ANNA UNIVERSITY : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

M.E. MANUFACTURING ENGINEERING

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

VISION OF THE DEPARTMENT

To develop disciplined, socially committed and technically competent Production Engineers with Creativity, Comprehension and Managerial skills to design and manufacture innovative cost effective quality products for the benefit of mankind.

MISSION OF THE DEPARTMENT

1. Train the students who will be able to design and manufacture Innovative, Environment Friendly, Ergonomic and Cost Effective Quality Products and Services.
2. Improve the technical quality of the students to meet the challenges, competitions and opportunities in production engineering.
3. Prepare the students who will be able to solve socially relevant engineering problems and other complex problems by means of inculcating Managerial Skills.
4. Enhance the department industry / research centre interaction by means of training, internship and student projects to solve industrial problems.

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UNIVERSITY DEPARTMENTS

M.E. MANUFACTURING ENGINEERING (FT and PT)

REGULATIONS - 2019

CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

I. Find gainful employment in Industry and Academic sector.
II. Enter into doctoral studies leading to research career.
III. Ability to analyse manufacturing system and provide optimal solutions to practical problems of any organization.
IV. Gain managerial leadership in their career path by their engineering and manufacturing management skill.
V. Become an ethically responsible person to work as an individual and part of team for societal cause.

PROGRAMME OUTCOMES (POs)

After going through post graduate Manufacturing Engineering, the graduates will exhibit ability to:

PO #	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, research literature, and analyse engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.
3	Design/development of solutions	Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

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10	Communication	Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

PROGRAMME SPECIFIC OUTCOMES (PSOs)

By completion of post graduate Manufacturing Engineering, the graduates will have following Program specific outcomes:

1. Knowledge on Modern Manufacturing systems: Familiarization of modern manufacturing systems and practices.
2. Knowledge on design, analysis and development of manufacturing processes, automation and quality systems.
3. Foundation of sustainable development: Knowledge on application of appropriate materials and manufacturing system and development ofanoptimal solution to the needs of Industry and society.

Mapping of PEOs with POs

Programme	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
I	✓		✓			✓	✓	✓	✓	✓		✓
II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
III	✓	✓	✓	✓	✓	✓	✓	✓			✓	
IV						✓		✓	✓	✓	✓	
V	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

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		Subject	Programme Outcome											
			PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 1	SEM I	Applied Probability and Statistics	✓	✓	✓	✓		✓					✓	✓
		Modern Manufacturing Processes	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Materials Technology	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓
		Robot Design and Programming	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Program Elective – I												
		Research Methodology and IPR	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Audit Course – I												
		Advanced Manufacturing Processes Laboratory	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
		Mechatronics and Robotics Laboratory	✓	✓	✓	✓	✓					✓	✓	✓
YEAR 1	SEM II	Finite Element Applications in Manufacturing	✓	✓	✓	✓	✓				✓	✓		✓
		Fluid Power Automation	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Program Elective – II												
		Program Elective – III												
		Audit Course – II												
		Modelling and and Simulation Laboratory	✓	✓	✓	✓	✓				✓		✓	✓
		Automation Laboratory	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓
		Mini Project with Seminar	✓	✓	✓	✓	✓			✓	✓	✓	✓	✓

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YEAR 2	SEM III	Program Elective – IV												
		Program Elective – V												
		Program Elective – VI												
		Open Elective												
		Dissertation - I	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	SEM IV	Dissertation - II	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

ELECTIVES

Subject		Programme Outcome											
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Programme Elective I	Material Testing and Characterization	✓	✓	✓	✓	✓	✓			✓			✓
	Computer Aided Product Design	✓	✓	✓	✓	✓					✓	✓	✓
	Theory of Metal Forming	✓	✓	✓	✓	✓							✓
	Manufacturing Process Planning and Cost Estimation	✓	✓	✓	✓	✓				✓			✓
Programme Elective II	Micro System Technology	✓	✓	✓	✓			✓					✓
	Mechatronics in Manufacturing System	✓	✓	✓	✓	✓				✓	✓		✓
	Advanced Welding Technology	✓	✓	✓	✓	✓		✓		✓			
	Quality and Reliability Engineering	✓	✓	✓	✓	✓	✓	✓		✓		✓	
Programme Elective III	Manufacturing Metrology	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
	Metal Cutting Theory and	✓	✓	✓	✓	✓		✓		✓			✓

	Practice												
	Computer Integrated Manufacturing	✓	✓	✓	✓	✓	✓	✓		✓			
	Production and Operation Management	✓	✓	✓	✓	✓	✓	✓		✓		✓	
Programme Elective IV	Processing of Polymers and Composites	✓	✓	✓	✓			✓		✓			✓
	Green Concepts	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓
	Manufacturing of Automotive Components	✓	✓	✓	✓	✓	✓	✓		✓			✓
	Financial Management	✓	✓	✓	✓		✓		✓		✓	✓	✓
Programme Elective V	Surface Engineering and Coatings	✓	✓	✓	✓	✓	✓		✓				✓
	Solid Freeform Manufacturing	✓	✓	✓		✓		✓	✓			✓	✓
	Advanced Casting Technology	✓	✓	✓	✓	✓							✓
	Manufacturing Management	✓	✓	✓	✓						✓	✓	✓
Programme Elective VI	Industrial Design And Ergonomics	✓	✓	✓	✓		✓	✓			✓		✓
	Industry 4.0 and Internet of Things	✓	✓	✓		✓	✓			✓	✓	✓	✓
	Design of Manufacturing Tools, Jigs and Fixtures	✓	✓	✓	✓	✓				✓	✓		
	Advanced Optimization Techniques	✓	✓	✓	✓	✓			✓	✓			✓

ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

M.E. MANUFACTURING ENGINEERING (FULL TIME)

REGULATIONS - 2019

I TO IV SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MA5101	Applied Probability and Statistics	FC	3	1	0	4	4
2.	MN5101	Modern Manufacturing Processes	PCC	3	0	0	3	3
3.	MN5102	Materials Technology	PCC	3	0	0	3	3
4.	MN5103	Robot Design and Programming	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.	MN5111	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
9.	MN5112	Mechatronics and Robotics 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	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5201	Finite Element Applications in Manufacturing	PCC	4	0	0	4	4
2.	MN5202	Fluid Power Automation	PCC	3	0	0	3	3
3.		Program Elective – II	PEC	3	0	0	3	3
4.		Program Elective – III	PEC	3	0	0	3	3
5.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
6.	MN5211	Modelling and Simulation Laboratory	PCC	0	0	4	4	2
7.	MN5212	Automation Laboratory	PCC	0	0	4	4	2
8.	MN5213	Mini Project with Seminar	EEC	0	0	2	2	1
			TOTAL	**15**	**0**	**10**	**25**	**18**

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* Audit Course is optional.

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SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.		Program Elective – IV	PEC	3	0	0	3	3
2.		Program Elective – V	PEC	3	0	0	3	3
3.		Program Elective – VI	PEC	3	0	0	3	3
4.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
5.	MN5311	Dissertation – I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MN5411	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 - 70

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UNIVERSITY DEPARTMENTS

REGULATIONS - 2019

M.E. MANUFACTURING ENGINEERING (PART TIME)

I TO VI SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5101	Modern Manufacturing Processes	PCC	3	0	0	3	3
2.	MA5101	Applied Probability and Statistics	PCC	3	1	0	4	4
3.		Program Elective – I	PEC	3	0	0	3	3
4.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
5.	MN5111	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
			TOTAL	**11**	**1**	**4**	**16**	**12**

* Audit Course is optional.

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5202	Fluid Power Automation	PCC	3	0	0	3	3
2.	MN5102	Materials Technology	PCC	3	0	0	3	3
3.		Program Elective – II	PEC	3	0	0	3	3
4.		Audit Course – II*	AC	2	0	0	2	0
PRACTICALS								
5.	MN5212	Automation Laboratory	PCC	0	0	4	4	2
			TOTAL	**11**	**0**	**4**	**15**	**11**

* Audit Course is optional.

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5201	Finite Element Applications in Manufacturing	PCC	4	0	0	4	4
2.		Program Elective – III	PEC	3	0	0	3	3
3.		Program Elective – IV	PEC	3	0	0	3	3
PRACTICALS								
4.	MN5211	Modelling and Simulation Laboratory	PCC	0	0	4	4	2
			TOTAL	**10**	**0**	**4**	**14**	**12**

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
2.	MN5103	Robot Design and Programming	PCC	3	0	0	3	3
3.		Program Elective – V	PEC	3	0	0	3	3
PRACTICALS								
4.	MN5112	Mechatronics and Robotics Laboratory	PCC	0	0	4	4	2
5.	MN5213	Mini Project with Seminar	EEC	0	0	2	2	1
			TOTAL	**8**	**0**	**6**	**14**	**11**

SEMESTER V

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.		Program Elective – VI	PEC	3	0	0	3	3
2.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
3.	MN5311	Dissertation – I	EEC	0	0	12	12	6
			TOTAL	**6**	**0**	**12**	**18**	**12**

SEMESTER VI

SL. No	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	MN5411	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 - 70

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PROGRAM CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1	MN5101	Modern Manufacturing Processes	PCC	3	0	0	3	3
2	MN5103	Robot Design and Programming	PCC	3	0	0	3	3
3	MN5111	Advanced Manufacturing Processes Laboratory	PCC	0	0	4	4	2
4	MN5112	Mechatronics and Robotics Laboratory	PCC	0	0	4	4	2
5	MA5101	Applied Probability and Statistics	PCC	3	1	0	4	4
6	MN5102	Materials Technology	PCC	3	0	0	3	3
7	MN5211	Modelling and Simulation Laboratory	PCC	0	0	4	4	2
8	MN5212	Automation Laboratory	PCC	0	0	4	4	2
9	MN5202	Fluid Power Automation	PCC	3	0	0	3	0
10	MN5201	Finite Element Applications in Manufacturing	PCC	4	0	0	4	4

PROGRAM ELECTIVE COURSES (PEC)

