ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
CHOICE BASED CREDIT SYSTEM
M.E. COMPUTER INTEGRATED MANUFACTURING

THE VISION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:

To be outstanding institute where students can gain acumen and to brew them so that they unswervingly meet the needs of the society.

THE MISSION OF THE DEPARTMENT OF MANUFACTURING ENGINEERING:

- To foster the growth of its members and develop them in new vistas promoting them to their fullest cognition.
- To be nationally recognized as the leader of Manufacturing Engineering in education and research.
- Bring augmentation to the Department, College and University.
- Discern the potential of its members.
- Have its members vivaciously conscripted nationally by employers and graduate programs.
- To evoke new ideas in the minds of its members and infuse nascent technology to modern era of manufacturing.

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M.E. COMPUTER INTEGRATED MANUFACTURING (FULL - TIME)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To train students to independently carry out research / investigations and development work to solve practical problems.

II. To train students to write and present a technical report/ documents.

III. To train students to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

IV. To train students to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

V. To train students to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

VI. To train students to solve technical problems with creativity, innovation, confidence and self-responsibility.

PROGRAMME OUTCOMES (POs):

The programme outcomes of the Computer Integrated Manufacturing Postgraduate students are given below:

PO 1: Ability to independently carry out research / investigations and development work to solve practical problems.

PO 2: Ability to write and present a substantial technical report/ documents.

PO 3: Ability to demonstrate mastery in the area of computer integrated manufacturing at a higher level.

PO 4: Ability to pursue professional career in manufacturing industries/educational institutions/research & development organisations as well as in allied fields and excel as an individual and also as a team player in multidisciplinary environments.

PO 5: Ability to provide solutions to industrial/research problems considering economic, environmental and social contexts for sustainable development.

PO 6: Ability to solve technical problems with creativity, innovation, confidence and self-responsibility.

Attested

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PROGRAMME SPECIFIC OUTCOMES (PSOs):

On completion of the Computer Integrated Manufacturing (CIM) programme the post graduates will have the following programme specific outcomes.

1. Ability to apply inter-disciplinary knowledge in various functional areas of Computer Integrated Manufacturing and will be familiar with engineering hardware/software and equipments as practiced in manufacturing industries to formulate and solve real time problems.
2. Identify and apply automation and use the latest technology in continuous improvement of manufacturing systems and processes with the integration of design system.
3. Encouraged and motivated to have out-of-box thinking in becoming entrepreneurs/ start-ups by developing new manufacturing systems and assessing the feasibility of technical, financial and social perspectives.
4. Demonstrate ability to communicate the outcomes of research and development activities in journals and presenting in national and international forums such as conferences.

PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	✓	✓	✓		✓	✓			✓			✓
II	✓						✓	✓	✓	✓		
III						✓			✓	✓	✓	✓
IV	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
V	✓		✓	✓	✓					✓		✓

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Mapping of Course Outcome and Programme Outcome

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	Semester 1	Statistical Methods for Engineers	✓	✓		✓	✓							
		Computer Applications in Design	✓	✓			✓							
		Computer Aided Manufacturing	✓	✓			✓							
		Solid Freeform Manufacturing	✓	✓	✓		✓		✓	✓				
		Program Elective I												
		Research Methodology and IPR												
		Audit Course - I												
		Computer Aided Design and Computer Aided Engineering Laboratory		✓			✓							
		Computer Aided Manufacturing Laboratory	✓	✓	✓		✓						✓	
	Semester 2	Advanced Metrology	✓	✓	✓		✓							
		Manufacturing Planning and Control Systems	✓	✓	✓	✓	✓						✓	
		Advances in Manufacturing Technology	✓	✓			✓							✓
		Mechatronics in Manufacturing Systems	✓	✓	✓	✓	✓				✓	✓		✓
		Program Elective II												
		Program Elective III												
		Audit Course – II												
		Advanced Metrology Laboratory	✓	✓	✓		✓							
		Advanced Manufacturing Technology Laboratory	✓	✓	✓	✓	✓							
		Mini Project with Seminar	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Year 2	Semester 3	Program Elective IV												
		Program Elective V												
		Open Elective												
		Inplant training / Internship	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
		Dissertation I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Semester 4	Dissertation II	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓

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CHOICE BASED CREDIT SYSTEM
M.E. COMPUTER INTEGRATED MANUFACTURING (FULL - TIME)
CURRICULA AND SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA5157	Statistical Methods for Engineers	FC	3	1	0	4	4
2.	ED5153	Computer Applications in Design	PCC	3	0	0	3	3
3.	CI5101	Computer Aided Manufacturing	PCC	3	0	0	3	3
4.	CI5151	Solid Freeform Manufacturing	PCC	3	0	0	3	3
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Program Elective I	PEC	3	0	0	3	3
7.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
8.	CI5111	Computer Aided Design and Computer Aided Engineering Laboratory	PCC	0	0	4	4	2
9.	CI5112	Computer Aided Manufacturing Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**22**

* Audit Course is optional.

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CI5201	Advanced Metrology	PCC	3	0	0	3	3
2.	CI5202	Manufacturing Planning and Control Systems	PCC	3	0	0	3	3
3.	CI5251	Advances in Manufacturing Technology	PCC	3	0	0	3	3
4.	MN5073	Mechatronics in Manufacturing Systems	PCC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Program Elective III	PEC	3	0	0	3	3
7.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
8.	CI5211	Advanced Metrology Laboratory	PCC	0	0	4	4	2
9.	CI5212	Advanced Manufacturing Technology Laboratory	PCC	0	0	4	4	2
10.	CI5213	Mini Project with Seminar	EEC	0	0	4	4	2
			TOTAL	**20**	**0**	**12**	**32**	**24**

* Audit Course is optional.

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SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	CI5311	Inplant Training / Internship	EEC	0	0	4	4	2
5.	CI5312	Dissertation I	EEC	0	0	12	12	6
			TOTAL	**9**	**0**	**16**	**25**	**17**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	CI5411	Dissertation II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE = 75

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FOUNDATION COURSE [FC]

Sl.No	COURSE CODE	Course Title	Periods per week			Credits	Semester
			L	T	P		
1.	MA5157	Statistical Methods for Engineers	3	1	0	4	1

PROGRAM CORE COURSES (PCC)

Sl. No	Course Code	Course Title	Periods per week			Credits	Semester
			L	T	P		
1.	ED5153	Computer Applications in Design	3	0	0	3	1
2.	CI5101	Computer Aided Manufacturing	3	0	0	3	1
3.	CI5151	Solid Freeform Manufacturing	3	0	0	3	1
4.	CI5111	Computer Aided Design and and Computer Aided Engineering Laboratory	0	0	4	2	1
5.	CI5112	Computer Aided Manufacturing Laboratory	0	0	4	2	1
6.	CI5251	Advances in Manufacturing Technology	3	0	0	3	2
7.	CI5201	Advanced Metrology	3	0	0	3	2
8.	CI5202	Manufacturing Planning and Control Systems	3	0	0	3	2
9.	MN5073	Mechatronics in Manufacturing Systems	3	0	0	3	2
10.	CI5211	Advanced Metrology Laboratory	0	0	4	2	2
11.	CI5212	Advanced Manufacturing Technology Laboratory	0	0	4	2	2

PROGRAM ELECTIVE COURSES [PEC]
SEMESTER I, ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Periods per week			Total Contact Periods	C
				L	T	P		
1.	CI5001	Electronics Packaging	PEC	3	0	0	3	3
2.	CI5002	Advances in Welding and Casting Technology	PEC	3	0	0	3	3
3.	CI5003	Precision Engineering	PEC	3	0	0	3	3
4.	MS5151	Manufacturing Management	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE II

Sl.No	Course Code	Course Title	Category	Periods per week			Contact Periods	C
				L	T	P		
1.	CI5004	Applied Materials Engineering	PEC	3	0	0	3	3
2.	CI5005	Micro and Nano Manufacturing	PEC	3	0	0	3	3
3.	IL5084	Supply Chain Management	PEC	3	0	0	3	3
4.	IL5077	Lean Manufacturing and Six Sigma	PEC	3	0	0	3	3
5.	IL5071	Advanced Optimization Techniques	PEC	3	0	0	3	3

SEMESTER II, ELECTIVE III

Sl. No	Course Code	Course Title	Category	Periods per week			Contact Periods	C
				L	T	P		
1.	CI5006	Sensors for Manufacturing and Condition Monitoring	PEC	3	0	0	3	3
2.	CI5007	Finite Element Analysis in Manufacturing Engineering	PEC	3	0	0	3	3
3.	CI5008	System simulation for Manufacturing Engineers	PEC	3	0	0	3	3
4.	QE5073	Product Innovation and Development	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE IV

Sl. No	Course Code	Course Title	Category	Periods per week			Contact Periods	C
				L	T	P		
1.	CI5009	Competitive Manufacturing Systems	PEC	3	0	0	3	3
2.	CI5010	Industrial Robotics and Intelligent Systems	PEC	3	0	0	3	3
3.	CI5071	Design for Manufacturing and Assembly	PEC	3	0	0	3	3
4.	IL5076	Industrial Automation and Robotics	PEC	3	0	0	3	3

SEMESTER III, ELECTIVE V

Sl.No	Course Code	Course Title	Category	Periods per week			Contact Periods	C
				L	T	P		
1.	CI5011	Manufacturing Information Systems	PEC	3	0	0	3	3
2.	CI5072	Sustainable Manufacturing	PEC	3	0	0	3	3
3.	IL5074	Enterprise Resource Planning	PEC	3	0	0	3	3
4.	ED5072	Advanced Machine Tool design	PEC	3	0	0	3	3

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RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS COURSES (RMC)

Sl.No	Code No.	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	RM5151	Research Methodology and Intellectual Property Rights	2	0	0	2	1

OPEN ELECTIVE COURSES [OEC]

(Out of 6 Courses one Course must be selected)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl.No	COURSE CODE.	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	CI5213	Mini Project with Seminar	0	0	4	2	2
2	CI5311	Inplant training / Internship	0	0	4	2	3
3	CI5312	Dissertation I	0	0	12	6	3
4	CI5411	Dissertation II	0	0	24	12	4

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Summary

	M.E. (Computer Integrated Manufacturing) (Full Time)					
	Subject Area	**Credits per Semester**				**Credits Total**
		I	**II**	**III**	**IV**	
1.	FC	04	00	00	00	04
2.	PCC	13	16	00	00	29
3.	PEC	03	06	06	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	02	08	12	22
7.	Non Credit / Audit Courses	✓	✓	00	00	
	Total Credits	**21**	**24**	**17**	**12**	**75**

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MA5157 STATISTICAL METHODS FOR ENGINEERS L T P C
3 1 0 4

COURSE OBJECTIVES:

- To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
- To give an idea of testing the statistical hypothesis claimed based on a set of data points using suitable test statistics which follows standard sampling distributions.
- To establish a relationship that make it possible to predict one or more variable in terms of others using correlation and regression analysis.
- To introduce the various experimental designs and their corresponding analysis of variance which play vital role in many real time scenarios.
- To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

UNIT I ESTIMATION THEORY 12

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency–Maximum Likelihood Estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS 12

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

UNIT III CORRELATION AND REGRESSION 12

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

UNIT IV DESIGN OF EXPERIMENTS 12

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

UNIT V MULTIVARIATE ANALYSIS 12

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course, students will be able to

- Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
- Use various test statistics in hypothesis testing for mean and variances of large and small samples.
- Determine the regression line using the method of least square and also to calculate the partial and multiple correlation coefficient for the given set of data points.
- Test the hypothesis for several means using one way, two way or three way classifications.
- Get exposure to the principal component analysis of random vectors and matrices.

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REFERENCES:
1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson and Duxbury, Singapore, 6th Edition, Boston, 2004.
2. Gupta, S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Eleventh Edition, Reprint, New Delhi, 2019.
3. Johnson, R. A. and Gupta, C. B., "Miller & Freund's Probability and Statistics for Engineers", Pearson Education, Asia, Eighth Edition, New Delhi, 2015.
4. Johnson, R.A., and Wichern, D.W., "Applied Multivariate Statistical Analysis", Pearson Education, Sixth Edition, New Delhi, 2013.
5. Spiegel, M.R. and Stephens, L.J.," Schaum's outlines on Statistics", Tata McGraw-Hill, 6th Edition, New York, 2018.

ED5153	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:
1. To understand fundamental concepts of computer graphics and its tools in a generic framework.
2. To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.
3. To impart the parametric fundamentals to create and manipulate geometric models using NURBS and solids.
4. To provide clear understanding of CAD systems for 3D modeling and viewing.
5. To create strong skills of assembly modeling and prepare the student to be an effective user of a standards in CAD system.

UNIT – I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.

Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm.

Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations-Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

UNIT – II CURVES AND SURFACES MODELLING 9

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.

Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT – III NURBS AND SOLID MODELING 9

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

UNIT – IV VISUAL REALISM 9

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring.

Animation - Conventional, Computer animation, Engineering animation - types and techniques.

UNIT – V ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT **9**

Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards.

Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Solve 2D and 3D transformations for the basic entities like line and circle.
2. Formulate the basic mathematics fundamental to CAD system.
3. Use the different geometric modeling techniques like feature based modeling, surface modeling and solid modeling.
4. Create geometric models through animation and transform them into real world systems
5. Simulate assembly of parts using Computer-Aided Design software.

REFERENCES:

1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1991.
2. Chitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
3. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2002
4. Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc., 2nd Edition, 1996.
5. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
6. William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, Mc Graw Hill Book Co. 1stEdition, 2001.

