecture -Assembly Language Programming- Instruction Set, Addressing Modes, Basic Programming – Interfacing - Sensors, Keyboard, LED, LCD, A/D and D/A Converters, Actuators – Embedded Systems.

UNIT - V RADIOGRAPHY(RT) 9

Design Process - Stages of Design Process – Skeletal Structure and Block Diagram of CNC Based - Vertical Machining Centre, turning centre, Water Jet Machine, Electrical Discharge Machine, Serial Manipulator, hydraulic press, 3 D printers– Coordinate Measuring Machine –Automated conveyors - Extended Transportation System – Total Integration of Manufacturing Systems for Production Automation

TOTAL PERIODS: 45

REFERENCE BOOKS:

1. Beno Benhabib, Manufacturing, design, production, automation and integration, Marcel Dekker, 2003
2. Bolton W, **—** Mechatronics: Electronic control systems in mechanical and electrical engineering, 6thedition, Pearson Education Limited, 2015.
3. Devadas shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning, 2011.
4. Mazidi M A and Mazidi J G, 8051 Microcontroller and Embedded Systems, 2002.
5. Vijayaraghavan G.K., Balasundaram M S, Ramachandran K P, Mechatronics: Integrated Mechanical Electronic Systems, Wiley, 2008.

PROFESSIONAL ELECTIVE COURSES – V

MF1017	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.

COURSE OUTCOMES (CO)

CO1 Understanding the various aspects of mechanical, ultrasonic, abrasive, chemical and electrical micromachining.
CO2 Understanding the various advanced methods in micromachining and grinding.
CO3 Understanding the basic principles of nano polishing and its techniques.
CO4 Understanding the basics of micro forming and welding.
CO5 Understanding the various applications of micro machining.

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

TOTALPERIODS: 45

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

MF1018	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES

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

COURSE OUTCOMES (CO)

CO1	The students will be able to know about the evolution, classification of various techniques in additive manufacturing.
CO2	The students will be able to know about the reverse engineering and cad modeling techniques in additive manufacturing.
CO3	The students will be able to know about liquid based and solid based additive manufacturing systems.
CO4	The students will be able to know about the powder based additive manufacturing systems.
CO5	The students will be able to know about the recent research techniques in additive manufactured systems.

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 PERIODS: 45

TEXT BOOKS:

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.

REFERENCE BOOKS:

1. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
2. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
3. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2011.

MF1019	DESIGN AND ANALYSIS OF EXPERIMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES

The objective of this course is to introduce experimental design techniques and familiarize with all of the best design techniques and study the objectives, similarities, differences, advantages, and disadvantages of each.

COURSE OUTCOMES (CO)

CO1 Ability to understand the Basic principle of DOEs and ANOVA.
CO2 Ability to understand the various Single Factor Experiments.
CO3 Ability to Learn Full and Fraction Factorial Experiment Design.
CO4 Ability to understand the Robust Design.
CO5 Ability to understand the Orthogonal Experiments.

UNIT - I INTRODUCTION 9

Basic principle of DOEs, Guide lines for Designing Experiments, Terminology, ANOVA, Computation of sum of squares and Basics of quality by design, Experiments with single factor, Model Adegnacy checking, Test on means.

UNIT - II SINGLE FACTOR EXPERIMENTS 9

Randomized complete block design, Latin square design, Graeco-Latin square design, Balanced Incomplete block design.

UNIT - III FACTORIAL DESIGN 9

Two-Factor factorial design, General factorial design, 2k Factorial design, 3k Factorial design, Blocking and confounding, Fractional replication and Factors with mixed levels.

UNIT - IV ROBUST DESIGN PROCESS 9

Comparison of classical and Taguchi's approach, variability due to noise factors, principle or robustization, classification of quality characteristics and parameters, objective functions in robust design, S/N ratios.

