SETHU INSTITUTE OF TECHNOLOGY
(An Autonomous Institution)
Pulloor, Kariapatti, Virudhunagar (Dist.) -Pin: 626 115.

Department of Mechanical Engineering
(Accredited by NBA, New Delhi)

(Approved Research Centre by Anna University, Chennai)

M.E. CAD/CAM

REGULATION 2019

Choice Based Credit System

CURRICULUM AND SYLLABUS

SETHU INSTITUTE OF TECHNOLOGY
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M.E. CAD/CAM

Department Vision statement

- To promote excellence in education and research in mechanical engineering for the benefits of industry and society.

Department Mission Statement

1. To provide quality technical educational experience to enable the graduates to become leaders in their chosen profession.
2. To educate through modern teaching tools and experiential learning to produce proficient engineer.
3. To develop skills in recent technological trends and design software and to facilitate various co-curricular activities to enhance employability and entrepreneurship.
4. To establish collaboration with industries for transfer of technical knowledge.
5. To promote research activities among faculty members and students.
   To offer beneficial services to the society.

PROGRAM OUTCOMES (POs): Post graduates in engineering will be able to:	
1.	Independently carry out research /investigation and development work to solve practical problems.
2.	Write and present a substantial technical report/document
3.	Demonstrate a degree of mastery over the area as per the specialization of the program, higher than the requirements in the appropriate bachelor program.
4.	Apply appropriate techniques, resources, modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of the limitations
5.	Engage in life-long learning with continuous enthusiasm and commitment to improve knowledge and competence.
6.	Act with ethical responsibility in professional practices to contribute for the sustainable development of the society.

Program Educational Objectives (PEOs)

After few years of graduation our Mechanical Engineering graduates are expected to:
To instill knowledge to students in current developments in the Computer Aided Design and Manufacturing to enlighten them to succeed in Manufacturing engineering and research related professions.
To develop design and analysis skills of the students in order to provide the solutions for the problems facing in modern manufacturing industries.
To inculcate students about professional ethics, effective communication skills and team work abilities to meet the global standards with social responsibility.

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M.E. CAD/CAM

REGULATION 2019 - OVERALL COURSE STRUCTURE

Code	Category	Total No. of Courses	Credits	Percentage
PCC	Professional Core Courses (Including Lab Courses)	8	20	29
PEC	Professional Electives Courses	5	15	22
OEC	Open Electives Courses	1	3	4
PW	Project Work & Seminar	3	29	41
MCC	Mandatory Credit Courses	1	3	4
AC	Audit Courses	2	Pass/ Fail	-
	TOTAL	**20**	**70**	**100**

COURSE CREDITS – SEMESTER WISE

Semester	I	II	III	IV	TOTAL
Credits	16	16	22	16	70

SEMESTER – I

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PCC	19PCD101	Computer Applications in Design	3	0	0	3	45
2.	PCC	19PCD102	Advanced Finite Element Analysis	3	0	0	3	45
3.	PEC	E1	Professional Elective – I	3	0	0	3	45
PRACTICAL								
4.	PCC	19PCD103	CAD Laboratory	0	0	4	2	60
5.	PCC	19PCD104	Computer Aided Engineering Laboratory	0	0	4	2	60
AUDIT COURSE								
6.	AC	19PGM801	Pedagogy Studies	2	0	0	P/F	30
MANDATORY								
7.	MCC	19PGM701	Research Methodology and IPR	3	0	0	3	45
			TOTAL	**14**	**0**	**8**	**16**	
							Total No of Credits – 16	

SEMESTER – II

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PCC	19PCD201	Design for Manufacture, Assembly and Environments	3	0	0	3	45
2.	PCC	19PCD202	Applied Materials Engineering	3	0	0	3	45
3.	PEC	E2	Professional Elective – II	3	0	0	3	45
PRACTICAL								
4.	PCC	19PCD203	CAM Laboratory	0	0	4	2	60
5.	PCC	19PCD204	Advanced Analysis and Simulation Laboratory	0	0	4	2	60
6.	PW	19PCD205	Mini project with Seminar	0	0	6	3	90
AUDIT COURSE								
7.	MCC	19PGM802	English for Research Paper Writing	2	0	0	0	45
			TOTAL	**11**	**0**	**14**	**16**	
							Total No of Credits = 16	

SEMESTER – III

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PEC	E3	Professional Elective – I	3	0	0	3	45
2.	PEC	E4	Professional Elective – I	3	0	0	3	45
3.	PEC	E5	Professional Elective – I	3	0	0	3	45
4.	OEC	OE	Open Elective – I	3	0	0	3	45
PRACTICAL								
5.	PW	19PCD301	Project Work I	0	0	20	10	300
			TOTAL	**12**	**0**	**20**	**22**	
							Total No of Credits – 22	

SEMESTER – IV

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
PRACTICAL								
1.	PW	19PCD401	Project Work II	0	0	32	16	480
			TOTAL	**0**	**0**	**24**	**12**	
							Total No of Credits – 12	

PROFESSIONAL ELECTIVE COURSES:

S.No	Course Code	Course Title	L	T	P	C
1.	19PCD501	Mechatronics in Manufacturing Systems	3	0	0	3
2.	19PCD502	Tribology in Design	3	0	0	3
3.	19PCD503	Design of Hydraulic and Pneumatic Systems	3	0	0	3
4.	19PCD504	Data Communication in CAD/CAM	3	0	0	3
5.	19PCD505	Performance Modeling and Analysis of Manufacturing System	3	0	0	3
6.	19PCD506	Optimization Techniques in Design	3	0	0	3
7.	19PCD507	Industrial Safety Management	3	0	0	3
8.	19PCD508	Integrated manufacturing system	3	0	0	3
9.	19PCD509	Vibration Analysis and Control	3	0	0	3
10.	19PCD510	Metrology and Non Destructive Testing	3	0	0	3
11.	19PCD511	Advanced Mechanics of Materials	3	0	0	3
12.	19PCD512	Design of Material Handling Equipments	3	0	0	3
13.	19PCD513	Advanced Tool Design	3	0	0	3
14.	19PCD514	Mechanisms Design and Simulation	3	0	0	3
15.	19PCD515	Computational Fluid Dynamics in Manufacturing	3	0	0	3
16.	19PCD516	Reliability Engineering Models	3	0	0	3
17.	19PCD517	Maintenance Engineering and Management	3	0	0	3
18.	19PCD518	Industrial Robotics and Expert Systems	3	0	0	3
19.	19PCD519	Lean Manufacturing	3	0	0	3
20.	19PCD520	Design for Cellular Manufacturing Systems	3	0	0	3
21.	19PCD521	Integrated Product Design And Processes	3	0	0	3
22	19PCD522	Additive Manufacturing	3	0	0	3

LIST OF OPEN ELECTIVES – ODD AND EVEN SEMESTER

S. No.	Course Code	Course Name	Semester
1.	19PCD601	Industrial Safety	ODD

AUDIT COURSES

S. No.	Course Code	Course Title	L	T	P	C
1.	19PGM801	Pedagogy Studies	2	0	0	P/F
2.	19PGM802	English for Research Paper Writing	3	0	0	P/F

Professional Core Courses (PCC)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
1.	19PCD101	Computer Applications in Design	3	1	0	3	60	SEM 1
2.	19PCD102	Advanced Finite Element Analysis	3	1	0	3	60	SEM 1
3.	19PCD103	CAD Laboratory	0	0	4	2	60	SEM 1
4.	19PCD104	Computer Aided Engineering Laboratory	0	0	4	2	60	SEM 1
5.	19PCD201	Design for Manufacture, Assembly and Environments	3	0	0	3	45	SEM 2
6.	19PCD202	Applied Materials Engineering	3	0	0	3	45	SEM 2
7.	19PCD204	Product Design and Lifecycle Management	3	0	0	3	45	SEM 2
8.	19PCD205	Advanced Simulation and Analysis Laboratory	0	0	4	2	60	SEM 2

Professional Electives Courses (PEC)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
1.	E1	Professional Elective – I	3	0	0	3	45	SEM 1
2.	E2	Professional Elective – II	3	0	0	3	45	SEM 2
3.	E3	Professional Elective – III	3	0	0	3	45	SEM 2
4.	E4	Professional Elective – IV	3	0	0	3	45	SEM 3
5.	E5	Professional Elective – V	3	0	0	3	45	SEM 3

Open Electives Courses (OEC)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
1.	OE	Open Elective – I	3	0	0	3	45	SEM 3

Project Work & Seminar (PW)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
1.	19PCD205	Mini project with Seminar	0	0	4	2	60	SEM 2
2.	19PCD301	Project Work (PHASE – I)	0	0	20	10	300	SEM 3
3.	19PCD401	Project Work (PHASE – II)	0	0	32	16	480	SEM 4

Mandatory Credit Courses (MCC)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
1.	19PGM701	Research Methodology and IPR	3	0	0	3	45	SEM 1

Audit Courses (AC)

S. No.	Course Code	Course Title	L	T	P	C	H	SEM
2.	19PGM801	Pedagogy Studies	2	0	0	P/F	30	SEM 1
3.	19PGM802	English for Research Paper Writing	2	0	0	P/F	30	SEM 3

SEMESTER – I

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PCC	19PCD101	Computer Applications in Design	3	0	0	3	45
2.	PCC	19PCD102	Advanced Finite Element Analysis	3	0	0	3	45
3.	PEC	E1	Professional Elective – I	3	0	0	3	45
PRACTICAL								
4.	PCC	19PCD103	CAD Laboratory	0	0	4	2	60
5.	PCC	19PCD104	Computer Aided Engineering Laboratory	0	0	4	2	60
AUDIT COURSE								
6.	AC	19PGM801	Pedagogy Studies	2	0	0	P/F	30
MANDATORY								
7.	MCC	19PGM701	Research Methodology and IPR	3	0	0	3	45
			TOTAL	**14**	**0**	**8**	**16**	
							Total No of Credits – 16	

19PCD101	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

This course aims at imparting knowledge on computer applications in design

UNIT-I INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS 9

Output primitives (points,lines,curvesetc.,), 2 - D & 3 - Dtransformation (Translation ,scaling, rotation) windowing - view ports -clipping transformation

UNIT-II CURVES AND SURFACES MODELING 9

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

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

UNIT-III NURBS AND SOLID MODELING 9

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

UNIT-IV VISUAL REALISM 9

Hidden – Line – Surface – solid removal algorithms shading –coloring .Introduction to parametric and variational geometry based software's and their principles creation of prismatic and l ofted parts using these packages.