0.3- Low 0.6- Medium 0.9- High

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.9	0.6		0.9					0.6			0.9		0.6
2	0.6	0.9	0.6		0.9					0.6			0.9		0.6
3	0.6	0.9	0.6		0.9					0.6			0.9		0.6
4	0.6	0.9	0.6		0.9					0.6			0.9		0.6
5	0.6	0.9	0.6		0.9					0.6			0.9		0.6

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CI5101 **COMPUTER AIDED MANUFACTURING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce the evolution of CAD, CAM, CIM, engineering product specification and interpreting geometric specifications.
- To train the candidates on the integration of Computer Aided Design and Computer Aided Manufacturing.
- To impart knowledge on manual part program and generation of CNC part program using Computer Aided Manufacturing packages.
- To introduce with the implementation of CAD and CAM in manufacturing process.
- To introduce the importance of Internet of Things in Computer Aided Manufacturing.

UNIT I INTRODUCTION TO CAM **9**

Introduction CAD, CAM, CAE, CIM, system configuration for CAM including hardware and software, evolution of product realization, historical development, engineering product specification. Geometric Tolerancing - ASME standard, interpreting geometric specifications, multiple part features and datum.

UNIT II CAD AND CAM INTEGRATION **9**

Introduction - Networking - Techniques, components, interface cards, network standards, Graphics standards - Graphical kernel system, Data exchange format - IGES and STEP.
Process planning, Computer Aided Process Planning (CAPP), Product life cycle management (PLM), Enterprise resource planning (ERP).

UNIT III PROGRAMMING OF CNC MACHINES **9**

Structure of CNC program, Coordinate system, G & M codes, cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, mirroring features, Manual part programming for CNC turning, machining center, wire electric discharge machining, abrasive water jet cutting machine, bulk and sheet metal forming, generation of CNC program using CAM softwares.

UNIT IV CAD AND CAM FOR MANUFACTURING PROCESSES **9**

Classification of Manufacturing process, construction and operations, Integration of CAD and CAM in CNC turning center, machining center, electric discharge machining, wire electric discharge machining, abrasive water jet cutting machine, bulk forming, sheet metal forming.

UNIT V IOT IN CAM **9**

Introduction, overview of IOT enabled manufacturing system, Real-time and multi-source manufacturing information sensing system, IOT enabled smart assembly station, cloud computing based manufacturing resources configuration method, Real-time key production performances analysis method, Real-time information driven production scheduling system.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of CAD, CAM, CIM, Engineering product specification and interpreting geometric specifications.
CO2: Improve knowledge on the integration of CAD and CAM.
CO3: Exhibit competency in manual part program and generation of CNC part program using CAM packages.
CO4: Describe the implementation of CAD and CAM in manufacturing processes.
CO5: Explain applications of IOT in computer aided manufacturing.

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	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.3	0.6	0.9	0.6	0.6	0.9	0.6	0.9	0.9	0.9
CO2	0.3	0.3	0.6	0.3	0.6	0.6	0.9	0.9	0.9	0.9
CO3	0.6	0.9	0.6	0.9	0.9	0.9	0.6	0.6	0.3	0.3
CO4	0.9	0.9	0.9	0.9	0.9	0.9	0.3	0.6	0.6	0.6
CO5	0.3	0.6	0.9	0.3	0.6	0.6	0.9	0.9	0.9	0.9

REFERENCES:

1. Chang T.C., Wysk, R.A. and Wang.H.P., "Computer Aided Manufacturing", Pearson Prentice Hall, India ,2009, ISBN: 978-0131429192.
2. HMT,"Mechatronics", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2005.
3. Rao P.N., "CAD/CAM", 3rd Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2010, ISBN-13: 978-0070681934.
4. Radhakrishnan P., "Computer Numerical Control ", New Central Book Agency, India,1992.
5. Nee Y.C., Soh K. Ong, Yun G. Wang., "Computer Applications in Near Net-Shape Operations", Springer, United Kingdom, 2012.
6. Yingfeng Zhang and Fei Tao, "Optimization of Manufacturing Systems Using the Internet of Things" Academic Press, United Kingdom, 2017.

CI5151 SOLID FREEFORM MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), proliferation into various fields and its effects on supply chain.
- To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
- To acquaint with polymerization and sheet lamination processes and their applications.
- To acquaint with material extrusion and powder bed fusion processes.
- To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I INTRODUCTION 9

Need - Development of SFM systems – Hierarchical structure of SFM - SFM process chain – Classification – Applications. Case studies: Bio printing- Food Printing- Electronics printing – Rapid Tooling - Building printing. AM Supply chain. Economics aspect: Strategic aspect- Operative aspect.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Concepts and Objectives - AM Unique Capabilities - Part Consolidation - Topology Optimization - Lightweight Structures - DFAM for Part Quality Improvement - CAD Modeling - Model Reconstruction - Data Processing for AM - Data Formats - Data Interfacing - Part Orientation - Support Structure Design and Support Structure Generation - Model Slicing - Tool Path Generation. Design Requirements of Additive Manufacturing: For Part Production, For Mass Production, For Series Production. Case Studies.

UNIT III VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES 9

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications.

Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT IV MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES 9

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM.

Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. Multijet Fusion.

Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT V JETTING AND DIRECT ENERGY DEPOSITION PROCESSES 9

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications.

Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations.

Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.

CO2: Evaluate the design for AM and its importance in the quality of fabricated parts.

CO3: Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.

CO4: Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.

CO5: Perceive jetting and direct energy deposition processes and their applications.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.6	0.9	0.3	0.9	0.9	0.6	0.9	0.9	0.9	0.9
CO2	0.9	0.6	0.9	0.9	0.9	0.6	0.9	0.9	0.9	0.6
CO3	0.9	0.9	0.6	0.9	0.6	0.3	0.6	0.9	0.9	0.9
CO4	0.9	0.9	0.6	0.9	0.6	0.3	0.6	0.9	0.9	0.9
CO5	0.9	0.9	0.6	0.9	0.6	0.3	0.6	0.9	0.9	0.9

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1. Andreas Gebhardt and Jan-Steffen Hotter, “Additive Manufacturing:3D Printing for Prototyping and Manufacturing”, Hanser publications Munchen, Germany, 2015. ISBN:978-1-56990-582-1.
2. Ben Redwood, Brian Garret, Filemon Schöffer, and Tony Fadel, “The 3D Printing Handbook: Technologies, Design and Applications”, 3D Hubs B.V., Netherland, 2017. ISBN-13: 978-9082748505.
3. Ian Gibson, David W. Rosen and Brent Stucker, “Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing” Springer - New York, USA, 2nd Edition, 2015. ISBN-13: 978-1493921126.
4. Liou, L.W. and Liou, F.W., “Rapid Prototyping and Engineering applications: A tool box for prototype development”, CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5. Milan Brandt., “Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications”, Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

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RM5151 **RESEARCH METHODOLOGY AND IPR** **L T P C**
2 0 0 2

COURSE 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.

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 HOURS: 30

COURSE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

REFERENCES:

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.
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		L T P C
CI5111	**COMPUTER AIDED DESIGN AND COMPUTER AIDED ENGINEERING LABORATORY**	**0 0 4 2**

COURSE OBJECTIVES:

- To familiarize the students with CAD and CAE modules.
- To create basic sketches and to design part modelling for the given mechanical components.
- To generate assemblies from the part model with respect to the constraints and to various data exchange formats.
- To familiarize the students with reverse engineering as a tool to create 3D models for 3D printing.
- To gain practical knowledge in CAE module through Finite Element Analysis.

LIST OF EXPERIMENTS:

CAD MODULE

1. Sketching and Part modelling (Solid modelling, Surface modelling, Feature manipulation) of mechanical components using CAD software package.
2. Assembly (Constraints, Exploded Views, Interference check) and Drafting (Layouts, Geometric Dimensions &Tolerance Standards, Sectional Views, & Detailing) of mechanical components using CAD software package.
3. Working with CAD Data Exchange formats: IGES, PDES, PARASOLID, DXF and STL
4. Study and exercise on freeform modelling.
5. Reverse engineering the given product/component and convert the data into 3D model.
6. Exercise on. STL file Preparation, Slicing, Support Structure Generation & Build setup Preparation.

CAE MODULE

1. Finite Element Analysis (FEA) using Pre-processing (solid modelling, meshing, analysis setup) and post processing (graphical display and report) with CAE software package
2. Finite Element Analysis (FEA) for plastic deformation using nonlinear material models with CAE software package

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Acquire knowledge on CAD and CAE modules.
CO2: Build and design interactive CAD models.
CO3: Interpret the given mechanical components and to design for 3D printing.
CO4: Demonstrate the use of FEA package.
CO5: Build, assemble parts and evaluate the information and resources using FEA.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.9				0.9		0.6	0.9	0.9	0.9
CO2	0.3	0.3	0.9			0.3	0.9	0.9	0.9	0.9
CO3	0.6	0.9	0.3	0.6		0.6	0.9	0.9	0.9	0.6
CO4	0.9	0.9	0.6	0.3	0.6	0.9	0.9	0.9	0.9	0.9
CO5	0.9	0.6	0.9	0.6	0.3	0.3	0.9	0.9	0.9	0.9

LIST OF ITEMS (Hardware/Software) REQUIRED:

1. Computers 24 Nos.
2. CAD software Package
3. Open source CAD software for Additive Manufacturing
4. CAE Software package

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CI5112 COMPUTER AIDED MANUFACTURING LABORATORY **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To familiarize students with manual CNC part programming for milling and turning machines.
- To generate part programs using CAM packages for milling and turning machines.
- To train students with dimensional and geometric measurements for machined features using video measuring system and coordinate measuring machine.
- To get hands on knowledge on programming logic controller - ladder programming and robot programming.
- To introduce the concept of printing parts using additive manufacturing and to introduce Relational database management system in Material requirements planning.

LIST OF EXPERIMENTS

1. Programming and simulation for various operations using canned cycle for CNC turning Centre.
2. Programming and simulation for machining of internal surfaces in CNC turning Centre
3. Programming and simulation for profile milling operations
4. Programming and simulation for circular and rectangular pocket milling
5. Programming and simulation using canned cycle for CNC Milling such as peck drilling and tapping cycle
6. CNC code generation using CAM software packages – Milling
7. CNC code generation using CAM software packages – Turning
8. Dimensional and geometric measurement of machined features using VMS and CMM
9. PLC ladder logic programming.
10. Robot programming for Material handling applications.
11. Study on RDBMS and its application in problems like inventory control MRP.
12. Design and fabrication of a component using extrusion based additive manufacturing.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Exhibit competency in manual CNC part programming for milling and turning machines.

CO2: Demonstrate generation of part programs using CAM packages for milling and turning Machines.

CO3: Acquire knowledge on dimensional and geometric measurements of machined features using video measuring system and coordinate measuring machine.

CO4: Demonstrate PLC ladder programming and robot programming.

CO5: Recognize the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.9	0.3	0.3	0.9	0.9	0.3	0.3			
CO2	0.9	0.3	0.3	0.9	0.9	0.6	0.3	0.3		
CO3	0.9	0.3	0.9	0.9	0.9	0.3	0.6	0.3		0.6
CO4	0.9	0.3	0.6	0.9	0.9	0.9	0.6	0.9	0.6	0.3
CO5	0.9	0.3	0.9	0.9	0.9	0.6	0.9	0.9	0.3	0.3

LIST OF EQUIPMENTS REQUIRED:

1. Computers 30
2. CAM Software for 3 axis machining or more
3. CNC Production type turning or Machining center
4. Video Measuring System
5. Coordinate Measuring Machine
6. Surface Roughness tester
7. 5 -axis Robot
8. Programmable Logic Controller with ladder logic programming software
9. RDMBS Package with relevant modules like Inventory Control and MRP
10. 3D Printer

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CI5201 **ADVANCED METROLOGY** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To teach the concepts of metrology.
- To train the students in various aspects of measurement of surface roughness.
- To train the students in the area of interferometry and form measurements.
- To train the students with understanding the fundamental principles of computer aided inspection and laser metrology.
- To introduce the basic principles of image processing and machine vision in context to metrological applications.

UNIT I CONCEPTS OF METROLOGY 9

Introduction - Terminologies - Standards of measurement - Interchangeability - Selective assembly - Accuracy and Precision – Calibration of instruments – Errors in measurements –Limits – Fits - Tolerances – Process capabilities - Laboratory accreditation, Basics of dimensional metrology and Form metrology - Clean room - Maintenance and handling of metrology equipment's - Standard practices of inspection rooms – Linear and Angular measurements – Comparators.

UNIT II MEASUREMENT OF SURFACE ROUGHNESS 9

Introduction – Types of Surface Texture - Surface Roughness Measurement Methods - Roughness parameters, bearing area parameters, Contact and Non-Contact type roughness measuring instruments, 3D Surface Roughness Measurement - Nano Level Surface Roughness Measurement – Instruments: Scanning Electron Microscope(SEM), Transmission Electron Microscope(TEM), Scanning and Transmission Electron Microscope(STEM), Atomic Force Microscopy(AFM).

UNIT III INTERFEROMETRYAND FORM MEASUREMENTS 9

Introduction - Principles of Interferometry - Optical flats in assessing surface contours - Interferometers – Measurement and Calibration - Laser Interferometry - Engineering applications of interferometry - Form measurements - flatness, straightness, roundness, cylindricity.