UNIT - V ORTHOGONAL EXPERIMENTS 9

Selection and application of orthogonal arrays for design, Conduct of experiments, collection of data and analysis of simple experiments, Modifying orthogonal arrays, Inner and outer OA experiments, Optimization using S/N ratios, attribute data analysis, a critique of robust design.

TOTAL PERIODS: 45

TEXT BOOKS:

1. K. Krishnaiah, P. Shahabudeen. "Applied Design of Experiments and Taguchi Methods" PHI (11 March 2012).
2. R. Panneerselvam, "Design and Analysis of Experiments" PHI Learning, 2012.

REFERENCE BOOKS:

1. Montgomery, D.C., "Design and Analysis of Experiments", John Wiley and Sons, 1997.
2. Philip J. Rose, "Taguchi Techniques for Quality Engineering", Prentice Hall, 1989.
3. Nicolo Belavendram, "Quality by Design: Taguchi Techniques for Industrial Experimentation", Prentice Hall, 1995.

MF1020	PRODUCT DESIGN AND LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES

- The new product management process
- Product lifecycle management stages
- The DFx concepts from the conception to recovery or disposal
- Applying analytic methods for all stages of product planning, development and control.

COURSE OUTCOMES (CO)

CO1 Understanding the concept of product design and development

CO2 Understanding & Analysing the model based study on costing and Accounting of the manufactured product.

CO3 Understanding the best practise followed for design and evaluation of prototype building and performing the decision analysis on new product development

CO4 The DFx concepts from the conception to recovery or disposal with standards and Failure mode effective analysis.

CO5 Assessing and improving product development and management performance in the context of a case study.

UNIT – I INTRODUCTION 9

Product development – Trends affecting product development – Best practices for product development – Product development process and organizations – Collaborative product development – concurrent engineering – risk management - Stages of Product development

UNIT – II PRODUCT DEVELOPMENT LIFE CYCLE – I 9

Early design – Requirement Definition and Conceptual design - Trade-off Analysis – Optimization using cost and utility metrics – Trade-off analysis models and parameters- design to cost – Design to

Life cycle cost – Design for warranties.

UNIT – III PRODUCT DEVELOPMENT LIFE CYCLE – II 9

Detailed design – Analysis and modeling – Best practices for detailed design – Design analyses – Prototypes in detailed design – Test and Evaluation – Design review, prototyping – simulation and testing – Manufacturing – Strategies – planning and methodologies.

UNIT – IV PRODUCT DEVELOPMENT LIFE CYCLE – III 9

Supply chain – Logistics, packaging, supply chain and the environment – ISO 14000/210 – Design for people – Ergonomics, Repairability, maintainability, safety and product liability – Task analysis and failure mode analysis.

UNIT – V PRODUCIBILITY AND RELIABILITY 9

Reducibility – strategies in design for manufacturing – requirements for optimizing design and manufacturing decisions – Simplification – commonality and preferred methods – Modularity and scalability – part reduction – functional analysis and value engineering – Reliability – Strategies and practices – Testability – Design for test and inspection.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Karl T. Ulrich, Ateven D. Eppinger "Product Design and Development" Tata McGraw-Hill, 2003.

REFERENCE BOOKS:

1. John W. Priest and Jose M. Sanchez, "Product development and design for manufacturing- A
2. 2. Collaborative approach to produciability and reliability", Marcel Dekker Publications, 2001.
3. 3. Stephen C. Armstrong, "Engineering and product development management – the holistic approach", Cambridge university press, 2001.
4. 4. Thomas A. Sabomone, "What every engineer should know about concurrent engineering", Marcel Dekker Publications, 1995.

OPEN ELECTIVECOURSES (OEC)

SEMESTER III

		L	T	P	C
OCP 101	**BUSINESS DATA ANALYTICS**	3	0	0	3

OBJECTIVES

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks

COURSE OUTCOMES (CO)

CO1 Identify the real world business problems and model with analytical solutions.
CO2 Solve analytical problem with relevant mathematics background knowledge.
CO3 Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
CO4 Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
CO5 Use open source frameworks for modeling and storing data and apply suitable visualization technique using R for visualizing voluminous data.