UNIT-V ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE 9

Assembly modeling – interferences of positions and orientation – tolerances analysis –mass property calculations – mechanism simulation. Graphics and computing standards–Open GL Data Exchange standards – IGES ,STEP etc–Communication standards.

Total :45Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Describe the Surface Modeling, Nurbs and Solid Modeling techniques such as interpolation and approximation
2. Solve 2D and 3D transformations for the basic entities.
3. Develop the basic mathematics fundamental for CAD system.
4. Analyze the different geometric modeling techniques by using CAD package.
5. Create geometric models through animation and transform them into real world systems
6. Simulate assembly of parts using Computer-Aided Design software.

REFERENCES:

1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
4. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2003
5. Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc. 2nd Edition, 1996.
6. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
7. William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1stEdition, 2001.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2	2			3	3	
CO.3	2			3	2	
CO.4	2		3	3	2	
CO.5	2	3	3	3	3	
CO.6	2	2	3	3	3	
19PCD101	**2**	**3**	**3**	**3**	**3**	

19PCD102	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To develop a thorough understanding of the advanced finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in engineering design

UNIT-I BENDING OF PLATES AND SHELLS 9

Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements- Application and Examples

UNIT-II NON-LINEAR PROBLEMS 9

Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation –Solution procedure- Application in Metal Forming Process and Contact Problems

UNIT-III DYNAMIC PROBLEM 9

Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Subspace Iterative Technique – Response analysis-Houbolt, Wilson, Newmark – Methods. Explicit & Implict Methods- Lanchzos, Reduced method for large size system equations.

UNIT-IV FLUID MECHANICS AND HEAT TRANSFER 9

Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming – Navier Stokes Equation –Steady and Transient Solution.

UNIT-V ERROR ESTIMATES AND ADAPTIVE REFINEMENT 9

Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement

Total :45Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Understand the Finite Element Formulation of Plate and Shell Elements, Non-Linear Problems and Dynamic Problem
2. Apply the concept of Finite Element Analysis to solve problems involving plate and shell elements.
3. Apply the concept of Finite Element Analysis to solve problems involving geometric and material non linearity
4. Formulate solution techniques to solve dynamic problems
5. Apply concepts of Finite Element Analysis to solve fluid mechanics and heat transfer problems
6. Investigate error norms, convergence rates and refinement.

REFERENCES:

1. Boothroyd, G, “Assembly Automation and Product Design” Marcel Dekker, New York, 1997.
2. Chitale A.K and Gupta R.C “ Product design and manufacturing “ PHI learning private limited, 6th Edition, 2015.
4. David Rogers, James Alan Adams “Mathematical Elements for Computer Graphics” 2nd Edition, Tata McGraw-Hill edition.2003
5. Donald D Hearn and M. Pauline Baker “Computer Graphics C Version”, Prentice Hall, Inc. 2nd Edition, 1996.
6. Ibrahim Zeid, "Mastering CAD/CAM", McGraw Hill, 2nd Edition, 2006
7. William M Newman and Robert F.Sproull “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. 1stEdition, 2001.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2	2		2	2	2	2
CO.3	2		2	2	2	2
CO.4	3		2	2	2	
CO.5	2		2	2	2	2
CO.6	3		2	2	2	
19PCD102	**3**		**2**	**2**	**2**	**2**

19PGM701 RESEARCH METHODOLOGY AND IPR	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis for Research design
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT-I FORMULATION OF RESEARCH PROBLEM 9

Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem – Types of Literature Review- Sources for Literature Review - Identifying gap areas from literature review.

UNIT-II RESEARCH DESIGN AND ETHICS 9

Research Design – Different Research designs- Sampling design- Types of sampling, Methods of Data collection- primary data, secondary data, Plagiarism, Application of results and ethics - Environmental impacts - Ethical issues – ethical committees

UNIT-III DATA ANALYSIS AND TESTING OF HYPOTHESES 9

Data Processing and Analysis strategies -Types of Analysis- Statistics in Research - Measures of Central Tendency - Measures of Dispersion - Measures of Asymmetry (Skewness) -Measures of Relationship - Simple Regression Analysis - Multiple Correlation and Regression Testing of Hypotheses- Chi-square test, Taguchi and ANOVA

UNIT-IV REPORT AND RESEARCH PROPOSAL WRITING 9

Significance of Report Writing - Different Steps in Writing Report - Layout of the Research Report – Types of Reports - Oral Presentation - Mechanics of Writing a Research Report - Bibliography, types of referencing, citations. Format of research proposal -Research Proposal writing - assessment by a review committee.