UNIT IV COMPUTER AIDED INSPECTION AND LASER METROLOGY 9

Introduction – Computer Aided Inspection Techniques - Tool Makers Microscope – Coordinate Measuring Machines – Applications – Advanced Laser gauging techniques – Lasers in precision Measurements – Laser Scanners for Reverse Engineering - In-process inspection -Industrial case studies.

UNIT V MACHINE VISION AND IMAGE PROCESSING 9

Introduction - Machine vision – Overview - Computer imaging systems, Image Analysis, Preprocessing, Human Vision System, Image model, Image enhancement, gray scale models, histogram models, Image Transforms - Applications of image processing -Advantages and limitations and Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Explain the fundamental concepts of measurement, standards, calibration, maintenance of laboratory facilities and handling of metrological equipments.

CO2: Explain roughness and its applications in manufacturing research, learn the important concepts, principles and applications related to interferometry.

CO3: Discuss the use of interferometry related sophisticated measurement and inspection facilities.

CO4: Execute the concepts of Computer aided inspection technologies for industrial Situations, design and develop new inspection techniques.

CO5: Describe the importance of image processing techniques and the possibilities of developing new heuristics for image processing related to metrology.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.6	0.3	0.6	0.6	0.3	0.3	0.6	0.3	0.3	0.3
CO2	0.6			0.6	0.3	0.3	0.6	0.6	0.3	0.3
CO3	0.3	0.3	0.3	0.3			0.6	0.6	0.6	0.3
CO4	0.9	0.3	0.6	0.6	0.3	0.6	0.9	0.9	0.6	0.6
CO5	0.9	0.3	0.6	0.6	0.6	0.6	0.9	0.9	0.6	0.6

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1. "ASTE Handbook of Industries Metrology", Prentice Hall of India Ltd., India,1992.
2. Bewoor A.K. and Kulkarni V.A.,"Metrology and Measurement", Tata McGraw-Hill, India, 2009.
3. Galyer F.W. and Shotbolt C.R., "Metrology for engineers", ELBS, Germany, 1990.
4. Jain R.K., "Engineering Metrology", Khanna Publishers, India, 2008.
5. Smith G.T., "Industrial Metrology", Springer, United States, 2002.

CI5202 MANUFACTURING PLANNING AND CONTROL SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To introduce students with Current Trends in Manufacturing Planning and Control System and Forecasting activities.
- To impart basic concepts of Aggregate Production Planning.
- To elaborate on Inventory management and Resource Requirements.
- To be familiarized with the functions of Shop Floor Control and associated systems.
- To gain knowledge on Computer Process Monitoring, Computer Process Interfacing and Process Control Strategies.

UNIT I MANUFACTURING PLANNING AND CONTROL AND FORECASTING 9

Introduction: Production Planning and Control-Limitations with Traditional Production Planning and Control-Need and Evolution of Manufacturing Planning and Control (MPC) System -Basic framework - Demand Management in MPC System- Forecasting: Time Horizon, Design of Forecasting Systems - Developing the Forecast Logic– Qualitative methods: Delphi Technique, Market Research, Quantitative methods -Time Series - Moving Averages, Exponential Smoothing - Regression- Measure of Forecast Accuracy- Numerical Problems

UNIT II AGGREGATE PRODUCTION PLANNING 9

Introduction-Need for Aggregate production planning (APP) - Alternatives for Managing Demand-Reservation of Capacity, Influencing Demand - Alternatives for Managing Supply - Inventory based Capacity Adjustment, Capacity Augmentation, Basic Strategies - Level, Chase, Mixed - Numerical Problems - APP Methods - Heuristic Methods, Optimal Methods.

UNIT III RESOURCE PLANNING 9

Inventory Management - Inventory Types and Control Procedures - Order point systems - Inventory Management Module - Rough-Cut Capacity Planning- Master Production Schedule - Material Requirements Planning (MRP) - Basic Concepts of MRP -Inputs to MRP- MRP Logic - Capacity Requirements Planning - Distribution Requirements Planning - Manufacturing Resource Planning (MRP II) - Enterprise Resource Planning (ERP)-Case studies.

Attested

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UNIT IV SHOP FLOOR CONTROL 9

Shop Floor Control - Functions - Shop Floor Control System - Order Release - Order Scheduling - Order Progress - Operation Scheduling-Priority Rules for Job Sequencing - The Factory Data Collection System - Online and Offline Data Collection Systems - Case studies.

UNIT V PROCESS MONITORING AND CONTROL 9

Computer Process Monitoring: Data Logging Systems - Data Acquisition Systems - Multilevel Scanning - Computer Control: Computer-Process Interfacing - Manufacturing Process Data - System Interpretation of Process Data - Interface Hardware Devices - Digital Input / Output Processing Interrupt system - Control Programming - Computer Process Control - Structural Model of a Manufacturing Process - Process Control Strategies-Case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Describe various activities of Manufacturing Planning and Control System and Forecasting activities.

CO2: Outline the concepts of Aggregate Production Planning.

CO3: Perceive Inventory management and Resource Requirements.

CO4: Evaluate the functions of Shop Floor Control and associated systems.

CO5: Discuss Computer Process Monitoring, Computer Process Interfacing and Process Control Strategies.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.9	0.9	0.9	0.6	0.6		0.9	0.6	0.9	0.3
CO2	0.9	0.9	0.9	0.9	0.6		0.9	0.6	0.9	0.3
CO3	0.9	0.9	0.9	0.9	0.6		0.9	0.6	0.9	0.6
CO4	0.9		0.9	0.6	0.9		0.9	0.9	0.9	0.6
CO5	0.9		0.9		0.9		0.9	0.6	0.9	0.6

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1. Groover M. and Zimmers E., “CAD/CAM: Computer-Aided Design and Manufacturing”, Prentice Hall., India, Reprint 2013, ISBN-13: 978-0131101302.
2. Mahadevan B., "Operations Management: Theory and practice", Pearson., India, 2015, ISBN-13: 978-9332547520.
3. Mahapatra P.B., “Computer-Aided Production Management”, Prentice-Hall, India, 2004, ISBN-13: 978-8120317420.
4. Nanua Singh, "System Approach to Computer Integrated Design and Manufacturing", Wiley India Edition, Reprint 2011, ISBN-13: 978-0471585176.
5. Thomas E. Vollmann, William Lee Berry, David Clay Whybark and Robert Jacobs F., “Manufacturing Planning and Control Systems for Supply Chain Management”, McGraw Hill., United States, 2014, ISBN: 9789339205331.

CI5251 ADVANCES IN MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To interpret and compare different non-traditional machining processes.
- To recognize different precision machining processes.
- To interpret modern metal forming processes.
- To differentiate between micromachining and microfabrication.
- To formulate smart manufacturing systems.

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UNIT I UNCONVENTIONAL MACHINING 9

Introduction - Electrical discharge machining - Micro electrical discharge machining - Wire electrical discharge machining - Micro wire electrical discharge machining - Electro chemical machining - Ultrasonic machining - Plasma arc machining- Laser beam machining- Electron beam machining - Ion beam machining - Abrasive flow machining - Abrasive water jet machining- Comparison of different non-traditional machining processes- Hybrid machining processes.

UNIT II PRECISION MACHINING 9

Introduction - Ductile mode machining of hard and brittle materials - Ultra precision grinding and selection of grinding wheels - Electrolytic in process dressing -Chemical mechanical polishing - Diamond turn machining - High speed machining -Magneto rheological finishing processes.

UNIT III MODERN METAL FORMING 9

Introduction - Orbital forging - Isothermal forging - Rubber pad forming –Incremental forming - Fine blanking -Powder forming: Powder rolling, Powder extrusion - High speed extrusion.

UNIT IV MICRO MACHINING AND MICRO FABRICATION 9

Introduction - Mechanical micro machining - Micromachining tool design - Chip formation - Size effect in micromachining - micro turning, micro milling. Micro drilling- micro machine tools. Introduction to micro fabrication - LIGA, surface micromachining - Bulk micromachining -Etching - Sputtering - Chemical vapor deposition - Physical vapor deposition.

UNIT V INDUSTRY 4.0 9

Introduction - Industry 4.0 – Smart manufacturing: Smart design, smart machining, smart monitoring, smart control, smart scheduling - Internet of Things - Industrial Internet of Things - Framework: Connectivity devices and services - Intelligent networks of manufacturing - Cloud computing - Data analytics -Cyber physical systems -Machine to Machine communication- case studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Categories different non-traditional machining processes.
CO2: Infer the different precision machining processes.
CO3: Recognize the modern metal forming processes.
CO4: Interpret different micro machining and micro fabrication techniques.
CO5: Demonstrate the Industry 4.0 and smart manufacturing system concepts.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.6		0.3	0.9	0.9		0.9	0.9	0.6	0.6
CO2	0.6	0.3	0.3	0.6	0.3	0.3	0.9	0.3	0.6	0.6
CO3	0.3	0.3	0.6	0.6	0.9	0.3	0.9	0.3	0.3	0.6
CO4	0.3	0.3	0.6	0.6	0.9	0.6	0.9	0.9	0.6	0.9
CO5	0.3		0.9	0.6	0.9	0.6	0.9	0.9	0.9	0.9

REFERENCES:

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2. Anand Pandey, “Modern Machining Processes”, Ane Books Pvt. Ltd., New Delhi, 2019.
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MN5073 MECHATRONICS IN MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE 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

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 III 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 INTEGRATION OF MANUFACTURING SYSTEMS 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: 45 PERIODS

COURSE OUTCOMES:

Students will be able to

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.

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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.
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Course Outcomes	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓							✓
CO2	✓	✓	✓						✓			
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓		✓				✓	✓		✓

CI5211 ADVANCED METROLOGY LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To introduce the practical applications of various measurement concepts.
- To gain knowledge on the design perspective of advanced measuring machines.
- To make the students understand the fundamental principles of measuring techniques by practicing exercises on various measuring instruments.
- To perform metallographic study of the given samples and heat treatment study of steel.
- To familiarize the importance of measurement and inspection in manufacturing industries.

LIST OF EXPERIMENTS:

1. Calibration of comparators using slip gauges
2. Assessment of gauge surfaces using optical flats
3. Measurement of Surface roughness of specimens using contact method
4. Non-contact surface roughness measurement of specimens
5. Counting of fringes produced by Michelson's interferometer
6. Measurement of dimensional features using machine vision system
7. Study exercises on clean room behaviour
8. Roundness and cylindricity measurement of components
9. Study on flatness measurement of surface using autocollimator
10. Measurement of dimensional features of a specimen - Contact type using CMM.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Operate sophisticated measuring machines with ease.
CO2: Improve the confidence in developing of new concepts and new measuring machines.
CO3: Recognize various technical terms and perform measurement tasks accurately.
CO4: Operate the right instrument and method of measurement for a particular Application.
CO5: Recognize the fundamental concepts of measurements, standards, calibrations, maintenance of laboratory facilities and handling of equipmnts.

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	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9	0.6	0.6	0.3	0.6	0.6	0.9	0.9	0.9	0.9
CO2	0.9	0.3	0.3	0.6	0.3	0.6	0.9	0.6	0.9	0.9
CO3	0.6	0.3	0.3	0.6	0.3	0.3	0.9	0.9	0.9	0.9
CO4	0.6		0.3	0.6	0.3	0.9	0.9	0.9	0.9	0.9
CO5	0.9	0.3	0.3	0.9	0.3	0.9	0.9	0.9	0.9	0.9

CI5212 ADVANCED MANUFACTURING TECHNOLOGY LABORATORY L T P C
0 0 4 2

COURSE OBJECTIVES:

- To familiarize the students with manual part program and generation of program using CAM package.
- To gain knowledge in robot programming.
- To acquaint the students with traditional and nontraditional micro machining processes.
- To gain knowledge on fabrication of composite materials.
- To familiarize the students with extrusion based additive manufacturing.

LIST OF EXPERIMENTS

1. Generation of CNC part programs and machining components for 5 axis CNC machining centre.
2. Machining using CNC wire EDM.
3. Thin film multilayer coating using PVD coating equipment
4. Machining using Abrasive water jet machine
5. Micro machining – micro turning, micro drilling & micro milling
6. Nontraditional micro machining – Electro Chemical Micro Machining (EMM)
7. Manufacturing of Polymer based composites using Resin Transfer Moulding Machine (RTM)
8. Fabrication of metal matrix composite using stir casting setup
9. Design and fabrication of components using additive manufacturing methods.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Demonstrate manual part program and to generate CNC program using CAM package.
CO2: Gain knowledge of robot programming.
CO3: Compare traditional and nontraditional micro machining processes.
CO4: To fabricate composite materials.
CO5: Build parts, using extrusion based additive manufacturing process.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.3	0.9	0.6	0.6			0.9	0.6	0.6	0.3
CO2	0.6	0.9	0.6	0.6	0.3	0.3	0.9	0.9	0.9	0.9
CO3	0.9	0.9	0.6	0.3	0.3	0.3	0.9	0.6	0.9	0.9
CO4	0.6	0.3	0.3	0.3	0.3	0.3	0.9	0.3	0.9	0.9
CO5	0.9	0.3	0.6	0.6	0.3	0.3	0.9	0.9	0.9	0.9

Attested

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CI5213 **MINI PROJECT WITH SEMINAR** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To drive them to acquire knowledge and fundamentals in the areas of Computer Integrated Manufacturing and to apply them.
- To encourage students to identify an Industrial problem that promotes creativity and innovation.
- To solve real life problems.
- To bring out the leadership and technical ability of the students.
- To enrich communication skills of the student through presentation of their project work.