UNIT - I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

UNIT - II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

UNIT - III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

UNIT - IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

UNIT - V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

TOTAL PERIODS: 45

REFERENCE BOOKS:

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

OMF 101	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	0

OBJECTIVES

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion

- Illustrate fault tracing
- Identify preventive and periodic maintenance

COURSE OUTCOMES (CO)

CO1 Ability to summarize basics of industrial safety
CO2 Ability to describe fundamentals of maintenance engineering
CO3 Ability to explain wear and corrosion
CO4 Ability to illustrate fault tracing
CO5 Ability to identify preventive and periodic maintenance

UNIT - I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT - II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment

UNIT - III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT - IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT - V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL PERIODS: 45

REFERENCE BOOKS:

1. Audels, Pump-hydraulic Compressors, Mcgraw Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn , Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook, Eighth Edition, 2008

OPE101	RENEWABLE SOURCES OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the energy scenario and various energy sources.
- To learn the solar photovoltaic and solar thermal systems.
- To impart knowledge on wind energy and bio-mass energy conversion systems.
- To provide knowledge about the Geothermal and Ocean energy conversion system.
- To design and implement hybrid energy conversion system.

COURSE OUTCOMES (CO)

CO1 Understand the energy scenario and the various sources of non-conventional energy sources.

CO2 Learn the physics of solar energy and to understand the solar photovoltaic, solar-thermal energy conversion system.

CO3 Acquire knowledge in wind and bio-mass energy conversion system.

CO4 Acquire knowledge in Geothermal and Ocean energy conversion system.

CO5 Design and implement hybrid energy systems.

UNIT I INTRODUCTION **9**

Renewable energy sources and its energy scenario - global and Indian; Environmental aspects and impacts of renewable energy generation on environment; Types of Renewable energy sources: solar - wind - Biomass - Ocean - Tidal - Geothermal and Fuel cell.

UNIT II SOLAR ENERGY SYSTEMS **9**

Solar radiation at the earth's surface - solar radiation measurements - estimation of average solar radiation - Introduction to Solar photo-voltaic (PV) system and Solar - thermal system; Equivalent circuit of a solar cell, solar array and its sizing. Solar thermal collectors: flat plate collectors - concentrating collectors; solar thermal applications - heating, cooling, desalination, drying, cooking - solar thermal electric power plant.

UNIT III WIND ENERGY AND BIO-MASS ENERGY **9**

Wind Sources: horizontal and vertical axis wind turbine - performance characteristics - types of wind turbine generators - Betz criteria; Bio-mass: Principles of Bio-Conversion - Anaerobic/aerobic digestion - types of Bio-gas digesters - gas yield - combustion characteristics of bio-gas - utilization for cooking.

UNIT IV GEOTHERMAL AND OCEAN ENERGY **9**

Geothermal: Resources - types of wells - methods of harnessing the energy. Ocean Energy: OTEC- Principles, utilization - setting of OTEC plants - thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques - mini-hydro power plants and their economics.

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS **9**

Need for Hybrid Systems - Types of Hybrid systems - Case studies of solar and Wind.

`TOTAL PERIODS : 45

TEXT BOOKS

1. S. P. Sukhatme, Solar Energy Principle of Thermal Collection and Storage‟, Tata McGraw Hill, 1990.
2. Rai G.D, "Non-Conventional Energy Sources", Khanna Publishers, 2011.

REFERENCE BOOKS

1. G. L. Johnson, Wind energy systems, Prentice Hall Inc. New Jersey.
2. J. M. Kriender, Principles of Solar Engineering‟, McGraw Hill, 1987.
3. Twidell&Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011
4. V. S. Mangal, Solar Engineering‟, Tata McGraw Hill, 1992.
5. N. K. Bansal, Renewable Energy Source and Conversion Technology‟, Tata McGraw Hill, 1989.
6. P. J. Lunde, Solar Thermal Engineering‟, John Willey & Sons, New York, 1988.
7. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes‟, Wiley & Sons, 1990.