SEMESTER I, ELECTIVE – I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5001	Material Testing and Characterization	PEC	3	0	0	3	3
2.	MN5002	Computer Aided Product Design	PEC	3	0	0	3	3
3.	MN5003	Theory of Metal Forming	PEC	3	0	0	3	3
4.	MN5004	Manufacturing Process Planning and Cost Estimation	PEC	3	0	0	3	3

SEMESTER II , ELECTIVE – II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5005	Micro System Technology	PEC	3	0	0	3	3
2.	MN5073	Mechatronics in Manufacturing Systems	PEC	3	0	0	3	3
3.	MN5006	Advanced Welding Technology	PEC	3	0	0	3	3
4.	MN5074	Quality and Reliability Engineering	PEC	3	0	0	3	3

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SEMESTER II , ELECTIVE – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5007	Manufacturing Metrology	PEC	3	0	0	3	3
2.	MN5008	Metal Cutting Theory and Practice	PEC	3	0	0	3	3
3.	MN5009	Computer Integrated Manufacturing	PEC	3	0	0	3	3
4.	MN5010	Production and Operations Management	PEC	3	0	0	3	3

SEMESTER III , ELECTIVE – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5011	Processing of Polymers and Composites	PEC	3	0	0	3	3
2.	MN5072	Green Concepts	PEC	3	0	0	3	3
3.	MN5012	Manufacturing of Automotive Components	PEC	3	0	0	3	3
4.	MN5071	Financial Management	PEC	3	0	0	3	3

SEMESTER III , ELECTIVE – V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5013	Surface Engineering and Coatings	PEC	3	0	0	3	3
2.	CI5151	Solid Freeform Manufacturing	PEC	3	0	0	3	3
3.	MN5014	Advanced Casting Technology	PEC	3	0	0	3	3
4.	MS5151	Manufacturing Management	PEC	3	0	0	3	3

SEMESTER III , ELECTIVE – VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MN5015	Industrial Design And Ergonomics	PEC	3	0	0	3	3
2.	MR5072	Industry 4.0 and Internet of Things	PEC	3	0	0	3	3
3.	MN5016	Design of Manufacturing Tools, Jigs and Fixtures	PEC	3	0	0	3	3
4.	IL5071	Advanced Optimization Techniques	PEC	3	0	0	3	3

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RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	RM5151	Research Methodology and IPR	2	0	0	2	2

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.	MN5213	Mini Project with Seminar	0	0	2	1	2
2.	MN5311	Dissertation - I	0	0	12	6	3
3.	MN5411	Dissertation - II	0	0	24	12	4

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SUMMARY

M.E MANUFACTURING ENGINEERING (PART TIME)								
	Subject Area	**Credits Per Semester**						**Credits Total**
		I	II	III	IV	V	VI	
1.	FC	00	00	00	00	00	00	00
2.	PCC	09	08	06	05	00	00	28
3.	PEC	03	03	06	03	03	00	18
4.	RMC	00	00	00	02	00	00	02
5.	OEC	00	00	00	00	03	00	03
6.	EEC	00	00	00	01	06	12	19
7.	Non Credit/Audit Courses	✓	✓	00	00	00	00	00
	Total Credit	**12**	**11**	**12**	**11**	**12**	**12**	**70**

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MA5101 **APPLIED PROBABILITY AND STATISTICS** **L T P C**
3 1 0 4

OBJECTIVES:

- To understand the basics of random variables with emphasis on the standard discrete and continuous distributions.
- To introduce the concepts of sampling distributions and the test statistics.
- To provide an understanding of the statistical methods and concepts by which real life problems are analyzed.
- To analyze various datas using statistical techniques.
- To train the students in design experiments and use these concepts for research.

UNIT I PROBABILITY THEORY **12**

Random variables – probability density and distribution functions-moment generating and characteristic functions – Binomial, Poisson, Normal distributions and their applications.

UNIT II SAMPLING THEORY **12**

Sampling distributions – Standard error – t, F, Chi square distributions – applications.

UNIT III ESTIMATION THEORY **12**

Interval estimation for population mean, standard deviation, difference in means, preparation ratio of standard deviations and variances.

UNIT IV TESTING OF HYPOTHESIS AND ANOVA **12**

Hypothesis testing – Small samples – Tests concerning proportion, means, standard deviations – Tests based on chi square – and Redistribution test -Design of experiments.

UNIT V ANOVA **12**

Design of experiments – One, Two factor Models

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be

- Able to analyze the performance in terms of probabilities and distributions achieved by the determined solution.
- Aware of various test statistics for the samples.
- Able to develop an ability to apply statistical tests in experiments as well as to analyze and interpret data.
- Able to use the statistical tools for their project and future research.
- Able to use the concepts in design of experiments in real life problems.

REFERENCES:

1. Gupta and Kapoor, “Fundamentals of Applied Statistics”, Sultan Chand and sons, 4th Edition, New Delhi, 2019.
2. Hooda, “Statistics for Business and Economics”, Macmillan, 3rd Edition, India, 2003.
3. John.E.Freunds, “Mathematical statistics with applications”, Pearson Education, 8th Edition, New Delhi, 2013.
4. Levin and Rubin, “Statistics for Management”, Pearson Education India, 7th Edition, New Delhi, 2013.

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MN5101 MODERN MANUFACTURING PROCESSES L T P C
3 0 0 3

OBJECTIVES:

- To create awareness on Abrasive aided machining
- To understand electrical and electrochemical machining processes.
- To analyse the principles of high energy aided machining.
- To study the surface and bulk machining processes of silicon wafer.
- To introduce students to the major manufacture steps in electronic circuit boards.

UNIT I ABRASIVE AIDED MACHINING PROCESSES 9

Abrasive machining – water jet machining - ultrasonic machining –Abrasive flow machining- Magnetorheological Abrasive flow machining- construction working principle – steps - types – process parameters – derivations – problems, merits, demerits and applications .

UNIT II ELECTRICAL AND CHEMICAL AIDED MACHINING PROCESSES 9

Wire cut EDM - Electric discharge machining – Electrochemical machining – chemical machining – Maskants - Electrochemical grinding - construction – principle – types – control - circuits – tool design – merits, demerits and applications. Hybrid Machining.

UNIT III HIGH ENERGY AIDED MACHINING PROCESSES 9

Laser beam machining – Electron beam machining – Plasma arc machining – Ion beam machining – construction working principle types – process parameter – derivations – problems, merits, demerits and applications.

UNIT IV FABRICATION OF MICRO DEVICES 9

Semiconductors – Si wafer - planarization – Oxidation - diffusion – ion implantation – etching – metallization – bonding – surface and bulk machining – LIGA Process

UNIT V MICROFABRICATION TECHNOLOGY 9

Moulding – PCB board hybrid and MCM technology – programmable devices and ASIC – electronic material and processing– stereolithography – Solid free form fabrication -SAW devices, Surface Mount Technology

TOTAL: 45 PERIODS

OUTCOMES :

Students will be able to

CO1 : Understand and grasp the significance of modern machining process and its applications.
CO2 : Identify the selection of machining process and its parameters.
CO3 : Express and appreciate the cutting edge technologies and apply the same for research purposes.
CO4 : Measure the stages involved in fabrication of micro devices.
CO5 : Create new devices involved in micro fabrication and recent technology.

REFERENCES:

1. Brahem T. Smith, Advanced Machining I.F.S. UK 2016.
2. Jaeger R.C., Introduction to Microelectronic Fabrication Addison Wesley, 2nd Edition, 1998.
3. Jain V K, Micromanufacturing Processes, CRC Press, 2012.
4. Julian W. Gardner, Vijay K Varadan and Osama O Awadelkarim, Microsensors MEMS and Smart devices, John Willey, 2013.
5. Pandey P.C. and Shan HS Modern Machining Processes, Standard Publishing Co., 1st Edition,1980.
6. Serope Kalpakjian and Steven R. Schmid- Manufacturing Process for Engineering Material – Pearson Education, 6th Edition, 2018

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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			✓	✓					✓	✓		

MN5102 MATERIALS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To understand the elastic and plastic behaviour of materials.
- To impart knowledge on fracture analysis.
- To familiarize on modern metallic materials.
- To review on polymeric and ceramics materials and their applications.
- To enable student to select material for specific applications.

UNIT I ELASTIC AND PLASTIC BEHAVIOR 10

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

UNIT II FRACTURE BEHAVIOUR 10

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

UNIT III MODERN METALLIC MATERIALS 8

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

UNIT IV NON METALLIC MATERIALS 7

Polymeric materials – Formation of polymer structure – Production techniques of fibres, foams, adhesives and coating – structure, properties and applications of Commodity and engineering polymers – Advanced structural ceramics, WC, TIC, TaC, Al_2O_3, SiC, Si_3N_4 CBN and diamond – properties, applications as abrasives and cutting tool- Properties and applications of CNT – Graphene based Material

UNIT V SELECTION OF MATERIALS 10

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

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TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

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

REFERENCES:

1. Ashby M.F., Material Selection in Mechanical Design, 5th Edition, Butter Worth 2017.
2. ASM Hand book, Vol.11, Failure Analysis and Prevention, 10th Edition, ASM, 2002.
3. Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, 3rd edition, Butterworth-Heiremann, 2001.
4. Thomas H. Courtney, Mechanical Behaviour of Materials, 2nd edition, McGraw Hill, 2000.
5. Marc Andre, Meyers and Krishan Kumar Chawla, Mechanical Behaviour of Materials, 2nd Edition, Cambridge University Press, 2009.
6. George E.Dieter, Mechanical Metallurgy, 3rd Edition,McGraw Hill, 2014.

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

MN5103 ROBOT DESIGN AND PROGRAMMING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To gain knowledge on growth of robots since origin based on the application.
- To study the kinematics of robot.
- To study the dynamics of robot.
- To expose the students in the various programming techniques in robot and illuminate the curiosity over recent AI techniques.
- To familiarize the sensors and actuators involved in the robot based the application.