Each student will choose a technical problem and solve it. At the end of the semester, each student has to submit the report and presentation for evaluation.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Develop creative and innovative ideas.
CO2: Develop skills to read, write and comprehend.
CO3: learn concepts, models, frameworks and tools that engineering graduates need in a world.
CO4: Exhibit competency in solving real life problems.
CO5: Effectively communicate the technical contents.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.9						0.9	0.6	0.9	0.9
CO2		0.9					0.9		0.9	0.9
CO3				0.3	0.3	0.3	0.9	0.6	0.9	0.9
CO4				0.3	0.3	0.3	0.9	0.6	0.9	0.9
CO5	0.9						0.9	0.6	0.9	0.9

CI5311 **INPLANT TRAINING / INTERNSHIP** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

- To familiarize students with real life situations in industrial organizations.
- To accelerate the learning process.
- To train the students to apply their gained knowledge in an Industrial organization.
- To expose students with best working practices and with ethical values.
- To inculcate integrity, responsibility, and self-confidence in student's mind.

DURATION:

The students have to undergo practical Inplant Training / Internship for four weeks (During Second Semester holidays) in recognized industrial establishments/educational institutions / research and development organizations under the guidance of a faculty member. Periodically they have to communicate to the guide about the progress in the industry. At the end of the training they have to submit a project report with following information:

1. Profile of the Industry
2. Product range
3. Organization structure
4. Plant layout
5. Processes/Machines/Equipment/devices
6. Personnel welfare schemes
7. Details of the training undergone
8. Learning points.

II. The presentation of the above will be carried out during third semester.

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Describe structure of the Industrial organization.
CO2: Realize the various functions of management.
CO3: Understanding of groups and group dynamics.
CO4: Describe the industrial culture.
CO5: Develop skills to read, write and comprehend.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9						0.9	0.9	0.9	0.9
CO2				0.9			0.9	0.6	0.9	0.9
CO3				0.9		0.9	0.9	0.6	0.9	0.9
CO4					0.9		0.9	0.6	0.9	0.6
CO5		0.9					0.9	0.6	0.9	0.9

CI5312 **DISSERTATION I** **L T P C**
0 0 12 6

COURSE OBJECTIVES:

- To identify industrial problem and solve them.
- To develop good written and oral communication skills and leadership skills.
- To train the students in preparing the project reports and to face reviews.
- To develop the ability to solve a specific Industrial problem.
- To accelerate the learning process.

EVALUATION

- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 180 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Recognize the importance of literature review.
CO3: Realize the importance of solving problems using literature review.
CO4: Recognize the modern concepts in technology and design.
CO5: Develop skills to read, write and comprehend.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9					0.9	0.9		0.9	0.9
CO2		0.9					0.6		0.9	0.9
CO3			0.3		0.3		0.9		0.6	0.9
CO4					0.9		0.9		0.9	0.9
CO5		0.9							0.9	0.9

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CI5411 **DISSERTATION II** **L T P C**
0 0 24 12

COURSE OBJECTIVES:

- To produce factual results of their applied research idea in the Manufacturing Engineering.
- To improve research and development activities.
- To develop technical competency to provide solutions for problems.
- To accelerate the learning process.
- To develop good communication skills.

EVALUATION

- Project work evaluation is based on Regulations of Credit System University Departments - Postgraduate programmes of Anna University

TOTAL: 360 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Apply the knowledge gained from theoretical and practical courses in solving problems.
CO2: Demonstrate a strong working knowledge of ethics and professional responsibility.
CO3: Demonstrate effective organizational leadership and change skills.
CO4: Realize the importance of solving problems using literature review.
CO5: Develop skills to read, write and comprehend.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.9					0.9	0.9		0.9	0.9
CO2					0.9				0.9	0.3
CO3				0.9					0.9	
CO4		0.9					0.6		0.9	0.6
CO5		0.9							0.9	0.9

CI5001 **ELECTRONICS PACKAGING** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce wafer preparation and PCB fabrication.
- To acquaint the students with through hole and surface mount components.
- To familiarize the students with steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
- To gain knowledge on surface mount technology.
- To outline the various inspections, testing and repair methods used in PCB.

UNIT I INTRODUCTION TO ELECTRONICS MANUFACTURING 9

History, definition, wafer preparation - crystal pulling, rod grinding, wire cutting, edge profiling Lapping, polishing, laser inspection, epitaxy, fabrication of laminates and printed circuit boards, types- single sided, double sided, multi-layer and flexible printed circuit board, design, materials, manufacturing, inspection. Electronic packaging – Through Hole Technology (THT) and Surface Mount Technology (SMT)

UNIT II THROUGH HOLE AND SURFACE MOUNTCOMPONENTS 9

Through-hole components – axial, radial, multi leaded, odd form. Surface mount components-active, passive. Interconnections - chip to lead interconnection, die bonding, wire bonding, TAB, Flip chip, chip on board, multi-chip module, direct chip array module, leaded, leadless, area array and embedded packaging, miniaturization and trends.

UNIT III SOLDERING AND CLEANING 9

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

UNIT IV SURFACE MOUNT TECHNOLOGY 9

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

UNIT V INSPECTION, TEST AND REWORK FOR PCB 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Realize wafer preparation and PCB fabrication.
CO2: Elaborate on through hole and surface mount technology components.
CO3: Discuss the steps involved in soldering post solder cleaning and its importance in PCB manufacturing.
CO4: Improve knowledge on surface mount technology.
CO5: Locate the required inspections, testing and repair methods used in PCB.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1			0.6	0.3			0.9	0.6	0.6	0.6
CO2			0.9	0.3			0.9	0.6	0.9	0.6
CO3			0.6	0.3			0.9	0.6	0.9	0.3
CO4			0.6	0.3			0.9	0.9	0.9	0.3
CO5			0.6	0.3	0.3		0.9	0.9	0.9	0.6

REFERENCES:

1. Gurnett K.W., “Surface Mount Handbook”, Newnes Elsevier, Netherlands, 1999.
2. Landers T.L., “Electronics Manufacturing Processes”, Prentice Hall, India, 1998.
3. Lee N.C., “Reflow Soldering Process and Trouble Shooting – SMT, BGA, CSP and Flip Chip Technologies”, Newnes Elsevier, 2001.
4. Prasad R.P., “Surface Mount Technology: Principles and Practice”, 2nd Edition, Springer-Science + business media, 2013.
5. Seraphim D., Lasky, R.C. and Che-Yu Li, “Principles of Electronic Packaging” Mcgraw Hill, India, 1989.
6. Strauss R.,“SMT Soldering Handbook”, Newnes Elsevier, Netherlands, 1998.

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CI5002 ADVANCES IN WELDING AND CASTING TECHNOLOGY L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on Metallurgy of welding.
- To be acquainted with Special welding processes.
- To elaborate gating system design and metallurgy.
- To provide knowledge on Special casting processes.
- To familiarize the students with automation and environmental aspects of welding and casting.

UNIT I WELDING DESIGN 9

Introduction - Fusion zone – Heat flow in welding -Weld solidification --Weldability of steels - Cast iron - Stainless steels, aluminum, copper and titanium alloys - Pre and Post weld heat treatments - Weld joint design- residual stress - Testing of Welding joints -Weld defects – Case study on welding design.

UNIT II SPECIAL WELDING PROCESSES 9

Principles, Equipment, Types, Advantages and Limitations of High frequency induction welding, Diffusion bonding, Cold pressure welding, Friction welding, Explosive welding, Plasma arc welding, Ultrasonic welding, Electron beam welding and Laser beam welding.

UNIT III CASTING DESIGN 9

Introduction - Solidification shrinkage- - Pattern allowances- Design of gating System-Design of thin and unequal sections -Rapid solidification processing (RSP) - Melt spinning -Roll quenching - Vibratory solidification -Splat cooling - Thixoforming – Rheocasting - Single crystal growing- Casting defects, inspection, diagnosis and rectification – Case study on casting design.

UNIT IV SPECIAL CASTING PROCESSES 9

Evaporative Pattern Casting Process and full mould process – Vaccum sealed moulding - vacuum casting - Magnetic Moulding - Squeeze Casting-types - Plaster mould casting - Ceramic mould casting- Investment casting - Shell Moulding - Continuous casting - Electro slag casting.

UNIT V AUTOMATION AND ENVIRONMENTAL ASPECTS OF WELDING AND CASTING 9

Mechanization and automation in foundries: Sand Plant, Material Handling, Mould and Core Making- Pollution control, energy and waste management in foundries.
Automated welded joint- Welding robots, Positioners and Manipulators -Microprocessor based control of resistance and arc welding- Arc sensing, Weld Seam Tracking and Vision system- Effects of welding fumes on environment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Use design knowledge to overcome defects in welding.
CO2: Select suitable welding process for the given applications.
CO3: Use design knowledge to produce quality casting.
CO4: Select suitable casting process for the given applications.
CO5: Implement automation principles with environment consciousness techniques in welding and casting plants.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9					0.3	0.9	0.6	0.6	0.3
CO2	0.6						0.9	0.3	0.3	0.6
CO3	0.9					0.3	0.9	0.6	0.6	0.6
CO4	0.6						0.9	0.3	0.6	0.6
CO5	0.6				0.6		0.9	0.9	0.9	0.9

REFERENCES:
1. American Welding Society,"Welding Handbook", Volume 1-5, 9th Edition, 2001.
2. Dieter Radaj, "Design and Analysis of Fatigue Resistant Welded Structures", Woodhead Publishing, United Kingdom, 1990, ISBN: 978-1855730045.
3. John Campbell, "Complete Casting Handbook: Metal Casting Processes, Metallurgy, Techniques and Design", 2nd edition, Butterworth-Heinemann., United Kingdom, 2015, ISBN: 978-1856178099.
4. Mahi Sahoo and Sam Sahu, "Principles of Metal Casting", McGraw-Hill Education, United States, 3rd Edition, 2014, ISBN: 978-0071789752.
5. Robert B. Tuttle, "Foundry Engineering: The Metallurgy and Design of Castings", Create Space Independent Publishing Platform, Amazon, 2012, ISBN: 9781478157434.

CI5003 PRECISION ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:
- To gain knowledge of the need for precision engineering and its application.
- To familiarize the importance of materials in precision engineering.
- To Introduce latest topics in manufacturing like micro machining and MEMS in order to equip them to join core electronic manufacturing industries.
- To Impart knowledge about the causes of errors and their remedies.
- To introduce the students with elements used in precision machines**.**

UNIT I INTRODUCTION 9

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

UNIT II MATERIALS FOR PRECISION ENGINEERING 9

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

UNIT III PRECISION MACHINING 9

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

UNIT IV ERRORS: CAUSES AND REMEDIES 9

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

UNIT V PRECISION MACHINE ELEMENTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Understand the need of precision engineering and its application.

CO2: Discuss process knowledge to use the light material / superior material as per the raising demands.

CO3: Discuss the advanced precision machining processes.

CO4: Explain the various errors, its causes and remedies to overcome these.

CO5: Describe elements used in precision machine tool.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9		0.6	0.3		0.3	0.9	0.3	0.3	0.6
CO2	0.9	0.3	0.3	0.3	0.3	0.6	0.6	0.3	0.6	0.6
CO3	0.9		0.6	0.6		0.3	0.9	0.6	0.6	0.9
CO4	0.9	0.3	0.6	0.9	0.6	0.6	0.9	0.6	0.6	0.6
CO5	0.9		0.9	0.6	0.3	0.3	0.9	0.6	0.3	0.6

REFERENCES:

1. James D. and Meadow, S., “Geometric Dimensioning and Tolerancing”, Marcel Dekker Inc.,1995.
2. Juliar W.Gardner, and Vijay K. Varadan, “Micro Sensors, MEMS and Smart Devices”, John Wiley and Sons, 2001.
3. Murthy R.L., “Precision Engineering in Manufacturing”, New age International Publications, New Delhi, First edition 1996; Reprint2005.
4. Paulo Davim "Microfabrication and Precision Engineering: Research and Development", Woodhead publishing, 2017.
5. Venkatesh V.C. and Sudin I., “Precision engineering”, Tata McGraw Hill Co., New Delhi, 2007.

MS5151 MANUFACTURING MANAGEMENT L T P C

3 0 0 3

OBJECTIVES

1. Students will be able to study the concepts in facility planning.
2. Students will be able to study types of plant layout and capacity planning methods.
3. Students will be able to study the concepts of Project management.
4. Students will be able to study the concepts and methods in production planning and control.
5. Students will be able to study the concepts in Inventory and maintenance management.

UNIT-I FACILITY PLANNING 9

Facility planning – Factors affecting selection of plant location, Factor rating analysis: Break – even analysis, Load distance model, closeness ratings – case study

UNIT-II CAPACITY & LAYOUT PLANNING 9

Types of plant layout, criteria for good layout, Process layout, Assembly line balancing. Computer based solutions to layout problems such as CRAFT, ALDEP, CORELAP and PREP. Capacity planning – Analysis of designed capacity, installed capacity, commissioned capacity, utilized capacity, factors affecting productivity and capacity expansion strategies.

UNIT-III PROJECT MANAGEMENT 9

Demand forecasting – Quantitative and qualitative techniques, measurement of forecasting errors, Project management – its role in functional areas of management, network representation of a project, CPM and PERT techniques – case study

Attested

UNIT-IV PRODUCTION PLANNING & CONTROL 9

Aggregate production planning, production planning strategies, Disaggregating the aggregate plan, Materials Requirement Planning (MRP), MRP-II, Supply chain management, Operation scheduling, prioritization.