OMB 103	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

COURSE OUTCOMES (CO)

CO1	Understand the costing concepts and their role in decision making
CO2	Understand the project management concepts and their various aspects in selection
CO3	Interpret costing concepts with project execution
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5	Become familiar with quantitative techniques in cost management

UNIT - I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT - II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT - III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle

Costing.

UNIT - IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity- Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT - V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL PERIODS: 45

REFERENCE BOOKS:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OMF 102	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

COURSE OUTCOMES (CO)

CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.
CO2	Know the various reinforcements used in composite materials.
CO3	Understand the manufacturing processes of metal matrix composites.
CO4	Understand the manufacturing processes of polymer matrix composites.
CO5	Analyze the strength of composite materials.

UNIT - I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT - III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and

applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT - IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT – V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL PERIODS: 45

Text Books:

1. Chawla K.K., 'Composite Materials' Science and Engineering, Springer Publications,Second Edition, 2013.

Reference Books:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Lubin.G, Hand Book of Composite Materials, 2013.

OCH 105	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

COURSE OUTCOMES (CO)

CO1	To understand the various types of wastes from which energy can be generated
CO2	To Gain knowledge on biomass pyrolysis process and its applications
CO3	To develop knowledge on various types of biomass gasifiers and their operations
CO4	To gain knowledge on biomass combustors and its applications on generating energy
CO5	To understand the principles of bio-energy systems and their features

UNIT - I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.

UNIT - II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT - III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT - IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT - V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL PERIODS: 45

TEXT BOOKS:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

REFERENCE BOOKS:

1. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
2. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SEMESTER I

		L	T	P	C
RM 1101	**RESEARCH METHODOLOGY AND IPR**	**2**	**0**	**0**	**2**

OBJECTIVES

To impart knowledge and skills required for research and IPR

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

COURSE OUTCOMES (CO)

CO1 Ability to formulate research problem
CO2 Ability to carry out research analysis
CO3 Ability to follow research ethics
CO4 Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5 Ability to understand about IPR and filing patents in R & D

UNIT - I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT - II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT - III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT - IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

TOTAL PERIODS: 30

REFERENCE BOOKS:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

AUDIT COURSES (AC)

SEMESTER I

		L	T	P	C
AX 1001	**ENGLISH FOR RESEARCH PAPER WRITING**	3	0	0	0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

COURSE OUTCOMES (CO)

CO1 Understand that how to improve your writing skills and level of readability
CO2 Learn about what to write in each section
CO3 Understand the skills needed when writing a Title

CO4 Understand the skills needed when writing the Conclusion
CO5 Ensure the good quality of paper at very first-time submission

UNIT - I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT - II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT - III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT - IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT - V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL PERIODS: 30

REFERENCE BOOKS:

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX 1002	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

COURSE OUTCOMES (CO)

CO1 Ability to summarize basics of disaster
CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice

from multiple perspectives.

CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 Ability to develop the strengths and weaknesses of disaster management approaches

UNIT - I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT - II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT - III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT - IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness

UNIT - V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL PERIODS: 30

REFERENCE BOOKS:

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, Pardeep et. al.," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX 1003	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P	C
		2	0	0	0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

COURSE OUTCOMES (CO)

CO1 Understanding basic Sanskrit language.
CO2 Write sentences.
CO3 Know the order and roots of Sanskrit.
CO4 Know about technical information about Sanskrit literature.
CO5 Understand the technical concepts of Engineering

UNIT - I ALPHABETS **6**
Alphabets in Sanskrit

UNIT - II TENSES AND SENTENCES **6**
Past/Present/Future Tense - Simple Sentences

UNIT - III ORDER AND ROOTS **6**
Order - Introduction of roots

UNIT - IV SANSKRIT LITERATURE **6**
Technical information about Sanskrit Literature