UNIT I INTRODUCTION **9**

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

UNIT II ROBOT KINEMATICS **9**

Introduction – Matrix representation Homogeneous transformation, forward and inverse – Kinematic equations, Denvit – Hartenbers representations – Inverse Kinematic relations. Fundamental

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problems with D-H representation, differential motion and velocity of frames – Jacobian, Differential Charges between frames:

UNIT III ROBOT DYNAMICS AND TRAJECTORY PLANNING 9

Lagrangeon mechanics, dynamic equations for sing, double and multiple DOF robots – static force analysis of robots, Trajectory planning – joint space, Cartesian space description and trajectory planning – third order, fifth order - Polynomial trajectory planning

UNIT IV ROBOT PROGRAMMING AND AI TECHNIQUES 9

Types of Programming – Teach Pendant programming – Basic concepts in AI techniques – Concept of knowledge representations – Expert system and its components.

UNIT V ROBOT SENSORS AND ACTUATORS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

Students will able to

CO1 : Apply their knowledge on calculation of end effector coordinate position and angle based on the application.
CO2 : Calculate force involved in the robot while under operation (i.e. gripping force).
CO3 : Compute the trajectory of robot based on both joint space and Cartesian space.
CO4 : Understand the traditional programming in robot and Modern AI Techniques.
CO5 : Identify appropriate sensors and actuators based on the application.

REFERENCES:

1. Fu K S, Gonzalez, Lee C S G, Robotics: Control, Sensing, Vision and Intelligence, McGraw-Hill *Book* Company, 1987.
2. Gordon Mair, 'Industrial Robotics', Prentice Hall U.K, 1998.
3. Groover.M.P. Industrial Robotics, McGraw – Hill International edition, 2012.
4. John J. Craig, Introduction to Robotics: Mechanics and Control, Pearson, 3rd edition, 2004.
5. Saeed.B.Niku, 'Introduction to Robotics, Analysis, system, Applications', Pearson educations, 2010.
6. Wesley E Snyder R, 'Industrial Robots, Computer Interfacing and Control', Prentice Hall International Edition, 2013.

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

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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: 30 PERIODS

COURCE 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	✓					✓						✓

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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.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

MN5111 ADVANCED MANUFACTURING PROCESSES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To understand of the various Mechanical, Chemical, Thermal and Electrical based modern machining processes through practical skill set.
- To analyse and observe the principles and its importance.
- To study the major application in manufacture of micro and macro devices.

LIST OF EXERCISES

1. Plate cutting in abrasive water jet machine
2. Micro hole drilling in ECM
3. Model fabrication in simple CNC router
4. 3D model fabrication using RPT
5. Profile cutting using WEDM
6. Ultrasonic welding
7. Ultrasonic machining
8. Ultrasonic cavitations –Stir Casting
9. Squeeze Casting
10. Incremental forming
11. Robot aided Welding

(Any 10 for Conduct of end semester examination)

OUTCOMES:

Students will be able to

CO1 : Understand and grasp the significance of modern machining process and its applications through hands-on experience.

CO2 : Identify the selection of machining processes and its process parameters.

CO3 : Express and perform project related works.

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

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MN5112 MECHATRONICS AND ROBOTICS LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To understand the various contact and non-contact measurement methods through practical skill set.
- To introduce to Vision system for quality inspection process.
- To understanding over the kinematic analysis on various robot configurations of serial manipulators
- To train students on robot programming for basic work handling operations.

LIST OF EXPERIMENTS

1. Experimentation on contact and non-contact temperature measurement
2. Experimentation on optical sensors for light measurement
3. Experimentation on LVDT based distance measurements
4. Experimentation on load cell and Strain gauge for force and weight measurements
5. Experimentation on Torque measurements
6. Experimentation on Ultrasonic non-contactdistance measurements
7. Experimentation on vibration measurements
8. Experimentation on machine vision for quality inspection
9. Embedded System
10. Modelling and simulation of basic mechanisms
11. Kinematic analysis one DOF and two DOF R, RR, P, PP configuration of serial manipulators.
12. Kinematic analysis six DOF serial manipulators
13. Trajectory planning of one DOF and two DOF R, RR, P, PP configuration of serial manipulators.
14. Trajectory planning of six DOF serial manipulators.
15. Robot programming for pick and place operation
16. Robot programming for palletizing operation

(Any 10 for Conduct of end semester examination)

OUTCOMES:

Students will be able to

CO1 : Perform contact and non-contact measurements practically.
CO2 : Work on the suitable sensors and transducers for the required application.
CO3 : Work on sophisticated Machine vision systems for quality inspection process.
CO4 : Perform kinematic analysis on various configurations of serial manipulators.
CO5 : To write robot program for basic work handling operations.

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

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MN5201 FINITE ELEMENT APPLICATIONS IN MANUFACTURING L T P C
4 0 0 4

OBJECTIVES:

- To introduce to fundamentals of finite element techniques.
- To analyse one dimensional phenomena using finite element techniques.
- To analyse 2D and 3D phenomena using finite element techniques.
- To impart knowledge about various factors, pre-processing and post-processing steps with implementation of computer in FEA.
- To impart knowledge in the area of finite element methods and its application in manufacturing.

UNIT I INTRODUCTION 12

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

UNIT II ONE DIMENSIONAL ANALYSIS 12

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

UNIT III SHAPE FUNCTIONS AND HIGHER ORDER FORMULATIONS 12

Shape functions for one and two dimensional elements- Three noded triangular and four nodded quadrilateral element Global and natural co-ordinates - Non linear analysis – Isoparametric elements – Jacobian matrices and transformations – Basics of two dimensional, plane stress, plane strain and axisymmetric analysis.

UNIT IV COMPUTER IMPLEMENTATION 12

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

UNIT V ANALYSIS OF PRODUCTION PROCESSES 12

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

TOTAL =60 PERIODS

OUTCOMES:

Students will be able to

CO1 : Perform the fundamentals of solving Finite element problems.
CO2 : Discretize and solve one-dimensional solid mechanics and heat transfer problems in FEA.
CO3 : Identify the impact of shape functions and usage of higher order formulation in converging solution to FEA problem.
CO4 : Implementation of computer on solving FEA based problems.
CO5 : Structuring a production process through FEA and control it's parameters.

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REFERENCES:

1. Amar Khennane, Introduction to Finite Element Analysis using MATLAB and Abacus, CRC Press,1st Edition, 2013.
2. Kobayashi S, Soo-ik-Oh and Altan T, Metal Forming and the Finite Element Methods, Oxford University Press,4th Edition,1989.
3. Lewis R.W. Morgan K, Thomas H.R and Seetharaman K.N, The Finite Element Method in Heat Transfer Analysis, John Wiley, 1st Edition, 1996.
4. Rao S.S, Finite Element method in engineering, Butterworth-Heinemann, 6th Edition, 2017.
5. Reddy J.N, An Introduction to the Finite Element Method, McGraw Hill,3rd Edition,2005,
6. Seshu P, Textbook of Finite Element Analysis, PHI Learning Pvt. Ltd, 2014.

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

MN5202 FLUID POWER AUTOMATION L T P C
3 0 0 3

OBJECTIVES:

- To make the students to learn the basics of hydraulics and pneumatics
- To understand and select appropriate pumps and actuators in fluid power.
- To familiarize the various controlling elements in fluid power.
- To train the students in designing the hydraulic and pneumatic circuits using various design procedures.
- To make the students to understand the various methods of control of hydraulic and pneumatic circuits.

UNIT I INTRODUCTION 9

Need for Automation,–Basics of hydraulic and pneumatic principles- applicable to pump, motor, valves and losses-ISO symbols for fluid power elements, Hydraulic and Pneumatic - Comparison – Selection criteria.

UNIT II FLUID POWER GENERATING/UTILIZING ELEMENTS 9

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

UNIT III CONTROL AND REGULATION ELEMENTS 9

Direction flow and pressure control valves-Methods of actuation, types, sizing of ports-pressure and temperature compensation, overlapped and under lapped spool valves-operating characteristics-electro hydraulic servo valves-Different types-characteristics and performance.

UNIT IV CIRCUIT DESIGN 9

Typical industrial hydraulic circuits-Design methodology – Ladder diagram-cascade method- Truth Table-Karnaugh–Veitch (KV) maps method-sequencing circuits-combinational and logic circuit.

UNIT V CONTROL OF HYDRAULIC AND PNEUMATIC CIRCUITS 9

Electrical control of pneumatic and hydraulic circuits-use of relays, timers, counters, Ladder diagram. Programmable logic control of Hydraulics Pneumatics circuits, Introduction to PLC – Architecture of PLC - ladder diagram for various circuits.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

CO1 : Understand the working principle of hydraulic and pneumatic components.
CO2 : Select and design the hydraulic and pneumatic circuits for different applications.
CO3 : Control hydraulic and pneumatic circuits for various applications.
CO4 : Solve the problems related to hydraulic and pneumatic circuits.
CO5 : Solve the problems related to fluid power applications.

REFERENCES:

1. Antony Esposito, Fluid Power Systems and control Prentice-Hall, 7th Edition, 2013
2. Bolton W, Mechatronics, Electronic control systems in Mechanical and Electrical Engineering Pearson Education,6th Edition, 2015.
3. Fitch E.C and Suryaatmadyn J.B, Introduction to Fluid Logic, McGraw Hill, 1978.
4. Jagadeesha T, hydraulics and pneumatics, I.K. International Publishing House Pvt. Limited, 2015.
5. Peter Rohner, Fluid Power Logic Circuit Design, 7th Edition, Macmillan Press, 2017.
6. Majumdar, S.R., Oil Hydraulic Systems: Principles and Maintenance,McGraw-Hill Education, 2003

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

MN5211 MODELLING AND SIMULATION LABORATORY L T P C
0 0 4 2

OBJECTIVES:

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

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LIST OF EXERCISES

1. One Dimensional FEA Problem like beam, Truss etc.
2. Two Dimensional FEA Problems like plane stress, plane strain, axisymmetric and vibration.
3. Three Dimensional FEA Problems like shell and contact.
4. FEA Application in metal forming like superplastic forming, deep drawing etc
5. FEA Application in Metal cutting
6. FEA Application in Casting process
7. 3D Modelling and Assemble of Engine
8. Modelling of Crack Shaft
9. Modelling of Connecting Rod
10. Modelling of Cotter Joint
11. Modelling of Plummer Block and Coupling

(Any 10 for Conduct of end semester examination)

OUTCOMES:

Students will be able to

CO1 : Apply the principles of Finite Element Analysis to solve problems in the field of production engineering.
CO2 : design and analyse various problems in field of manufacturing
CO3 : identify the problems and simulate using Finite element analysis
CO4 : Relate to Finite element analysis in various manufacturing applications.
CO5 : Develop skills in field of design and simulation using FEA.