UNIT-V INTELLECTUAL PROPERTY AND PATENT RIGHTS 9

Nature of Intellectual Property – Patents- Designs, Trade and Copyright- Geographical Indications. Process of Patenting and Development – Patent Search- Invention, Innovation- Documents for Patent filing - Examination- Grant of Patent. Scope of Patent Rights - Case Studies

Total :45Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Analyze the literature to identify the research gap in the given area of research
2. Design suitable research methodology to pursue the research in scientific and systematic procedure with statistical / IT Tools
3. Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion
4. Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report

5. Conduct patent database search in various countries for the research problem identified

6. Apply ethical principles in research and reporting to promote healthy scientific practice

REFERENCES:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications.2 volumes.
4. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						2
CO.2	3			3		
CO.3	3					2
CO.4		3				
CO.5						2
CO.6					3	3
19PGM701	**3**	**3**		**3**	**3**	**3**

19PCD103	CAD LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

•To understand the different type of solid model package and create the graphical solid model.

•Apply the principles of two-dimensional CAD in the solution of various design problems.

LIST OF EXPERIMENTS :

1. CAD Introduction
2. Sketcher
3. Solid modeling – Extrude, Revolve, Sweep and variational sweep, Loft
4. Surface modeling – Extrude, Sweep, Trim and Mesh of curves, Freeform
5. Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
6. Assembly – Constraints, Exploded Views, Interference check
7. Drafting – Layouts, Standard & Sectional Views, Detailing & Plotting
8. CAD data exchange formats – IGES, PDES, PARASOLID, DXF and STL
9. Design of straight helical gears and analyzing the kinematics of gear train using motion study.

Exercises in modeling and drafting of mechanical components – assembly using parametric and feature based packages like PRO-E/SOLIDWORKS /CATIA/NX

Total: 60 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Understand the concepts of various CAD comments.
2. Use the modern engineering tools necessary for engineering practice.
3. Draw 2D part drawings, sectional views, and assembly drawings as per standards.
4. Create 3D Model on any CAD software.
5. Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.
6. Examine interference to ensure that parts will not interfere.

Equipment details

DELL Computer and 19” Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
CREO 5.0 software.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2			3	3	3	3
CO.3			2	3	3	
CO.4			3	3	3	
CO.5			3	3	3	
CO.6			3	3	3	3
19PCD103			**3**	**3**	**3**	**3**

19PCD104 COMPUTER AIDED ENGINEERING LABORATORY	L	T	P	C
	0	0	4	2

OBJECTIVE:

- To analys is the complex problem by using the ANSYS/ABAQUS etc.,
- Synthesize information and apply critical thinking skills to solve instructional problems typical to industry.

LIST OF EXPERIMENTS :

- Analysis of Mechanical Components – Use of FEA Packages like ANSYS/ NASTRAN etc.,
- Force and Stress analysis using link elements in Trusses, cables etc.
- Stress and deflection analysis in beams with different support conditions.
- Stress analysis of flat plates and simple shells.
- Stress analysis of axi – symmetric components.
- Thermal stress and heat transfer analysis of plates.
- Thermal stress analysis of cylindrical shells.
- Vibration analysis of spring-mass systems.
- Model analysis of Beams.
- Harmonic, transient and spectrum analysis of simple systems

Total: 60 Periods

COURSE OUTCOMES:

After successful completion of this course the students will be able to:

1. Understand the concept ANSYS software for structural thermal and Vibrational Problems.
2. Apply the appropriate methods to analyze stress and deflection in beams and flat plates.
3. Apply thermal stress analysis techniques to plates and cylindrical shells.
4. Apply vibration analysis techniques to determine natural frequencies and modes of vibration.
5. Apply the harmonic, transient, and spectrum analysis techniques to simple systems to understand their dynamic behavior.
6. Apply the appropriate methods to analyze stress and deflection in axis symmetric components.

Equipment details

DELL Computer and 19” Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
ANSYS with CFD, Version 19.0

CO/PO MAPPING

CO	POs					
	1	**2**	**3**	**4**	**5**	**6**
CO.1						
CO.2	2		2	3	3	2
CO.3	2		2	3	3	2
CO.4	2		2	3	3	2
CO.5	2		2	3	3	2
CO.6	2		2	3	3	2
19PCD104	**2**		**2**	**3**	**3**	**2**

19PGM801	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	P/F

OBJECTIVES:

- To make the students understand a range of cognitive capacities in human learners.
- To explain the outcome-based education system.
- To describe the curriculum design process.

UNIT-I EDUCATIONAL PSYCHOLOGY AND ENGINEERING EDUCATION 7

Learning process, motivation and engagement, ICT in learning and teaching, Facilitating the learners, Engineering education and recent trends, Research in Engineering education, General maxims of teaching, Teacher-centered, learner-centered and learning-centered approaches, Becoming a reflective teacher, Disruptive Innovation in Education.