UNIT - V TECHNICAL CONCEPTS OF ENGINEERING **6**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL PERIODS: 30

REFERENCE BOOKS:
1. "Abhyaspustakam" – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

AX 1004	VALUE EDUCATION	L	T	P	C
		3	0	0	0

OBJECTIVES
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

COURSE OUTCOMES (CO)
CO1 Knowledge of self-development.
CO2 Learn the importance of Human values.
CO3 Developing the overall personality

UNIT - I **6**
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT - II **6**
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT - III **6**
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and

discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT - IV **6**

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL PERIODS: 24

SUGGESTED READING

1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX 1005	**CONSTITUTION OF INDIA**	**L**	**T**	**P**	**C**
		2	0	0	0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

COURSE OUTCOMES (CO)

C107E.1 To understand the history of making and philosophy of the Indian constitution
C107E.2 To understand the constitutional rights and duties
C107E.3 To understand the organs of governance
C107E.4 To understand the Local administration concepts
C107E.5 To understand the role and function election commission

UNIT - I HISTORY OF MAKING OF THE INDIAN CONSTITUTION & PHILOSOPHY OF THE INDIAN CONSTITUTION **10**

History, Drafting Committee, (Composition & Working), Preamble, Salient Features

UNIT – II CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES **5**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III ORGANS OF GOVERNANCE **5**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT - IV LOCAL ADMINISTRATION **5**

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational

Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT - V ELECTION COMMISSION 5

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL PERIODS: 30

TEXT BOOKS:

1. The Constitution of India,1950 (Bare Act), Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

REFERENCE BOOKS:

1. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
2. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX 1006	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES

- Review existing evidence on their view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.

COURSE OUTCOMES (CO)

CO1 What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?

CO2 What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?

CO3 How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

CO4 To Review existing evidence on their view topic to inform programme design and policy.

CO5 To Identify critical evidence gaps to guide the development.

UNIT - I INTRODUCTION AND METHODOLOGY: 6

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching.

UNIT - II THEMATIC OVERVIEW 6

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT - III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 6

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV PROFESSIONAL DEVELOPMENT 6

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT - V RESEARCH GAPS AND FUTURE DIRECTIONS 6

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL PERIODS: 30

REFERENCE BOOKS:

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX 1007	STRESS MANAGEMENT BY YOGA	L	T	P	C
		3	0	0	0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

COURSE OUTCOMES (CO)

CO1 Develop healthy mind in a healthy body thus improving social health also
CO2 Improve efficiency

UNIT - I 10

Definitions of Eight parts of yoga.(Ashtanga)

UNIT - II 10

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT - III 10

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL PERIODS: 30

SUGGESTED READING

1. Yogic Asanas for Group Training-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX 1008	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
		2	0	0	0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

COURSE OUTCOMES (CO)

CO1 To understand the holistic development of personality – I
CO2 To understand the holistic development of personality – II
CO3 To understand the day-to-day work and duties in Shrimad Bhagwad Geeta
CO4 To understand the statements of basic knowledge in Shrimad Bhagwad Geeta
CO5 To understand the personality of role model in Shrimad Bhagwad Geeta

UNIT - I HOLISTIC DEVELOPMENT OF PERSONALITY - I 6

Neetisatakam - holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism)

UNIT - II HOLISTIC DEVELOPMENT OF PERSONALITY - II 6

Neetisatakam-holistic development of personality – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT - III DAY-TO-DAY WORK AND DUTIES 6

Approach to day-to-day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35

UNIT - IV STATEMENTS OF BASIC KNOWLEDGE 6

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter 2-Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16,17, 18 - Chapter 18-Verses 45, 46, 48.

UNIT - V PERSONALITY OF ROLE MODEL 6

Personality of role model - shrimad bhagwad geeta – Chapter 2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL PERIODS: 30

TEXT BOOKS:

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010

REFERENCE BOOKS:

1. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.