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

MN5212 **AUTOMATION LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To make the students to learn the basic concepts of hydraulics and pneumatics and their controlling elements in the area of manufacturing process.
- To train the students in designing the hydraulic and pneumatic circuits using various design procedures.
- To make the students gain an experience in the field of fluid power applications.
- To gain knowledge related to fluid power elements and its control.
- To train the students to simulate various hydraulic and pneumatic circuits using software.

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LAB EXPERIMENTS:

1. Study and use of pneumatic and hydraulic elements.
2. Simulation of speed control circuits in a hydraulic trainer.
3. Simulation of hydraulic circuits in a hydraulic trainer.
4. Simulation of single and double acting cylinder circuits using different directional control values.
5. One shot and regenerative pneumatic circuits.
6. Sequencing of pneumatic circuits.
7. Simulation of Logic pneumatic circuits.
8. Simulation of electro pneumatic sequencing circuits.
9. Simulation of PLC based electro pneumatic sequencing circuits.
10. To compare the ladder diagram for electrical and PLC control for the given sequence.
11. Offline – Programming of movement sequence of Robot Configuration using simulation software.
12. Offline – manufacturing process planning for specific operation sequence graphically using simulation software.
13. Estimation of manufacturing operation time and perform line balancing
14. Virtual reality viewers using 3D CAD models for Industry 4.0.
15. Internet of things application for pilot project.

(Any 10 for Conduct of end semester examination)

OUTCOMES:

Students will be able to

CO1 : Design, model and automate simple and complicated industrial automation using hydraulics and pneumatics.
CO2 : Perform simulation for various hydraulics and pneumatics circuits.
CO3 : Design and develop circuits for various hydraulics and pneumatics applications.
CO4 : Practically experience of various hydraulic and pneumatic elements.
CO5 : Simulate various hydraulics and pneumatics circuits using software.

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

Attested

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MN5213 **MINI PROJECT WITH SEMINAR** **L T P C**
0 0 2 1

OBJECTIVES

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

A group of 2 students have to choose a problem and carry out scientific systematic investigation experimentally/ theoretically in suggestinga viable solution. At the end of the semester, each group of students have to submit a report for evaluation.

TOTAL: 30 PERIODS

OUTCOMES

Students at the end of course will be

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

MN5311 **DISSERTATION - I** **L T P C**
0 0 12 6

OBJECTIVES:

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

EVALUATION:

- A project topic may be selected based on the literature survey and the creative ideas of the students themselves in consultation with their project supervisor. The topic should be so chosen that it will improve and develop the skills to design, fabricate, analyse, test and research. Literature survey and a part of the project work be carried out in dissertation I.
- The project work is evaluated jointly by external and internal examiners constituted by the Head of the Department based on oral presentation and the project report.
- A project report for dissertation I is to be submitted at the end.
- Project work evaluation is based on the Regulations of the Credit system for the Post graduate programmes of Anna University

Attested

TOTAL: 90 PERIODS

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OUTCOMES:

CO1 : The students would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative and get trained in planning, organizing and coordination various components of dissertation work.

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

MN5311 **DISSERTATION - II** **L T P C**
0 0 24 12

OBJECTIVES:

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

EVALUATION:

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

OUTCOMES:

CO1 : The students' would apply the knowledge gained from theoretical and practical courses in solving problems, so as to give confidence to the students to be creative, well planned, organized, coordinated project outcome of the aimed work.

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

Attested

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MN5001 MATERIAL TESTING AND CHARACTERIZATION L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I MICRO AND CRYSTAL STRUCTURE ANALYSIS 9

Principles of Optical Microscopy – Specimen Preparation Techniques – Polishing and Etching – Polarization Techniques – Quantitative Metallography – Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials - Elements of Crystallography – X- ray Diffraction – Bragg's law – Techniques of X-ray Crystallography
– Debye – Scherer camera – Geiger Diffractometer – analysis of Diffraction patterns – Inter planer spacing – Identification of Crystal Structure, Elements of Electron Diffraction – Estimation of residual stress and grain size.

UNIT II ELECTRON MICROSCOPY 9

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

UNIT III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Energy dispersive and Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)- Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA) - Dynamic Mechanical Analysis (DMA)

UNIT IV MECHANICAL TESTING – STATIC TESTS 9

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

UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

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

Attested

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REFERENCES:

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

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

MN5002 COMPUTER AIDED PRODUCT DESIGN L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 8

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

UNIT II COMPUTER GRAPHICS FUNDAMENTALS AND GEOMETRIC 8

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

UNIT III PRODUCT DESIGN CONCEPTS AND PRODUCT DATA MANAGEMENT 10

Understanding customer needs – Product function modelling – Function trees and function structures – Product tear down methods – Bench marking – Product portfolio – concept generation and selection – Product Data Management – concepts – Collaborative product design– manufacturing planning factor – Customization factor – Product life cycle management.

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UNIT IV PRODUCT DESIGN TOOLS AND TECHNIQUES 10

Product modelling – types of product models; product development process tools – TRIZ – Altshuller's inventive principles – Modelling of product metrics – Design for reliability – design for manufacturability – machining, casting, and metal forming – design for assembly and disassembly - Design for environment

UNIT V PRODUCT DESIGN TECHNIQUES 9

FMEA – QFD – Poka Yoke - DOE – Taguchi method of DOE – Quality loss functions – Design for product life cycle.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the design phases and various design hardware and software.
CO2 : Relating basics of various geometrical feature creation.
CO3 : Systematically work on each stages in the development of a new product and its management.
CO4 : Predicting on various factors for various design applications.
CO5 : Mixing the techniques in the design of new product.

REFERENCES:

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

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

MN5003 THEORY OF METAL FORMING L T P C
3 0 0 3

OBJECTIVES:

- To provide knowledge on the mechanism involved in plastic deformation and parameter representation.
- Enable students to understand various bulk forming process and its recent technology.
- To provide overview of various sheet metal forming process
- To study the powder metallurgy techniques and Special metal forming processes.
- To introduce the significance of surface treatment and industrial application of metal forming

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UNIT I THEORY OF PLASTICITY 9

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

UNIT II THEORY AND PRACTICE OF BULK FORMING PROCESSES 9

Analysis of plastic deformation in Forging, Rolling, Extrusion, rod/wire drawing and tube drawing – Effect of friction – calculation of forces, work done – Process parameters, equipment used – Defects – applications – Recent advances in Forging, Rolling, Extrusion and Drawing processes – Design consideration in forming.

UNIT III SHEET METAL FORMING 9

Formability studies – Conventional processes – High energy rate forming (**HERF**) techniques – Superplastic forming techniques – Hydro forming – Stretch forming – Water hammer forming – Principles and process parameters – Advantage, Limitations and application – Incremental forming.

UNIT IV POWDER METALLURGY AND SPECIAL FORMING PROCESSES 9

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

UNIT V SURFACE TREATMENT AND METAL FORMING APPLICATIONS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

Students will able to

- **CO1 :** Understand the state of stress in metal forming process.
- **CO2 :** To identify the appropriate bulk forming process based on the application.
- **CO3 :** Understand the conventional sheet metal forming process and various high energy rate forming techniques.
- **CO4 :** Understand the powder metallurgy forming technique.
- **CO5 :** Select appropriate surface heat treatment technique.

REFERENCES:

1. Altan T, Metal forming – Fundamentals and applications – American Society of Metals, Metals park,1983.
2. Helmi A Youssef, Hassan A. El-Hofy, Manufacturing Technology: Materials, Processes and Equipment, CRC publication press, 1st Edition,2017.
3. Marciniak Z, Duncan J.L, Hu S.J, Mechanics of Sheet Metal Forming, Butterworth-Heinemann,2nd Edition, 2002.
4. Nagpal G.R, Metal Forming Processes, Khanna publishers, 2005.
5. Shiro Kobayashi, Soo-Ik-Oh-Altan T, Metal forming and Finite Element Method, Oxford University Press,1989.
6. Surender kumar, Technology of Metal Forming Processes, Prentice Hall India Publishers,1st Edition, 2008.

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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	✓	✓	✓	✓	✓							✓

MN5004 MANUFACTURING PROCESS PLANNING AND COST ESTIMATION **L T P C 3 0 0 3**

OBJECTIVES:

- To introduce the concepts of manufacturing process planning.
- To familiarize the idea of cost accounting and information.
- To develop estimation skills in estimating material and labour cost.
- To introduce concepts of depreciation and different methods of depreciation.
- To develop estimation skills in estimating cost of manufactured product such as casting, welding, forging, machining.

UNIT I PROCESS PLANNING **9**

Process planning– Aims– Information required– Techniques of process planning – Questionnaire method– Key functional analysis– preparation of processor planning operation sheets– Routing– Process selection– Break even analysis.

UNIT II COST ESTIMATION AND ACCOUNTING **9**

Cost estimation- aims and objectives - cost accounting - aims and accounting - Difference between estimation and accounting - Realistic estimation - Estimation procedure - Elements of cost - Material cost - labour cost-expenses overheads - Factory overheads - Administrative overheads – selling and distribution overheads – components of cost.

UNIT III ESTIMATION OF MATERIAL AND LABOR COST **9**

Material cost estimation – Procedure – Mensuration formulae – Estimation of material cost for different jobs of varying geometries such as casting, forging., Estimation of labour cost –set up time – Tear down time – operation time – Machining time – Time allowances – Relaxation allowances – Personnel allowances – Allowances specific

UNIT IV DEPRECIATION **9**

Depreciation – Definition – causes of depreciation – Methods of depreciation – Straight line Method – Declining balance method – sum of the years digit method – sinking fund method-Annuity method – Repair provision method.