UNIT-II OUTCOME BASED EDUCATION 7

Outcome Based Education: A broad context for quality teaching and learning, planning for quality teachingand learning, Necessity for learning outcomes - Course Outcomes and Program Outcomes, Defining learning outcomes, learning outcomes in the cognitive domain, learning outcomes in the affective domain,learning outcomes in the psychomotor domain, Program Outcomes, Graduate Attributes, Program Educational Objectives, linking learning outcomes to teaching and assessment.

UNIT-III CURRICULUM DESIGN 7

Curriculum design cycle, curriculum structure, credit and academic load, need assessment – feedback fromstakeholders, concept of “Constructive alignment”, the two loop approach of ABET, tuning approach of curriculum design, CDIO concept of curriculum design and implementation, Industry relevant curriculumdesign and implementation, concept mapping, Instructional design and delivery.

UNIT-IV TEACHING AND ASSESSMENT STRATEGIES 9

Direct instruction as teaching strategy, co-operative learning, problem-solving, industry relevant teaching,role-play, case study, technology enabled teaching, research orientation, measurement and evaluation of students’ achievement, assessment of learning outcomes - assessment tools: direct and indirect assessmenttools, rubrics for assessment, attainment analysis, corrective action- curriculum updation, improvement in pedagogy, innovative assessment methods.

Total : 30 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Develop the skills required in preparing daily lesson plans and unit lesson plans using various methods and approaches.
2. Apply the knowledge of the relative fields of engineering and sciences relevant to the various complex problems of the society
3. Analyse the complex problems critically and identify methodology for solution using the knowledge acquired by the students in their curriculum

4. Design effective teaching methodologies, approaches and techniques for teaching engineering and sciences

5. Develop the skills required among students to solve the complex problems using various engineering methodologies

6. Design proper assessment techniques to analyse the knowledge and skills acquired by the learners

REFERENCES:

1) Dr.Sue Duchesne, Anne McMaugh, Sandra Bochner, Kerri-Lee Krause, "Educational Psychologyfor Learning and Teaching", Cengage Learning, 4th Edition, 2019.
2) *Lisa R. Lattuca, Patrick T. Terenzini, J. Fredericks Volkwein, and George D. Peterson, "*The Changing Face of Engineering Education*"* The Bridge, National Academy of Engineering, Summer 2006
3) Anderson, L. & Krathwohl , D. A Taxonomy for Learning, Teaching and Assessing: A Revisionof Bloom's Taxonomy of Educational Objectives . New York: Longman, 2001.
4) Blumberg, P. Developing learner-centred teaching: A practical guide for faculty. San Francisco:Jossey-Bass, 2017.
5) Teaching Support Services. Learning objectives. University of Guelph, Guelph, ntario. Retrievedfrom http://www.uoguelph.ca/tss/resources/idres/learningobjectives1.pdf
6) .V. Boev, N.Gruenwald and G.Heitmann, "Engineering Curriculum Design aligned with Accrediation Standards", Hochschule Wismar Publishers, 2013

Fink, D. L. Integrated course design. Manhattan, KS: The IDEA Center, 2005. Retrieved from http://www.theideacenter.org/sites/default/files/Idea_Paper_42.pdf

SEMESTER – II

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PCC	19PCD201	Design for Manufacture, Assembly and Environments	3	0	0	3	45
2.	PCC	19PCD202	Applied Materials Engineering	3	0	0	3	45
3.	PEC	E2	Professional Elective – II	3	0	0	3	45
PRACTICAL								
4.	PCC	19PCD203	CAM Laboratory	0	0	4	2	60
5.	PCC	19PCD204	Advanced Analysis and Simulation Laboratory	0	0	4	2	60
6.	PW	19PCD205	Mini project with Seminar	0	0	6	3	90
AUDIT COURSE								
7.	MCC	19PGM802	English for Research Paper Writing	2	0	0	P/F	45
			TOTAL	**11**	**0**	**14**	**16**	
							Total No of Credits = 16	

19PCD201	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Design for Manufacture, Assembly and Environments is to create new and better ideas and improvingthe existing one
- To analyze and Redesign the component by the influence of man, machine, material and process

UNIT-I INTRODUCTION 9

General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances - Geometric tolerances - Assembly limits -Datum features – Tolerance stacks.

UNIT-II FACTORS INFLUENCING FORM DESIGN 9

Working principle, Material, Manufacture, Design- Possible solutions - Materials choice - Influence of materials on form design - form design of welded members, forgings and castings.

UNIT-III COMPONENT DESIGN - MACHINING CONSIDERATION 9

Design features to facilitate machining - drills - milling cutters - keyways – Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.

UNIT-IV COMPONENT DESIGN - CASTING CONSIDERATION 9

Hidden – Line – Surface – solid removal algorithms shading –coloring .Introduction to parametric and variational geometry based software's and their principles creation of prismatic and l ofted parts using these packages.

UNIT-V DESIGN FOR THE ENVIRONMENT 9

Introduction – Environmental objectives – Global issues – Regional and local issues –Basic DFE methods – Designguide lines – Example application – Lifecycle assessment – Basic method – AT and T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly –Design for recyclability – Design for remanufacture – Design for energy efficiency –Design to regulations and standards.