UNIT-V INVENTORY AND MAINTENANCE MANAGEMENT 9

Introduction to EOQ models, Inventory control techniques – ABC, FSN, VED etc. Types of inventory control – Perpetual, two-bin and periodic inventory system – JIT, SMED, Kanban, Zero inventory, Maintenance strategies and planning, Maintenance economics: quantitative analysis, optimal number of machines, Replacement strategies and policies – economic service life, opportunity cost, replacement analysis using specific time period.

TOTAL =45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Able to acquire knowledge on facility, and problems associated with it.
2. Ability to learn the various capacity and layout planning models
3. Understand the concepts of demand forecasting and project management with relevant case studies.
4. Able to understand the concepts of production planning and scheduling.
5. Understand the various inventory and maintenance management techniques.

REFERENCES:

1. Chary, SN, “Production and Operations Management”, 4th Edition, SIE, TMH, 2009.
2. Chase. RB, N. J. Aquilano, & F. R. Jacobs, “Operations Management – For Competitive Advantage”, 11th Edition, SIE, TMH, 2007.
3. James. B. Dilworth, “Operations Management – Design, Planning and Control for Manufacturing and Services”, McGraw Hill Inc. Management Series, 1992.
4. KanishkaBedi, “Production and Operations Management”, 2 nd Edition, Oxford Higher Education, 2007
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7. Pannererselvam, R “Production and Operations Management”, 3rd Edition, PHI, 2012.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.3			0.3				0.3		0.3		0.3		
2	0.6	0.3			0.3						0.3				0.3
3	0.6	0.3			0.3						0.3		0.3	0.3	0.3
4	0.6	0.3									0.3				
5	0.6	0.3									0.3		0.3		0.3
S- Strong(0.9) ; M-Medium (0.6) ; L-Low(0.3)															

CI5004 APPLIED MATERIALS ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To provide knowledge in the areas of elastic and plastic behavior of materials.
- To understand the fracture behavior of materials.
- To elaborate the theories on plastic forming.
- To classify the different types of advanced materials.
- To select the material for specific industrial applications.

UNIT I ELASTIC AND PLASTIC BEHAVIOUR 9

Elastic, plastic and elastic and viscoelastic Behavior-Mechanism of Elastic and Plastic deformation, Shear strength of perfect and real crystals - Deformation by slip and twinning, strengthening mechanism, solid solution, grain boundary, poly phase mixture, precipitation, particle, fibre and dispersion strengthening, work hardening - Effect of temperature, strain and strain rate on plastic behavior

UNIT II FRACTURE BEHAVIOUR 9

Types of fracture -Griffith's theory, dislocation theory, ductile to brittle transition in steel - Stress intensity factor, fracture toughness and toughening mechanisms -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 failure.

UNIT III PLASTIC FORMING OF METALS 9

Fundamentals of metal working, mechanics of metal working, flow-stress distribution, residual stresses, temperature in metal working- Forging in plane strain, open and closed die forging - Forces and geometrical relationships in rolling, theories of cold and hot rolling, bending and stretch forming.

UNIT IV ADVANCED MATERIALS 9

Dual phase steels, high strength low alloy steel, transformation induced plasticity steel, Maraging steel, smart materials, properties and applications of engineering plastics and composites materials - advanced structural ceramics -WC, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN, and Diamond - Functionally gradient materials, Nano materials.

UNIT V SELECTION OF MATERIALS AND TESTING 9

Motivation, cost basis and service requirements - Selection for mechanical properties, Selection for surface durability - Relationship between materials processing and selection - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Forgeability and castability test- NDT techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1.Discuss elastic plastic behavior of metals and its strengthening mechanisms.
CO2.Analyse the fracture behavior of metals and give solutions to avoid them.
CO3.Create processing techniques for controlling shape of the final product.
CO4.Select suitable materials for the specific industrial applications.
CO5.Able to work in R&D activity in the field of material science.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9	0.9		0.3	0.3	0.6	0.6	0.3	0.3	0.9
CO2	0.9	0.9		0.3	0.3	0.3	0.6	0.3	0.6	0.9
CO3	0.6	0.6	0.6	0.6	0.3	0.3	0.6	0.6	0.6	0.6
CO4	0.6			0.3	0.6		0.9	0.9	0.9	0.9
CO5	0.9	0.9	0.3	0.6	0.3	0.3	0.9	0.6	0.9	0.6

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1. ASM Handbook Volume 02: "Properties and Selection: Nonferrous Alloys and Special-Purpose Materials", ASM international,10th edition, 1990.
2. ASM hand book, volume 11, "Failure Analysis and Prevention", ASM international,10th edition, 2002.
3. Burakonsa T.Z., and Wierzchan.T., "Surface Engineering of Materials"- Principles of Equipment, Techniques, CRC press, 1st edition 1998.
4. Crane F.A.A., Charles J.A., and Furness, J.A.G., "Selection and use of engineering Materials", Reed Elsevier India, 2006.
5. Courtney T.H., "Mechanical Behaviour of Materials", 2nd edition, McGraw Hill, 2017.
6. Dieter G.E., "Mechanical Metallurgy", McGraw Hill education, 3rd edition, 2017.

CI5005 **MICRO AND NANO MANUFACTURING** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To introduce Meso, Micro and Nano manufacturing and their respective applications.
- To familiarize the students with diamond, turn machining.
- To acquaint the students with advanced micro machining and nano finishing methods.
- To familiarize the students with synthesis of nanomaterials.
- To gain knowledge on the types of characterization techniques to be used.

UNIT I INTRODUCTION **9**

Introduction to Meso, Micro and Nano manufacturing, Miniaturization and applications, classification-subtractive, additive, mass containing processes, Theory of micromachining, micro turning, micro drilling, micro milling- Micro stereo lithography - micro forming, micro moulding, micro casting- micro joining, Applications of Micro and Nano products in IT and telecommunications, Automotive, Medicine.

UNIT II DIAMOND TURN MACHINING **9**

Diamond turn machining-need, classification, components, material removal mechanisms, Tooling for diamond turning, Process parameters and optimization - Molecular Dynamic simulation to study nanoscale cutting-tool path strategies in surface generations- symmetric, asymmetric and freeform, applications of DTM products.

UNIT III ADVANCED MICROMACHINING / NANO FINISHING PROCESSES **9**

Introduction to mechanical and beam energy based micro machining processes- Ultrasonic micro machining, Focused Ion Beam machining, Laser Beam micro machining, Micro/ Nano finishing processes- Ball End Magneto Rheological finishing process-Focused Ion Beam nano finishing, Elastic Emission machining, Nano finishing for spherical components, Elasto-abrasive finishing, Chemo-mechanical Magneto abrasive finishing , Electrochemical magneto abrasive finishing, Electro-discharge diamond grinding-Hybrid micro/nano machining – Electro Chemical Spark Micro Machining, Electro Discharge Grinding, Electrolytic In Process Dressing Grinding

UNIT IV SYNTHESIS OF NANOMATERIALS **9**

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

UNIT V CHARACTERISATION TECHNIQUES **9**

Metrology for micro machined Components-Optical Microscopy, White Light Interferometry, Molecular Measuring Machine, Micro CMM- Scanning Probe Microscopy (SPM) – Scanning Electron Microscope, Transmission Electron Microscope, Scanning Thermal Microscopy, Tribological characteristics -Micro abrasion wear - Nano indentation- Ellipsometric Analysis, Surface integrity of micro and nano machined surfaces

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of Meso, Micro and Nano manufacturing and their respective applications.

CO2: Elaborate on Diamond turn machining process.

CO3: Describe the advanced micro machining and nano finishing methods.

CO4: Acquire knowledge on synthesis of nanomaterials.

CO5: Identify the type of characterization techniques to be used.

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	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1			0.6	0.3			0.9	0.6	0.6	0.9
CO2	0.6		0.9	0.3		0.3	0.9	0.6	0.6	0.9
CO3			0.9	0.3			0.9	0.6	0.6	0.9
CO4			0.6	0.3			0.9	0.6	0.6	0.9
CO5			0.9	0.3			0.9	0.6	0.3	0.6

REFERENCES:

1. Balasubraminan R., Rama Gopal, V and Sarepaka Sathyan Subbiah, "Diamond Turn Machining: Theory and Practice", CRC Press, Florida, USA, 2018, ISBN (13):978-1-4987-8758-1.
2. Bhushan B., "Handbook of Nanotechnology", Springer, Germany, 2017, ISBN (13): 978-3662543559.
3. Jain V.K., "Micro manufacturing Processes", CRC Press, Florida, USA, 2017, ISBN: 9781439852903.
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5. Jain V.K., "Introduction to Micromachining", Narosa Publishing House, New Delhi, India, 2018, ISBN: 978-81-8487-361-0.
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IL5084 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations.
- Explain the use of information technology in supply chain management.

UNIT – I INTRODUCTION SUPPLY CHAIN MANAGEMENT 9

Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system

UNIT – II SUPPLY CHAIN NETWORK DESIGN 9

Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.

UNIT – III DEMAND AND SUPPLY IN SUPPLY CHAIN 9

Forecasting in supply chain- Methods, Approach, Errors. Aggregate planning in supply chain-Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand. Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.

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UNIT – IV SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN 9

Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainity.

UNIT – V SUPPLY CHAIN AND INFORMATION SYSTEMS 9

Information in supply chain, Role of Information technology, IT framework in supply chain, Supplier and Customer relationship management. Role of e-business in supply chain, e-sourcing and e-procurement. Technology drivers in supply chain.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Students will be able to:

- To introduce the concepts and elements of supply chain management.
- Design supply chain various manufacturing and service sectors.
- To understand the principle of demand and supply in supply chain
- To gain knowledge on the sourcing and inventory decisions in supply chain.
- To understand the concepts of supply chain information systems.

	PO1	PO2	P03	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11
CO1					✓						
CO2		✓									
CO3		✓	✓				✓	✓			
CO4					✓						✓
CO5					✓						✓

REFERENCES

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2. Dougart L., Stock J. and Ellram L., “Logistic Management”, Irwin McGraw Hill International Edition" 1998.
3. Kaminsky S., “Design and Managing the Supply chain” , McGraw Hill International Edition. 2000.
4. Raghuram G, and N.Rangaraj, “Logistics and Supply Chain Management -cases and concepts”, McMilan India Pvt Ltd, New Delhi,. 2000.
5. Sahay B.S. “Supply Chain Management: For Global Competitiveness”, 2nd Edition, Macmillan, India Ltd, 2011.

IL5077 LEAN MANUFACTURING AND SIX SIGMA L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize the basics of Lean and Six Sigma.
- Describe the need and the process of integrating Lean and Six sigma.
- Identify and select the resources required for LSS Projects and selection of projects including Team building.
- Infer the DMAIC process and study the various tools for undertaking LSS projects.
- Relate how to institutionalize the LSS efforts.

UNIT I INTRODUCTION TO LEAN AND SIX SIGMA 9

Introduction to Lean- Definition, Purpose, Features of Lean ; Top seven wastes, Need for Lean management, The philosophy of lean management, Creating a lean enterprise, Elements of Lean, Lean principles, the lean metric, Hidden time traps. Introduction to quality, Definition of six sigma, origin of six sigma, Six sigma concept and Critical success factors for six sigma; Case analysis.

UNIT II INTEGRATION OF LEAN AND SIX SIGMA 9

Evolution of lean six sigma, the synergy of Lean and six sigma, Definition of lean six sigma, the principles of lean six sigma, Scope for lean six sigma, Features of lean six sigma. The laws of lean six sigma, Key elements of LSS, the LSS model and the benefits of lean six sigma. Initiation - Top management commitment – Infrastructure and deployment planning, Process focus, organizational structures, Measures – Rewards and recognition, Infrastructure tools, structure of transforming event and Launch preparation; Case study presentations.

UNIT III PROJECT SELECTION AND TEAM BUILDING 9

Resource and project selection, Selection of Black belts, Training of Black belts and Champions, Identification of potential projects, top down (Balanced score card) and Bottom up approach – Methods of selecting projects – Benefit/Effort graph, Process mapping, value stream mapping, Predicting and improving team performance, Nine team roles and Team leadership; Case study presentations.

UNIT IV THE DMAIC PROCESS AND TOOLS 9

The DMAIC process – Toll gate reviews; The DMAIC tools; Define tools – Project definition form, SIPOC diagram; Measure tools – Process mapping, Lead time/cycle time, Pareto chart, Cause and Effect matrix, FMEA; Idea – generating and organizing tools – Brainstorming, Nominal group technique, Multi-voting and Cause and effect diagram, Data collection and accuracy tools- Check sheet, Gauge R&R; Understanding and eliminating variation- run charts, control charts and process capability analysis; Analyze tools - Scatter plots, ANOVA, Regression analysis, Time trap analysis; Improve tools – Mistake proofing, Kaizen, set up time reduction (SMED), TPM, DOE and the pull system. Control tools – statistical process control.