UNIT V ESTIMATION OF COST FOR MANUFACTURING PROCESS **9**

Estimation of cost for forging, welding - Estimation of cost for foundry – Estimation of machining time for various machining operations such as Turning , Drilling, Reaming, Milling, Grinding, Boring, Shaping, Planning operations etc.,

TOTAL: 45 PERIODS

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OUTCOMES:

Students will be able to

CO1 : Design a suitable manufacturing planning sheet for a manufactured product.
CO2 : Arrive at cost of manufactured product in stages.
CO3 : Estimate material and labour cost.
CO4 : Identify a suitable method for depreciation.
CO5 : estimate cost or manufactured product such as casting, welding, forging, machined component.

REFERENCES:

1. Kesavan R, Elanchezhiyan and C, Vijayaramnath B, Process planning and cost estimation New age International, Delhi-2009
2. Narang GBS, Production and Costing – Khanna publications – 1991
3. Adithan M, Process planning and cost estimations, New age, 2007.
4. Charles T, Honegran, Srikant M Dater, Madhav V Rajan, Cost Accounting, Pearson, 2015.
5. Pannerselvam R, Sivasankaran P, Process planning and cost estimation, PHI-2016.
6. Peter Scales, Process Planning, Butterworth, 2003.

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

MN5005 **MICRO SYSTEM TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVES:

- To Provide Knowledge of Semiconductors and Solid Mechanics of MEMS Devices
- To introduce to various types of fabrication processes in MEMS Devices.
- To educate on the Rudiments of micro devices.
- To provide overview of properties and methods of nanomaterials.
- To educate on the analytical tools for imaging and characterization of MEMS.

UNIT I OVER VIEW OF MEMS AND MICROSYSTEMS 6

Definition – historical development – properties, design and fabrication micro-system, microelectronics, working principle, applications and advantages of micro system. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo-resistors, Gallium arsenide, quartz, polymers for MEMS, conductive polymers.

UNIT II FABRICATION PROCESSES AND MICRO SYSTEM PACKAGING 10

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

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UNIT III MICRO DEVICES 8

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

UNIT IV SCIENCE AND SYNTHESIS OF NANO MATERIALS 10

Classification of nano structures – Effects of nano scale dimensions on various properties – structural, thermal, chemical, magnetic, optical and electronic properties fluid dynamics –Effect of nano scale dimensions on mechanical properties - vibration, bending, fracture Nanoparticles, Sol-Gel Synthesis, Inert Gas Condensation, High energy Ball Milling, Plasma Synthesis, Electro deposition and other techniques. Synthesis of Carbon nanotubes – Solid carbon source based production techniques – Gaseous carbon source based production techniques – Diamond like carbon coating. Top down and bottom up processes.

UNIT V INSPECTION OF MICRO/NANO SYSTEMS 11

Micro/Nano-processing systems – Nano measuring systems – characterization – analytical imaging techniques – microscopy techniques, electron microscopy scanning electron microscopy, confocal LASER scanning microscopy - transmission electron microscopy, transmission electron microscopy, scanning tunnelling microscopy, atomic force microscopy, diffraction techniques – spectroscopy techniques – Raman spectroscopy, 3D surface analysis – Mechanical, Magnetic and thermal properties – Nano positioning systems.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- **CO1 :** Understand the properties of various polymers, different materials used for MEMS and working principle of MEMS.
- **CO2 :** Get knowledge about various fabrication techniques of MEMS.
- **CO3 :** Get awareness of various micro actuators and its application.
- **CO4 :** Impart the knowledge to the students about nano materials and techniques in synthesis of nano materials.
- **CO5 :** Understand the various nano measurements techniques.

REFERENCES:

1. Mahalik N P, MEMS, McGraw Hill (India), 2009
2. Marc Madou , Fundamentals of Micro fabrication, CRC Press, New York, 2011.
3. Mohamed Gad-el-Hak, MEMS Handbook, CRC press, 2006,
4. Sami Franssila, Introduction to Micro fabrication, John Wiley and sons Ltd, 2010.
5. Tai – Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata-McGraw Hill, New Delhi, 2007.
6. Waqar Ahmed and Mark J. Jackson, Emerging Nanotechnologies for Manufacturing, Elsevier Inc., 2014.

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

Attested

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MN5073 MECHATRONICS IN MANUFACTURING SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To provide overview of various electrical and electronic control techniques used in modern manufacturing systems.
- To know the basic working principle of sensors and transducers of use for manufacturing systems
- To know the basic working principle of drives and actuators of use for manufacturing systems
- To know the features, modules and interfaces of microcontrollers and microprocessors
- To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

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

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.

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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.

REFERENCES:

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

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

MN5006 ADVANCED WELDING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To provide overview of different arc and gas welding processes.
- To know various solid state and special welding processes.
- To introduce to metallurgy of welding.
- To design the weldments for various materials.
- To gain knowledge on various welding defects and inspection methods.

UNIT I ARC AND GAS WELDING PROCESSES 9

Fundamental Principles – Air Acetylene Welding, Oxyacetylene Welding, Carbon Arc Welding, Shielded Metal Arc Welding, Submerged Arc Welding, TIG and MIG Welding, Plasma Arc Welding and Electroslag Welding Processes – Advantages, Limitations and Applications - Spot Welding, Seam Welding, Projection Welding, Resistance Butt Welding, Flash Butt Welding, Percussion Welding and High Frequency Resistance Welding Processes – Advantages, Limitations and Applications – Robotic Welding

UNIT II SOLID STATE AND SPECIAL WELDING PROCESSES 9

Cold Welding, Diffusion Bonding, Explosive Welding, Ultrasonic Welding, Friction Welding, Friction Stir Welding - Forge Welding, Roll Welding and Hot Pressure Welding Processes – Advantages, Limitations and Applications - Thermit Welding, Atomic Hydrogen Welding, Electron Beam Welding, Laser Beam Welding, Friction Stir Welding, Under Water Welding, Welding Automation In Aerospace, Nuclear and Surface Transport Vehicles.

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UNIT III WELDING METALLURGY 9

Heat flow - temperature distribution-cooling rates - influence of heat input, joint geometry, plate thickness, preheat, significance of thermal severity number, Epitaxial growth - weld metal solidification - columnar structures and growth morphology effect of welding parameters - absorption of gases - gas/metal and slag/metal reactions, Phase transformations- weld CCT diagrams - carbon equivalent-preheating and post heating weldability of low alloy steels, welding of stainless steels use of Schaffler and Delong diagrams, welding of cast irons - Welding of Cu, Al, Ti and Ni alloys – processes, difficulties, microstructures, defects andremedial measures, Origin - types - process induced defects, - significance - remedial measures**,** Hot cracking - cold cracking -lamellar tearing - reheat cracking - weldability tests - effect ofmetallurgical parameters,.

UNIT IV DESIGN OF WELDMENTS 9

Type of joints, joint efficiency, factor of safety, symbols, selection of edge preparation, design considerations, types of loading, Permissible stress, allowable defects, computation of stresses in welds, weld size calculation, code requirement for statically loaded structures - Design for fluctuating and impact loading - dynamic behaviour of joints – stress, concentrations - fatigue analysis - fatigue improvement techniques - permissible stress- life prediction, Concept of stress intensity factors - LEFM and EPFM concepts - brittle fracture- transition, temperature approach - fracture toughness testing, application of fracture mechanics to fatigue Welding residual stresses - causes, occurrence, effects and measurements - thermal and mechanical relieving; types of distortion - factors affecting distortion - distortion control methods - prediction - correction, jigs, fixtures and positioners.

UNIT V WELDING DEFECTS AND INSPECTION 9

Classification of weld defects- General sources of weld defects- Arc welding defects- Weld defects in other than Arc welding processes. Resistance welding defects- Defects in Friction welding- Defects in friction stir welding - Defects in welds of other welding processes-Visual Inspection-Liquid Penetrant Inspection- Magnetic particle inspection- Ultra sonic testing(UT) Radiography testing (RT) - Eddy current testing –Thermography- Optical and Acoustical holography.

TOTAL : 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the different arc and gas welding processes.
CO2 : Know and perform solid state and special welding process.
CO3 : Understand and analyze the material structures after welding.
CO4 : Design the weldments for various materials.
CO5 : Attain the knowledge about various welding defects and inspection methods.

REFRENCES:

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6. Welding Handbook, Volume 2, 7thEdition, American Welding Society

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

Attested

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MN5074	QUALITY AND RELIABILITY ENGINEERING	L T P C 3 0 0 3

OBJECTIVES:

- To study the approaches and techniques to assess quality by statistical process control.
- To study the methodology to assess and sampling of parameters
- To introduce to experimental design and Taguchi method.
- To illustrate the students the concepts of reliability engineering tools.
- To train students the designfor reliability and maintainability.

UNIT I QUALITY AND STATISTICAL PROCESS CONTROL 8

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

UNIT II ACCEPTANCE SAMPLING 8

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

UNIT III EXPERIMENTAL DESIGN AND TAGUCHI METHOD 9

Fundamentals – factorial experiments – random design, Latin square design – Taguchi method – Loss function – experiments – S/N ratio and performance measure – Orthogonal array.

UNIT IV CONCEPT OF RELIABILITY AND DESIGN 9

Definition – reliability vs quality, reliability function – MTBF, MTTR, availability, bathtub curve – time dependent failure models – distributions – normal, Weibull, lognormal – Reliability of system and models – serial, parallel and combined configuration – Markove analysis, load sharing systems, standby systems, covariant models, static models, dynamic models.

UNIT V DESIGN FOR RELIABILITY AND MAINTAINABILITY 11

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

TOTAL: 45 PERIODS

OUTCOMES:

Student will be able to

CO1 : Understand the basic techniques of quality improvement, fundamental knowledge of statistics and probability and use control charts.
CO2 : Describe different sampling plans.
CO3 : Solve problems by various design methods.
CO4 : Acquire basic knowledge of reliability.
CO5 : Implement the concepts of reliability and maintainability.