Total :45Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Illustrate the design philosophy, material selection and principles for manufacturability.
2. Select relevant process; apply the general design principles for manufacturability; GD&T.
3. Apply design considerations while designing the cast and welded components.
4. Apply design considerations while designing the formed and machined components.
5. Apply design considerations for assembled systems.
6. Apply design considerations for environmental issues.

REFERENCES BOOKS:

1. Boothroyd G, "Design for Assembly Automation and Product Design", Marcel Dekker, New York, 1980.
2. Bralla, "Design for Manufacture handbook", McGraw hill, 1999.
3. Boothroyd, G, Heartz and Nike, "Product Design for Manufacture", Marcel Dekker, 1994.
4. Dickson, John. R and Corroda Poly, "Engineering Design and Design for Manufacture and StructuralApproach", Field Stone Publisher, USA, 1995.
5. Fixel, J, "Design for the Environment ", McGraw hill, 1996.
6. Graedel T.and Allen By. B, "Design for the Environment Angle Wood Cliff ", Reason Pub., Prentice Hall,1996.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2		3	2	3	3	
CO.3			2	2	2	
CO.4			2	2	3	
CO.5			2	2	2	
CO.6			2	2	3	3
19PCD201		**3**	**2**	**3**	**3**	**3**

19PCD202	APPLIED MATERIALS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide knowledge in the areas of characterization of materials
- To impart knowledge on selection of materials for important applications

UNIT-I PLASTIC BEHAVIOUR & STRENGTHENING 9

Mechanism of Plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanism, work hardening, solid solutioning, grain boundary strengthening, Poly phase mixture, precipitation, particle fibre and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviour, Super plasticity.

UNIT-II FRACTURE BEHAVIOUR 9

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

UNIT-III CHARACTERIZATION OF MATERIALS 9

X-ray diffraction, Crystallography basics, characteristic spectrum, Bragg's law, Diffraction methods – Lauer,rotating crystal and powder methods. Optical microscopy, Construction and operation of Transmission electron microscope – Selected Area Electron Diffraction and image formation, specimen preparation techniques Scanning electron microscopy, Transmission electron microscopy, Atomic force microscope, thermal analysis techniques.

UNIT-IV MATERIAL TESTING & SELECTION OF MATERIALS 9

Tension, Hardness, torsion, bending, fracture and impact tests. Motivation for selection of materials , cost basis and service requirements – selection for Mechanical properties, strength, toughness, fatigue and creep

– Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with Relevance to aero, auto, marine, machinery and nuclear applications.

UNIT-V MODERN MATERIALS AND TREATMENT 9

Dual phase steels, high strength low alloy (HSLA) Steel, transformation included plasticity (TRIP) Steel, maraging steel, shape memory alloys, properties applications of engineering plastics and composites materials, advanced structural ceramics – Wc, TiC, TaC, Al_2O_3, SiC, Si_3N_4, CBN, diamond, heat treatment alloy and tool steels, vapour deposition – Plasma, PVD- thick and thin film deposition – Nano materials- production of Nano sized materials.

Total : 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Summarize the behavior of materials under different loading conditions
2. Describe the deferent types of ceramics
3. Describe the Relationship between materials selection and processing
4. Select appropriate material for the application concerned
5. Apply the modern materials
6. Apply the different coatings on engineering materials

REFERENCES BOOKS:

1. George E. Dieter, “Mechanical Metallurgy”, McGraw Hill,1988.
2. Charles J.A, Crane F.A.A. and Furness J.A.G, “Selection and use of Engineering Materials ”, ThirdEdition, Butterworth – Heiremann, 1997.
3. Cullity B. D, “Elements of X-ray diffraction”, Addison-Wesley Company Inc., Third Edition, Newyork,2000.
4. Brandon D. G, “Modern Techniques in Metallography”, Von Nostrand Inc NJ, USA, 1986.
5. Thomas G, “Transmission electron microscopy of metals”, John Wiley, 1996.
6. James K.Wessel, Wiley and Intersam John, “The Hand book of Advance Materials ”, Wilson Publishers,2004.
7. Tadeu Z Burakowski, Tadenz. Wierzchon, “Surface Engg of Metals”, Principles, Equipment, Technlogies,CRC press, 1998.
8. Thomas H.Courtney, “Mechanical Behaviour of Materials”, McGraw Hill, 2nd edition, 2000.
9. Flinn R.A. and Trojan, P.K, “Engg Materials and their Applications ”,4th Edition, Jaico, 1999.
10. Metals hand book, vol. 10, “Failure Analysis and Prevention”,10th edition, 1999.
11. Weinberg, F, “Tools and Techniques in Physical Metallurgy”, Marcel and Decker, 1970.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2						
CO.3						
CO.4	3		3		3	3
CO.5	3		3		3	2
CO.6	3		3	2	3	3
19PCD202	**3**		**3**	**2**	**3**	**3**

19PCD203	CAM LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To impart CNC part programming skills for turning and milling applications.
- To give a good exposure of CAM software in order to perform simulation and to generate CNC codes.
- To provide an adequate knowledge to use Computer Aided Measuring Instruments for manufacturing applications.