UNIT V INSTITUTIONALIZING AND DESIGN FOR LSS 9

Institutionalizing lean six sigma – improving design velocity, creating cycle time base line, valuing projects, gating the projects, reducing product line complexity, Design for lean six sigma, QFD, Theory of Inventive Problem solving (TRIZ), Robust design; Case study presentations.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

- CO1: The students will be able to understand what is Lean and Six sigma and their importance in the globalised competitive world.
- CO2: The students will be able to understand the importance of integrating Lean and Six sigma and also the process of their integration.
- CO3: The students will be able to plan the Resources required to undertake the LSS projects and also acquire how to select the suitable projects and the teams.
- CO4: The students will be able apply DMAIC methodology to execute LSS projects and in this regard they will be acquainted with various LSS tools.
- CO5: The students will be able to understand the process of institutionalizing the LSS effort and also understand the Design for LSS.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓										✓
CO2						✓				✓		✓
CO3					✓				✓			
CO4	✓				✓		✓				✓	✓
CO5			✓			✓	✓	✓				

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REFERENCES:

1. James P. Womack, Daniel T. Jones, Lean Thinking, Free press business, 2003.
2. Michael L. George, Lean Six Sigma, McGraw-Hill., 2002.
3. Ronald G.Askin and Jeffrey B.Goldberg, Design and Analysis of Lean Production Systems, John Wiley & Sons., 2003.
4. Salman Taghizadegan, Essentials of Lean Six Sigma, Elsevier, 2010.

IL5071 ADVANCED OPTIMIZATION TECHNIQUES L T P C
3 0 0 3

COURSE OBJECTIVES:

- Learn to solve integer programming problems
- To know how to solve the Dynamic programming problems
- Learn to solve non – linear programming problems with un constrained optimization problems
- Understand to solve non-linear programming problems using KKT conditions, quadratic and separable programming
- To create awareness of Meta heuristic algorithms.

UNIT I INTEGER PROGRAMMING 9

Branch and Bound technique –cutting plane algorithm method - Travelling Salesman problem - Traveling Salesman Problem - Branch and Bound Algorithms for TSP - Heuristics for TSP - Chinese Postman Problem - Vehicle Routeing Problem

UNIT II DYNAMIC PROGRAMMING 9

Characteristics of Dynamic Programming Problems - Deterministic Dynamic Programming - Forward and Backward recursive recursion – selected dynamic programming application – investment model – inventory model – replacement model –reliability model – stage coach problem.

UNIT III NONLINEAR PROGRAMMING - I: 9

Types of Nonlinear Programming Problems - One-Variable Unconstrained Optimization - Multivariable Unconstrained Optimization -

UNIT IV NONLINEAR PROGRAMMING – II: 9

The Karush-Kuhn-Tucker (KKT) Conditions for Constrained Optimization - Quadratic Programming - Separable Programming - Convex Programming - Nonconvex Programming

UNIT V NON-TRADITIONAL OPTIMIZATION 9

Overview of Genetic algorithms, Simulated Annealing, neural network based optimization. Particle Swarm optimization, Ant Colony Optimization, Optimization of Fuzzy Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Know how to solve integer programming problems
CO2: Able to solve Dynamic programming problems
CO3: Familiar in solving unconstrained non linear optimization problems
CO4: Familiar in solving constrained liner optimization problems
CO5: Know how to solve non linear optimization problems using Meta heuristic algorithms

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CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓							
CO2	✓	✓		✓	✓							
CO3	✓	✓		✓	✓							
CO4	✓	✓		✓	✓							
CO5	✓	✓		✓	✓							

REFERENCES:

1. Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 1995.
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3. Christos H. Papadimitriou, Kenneth Steiglitz, Combinatorial Optimization, PHI 2006
4. Ravindran – Phillips –Solberg, “Operations Research – Principles and Practice”, John Wiley India, 2006.
5. Singiresu S.Rao, “Engineering optimization – Theory and practices”, John Wiley and Sons, 1996.

CI5006 SENSORS FOR MANUFACTURING AND CONDITION MONITORING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To make students familiar with various sensors in manufacturing and signal processing.
- To impart knowledge on sensors used in workpiece monitoring.
- To explain various sensors used in machine tool monitoring.
- To learn various sensors used in machining process monitoring.
- To brief the advanced and smart sensor technologies.

UNIT I INTRODUCTION TO SENSORS 9

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

UNIT II SENSORS FOR WORKPIECE MONITORING 9

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

UNIT III SENSORS FOR MACHINE TOOL MONITORING 9

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

UNIT IV SENSORS FOR MACHINING PROCESSES 9

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

UNIT V ADVANCED SENSORS 9

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

TOTAL: 45 Periods

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Recognize the importance of sensors and condition monitoring in manufacturing.
CO2: Identify suitable sensors for monitoring workpiece during machining operation.
CO3: Identify suitable sensors for monitoring machine tool during machining operation.
CO4: Identify suitable sensors in monitoring the machining process.
CO5: Perceive the usage and importance of advanced sensors in manufacturing industries.

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	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.3	0.3	0.3				0.9	0.9	0.9	0.6
CO2	0.6	0.3					0.9	0.9	0.9	0.9
CO3	0.6	0.3					0.9	0.9	0.9	0.9
CO4	0.6	0.3					0.9	0.9	0.9	0.9
CO5		0.6	0.3				0.9	0.9	0.9	0.90.9

REFERENCES:

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CI5007 FINITE ELEMENT ANALYSIS IN MANUFACTURING ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

- To equip students with fundamentals of finite element principles.
- To impart knowledge on computer implementation techniques.
- To develop finite element model for the plane elasticity problems.
- To introduce non-linear analysis and its computational methods.
- To emphasis on the finite element approach of production processes.

UNIT I INTRODUCTION 9

Mathematical modelling of field problems in engineering - Basic concepts of the finite element method- Formulation methods: Variational and weighted residual methods - Element types: basic elements, Linear and higher order elements, isoparametric elements - Derivation of shape functions and stiffness matrices and force vectors - Assembly of matrices - problems on stress, and strain analysis.

UNIT II COORDINATE TRANSFORMATION AND NUMERICAL INTEGRATION 9

Higher order elements - Natural co-ordinate systems - Coordinate transformation-isoparametric elements – Shape functions for isoparametric elements - Serendipity elements - Numerical integration and application - Jacobian of transformation - Order of convergence - example problems.

UNIT III PLANE ELASICITY 9

Introduction to elasticity equations - stress strain relations, constitutive equations - Plane stress, plane strain and axisymmetric problems.

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UNIT IV NON-LINEAR ANALYSIS 9

Introduction to non-linear problems - solution techniques- Plasticity: introduction general formulations for small strains, formulation for yield criterion, computational procedure, simple material nonlinearity: isotropic material and anisotropic materials, viscoelasticity- Lagrangian and updated Lagrangian formulations.

UNIT V ANALYSIS OF PRODUCTION PROCESSES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1.Explain the basic principles of the finite element technique.

CO2. Describe the computer implementation techniques of finite element model.

CO3. Analyze different types of plane elasticity problems.

CO4. Discuss the basics of non-linear finite element analysis.

CO5: Effectively use the FEA tools for solving problems in Manufacturing Engineering and Work in industrial R&D.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9		0.9	0.9	0.9	0.9	0.9	0.6	0.6	0.9
CO2	0.6		0.6	0.6			0.9	0.6	0.6	0.9
CO3	0.3			0.3			0.9	0.6	0.9	0.9
CO4	0.9		0.3	0.3			0.9	0.6	0.6	0.9
CO5	0.9	0.6	0.6	0.9	0.9	0.3	0.9	0.9	0.6	0.9

REFERENCES:

1. Cook R.D. and Malkus, D.S., “Concepts and Applications of Finite Elements Analysis”, Wiley, 4th edition, 2007.
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4. Paulo Davim J., “Finite Element Method in Manufacturing Processes”, ISTE Ltd.; 1st edition, 2011.
5. Prakash M. Dixit and Uday S. Dixit, “Modelling metal forming and machining processes” Springer, 2008.
6. Reddy J.N., “An Introduction to the Finite Element Method”, McGraw Hill, 3rd edition 2017.

CI5008 SYSTEM SIMULATION FOR MANUFACTURING ENGINEERS L T P C

3 0 0 3

COURSE OBJECTIVES:

- To discuss the importance and advantages of applying simulation techniques related to different organizations.
- To teach various random number generation techniques, its use in simulation, tests and Validity of random numbers for its use in development of simulation models, verification, validation and analysis.
- To explain the applications of random probability distributions in real time environments.
- To train students to solve discrete event problems using software.
- To train students on Simulation models using a simulation software.

UNIT I INTRODUCTION 9

Systems, general systems theory, concept of simulation, Stochastic activities, Types of Models, Principles used in Modeling, simulation as a decision making tool, types of simulation, Advantages and disadvantages of simulation, Steps in simulation model building

UNIT II RANDOM NUMBERS 9

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

UNIT III DESIGN OF SIMULATION 9

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart, starting condition, run size, experimental design consideration, output analysis and interpretation, validation. Monte Carlo method of simulation, Manual simulation techniques-based on tag numbers; based on probability distributions.

UNIT IV SIMULATION SOFTWARE 9

Study and selection of simulation languages, Use of any one of the simulation software for simulation model building. Creation of database, Data handling - import and export of data, injecting and extraction of information in the model blocks, Collection of model history and information, Dealing with statistics of the models and analysis - Interpretation of results

UNIT V CASE STUDIES IN SIMULATION 9

Ear deaf Analysis-Development of simulation models for Manufacturing and production systems, inventory optimization techniques, Advanced Sequencing and Scheduling problems, queuing systems - Problems, Heuristics for scheduling - Single pass heuristics, multipass heuristics, Evolutionary Optimization techniques-Tabu search, Simple Genetic algorithm, Ant Colony algorithm, Particle Swarm optimization - Case studies

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss various types of systems and identify different elements of a system to build simulation models and to use them.

CO2: Generate, test and use random numbers in different ways.

CO3: Explain various steps in building simulation models and how to run them for effective analysis of real life scenarios and obtain superior results.

CO4: Develop capabilities of taking up consultancy projects.

CO5: Describe various cases in system simulation and its approaches.

	PO						PSO			
	1	**2**	**3**	**4**	**5**	**6**	**1**	**2**	**3**	**4**
CO1	0.6	0.3		0.6		0.6	0.9	0.9	0.9	0.3
CO2	0.6	0.9	0.3	0.9	0.6	0.3	0.9	0.9	0.9	0.6
CO3	0.9	0.3		0.9	0.9	0.9	0.9	0.9	0.9	0.6
CO4	0.9	0.6	0.6	0.6	0.9	0.9	0.9	0.9	0.9	0.6
CO5	0.9			0.3		0.3	0.9	0.9	0.9	0.3

REFERENCES:

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2. Banks J., Nelson B.L., Nicol D.M and Shahabudeen. P, “Discrete event system simulation”, 4th edition Prentice Hall, India, 2005.
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QE5073 PRODUCT INNOVATION AND DEVELOPMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

- Gain knowledge of innovation in Product design and development.
- Summarize the development of new products through conceptualization, design and development phases.
- Associate various aspects of product development with industrial design and manufacturing.
- Interpret the fundamental concept of Rapid Prototyping.
- Generate products which are suitable for the needs of the society.

UNIT I PRODUCT DEVELOPMENT AND CONCEPT SELECTION 9

Product development process – Product development organizations- Identifying the customer needs – Establishing the product specifications – concept generation – Concept selection.

UNIT II PRODUCT ARCHITECTURE 9

Product architecture – Implication of the architecture – Establishing the architecture – Related system level design issues.

UNIT III INDUSTRIAL AND MANUFACTURING DESIGN 9

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

UNIT IV PROTOTYPING AND ECONOMIC ANALYSIS 9

Principles of prototyping – Planning for prototypes – Rapid Prototyping- Elements of economic analysis – Base case financial model – Sensitivity analysis – Influence of the quantitative factors.

UNIT V MANAGING PRODUCT DEVELOPMENT PROJECTS 9

Sequential, parallel and coupled tasks - Baseline project planning – Project Budget- Project execution – Project evaluation- patents- patent search-patent laws-International code for patents.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: The students should be able to understand the basic concept of product development.
CO2: Design and develop new products in a systematic using the studied tools and techniques.
CO3: To associate various aspects of product development with industrial design and manufacturing.
CO4: To understand the fundamental concept of Rapid Prototyping.
CO5: To be able to design products which are suitable for the needs of the society.

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11
1		✓			✓						
2		✓	✓								
3											
4	✓										
5			✓					✓		✓	✓

REFERENCES:

1. Gevirtz C, Developing New products with TQM, McGraw – Hill International editions,1994.
2. Jamnia A, Introduction to Product Design and Development for Engineers, Taylor and Francis Group, 2018.
3. RosenthalS, Effective product design and development, Irwin 1992.
4. Ulrich K, Eppinger S, Product Design and Development, McGraw- Hill International Fifth Editions, 2012.

Attested

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CI5009 COMPETITIVE MANUFACTURING SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To expose students on the areas of competitive environment, the best manufacturing practices in the world.
- To impart the concepts of group technology and flexible manufacturing systems.
- To gain knowledge in simulation techniques of flexible manufacturing systems.
- To outline computer software and database of flexible manufacturing systems.
- To familiarize the principles of just in time manufacturing systems.

UNIT I MANUFACTURING IN A COMPETITIVE ENVIRONMENT 9

Introduction – Competitiveness - Cost, Time, Quality, Flexibility - Product flexibility, Operation flexibility, Capacity flexibility - Automation of Manufacturing Process - Numerical Control - Adaptive Control - Material Handling and Movement - Industrial Robots - Sensor Technology - Flexible Fixtures - Design for Assembly, Disassembly and Service – Product Lifecycle Management.