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REFERENCES:

1. Amitava Mitra, Fundamentals of Quality Control and Improvement, 4th Edition, Pearson Education, 2016.
2. Charles E Ebling, An Introduction to Reliability and Maintainability Engineering, Tata-McGraw Hill, 2018.
3. David J Smith, Reliability, Maintainability and Risk: Practical Methods for Engineers, Butterworth 2010.
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6. Patrick D T O'Connor, Practical Reliability Engineering, 4th Edition, John-Wiley and Sons Inc, 2012.

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

MN5007 MANUFACTURING METROLOGY L T P C
3 0 0 3

OBJECTIVES:

- To instruct through basic nomenclature of metrology.
- To create awareness of tools for inspection of surface, threads and gears.
- To introduce to laser metrology and CMM.
- To introduce to machine vision and electro-optical devices.
- To impart knowledge on basic quality tools and role of metrology in quality control.

UNIT I BASICS OF METROLOGY 9

Elements of Measuring System –Accuracy – Precision and Calibration of instruments –Errors in measurement – Uncertainty in measurements – Sources and types- Illustrative problems on estimation of Uncertainty - Interchangeability – Selective assembly - Limits – Fits – Tolerances – Process capability – Terminology - Design of limit gauges – Taylor's principle - Illustrative problems- Geometric Dimensioning and Tolerancing - Linear and angular measuring instruments – Types – Principles and Applications – Types of Comparators

UNIT II SURFACE METROLOGY, INSPECTION OF THREADS AND GEARS 9

Measurement of straightness and flatness– Measurement of roundness – surface texture measurement methods– Surface texture measuring instruments- Metrology of screw threads -two wire and three wire methods -gear terminology - measurement of various elements of gears - pitch circle method, constant chord method, base tangent method

UNIT III LASER METROLOGY AND COMPUTER AIDED METROLOGY 9

Lasers in metrology - Laser micrometer - Laser interferometer–Co-ordinate measuring machines - CMM configurations – hardware components – software – Probe sensors- Errors – Environmental factors –Role of CMM in reverse engineering-Machine Vision - Basic concepts of Machine Vision System – Elements – Applications - On-line and in-process monitoring in production - Computed tomography – White light Scanners.

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UNIT IV MACHINE VISION 9

Role of metrology in quality control - Dimensions of product and service quality -The seven traditional tools of quality- Histogram – Pareto diagram – Cause and effect diagram –Flow charts –Check sheet – Scatter diagram – Quality control charts – The seven new tools of quality –Why-why analysis - Affinity diagram – Inter relationship digraph - Tree diagram - Prioritization matrix - Process decision program chart - Activity network diagram

UNIT V APPLICATION OF QUALITY CONTROL IN MANUFACTURING 9

Need for quality management system –– ISO 9001 and other management system and models **-** Benchmarking - Continuous process improvement – PDCA cycle - 5s - Kaizen Quality Function Deployment (QFD) – Taguchi method – Total Productive Maintenance - Failure mode and effect analysis – Six sigma

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the basic definitions of metrology.
CO2 : Know the advance working principles of modern measurement systems
CO3 : Get knowledge in selection of various quality tools for proper application.
CO4 : Apply the machine vision techniques in measurements.
CO5 : Know the basics of quality management system (ISO), six sigma tools.

REFERENCES:

1. Connie Dotson, Ronger Harlow, Richard L Thompson, “Fundamentals of Dimensional Metrology”, Thomson Delmar Learning, 4th edition, 2011.
2. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Indian,Revised 3rdEdition,2013.
3. Gayler G.N. and Shotbolt C.R., “Metrology for Engineers”,ELBS, 5thEdition, 2000.
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5. J.F.W. Galyer, Charles Reginald Shotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th revised edition, 1990.
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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	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓

Attested

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MN5008 **METAL CUTTING THEORY AND PRACTICE** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce to types of tool, wear and tool life in metal cutting process.
- To understand the mechanisms of metal removal in metal cutting operations.
- To understand the process of heat generation during metal cutting process and knowledge about various cutting fluids and its properties.
- To train students on identifying the machining parameters.
- To familiarize the various types of cutting tool materials.

UNIT I TOOL NOMENCLATURE, TOOL WEAR AND TOOL LIFE 9

Nomenclature of single point cutting tool and nomenclature of multi point cutting tools – Twist Drill – milling cutter – Tool geometry - Mechanisms of tool wear – Abrasion – Adhesion – Diffusion – Types of tool wear – flank wear – crater wear – Tool life – Tool life equations - factors affecting tool life – Illustrative problems-observation made in the cutting of metals-basic mechanism of chip formation-thin and thick zone modes-types of chips-chip breaker-orthogonal Vs oblique cutting-force velocity relationship for shear plane angle in orthogonal cutting-energy consideration in machining-review of Merchant, Lee and Shafter theories-critical comparison.

UNIT II MECHANICS OF METAL CUTTING 9

Types of chips – Continuous chips – Discontinuous chips – continuous chips with BUE – Mechanism of chip formation- Chip thickness ratio - Orthogonal cutting – Oblique cutting - Merchant circle diagram – Force relationships - shear angle - shear stress - shear strain – velocity relationships – Illustrative Problems

UNIT III THERMAL ASPECTS AND CUTTING FLUIDS 9

Sources of heat generation in metal cutting- Experimental determination of tool temperatures – Tool – work piece thermocouple- embedded thermocouple – Infrared photographic technique- Cutting fluid – properties – types of cutting fluids – Selection of cutting fluids.

UNIT IV MACHINING PARAMETERS AND RELATED QUANTITIES 9

Machining parameters and related quantities to various metal cutting operations – turning, drilling, reaming, boring, milling, broaching, thread cutting, grinding, fine finishing processes and gear cutting.

UNIT V CUTTING TOOL MATERIALS 9

Types of motions in machining – Desirable properties of tool materials – Characteristics of cutting tool materials – High carbon steel, High speed steel, cast alloys, carbides, ceramics, Diamond and CBN tools- coating of tools – bits and inserts - Need for rational approach to the problem of cutting materials - Machinability

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Evaluate the tool wear and tool life for various type of cutting tools (single point, multi - point etc.)

CO2 : Calculate various mechanics (cutting force relationships) during metal cutting operations.

CO3 : Determine the tool temperature and heat generation during cutting operation using various measurement techniques and also select optimal cutting fluid based on the application.

CO4 : Select the machining parameters for various machining operations.

CO5 : Get knowledge of various recent cutting tool materials and its properties to aid them in the selection of efficient tool material for the machining process.

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REFERENCES

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2. Boothroid D.G and Knight W.A., Fundamentals of machining and machine tools, Marcel Dekker, New York, 1989.
3. Juneja B.L, Sekhan G.S and Nitin Seth, "Fundamentals of metal cutting and machine tools", New Age International Publishers, 2012.
4. Nagpal G.R, "Machine Tool Engineering", Khanna Publishers, 2011.
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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	✓	✓	✓	✓	✓		✓		✓			✓

MN5009 COMPUTER INTEGRATED MANUFACTURING L T P C
3 0 0 3

OBJECTIVES:

- To provide the overview of evolution of automation and CIM.
- To understand the various Automation tools include various material handling system and its Principles.
- To train students to apply group technology and FMS.
- To familiarize the computer aided process planning in manufacturing.
- To introduce to basics of data transaction, information integration and control of CIM.

UNIT I INTRODUCTION 6

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – Impact of CIM on personnel – CIM status.

UNIT II AUTOMATED MANUFACTURING SYSTEMS 10

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types of vehicles and AGVs applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance – smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing

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UNIT III GROUP TECHNOLOGY AND FMS 10

Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS ─ FMS applications, Benefits.

UNIT IV PROCESS PLANNING 10

Process planning – Activities in process planning, Informations required. From design to process planning – classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning.

UNIT V TYPES OF PROCESS CONTROL AND AUTOMATIC DATA CAPTURE 9

Introduction to process model formulation – linear feed back control systems – Optimal control – Adaptive control –Sequence control and PLC. Computer process control – Computer process interface – Interface hardware – Computer process monitoring – Direct digital control and Supervisory computer control - Overview of Automatic identification methods – Bar code technology – Other Automatic data capture technologies.

TOTAL : 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the basics of computer aided engineering.
CO2 : Choose appropriate automotive tools and material handling systems.
CO3 : Understand the overview of group technology, FMS and automation identification methods.
CO4 : Design using computer aided process planning for manufacturing of various components
CO5 : Acquire knowledge in computer process control techniques.

REFERENCES:

1. Alavudeen and Venkateshwaran, Computer Integrated Manufacturing‖, PHI Learning Pvt. Ltd., New Delhi, 2013.
2. Gideon Halevi and Ronald D. Weill, Principles of Process Planning‖, Chapman Hall, 1995.
3. James A. Retrg, Herry W. Kraebber, Computer Integrated Manufacturing‖, Pearson Education, Asia,3rdEdition,2004.
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5. Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.
6. Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016.

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

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MN5010 PRODUCTION AND OPERATIONS MANAGEMENT L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I FORECASTING 9

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

UNIT II SCHEDULING AND SEQUENCING 9

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

UNIT III INVENTORY 9

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

UNIT IV PROJECT MANAGEMENT 9

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

UNIT V PLANT ENGINEERING AND WORK STUDY 9

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

TOTAL : 45 PERIODS

OUTCOMES:

Students will be able to

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

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REFERENCES:

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

MN5011 PROCESSING OF POLYMERS AND COMPOSITES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the various processing methods of polymers.
- To enlighten the students about the different types of fibres and matrix materials.
- To analyse the different polymer matrix composites processing methods and their applications.
- To expose the students to the various metal matrix composite processing methods.
- To analyse the various processing techniques of various ceramic matrix composites.

UNIT I PROCESSING OF POLYMERS 9

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

UNIT II FIBRES AND MATRIX MATERIALS 9

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

UNIT III PROCESSING OF POLYMER MATRIX COMPOSITES 9

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

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UNIT IV PROCESSING OF METAL MATRIX COMPOSITES 9

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

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

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process – in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel – interfaces in CMCs – mechanical properties and applications of CMCs – Carbon-carbon Composites – applications.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Get knowledge on various processing methods of polymers.
CO2 : Get knowledge about various types of fibres and matrix materials.
CO3 : Understand the various polymer matrix composites processing methods.
CO4 : Analyse the various processing methods of metal matrix composites.
CO5 : Analyse the various processing techniques of ceramic matrix composites.