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. Understand the basic concepts in NC technology.
2. Explain the manual CNC part programming for milling and turning machines.
3. Create part programs using CAM packages for milling and turning Machines.
4. Appraise dimensional and geometric measurements of machined features using video Measuring system and coordinate measuring machine.
5. Construct PLC ladder programming and robot programming.
6. Relate the concept of printing parts using additive manufacturing and appreciate the application RDBMS in MRP.

Equipment details:

DELL computers
MTAB XL TURN
CNC Lathe, M TAB CNC XL MILL
CNC Mill, CADEM 6.0 software

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2						
CO.3			3	2	3	3
CO.4			3	2	3	3
CO.5			3	2	3	3
CO.6			3	2	3	3
19PCD203			**3**	**2**	**3**	**3**

19PCD204 ADVANCED ANALYSIS AND SIMULATION LABORATORY	L	T	P	C
	0	0	4	2

OBJECTIVES:

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.To learn and get familiar with the ANSYS Workbench.
- To learn the basic steps of modelling MEMS devices using ANSYS Workbench.To learn the simulation and analysis steps of the MEMS model.

SIMULATION

1.MATLAB basics, Dealing with matrices, Graphing-Functions of one variable and two variables

2.Use of Matlab to solve simple problems in vibration

3.Mechanism Simulation using Multibody Dynamic software

ANALYSIS

1. Structural analysis of Piston using ANSYS Workbench.
2. Structural Analysis of a Cantilever Using ANSYS Workbench
3. Structural Analysis of Simply Supported Beam Using ANSYS Workbench
4. Thermal analysis of Disc Brake using ANSYS Workbench
5. Thermal analysis of Piston using ANSYS Workbench

COURSE OUTCOMES:

1. Outline the basic concepts of FEA and CFD using ANSYS software for different structures
2. Solve engineering problems numerically using Computer Aided Finite Element Analysis packages
3. Analyze the force, stress, deflection in mechanical components.
4. Analyze thermal stress and heat transfer in mechanical components.
5. Analyze the vibration of mechanical components.
6. Analyze the modal, harmonic, transient and spectrum concepts in mechanical components.

Equipment details

DELL Computer and 19” Monitor,
DELL optic plus mini tower CPU Intell core i5- Windows 10 Linux,
8 GB DDR4 RAM 1TM SATA Hard Disk Drive,
ANSYS with CFD, Version 19.0

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2	2		3	2	3	2
CO.3	2		3	2	3	2
CO.4	2		3	3	3	2
CO.5	2		3		3	2
CO.6	2		3	3	3	2
19PCD204	**2**		**3**	**3**	**3**	**2**

		L	T	P	C
19PCD205	**MINI PROJECT WITH SEMINAR**	**0**	**0**	**4**	**3**

OBJECTIVES:

- To inculcate the importance of communication skills
- To familiarize with the concepts in emerging engineering field

DESCRIPTION:

This course is introduced to enrich the communication skills of the student and to create awareness on recent development in Mechanical Engineering, Computer aided design and manufacturing through Technical presentation. In this course, a student has to present at least two Technical papers or recent advances in Engineering / Technology that will be evaluated by a Committee constituted by the Head of the Department. Students should work on a small research problem. Students have to carry out the project under the guidance of faculty member using the knowledge of subjects that he/she has learned. The student should submit the report at the end of the semester. The product should be demonstrated at the time of examination.

TOTAL: 60 PERIODS

COURSE OUTCOMES

1. Understand inductive and deductive reasoning and increase their general problem solving machine.
2. Demonstrate a sound technical knowledge of their selected seminar topic.
3. Develop communicating skills.
4. Updated the latest technology in the field of CAD/CAM.
5. Assimilate literature on technical article of specified topics and develop comprehension.
6. Prepare technical report with proper citation and research ethics

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2						
CO.3		2	3		2	
CO.4		2	3	2		
CO.5	3	3	3		2	2
CO.6		3	2			3
19PCD205	**3**	**3**	**3**	**2**	**2**	**3**

19PGM802	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	P/F

OBJECTIVES:

- To give and exposure on writing skills and readability
- To impart the knowledge of each section of the paper
- To enhance the student to write the good quality Research paper

UNIT-I INTRODUCTION TO RESEARCH 9

Introduction to Research Paper, Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs, Clarity and Removing Redundancy, Highlighting the Findings, Hedging and Criticizing, Paraphrasing and Plagiarism - Useful idioms & phrases.

UNIT-II STRUCTURE OF RESEARCH PAPER 6

Types of the Research papers, Regular Research Paper - Review Research Paper – Case Study Research Paper – Research Letters - Sections of a Paper, Title, Author names and affiliations - Corresponding author - Abstracts, Keywords, Highlights, Graphical Abstract - Introduction, Methods, Results, Discussion, Conclusions, Acknowledgment - the First Draft.