UNIT II GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS 9

Part Families - Classification and Coding - Production Flow Analysis - Machine Cell Design – Benefits - Components of Flexible Manufacturing Systems (FMS) - Computer Control and Functions - Planning, Scheduling and Control of FMS - Knowledge Based Scheduling.

UNIT III SIMULATION OF FLEXIBLE MANUFACTURING SYSTEMS 9

Introduction - Application of Simulation – Simulation Process - Stating the Project's Objective(s), Building the Abstract Model, Input Analysis, Building the Simulation Model, Model Verification, Model Validation, Output Analysis - Model of FMS - Simulation Software – Limitations-Case studies.

UNIT IV COMPUTER SOFTWARE AND DATABASE OF FLEXIBLE MANUFACTURING SYSTEMS 9

FMS Software - Introduction, General Structure and Requirements, Functional Descriptions, Operational Overview, Types of Software Specification and Selection - Trends. Manufacturing Data Systems - Data Flow - FMS Database Systems – Computer Aided Design/Computer Aided Manufacturing Considerations - Planning for FMS Database.

UNIT V JUST IN TIME MANUFACTURING SYSTEMS 9

Toyota Production System (TPS): An overview, Components - Introduction to Lean Manufacturing, Comparison of TPS and Lean - Three Ms - Muda, Mura and Muri - Push versus Pull Systems - Types of Kanbans - Kanban Planning and Control Models - Signal Kanban - Other types of Kanbans - Express Kanban - Emergency Kanban - Through Kanban - Level Schedules for Mixed Model Assembly Lines -Alternative JIT Systems - Just-in-time (JIT) Purchasing - Total Quality Control and JIT - JIT Implementation - Barriers, Potential Benefits.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

- CO1: Describe the areas of Competitive Environment and the best Manufacturing Practices in the World.
- CO2: Perceive concepts of Group Technology and Flexible Manufacturing Systems.
- CO3: Acquaint with Simulation of Flexible Manufacturing Systems.
- CO4: Evaluate Computer Software and Database of Flexible Manufacturing Systems.
- CO5: Explain Just in Time Manufacturing Systems.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9		0.9		0.9		0.6	0.6	0.6	0.3
CO2	0.9		0.9		0.9		0.9	0.6	0.6	0.6
CO3	0.9		0.9		0.9		0.9	0.6	0.6	0.3
CO4	0.6		0.9		0.9		0.9	0.9	0.6	0.3
CO5	0.6		0.9		0.9		0.9	0.9	0.6	0.6

REFERENCES

1. Chryssolouris G., "Manufacturing Systems: Theory and Practice", 2nd Edition, Springer., United States, Reprint 2010, ISBN 9780387256832.
2. Dennis P., “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, 3rd edition, Routledge.,United States, 2015, ISBN-13: 978-1563273568.
3. Groover M.P., “Automation, Production Systems and Computer Integrated Manufacturing", 3rd Edition, Prentice-Hall.,India, 2016, ISBN-13: 978-9332572492.
4. Jha N.K., “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., United States, 2012, ISBN-13: 9780323139359.
5. Nanua Singh "System Approach to Computer Integrated Design and Manufacturing", Wiley India Edition, Reprint 2011, ISBN-13: 978-0471585176.

CI5010 INDUSTRIAL ROBOTICS AND INTELLIGENT SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To comprehend the basic elements of a robot, it’s anatomical features, the types of actuators, sensors, end effectors in robots, their design aspects and about the robotic machine vision.
- To familiarize the students with kinematic behaviour of serial and parallel manipulators.
- To familiarize the students with dynamic behaviour of serial and parallel manipulators.
- To acquaint the students with design and control of robot cell and the safety aspects to be followed in a robot cell.
- To introduce the evolution, types and principle of robot programming, the basic artificial intelligence techniques and the machine learning algorithms considering robot intelligence.

UNIT I ELEMENTS OF ROBOT 9

Introduction to robotics- Definition- need and scope of Industrial robots- Robot Anatomy-Joints, Links, Actuators - Work volume - Hydraulic and Pneumatic drives, Linear and rotary actuators, control valves, Electro hydraulic servo valves, electric drives, Motors- Design of drive systems- Sensors for Robots - End effectors – Vacuum, magnetic and air operated Grippers - Design of end effectors - Robot Machine Vison - Applications-Case study

UNIT II KINEMATICS OF SERIAL AND PARALLEL MANIPULATORS 9

Science of robotics- Robot Kinematics, Direct and inverse kinematics, Kinematics of Serial robots- D-H Transformation- kinematics of parallel robots-velocity and static analysis of Manipulators- Robot trajectories- Kinematic Simulation.

UNIT III DYNAMICS OF SERIAL AND PARALLEL MANIPULATORS 9

Introduction - Lagrangian formulation- Examples of Equations of Motion- Inverse Dynamics & Simulation of Equations of Motion- Recursive Formulations of Dynamics of Manipulators- Articulated-body algorithm– Dynamic Simulation.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

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

UNIT V ROBOT INTELLIGENCE 9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – Motion interpolation- other programming languages- Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots- Machine learning - basics-introduction to types of Algorithm - Application- Cobot- Swarm Robotics- Soft robotics- Bio Robots-Case study.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

- CO1: Apprehend the preliminary concepts that comprise a robotic system.
- CO2: Acquire knowledge on robot kinematic system.
- CO3: Acquire knowledge on robot dynamic system.
- CO4: Create a typical robot work cell for a problem.
- CO5: Recognize the importance of robot intelligence in all applications.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.3		0.9	0.3	0.6	0.9	0.9	0.9	0.6	0.6
CO2	0.6	0.6	0.6	0.6	0.9	0.6	0.9	0.9	0.9	0.6
CO3	0.6	0.9	0.3	0.9	0.3	0.9	0.9	0.9	0.9	0.9
CO4		0.6		0.6		0.3	0.9	0.9	0.6	0.9
CO5	0.9	0.3		0.6	0.3	0.6	0.9	0.9	0.9	0.9

REFERENCES:

1. Deb S.R. and Deb S., “Robotics Technology and Flexible Automation”, 2nd Edition,TataMcGraw-Hill Education Pvt. Ltd., New Delhi, India, 2010, ISBN (13): 978-0-07-133129-6.
2. Fu K.S., Gonzalez R.C. and Lee C.S.G. “Robotics: Control, Sensing, Vision and Intelligence”, McGraw Hill, New York, USA, 1992.
3. Groover M.P., Weis M. and Nagel R.N., Odrey N.G. and Ashish Dutta, “Industrial Robotics Technology, Programming and Applications”, 2nd Edition, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, India, 2012, ISBN (13): 978-1-25-900621-0.
4. Jordanides T. and TorbyB.J., “Expert Systems and Robotics “, Springer-VerlagNewYork,USA, 1991.
5. Mark W. Spong and Vidyasagar M., “Robot Dynamics and Control”, 2ndEdition, Wiley India Pvt. Ltd., New Delhi, India, 2008, ISBN-13: 978-81-265-1780-0.
6. Robin R. Murphy, “Introduction to AI Robotics”, The MIT Press, Massachusetts, USA, 2000.

CI5071 DESIGN FOR MANUFACTURING AND ASSEMBLY L T P C

3 0 0 3

COURSE OBJECTIVES:

- To impart the knowledge in design for manufacturing and assembly (DFM/A) principles.
- To be acquainted with the use of DFM/A tools.
- To elaborate DFM/A system architecture.
- To outline product model and interfacing.
- To discuss system implementation by considering various manufacturing constraints.

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UNIT I INTRODUCTION 9

Implementation of concurrent engineering- Issues involved in introducing design for manufacturing and assembly (DFM/A)-DFM/A principles and techniques - Current state of commercial DFM/A packages- Requirements for a new generation of DFM/A Systems -Knowledge-based approaches to DFM/A-Interfacing design (CAD) and DFM/A Systems, Case studies.

UNIT II DFM/A METHODOLOGIES 9

Total design Environment-Tools: Quality function deployment, Failure modes and effects analysis (FMEA)- Design for manufacturing and assembly principles: Mechanical Assembly-General DFA principles- DFA guidelines: General mechanical, General electro-mechanical - Design for manual assembly- Design for electronics Assembly-Design for Testability-Machining-Currently available manufacturability analysis tools- Integrating DFM/ A into different design regimes - Case studies

UNIT III DFM/A SYSTEM ARCHITECTURE 9

System of system design Scenario --Manufacturing Aspects- Design - Analysis-Methods of data representation- Object-oriented Approach-Databases- Design for Manufacturing-Design for Assembly-Conceptual architecture- Analysis and integration and inference- Interfaces-Analysis engine concepts- Process model- Control and system operation- Control issues.

UNIT IV PRODUCT MODEL AND CAD INTERFACING 9

Product Model - Structure and object - Oriented Approach-Classes and objects - Polymorphism and inheritance - Modelling concepts- Product model structure overview- Detailed product model-Storage of object-Oriented product models - Features in CAD-DFM integration - Feature representation methodologies- Classification of features -Hierarchical structure of the features - Interfacing with different CAD systems - Interface mechanisms for applications-knowledge engineering and inferencing

UNIT V SYSTEM IMPLEMENTATION 9

System for design for PCB assembly, small parts assembly, mechanical assembly, machining Generic architecture operational aspects- Architecture realization- Control module

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the End of the Course, the students will be able to

CO1: Describe the design for manufacturing principles.
CO2: Implement DFM/A principles in the required applications.
CO3: Use DFM/A tools.
CO4: Select appropriate DFM/A system architecture with the given manufacturing aspects.
CO5: Create Product model.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9			0.9		0.6	0.9	0.6	0.6	0.3
CO2	0.9			0.9		0.6	0.9	0.6	0.6	0.6
CO3	0.9			0.9		0.6	0.9	0.6	0.6	0.6
CO4	0.9	0.6		0.9		0.6	0.9	0.6	0.6	0.6
CO5	0.9	0.9		0.9		0.6	0.9	0.6	0.9	0.6

REFERENCES:

1. David M. Anderson, “Design for manufacturability “, CRC Press.,United States, 2014,ISBN 9781482204926.
2. Geoffrey Boothroyd, Peter Dewhurst, and Winston A. Knight, “Product Design, for Manufacture, and Assembly”, 3rd Edition, CRC Press., United States,2011, ISBN 9781420089271.
3. James G. Bralla, “Design for manufacturability handbook”, McGraw Hill., United States, 1999, ISBN-13: 978-0070071391.

4. Molloy O., Tilley S., and Warman E., “Design for Manufacturing and Assembly Concepts, architectures and implementation”, Springer., United Kingdom, 1998, Reprint 2012, ISBN: 978-1461376507.
5. Peck H., “Designing for manufacture”, Sir Isaac Pitman & Sons Ltd., United States 1973.

IL5076 INDUSTRIAL AUTOMATION AND ROBOTICS L T P C
3 0 0 3

COURSE OBJECTIVES:

- Justify the high cost of investment in automation through production economics concepts.
- Summarize the fundamental concepts and elements of computer-integrated manufacturing.
- Articulate various aspects of automated manufacturing such as fixed automation and programmable automation.
- Familiarize the automated material handling and storage systems
- Discover computerized planning, lean and agile systems.

UNIT I AUTOMATION 9

Types of production – Functions – Automation strategies – Production economics – Costs in manufacturing – Break-even analysis.

UNIT II AUTOMATED FLOW LINES 9

Transfer mechanism - Buffer storage – Analysis of transfer lines - Automated assembly systems.

UNIT III NUMERICAL CONTROL AND ROBOTICS 9

NC-CNC – Part programming – DNC – Adaptive control – Robot anatomy – Specifications – End effectors – Sensors - Robot cell design – CAD/CAM.

UNIT IV AUTOMATED HANDLING AND STORAGE 9

Automated material handling systems – AGV- AS/RS – carousel storage – Automatic data capture – bar code technology- RFID

UNIT V MANUFACTURING SUPPORT SYSTEMS 9

Product design and CAD, CAD/CAM and CIM, Computer aided process planning- variant and generative approaches, Concurrent engineering and design for manufacture, Lean production, Agile manufacturing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Select automated equipment based on break-even quantity and compute cost per component.
CO2: Analyze an automated flow line without and with buffer for its performance measures.
CO3: Acquire knowledge in Numerical control programming.
CO4: Identify the elements of manufacturing automation; these include CNC, Robotics, automated assembly and material handling.
CO5: Understand manufacturing planning and control systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓			✓						✓	
CO2					✓							
CO3		✓	✓		✓		✓					
CO4					✓						✓	
CO5			✓		✓							✓

REFERENCES:

1. Mikell P.Groover, “Automation, Production Systems and Computer Integrated Manufacturing” PHI, 2003. 24
2. Weatherall, “Computer Integrated Manufacturing – A total company strategy”, 2nd edition, 1995.

CI5011 MANUFACTURING INFORMATION SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

- To impart knowledge on databases and its application in manufacturing systems.
- To elaborate with order policies, data base terminologies, designing, manufacturing considerations.
- To outline modules involved in inventory, process flow and shop floor control.
- To be acquainted with integration of the modules to function as a single application that aids different departments of the factory.
- To introduce the concepts of the shop floor data capturing systems, Industry 4.0 and smart factories.

UNIT I DATABASE 9

Data and information: Use of information -Information needs of Manufacturing -Manufacturing Information. Database – Concept – Evolution - Structures of a Data Base Management System. Terminologies – Data modeling: Entities and Attributes – keys - Data Independence - Schema and Subschema – Entity Relationship (ER) diagram - Entity modeling - Data Base Administrator-Trends in Database.