REFERENCES:

1. Harold Belofsky, Plastics, Product Design and Process Engineering, Hanser Publishers, 2002.
2. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009.
3. Krishan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012.
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5. Mallick P.K., Fibre Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010.
6. Seamour E.B, Modern Plastics Technology, Prentice Hall, 2002

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

MN5072 GREEN CONCEPTS L T P C
3 0 0 3

OBJECTIVES

- To impart knowledge about air pollution and its effects on the environment.
- To enlighten the students with knowledge about noise and its effects on the environment.
- To enlighten the students with knowledge about water pollution and its effects on the environment.
- To impart the knowledge of fire safety and its production.
- To impart the knowledge about the need, procedure and benefits of Green-Co rating.

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UNIT I AIR POLLUTION SAMPLING AND MEASUREMENT 9

Primary and Secondary Pollutants, Automobile Pollutants, Industrial Pollution, Ambient air quality Standards, Metrological aspects of air Pollution, Temperature lapse Rates and Stability-wind velocity and turbulence-Pump behaviour dispersion of air Pollutants-solution to the atmosphere dispersion equation-the Gaussian Plume Model, Air pollution sampling-collection of gaseous air pollutants collection of particulate pollutants-stock sampling, analysis of air pollutants-sulphur dioxide-nitrogen dioxide, carbon monoxide, oxidants and ozone

UNIT II NOISE POLLUTION AND CONTROL 9

Frequency and Sound Levels, Units of Noise based power radio, contours of Loudness. Effect of human, Environment and properties, Natural and Anthrogenic Noise Sources, Measuring Instruments for frequency and Noise levels, Masking of sound, Types, Kinetics, Selection of different reactors used for waste treatment, Treatment of noise at source, Path and Reception, Sources of noise, Effects of noise-Occupational Health hazards, thermal Comforts, Heat Island Effects, Radiation Effects.

UNIT III WATER DEMAND AND WATER QUALITY 9

Factors affecting consumption, Variation, Contaminants in water, Nitrates, Fluorides, Detergents, taste and odour, Radio activity in water, Criteria, for different impurities in water for portable and non portable use, Point and non-point Source of pollution, Major pollutants of Water, Water Quality Requirement for different uses, Global water crisis issues.

UNIT IV FIRE SAFETY 9

Basic Elements, Causes, Industrial Fires, Explosions, Effects on Environmental, Property and Human Loss, Prevention technique, Building Design, Fire Protection System, contingency plan, Emergency preparedness, Evacuation.

UNIT V GREEN CO-RATING 9

Ecological footprint, Need for Green Co-rating systems, Intent, System approach, Weightage, Assessment Process, types of ratings, Green Co-Benefits, Case studies of Green Co-Rating.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand manufacturing processes towards minimization or prevention of air pollution.
CO2 : Understand manufacturing processes towards minimization or prevention of noise pollution.
CO3 : Understand manufacturing processes towards minimization or prevention of water pollution.
CO4 : Presenting the knowledge of fire safety and its production.
CO5 : Predicting green co-rating and its benefits.

REFERENCES:

1. Dornfield David, Green Manufacturing, Springer, 2013
2. Davim J Paulo, Green Manufacturing Processes and Systems, Springer, 2013
3. Cairncrss and Francis – Costing the earth – Harvard Business School Press – 2009
4. World Commission on Environment and Development (WCED), Our Common Future, Oxford University Press 2005.
5. Green Co Case Study Booklet, CII – Sohrabji Godrej Green Business Centre, 2015.

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

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MN5012	MANUFACTURING OF AUTOMOTIVE COMPONENTS	L T P C 3 0 0 3

OBJECTIVES:

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

UNIT I MATERIAL NEEDS IN AUTOMOBILE 9

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

UNIT II MATERIALS AND TECHNOLOGIES FOR AUTOMOBILE 8

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

UNIT III MANUFACTURING OF PISTON, VALVES AND BATTERY PARTS 10

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

UNIT IV MANUFACTURING OF ENGINE BLOCK, CABLES AND LOCKS 8

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

UNIT V MANUFACTURING OF TRANSMISSION PARTS 10

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

TOTAL: 45 PERIODS

OUTCOMES:

The students will

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

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REFERENCES:

1. Ahmed Elmarkkbi, Advanced Composite Materials for Automotive Applications, Wiley publications, 2014.
2. Brian Cartor, Patric Grant, Automotive Engineering Light Weight, Functional and Novel materials, Taylor and Francis, CRC Press, 2008.
3. Gupta K.M, Automobile Engineering Vol.I and II, Umesh Publishers, 2000.
4. Joao Paulo Carmo, New Advances in Vehicular Technology and Automotive Engineering, JanezaTrdine publisher, 2012.
5. Kirpal Singh, Automobile Engineering, Vol.I and II, Standard Publishers, New Delhi, 1997.
6. Ramalingam K K, Automobile Engineering: Theory and Practice, 2nd Edition, Scitech Publications (India), 2001.

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

MN5071 **FINANCIAL MANAGEMENT** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the concepts of financial accounting.
- To introduce the various functions of financial management to handle higher level financial decisions.
- To gain the knowledge about concepts of financial and various budgeting and cost accounting.
- To develop the knowledge in the field of capital budgeting and cost accounting.
- To gain the knowledge about financial management techniques to make a profit.

UNIT I FINANCIAL ACCOUNTING **9**

Accounting concepts – Business transaction – Assets- Viabilities – Roumers equity-Assets – types – Financial statements – Income statement – Balance sheets – sources of finance – Internal sources – External sources – Equity capital – Dept capital .

UNIT II FINANCIAL MANAGEMENT **9**

Functions of finance department – Purpose of finance – capital – Types – Working Capital – Sources of working capital – Working capital management – Grow working capital – Net working capital – Operating cycle – Working capital financing policy – cash management – Management of accounts relievable – Inventory pricing – Dividend policy – capital structure .

UNIT III CAPITAL BUDGETING **9**

Evaluation of alternate investment criteria – Methods of capital budgeting – Pay Back Method – Accounting rate of return method – Present value method – Benefit cost ratio- Net Benefit cost ratio – Internal rate of return – Cost of capital – Determination of interest rate .

UNIT IV COST ACCOUNTING 9

Cost accounting and cost estimation – Difference – Aims and objectives of cost estimation and cost accounting – Elements of cost – Components of cost – Estimation of material cost - labor cost – Overheads – Types - Factory overheads - Administrative overheads – selling overheads - Distribution overheads – Fixed overheads and Fluctuating overheads.

UNIT V DEPRECIATION AND PROFIT PLANNING 9

Depreciation – causes of depreciation - Methods of depreciation – Straight line method Declining balance method – sum of the years digit method – sinking fund method- Annuity method – Repair provision method – Profit planning – Fixed cost – Variable cost – Selling price – Breakeven analysis – Breakeven volume – Angle of Incidence – Margin of safety - Multiproduct Breakeven analysis – Effect of changes in Selling price , Fixed cost , Variable cost on Breakeven volume , Margin of safety , angle Incidence.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Train in various functions of finance such as working capital management, current assets managements to make investment decisions.
CO2 : Handle the highest level financial decisions.
CO3 : Work in a capital financing policy and handle the cash management.
CO4 : Perform the various method in capital budgeting, understand and analyse different costs involved in financial managements.
CO5 : Make investment decisions when they take up senior managerial position.

REFERENCES:

1. Prasanna Chandra, Financial Management, Tata McGraw Hill(India), 9th edition 2018.
2. Narang G.B.S, Production and Costing, Khanna Publishers, 2005.
3. Kesavan R, Elanchezian C and Vijaramnath B, Engineering Economics and Cost Analysis, Anuradha Publications, 3rd Edition – 2012
4. Khan MY, Jain P K, Basic Financial Management, McGraw Hill,7th Edition,2014.
5. James C, Van Home, Fundamentals of Financial Management, Prentice hall, 1989.
6. Rodney D Stewart, Cost Estimation, Wiley, 1991.

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

MN5013 SURFACE ENGINEERING AND COATINGS L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on friction.
- To understand wear and measurement methods.
- To understand corrosion and combating methods.
- To learn various techniques to cure corrosion, wear and friction using surface treatments.
- To familiarize the real friction, wear and corrosion combating methods.

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UNIT I FRICTION 7

Topography of Surfaces – Surface features – Properties and measurement – Surface interaction – Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and non-metallic materials – Friction in extreme conditions – Thermal considerations in sliding contact

UNIT II WEAR 6

Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and non metals - International standards in friction and wear measurements

UNIT III CORROSION 10

Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors

UNIT IV SURFACE TREATMENTS 12

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings

UNIT V CASE STUDIES ON TRIBOLOGY AND CORROSION 10

Bio-fouling, Tribology and corrosion applicable in biomedical implants, Nano Tribology –electronic devices, hot corrosion in power plants – corrosion in nuclear industry –Machining through controlled Wear and corrosion.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Understand the surface engineering and surface modification methods that will come in handy to solve the industrial problems.

CO2 : Examining related to various materials failure due to friction, wear and corrosion.

CO3 : Predicting the surface problems and select a suitable surface treatment.

CO4 : Integrating case studies in various applications related to surface engineering.

CO5 : Learn various process and techniques developed for surface treatment.

REFERENCES:

1. Basu S K, Sengupta S N and Ahuja B.B, Fundamentals of Tribology, Prentice –Hall of India Pvt Ltd , New Delhi,1st Edition,2010.
2. Halling J (Editor), “Principles of Tribology“, Macmillian – 1991.
3. Rabinowicz E, “Friction and Wear of materials”, John Willey and Sons, UK, 2013.
4. Stachowiak G W and Batchelor A W , “Engineering Tribology”, Butterworth-Heinemann, UK, 4th edition 2014.
5. Williams J.A, “Engineering Tribology”, Oxford Univ. Press, 2005.

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

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

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

REFERENCES:

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.

MN5014 ADVANCED CASTING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES:

- To gain the knowledge about principles of foundry
- To gain the knowledge about principles of casting technology
- To gain the knowledge about principles of Moulding technology.
- To familiarize the casting of ferrous and non ferrous alloys
- To know the advanced casting technology.

UNIT I PATTERN MAKING, MOULDING AND CORE MAKING 9

Pattern materials-Pattern allowances-Pattern layout, pattern making – Moulding sands – Ingredients – Specification and testing of moulding sands – classification of moulding sands –Sand conditioning –Characteristics of cores and core sands – types of cores

UNIT II SOLIDIFICATION AND GATING 9

Solidification principles – planar and dendritic solidification – constitutional super cooling - Freezing of a pure metal –Freezing of alloys – Properties related to freezing mechanism- Directional solidification – progressive solidification - Gates and risers-their functions – types-design principles, design of gating and riser - illustrative problems in riser and gating design-

UNIT III MOULDING METHODS AND QUALITY CONTROL 9

Green sand moulding-dry sand moulding-CO2 moulding-no bake moulding- shell moulding, investment casting- permanent moulding-die casting - centrifugal casting-continuous casting-Defects in casting – Inspection and testing of castings – fettling and heat treatment of castings

UNIT IV CASTING OF FERROUS AND NON FERROUS ALLOYS 9

Melting equipment for foundries – Types of furnaces – Refractories for melting units -Casting of Aluminium, Magnesium, Copper and their alloys – Casting of steel, cast iron and gray iron

UNIT V ADVANCES IN CASTING 9

Rheocasting - Thixo casting - magnetic moulding - Impulse moulding- high pressure moulding – Stir casting - Squeeze casting – Application of ultrasonic cavitations to develop composites - mechanization and automation of foundries –Application of computers in foundries- product design and analysis- casting design and simulation – software packages for foundry use- pollution control in foundries – energy saving in foundries.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1 : Imply the techniques to make the pattern, core and moulding.
CO2 : Evaluate the process parameters involved in casting processes.
CO3 : Identify the appropriate casting techniques for various materials.
CO4 : Know about various equipments and furnaces used in casting process.
CO5 : Grasp the significance of advanced casting process and its applications.

REFERENCES

1. ASM Metals Hand Book, Vol 15, “Casting" ASM International, 9th Edition, 2008.
2. Beeley P R, "Foundry Technology", Butterworths, London, 2nd Edition, 2001.
3. Heine R W, Loper C R,Rosenthal P C "Principles of Metal Casting", Tata McGraw Hill, New Delhi, 2012.
4. Jain P L, “Principles of Foundry Technology", Tata McGraw Hill, New Delhi, 5th Edition, 2007.
5. Ramana Rao T V, “Metal Casting: Principles and Practice", New Age International Publishers, New Delhi, 2006.
6. Srinivasan N K,"Foundry Engineering", Khanna Tech Publishers, New Delhi, 1994.

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

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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

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

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
5. Lee. J. Krajewski, L. P. Ritzman, & M. K. Malhothra, "Operations Management – Process and Value Chains", 8th Edition, PHI/Pearson Education, 2007.
6. MelnykDenzler, "Operations Management – A Value Driven Approach", Irwin McGraw Hill 1996.
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)															

MN5015 INDUSTRIAL DESIGN AND ERGONOMICS L T P C
3 0 0 3

OBJECTIVES

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

UNIT I INTRODUCTION 9

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

UNIT II ERGONOMICS AND PRODUCTION 9

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

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UNIT III DESIGN PRINCIPLES FOR DISPLAY AND CONTROLS 9

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

UNIT IV ENVIRONMENTAL FACTORS 9

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

UNIT V AESTHETIC CONCEPTS 9

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

OUTCOMES

Students at the end of course will be able to

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

REFERENCES

1. Benjamin W.Niebel, Motion and Time Study, Richard, D. Irwin Inc., 7th Edition, 2002
2. Brain Shakel,"Applied Ergonomics Hand Book", Butterworth Scientific London 1988.
3. Bridger, R.C., Introduction to Ergonomics, 2nd Edition, 2003, McGraw Hill Publications.
4. Martin Helander, A Guide to human factors and Ergonomics, Taylor and Francis, 2006
5. Mayall W.H. "Industrial design for Engineers", London Hiffee books Ltd., 1988.
6. Sanders and McCormick, Human factor Engineering and Design McGraw Hill Publications, 1993.

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

Attested

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MR5072 **INDUSTRY 4.0 AND INTERNET OF THINGS** **L T P C**
3 0 0 3

COURSE OBJECTIVES

- To introduce and familiarize the industry 4.0 and its physical structure and inter-connectivity.
- To understand the architecture, IOT and its protocols
- To outline the cloud computing and data analytics
- To familiar the concepts of integrated IOT.
- To learn the IOT, cloud computing, data analytics and Industry 4.0

UNIT - I INDUSTRY 4.O **10**

Digitalization and the Networked Economy - Introduction to Industry 4.0 - Comparison of Industry 4.0 Factory and Today's Factory - Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Smart Devices and Products - Smart Logistics - Support System for Industry 4.0 - Cyber-physical Systems Requirements - Data as a New Resource for Organizations - Cloud Computing - Trends of Industrial Big Data and Predictive Analytics for Smart Business- Architecture of Industry 4.0.

UNIT - II IOT AND ITS PROTOCOLS **8**

Definitions and Functional Requirements – Motivation – Architecture - Web 3.0 View of IoT – Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit approach for End - User Participation in the Internet of Things. Middleware for IoT: Overview – Communication Middleware for IoT – IoT Information Security. IIoT Reference Architecture - Designing Industrial Internet Systems - Access Network Technology and Protocols Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BAC Net Protocol – Modbus –KNX – Zigbee Architecture – Network layer APS layer – Security.

UNIT - III CLOUD COMPUTING **10**

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT – Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture and Data Analytics

UNIT - VI INTEGRATED IOT **9**

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things - Network Dynamics: Population Models – Information Cascades - Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small - World Phenomenon

UNIT - V APPLICATIONS **8**

The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments - Resource Management in the Internet of Things: Clustering, Synchronization and Software Agents - Industry 4.0 in Car Manufacturing – Electronics Manufacturing – IOT Based Building Automation - Agricultural Automation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1: Realize the need of industry 4.0 and its inter-connectivity.
CO2: Interpret the architecture of IOT and its protocols
CO3: Recognize the uses of cloud computing and data analytics
CO4: Familiar the concepts of integrated IOT.
CO5: Plan the uses of IOT, cloud computing, data analytics and Industry 4.0 technologies.

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COURSE OUTCOMES COs	Programme Outcomes											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	√										√	√
2		√	√	√							√	√
3		√	√	√	√						√	√
4		√	√	√	√						√	√
5	√	√	√	√	√		√				√	√

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4. Giovanni De Micheli and Luca Benini, "Networks on Chips: Technology and Tools", Morgan Kaufmann, 2006.
5. Kiran Kumar Pabbathi, “Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0”, Createspace Independent Publishing Platform, 2018.
6. Natalie Enright Jerger and Li Shiuan Peh, “On-Chip Networks, Synthesis Lectures on Computer Architecture”, Morgan and Claypool Publishers, 2009.
7. William James Dally and Brian Towles, "Principles and Practices of Interconnection Networks", Morgan Kaufmann, 2004.

MN5016 DESIGN OF MANUFACTURING TOOLS, JIGS AND FIXTURES **L T P C 3 0 0 3**

OBJECTIVES

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

UNIT I INTRODUCTION **9**

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

UNIT II DESIGN OF CUTTING AND METROLOGY TOOLS **9**

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

UNIT III DESIGN OF PRESS TOOLS 9

Design of Press-working Tools: Power presses, Cutting operations, Types of die-cutting operations - and their design, Evolution of blanking and progressive blanking. Design of Sheet Metal Bending, Forming and Drawing Dies: Introduction, Bending dies, Forming dies, and Drawing dies. Evolution of a draw die, Progressive dies. Strip development for progressive dies, Examples of progressive dies. Extrusion dies, Drop forging dies and auxiliary tools.

UNIT IV DESIGN OF CLAMPS LOCATING METHODS AND FIXTURES 9

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

UNIT V DESIGN OF JIGS AND TOOL GUIDES 9

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

OUTCOMES

Students at the end of course will be able to

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

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1. Cyril Donaldson, Lecain, G.H. and Goold, V.C. Tool Design , 4th editions, TMH Publishing Co Ltd., New Delhi, 2012.
2. Donaldson, Lecain And Goold “Tool Design”, 3rdEdition, Tata McGraw Hill, 2000.
3. Hoffman “Jigs And Fixture Design”, Thomson Delmar Learning, Singapore, 2004.
4. Joshi, P.H. “Jigs And Fixtures”, 2ndEdition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
5. Kempster, “Jigs And Fixture Design”, 3rd Edition, Hoddes And Stoughton, 1974.
6. Nagpal, G.R., “Tool Engineering and Design”, 6th edition, Khanna Publishers, , 2009.
7. Venkataraman. K., “Design Of Jigs Fixtures and Press Tools”, Tata McGraw Hill, New Delhi, 2005.

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

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

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

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

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

Attested

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REFERENCES:

1. Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc. 1995.
2. Kalymanoy Deb, “Optimization for Engineering Design”, PHI, 2003
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.

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.

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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.

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.

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TOTAL: 45 PERIODS

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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:

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6. A. Ohri, “R for Business Analytics”, Springer, 2012
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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

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

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

Attested

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UNIT I INTRODUCTION TO COSTING CONCEPTS 9

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

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

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

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

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

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

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

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

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

TOTAL: 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

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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.

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				✓	✓		✓					

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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

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

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

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

UNIT II BIOMASS PYROLYSIS 9

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

UNIT III BIOMASS GASIFICATION 9

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

UNIT IV BIOMASS COMBUSTION 9

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

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

Attested

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	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.

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

Attested

TOTAL: 30 PERIODS

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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
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												✓

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.

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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 THEMATIC OVERVIEW

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

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

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

UNIT IV PROFESSIONAL DEVELOPMENT

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

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

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

Attested

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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

Attested

TOTAL: 30 PERIODS

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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.