UNIT II DATABASE DESIGN 9

Network, Hierarchical, Relational Model, Object-oriented and Hypermedia Databases - Network Approach - Relational Database; Concepts - Principles - Functional Dependency - Normalization: First normal form - Second normal form - Third normal form - Boyce-codd normal form - Fourth and Fifth normal form - Functional layers of Relational Database - Relational calculus and Relational algebra - Query Languages - Relational Operations - Case studies.

UNIT III MANUFACTURING CONSIDERATION 9

The product and its structure, inventory and process flow – Shop Floor Control. Data Structure and procedure – Various models – Order scheduling module, Input / Output Analysis Module, and Stock Status Database – The complete Inventory order management database.

UNIT IV INFORMATION SYSTEM FOR MANUFACTURING 9

Parts Oriented Production Information System - Concepts and Structure - Computerized Production Scheduling, Online Production Control Systems, Computer based production management system, Computerized Manufacturing Information System - Shop floor data capturing systems: Bar Code, Electronic labels, Optical character recognition - Case studies.

UNIT V INDUSTRY 4.0 AND SMART FACTORIES 9

Industry 4.0-Need - Characteristics – Benefits for Small Medium Enterprise (SME) -Design Principles - Building Blocks of Industry 4.0 - Introducing Smart Factories -Smart Factories in Action – Real world smart Factories - Case Studies.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Perceive the data base concepts, terminologies, trends and its application in manufacturing field.

CO2: Discuss common types of databases, normalization and its importance, and operations involved in database management.

CO3: Elaborate various sub modules involved in inventory, process flow and shop floor control.

CO4: Acquire knowledge in integration of the modules to function as a single application that aids different departments of the factory.

CO5: Recognize the importance of data integration in advanced manufacturing environments like industry 4.0 and smart factory systems.

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.3	0.9	0.9	0.9	0.6	0.3	0.9	0.9	0.9	0.6
CO2	0.6	0.9	0.9	0.6	0.3	0.9	0.9	0.9	0.6	0.6
CO3	0.6		0.9	0.6	0.6		0.9	0.6	0.6	0.3
CO4	0.3	0.9	0.9	0.9	0.9		0.9	0.9	0.9	0.6
CO5	0.3	0.9	0.9	0.9	0.9		0.9	0.9	0.9	0.9

REFERENCES:

1. Alasdair Gilchrist “Industry 4.0 – The Industrial Internet of Things” Apress 2016. 1st edition ISBN: 978-1-4842-2046-7.
2. Boyle, Randall, Kroenke and David M., “Experiencing MIS”, Pearson Higher Education, USA, 2017. ISBN 13:978-1-292-16357-4.
3. Date C.J., ”An Introduction to Database Systems” Pearson education, USA, 8th Edition, 2003. ISBN: 978-0321197849.
4. Franjo C., “Manufacturing Information & Data Systems Analysis, Design & Practice”, Butterworth-Heinemann, UK, 2002. ISBN :9781857180312.
5. Sartori L.G., “Manufacturing Information Systems”, Addison-Wesley, Harlow, UK, 1988. ISBN-13: 978-0201178111.

CI5072 SUSTAINABLE MANUFACTURING L T P C
3 0 0 3

COURSE OBJECTIVES

- To be acquainted with sustainability in manufacturing and its evaluation.
- To provide knowledge in environment and social sustainability.
- To provide the student with the knowledge of strategy to achieve sustainability.
- To familiarize with trends in sustainable operations.
- To create awareness in current sustainable practices in manufacturing industry.

UNIT I ECONOMIC SUSTAINABILITY 9

Industrial Revolution-Economic sustainability: globalization and international issues- Sustainability status - Emerging issues- Innovative products- Reconfiguration manufacturing enterprises - Competitive manufacturing strategies - Performance evaluation- Management for sustainability - Assessments of economic sustainability

UNIT II SOCIAL AND ENVIRONMENTAL SUSTAINABILITY 9

Social sustainability – Introduction-Work management -Human rights - Societal commitment - Customers -Business practices -Modelling and assessing social sustainability. Environmental issues pertaining to the manufacturing sector: Pollution - Use of resources -Pressure to reduce costs - Environmental management: Processes that minimize negative environmental impacts - environmental legislation and energy costs - need to reduce the carbon footprint of manufacturing Operations-Modelling and assessing environmental sustainability

UNIT III SUSTAINABILITY PRACTICES 9

Sustainability awareness - Measuring Industry Awareness-Drivers and barriers -Availability of sustainability indicators -Analysis of sustainability practicing -Modeling and assessment of sustainable practicing -Sustainability awareness -Sustainability drivers and barriers -Availability of sustainability indicators- Designing questionnaires- Optimizing Sustainability Indexes-Elements – Cost and time model

UNIT IV MANUFACTURING STRATEGY FOR SUSTAINABILITY 9

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

UNIT V TRENDS IN SUSTAINABLE OPERATIONS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of this course, the students shall be able to:

CO1: Discuss the importance of economic sustainability.
CO2: Describe the importance of sustainable practices.
CO3: Identify drivers and barriers for the given conditions.
CO4: Formulate strategy in sustainable manufacturing.
CO5: Plan for sustainable operation of industry with environmental, cost consciousness

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
CO1	0.9	0.9				0.9	0.9	0.6	0.9	0.9
CO2	0.9	0.6				0.9	0.9	0.6	0.6	0.9
CO3	0.9	0.9		0.9		0.6	0.6	0.6	0.6	0.6
CO4	0.9	0.9		0.6		0.6	0.6	0.9	0.6	0.6
CO5	0.9	0.9	0.6			0.9	0.9	0.9	0.9	0.9

REFERENCES:

1. Davim J.P., “Sustainable Manufacturing”, John Wiley & Sons., United States, 2010, ISBN: 978-1-848-21212-1.
2. Ibrahim Garbie, “Sustainability in Manufacturing Enterprises Concepts, Analyses and Assessments for Industry 4.0”, Springer International Publishing., United States, 2016, ISBN-13: 978-3319293042.
3. Jovane F., Ęmper, W.E. and Williams, D.J., “The ManuFuture Road: Towards Competitive and Sustainable High-Adding-Value Manufacturing”, Springer,2009, United States, ISBN 978-3-540-77011-4.
4. Kutz M., “Environmentally Conscious Mechanical Design”, John Wiley & Sons., United States, 2007, ISBN: 978-0-471-72636-4.
5. Seliger G., “Sustainable Manufacturing: Shaping Global Value Creation”, Springer, United States, 2012, ISBN 978-3-642-27289-9.

IL5074 **ENTERPRISE RESOURCE PLANNING** **L T P C**

3 0 0 3

COURSE OBJECTIVES:

- Describe an idea about ERP
- Creating awareness of core and extended modules of ERP
- Extract knowledge of ERP implementation cycle
- Gaining knowledge about effects of ERP after its implementation.
- Understanding the emerging trends on ERP

UNIT I INTRODUCTION **9**

Overview of enterprise systems – Evolution - Risks and benefits - Fundamental technology - Issues to be consider in planning design and implementation of cross functional integrated ERP systems.

UNIT II ERP SOLUTIONS AND FUNCTIONAL MODULES **9**

Overview of ERP software solutions- Small, medium and large enterprise vendor solutions, BPR, and best business practices - Business process Management, Functional modules.

UNIT III ERP IMPLEMENTATION **9**

Planning Evaluation and selection of ERP systems - Implementation life cycle - ERP implementation, Methodology and Frame work- Training – Data Migration. People Organization in implementation-Consultants, Vendors and Employees.

UNIT IV POST IMPLEMENTATION **9**

Maintenance of ERP- Organizational and Industrial impact; Success and Failure factors of ERP Implementation.

UNIT V EMERGING TRENDS ON ERP **9**

Extended ERP systems and ERP add-ons -CRM, SCM, Business analytics - Future trends in ERP systems-web enabled, Wireless technologies, cloud computing.

TOTAL : 45 PERIODS

COURSE OUTCOMES

CO1: Get an idea about ERP
CO2: Awareness of core and extended modules of ERP
CO3: Knowledge of ERP implementation cycle
CO4: Gain knowledge about effects of ERP after its implementation.
CO5: Understand the emerging trends on ERP

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓						✓	
CO2		✓			✓							
CO3		✓			✓						✓	
CO4		✓			✓							✓
CO5		✓			✓						✓	✓

REFERENCES

1. Alexis Leon, Enterprise Resource Planning, second edition, Tata McGraw-Hill, 2008.
2. Jagan Nathan Vaman, ERP in Practice, Tata McGraw-Hill, 2008
3. MahadeoJaiswal and Ganesh Vanapalli, ERP Macmillan India, 2009
4. Sinha P. Magal and Jeffery Word, Essentials of Business Process and Information System, Wiley India, 2012
5. Vinod Kumar Grag and N.K. Venkitakrishnan, ERP- Concepts and Practice, Prentice Hall of India, 2006.

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ED5072	ADVANCED MACHINE TOOL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Selecting the different machine tool mechanisms.
2. Designing the Multi speed Gear Box and feed drives.
3. Designing the machine tool structures.
4. Designing the guideways and power screws.
5. Designing the spindles and bearings.

UNIT-I INTRODUCTION TO MACHINE TOOL DESIGN 9

Introduction to Machine Tool Drives and Mechanisms, Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission

UNIT-II REGULATION OF SPEEDS AND FEEDS 9

Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design

UNIT-III DESIGN OF MACHINE TOOL STRUCTURES 9

Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriage

UNIT-IV DESIGN OF GUIDEWAYS AND POWER SCREWS 9

Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slide ways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws

UNIT-V DESIGN OF SPINDLES AND SPINDLE SUPPORT 9

Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings. Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness

TOTAL = 45 PERIODS

COURSE OUTCOMES:

On Completion of the course the student will be able to

1. Select the different machine tool mechanisms.
2. Design the Multi speed Gear Box and feed drives.
3. Design the machine tool structures.
4. Design the guideways and power screws.
5. Design the spindles and bearings.

REFERENCES:

1. N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010
2. G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009
3. D. K Pal, S. K. Basu, “Design of Machine Tools”, 5th Edition. Oxford IBH, 2008
4. N. S. Acherkhan, “Machine Tool Design”, Vol. I, II, III and IV, MIR publications, 1968
5. F. Koenigsberger, Design Principles of Metal-Cutting Machine Tools, Pergamon Press, 1964
6. F. Koenigsberger, Machine Tool Structures,Pergamon Press,1970

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0.3- Low 0.6- Medium 0.9- High

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.9	0.9	0.6		0.3	0.6	0.3					0.3	0.6	0.6
2	0.9	0.9	0.9	0.6		0.3	0.6	0.3					0.3	0.6	0.6
3	0.9	0.9	0.9	0.6		0.3	0.6	0.3					0.3	0.6	0.6
4	0.9	0.9	0.9	0.6		0.3	0.6	0.3					0.3	0.6	0.6
5	0.9	0.9	0.9	0.6		0.3	0.6	0.3					0.3	0.6	0.6

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OPEN ELECTIVE COURSES (OEC)

OE5091	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

COURSE 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.

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.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

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.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

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.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

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Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

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.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and 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.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

On completion of the course, the student will be able to:

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

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, 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.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 INDUSTRIAL SAFETY L T P C
3 0 0 3

COURSE OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- 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: 45 PERIODS

COURSE OUTCOMES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew 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

OE5093 OPERATIONS RESEARCH L T P C
3 0 0 3

COURSE OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

Attested

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENT OF ENGINEERING PROJECTS L T P C
3 0 0 3

COURSE 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

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

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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: 45 PERIODS

COURSE OUTCOMES

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

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

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

COURSE 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.

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.

Attested

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: 45 PERIODS

COURSE OUTCOMES:

- 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

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. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 WASTE TO ENERGY L T P C
3 0 0 3

COURSE 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

UNITI 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

UNITII 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.

UNITV 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: 45 PERIODS

COURSE OUTCOMES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

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

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AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

COURSE 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

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: 30 PERIODS

COURSE OUTCOMES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

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

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4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

COURSE 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

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 : 30 PERIODS

COURSE OUTCOMES:

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											

CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

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, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

COURSE 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.

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: 30 PERIODS

COURSE OUTCOMES:

- 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

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REFERENCES

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.

AX5094	VALUE EDUCATION	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

Students will be able to

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

UNIT I

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

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

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

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: 30 PERIODS

COURSE OUTCOMES:

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING

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

AX5095	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

COURSE 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.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
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 IV ORGANS OF GOVERNANCE:
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 V LOCAL ADMINISTRATION:
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 VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

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

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

COURSE OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

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 INTRODUCTION AND METHODOLOGY:

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 III THEMATIC OVERVIEW

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

UNIT IV EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

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 V PROFESSIONAL DEVELOPMENT

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 VI RESEARCH GAPS AND FUTURE DIRECTIONS

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

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

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

AX5097 STRESS MANAGEMENT BY YOGA L T P C
2 0 0 0

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

UNIT I
Definitions of Eight parts of yoga.(Ashtanga)

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

TOTAL: 30 PERIODS

COURSE OUTCOMES
Students will be able to:
- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING
1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS L T P C
2 0 0 0

COURSE 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

UNIT I
Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses-29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses-71,73,75,78 (do's)

UNIT II
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 - Chapter 18-Verses 45, 46, 48.

UNIT III
Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-

Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

Attested

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