UNIT-III METHODOLOGY, RESULTS & DISCUSSION AND CONCLUSION 9

Introduction – Writing preview of Research work – Review of literature – assimilating the points – Logical flow – Research gap - Writing the Methodology – Sequence - Specification – Explaining results – Interpretation and plotting – Discussion of the salient findings – Critical analysis – Writing the Conclusion

UNIT-IV SUBMISSION OF RESEARCH PAPER 6

References – Citations and Checking the Citations – Various forms of Citation - Guidelines for authors –Manuscript submission – Conflict of Interest - Authors reply for Reviewer comments – Point by Point Explanation –Resubmission – Acceptance – Copyright – Proof reading and final submission.

Total : 45Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Understand the skills needed when writing the Conclusion
5. Ensure the good quality of paper at very first-time submission
6. Formulate the Acceptable Research Manuscript

REFERENCES BOOKS:

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

SEMESTER – III

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
THEORY								
1.	PEC	E3	Professional Elective – III	3	0	0	3	45
2.	PEC	E4	Professional Elective – IV	3	0	0	3	45
3.	PEC	E5	Professional Elective – V	3	0	0	3	45
4.	OEC	OE	Open Elective – I	3	0	0	3	45
PRACTICAL								
5.	PW	19PCD301	Project Work I (Phase – I)	0	0	20	10	300
			TOTAL	**12**	**0**	**20**	**22**	
Total No of Credits – 22								

19PCD301	PROJECT WORK (PHASE – I)	L	T	P	C
		0	0	20	10

OBJECTIVES:

- To identify a specific problem for the current need of the society and collecting information related to the same through detailed review of literature.
- To develop the methodology to solve the identified problem.
- To train the students in preparing project reports and to face reviews and viva-voce examination.

SYLLABUS

The student individually works on a specific topic approved by the head of the division under the guidance of a faculty member who is familiar in this area of interest. The student can select any topic which is relevant to the area of engineering design. The topic may be theoretical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work. The students will be evaluated through a viva-voce examination by a panel of examiners including one external examiner.

TOTAL: 300 PERIODS

COURSE OUTCOMES

After successful completion of this course, the Students will be able to

1. Apply the knowledge gained from theoretical and practical courses in solving problems with innovative solutions and by planning organizing and coordinating for the execution of the project work.
2. Analyse and interpret the data/information from various literature sources and synthesize the information to provide valid conclusions about the problem identification, formulation and solution of the project
3. Design, model and develop optimal solutions for problems being investigated.
4. Demonstrate professionalism with ethics; present effective communication skills and relate engineering issues to broader societal context.

COURSE ARTICULATION MATRIX:

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1	3	3	3	3	3	3
CO.2	3	3	3	2	2	2
CO.3	3	2	3	3	3	3
CO.4	3	3	3	2	2	3
19PCD301	**3**	**3**	**3**	**3**	**3**	**3**

Ref: 3-Strong 2-Medium 1 –Weak

SEMESTER – IV

S. No.	Course Category	Course Code	Course Name	L	T	P	C	H
PRACTICAL								
1.	**PW**	**19PCD401**	**PROJECT WORK (PHASE – II)**	**0**	**0**	**32**	**16**	**480**
			TOTAL	**0**	**0**	**32**	**16**	
								Total No of Credits = 16

19PCD401	PROJECT WORK (PHASE – II)	L	T	P	C
		0	0	32	16

OBJECTIVES:

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

SYLLABUS

The student should continue the phase I work on the selected topic as per the formulated methodology under the same supervisor. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee ,a detailed report should be prepared and submitted to the head of the department. The students will be evaluated based on the report submitted and the viva-voce examination by a panel of examiners including on external examiner

TOTAL: 480 PERIODS

COURSE OUTCOMES

After successful completion of this course, the Students will be able to

1. Analyze and review the research literature critically and evolve suitable methodologies for solving the complex engineering problem
2. Analyze the complex engineering problem critically to provide optimal solution after considering public health, safety, ethical, societal and environmental factors.
3. Design/Develop sustainable solutions after independently carrying out research and investigation to solve practical problems.
4. Utilize modern engineering and IT tools, techniques including prediction and modeling for complex engineering activities and augment the effectiveness of the solution with an understanding of the limitations]
5. Write effective reports and make clear presentation to the engineering community and society
6. Engage in learning for effective project implementation with a commitment to improve knowledge and competence in context of technological updation.

COURSE ARTICULATION MATRIX:

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1	3		3	2	2	2
CO.2	3		3	3	3	3
CO.3	3		3	3	3	3
CO.4	3		3	3		3
CO.5		3			3	3
CO.6			3		3	
19PCD401	**3**	**3**	**3**	**3**	**3**	**3**

Ref: 3-Strong 2-Medium 1 –Weak

PROFESSIONAL ELECTIVE COURSES:

S.No	Course Code	Course Title	L	T	P	C
1.	19PCD501	Mechatronics in Manufacturing Systems	3	0	0	3
2.	19PCD502	Tribology in Design	3	0	0	3
3.	19PCD503	Design of Hydraulic and Pneumatic Systems	3	0	0	3
4.	19PCD504	Data Communication in CAD/CAM	3	0	0	3
5.	19PCD505	Performance Modeling and Analysis of Manufacturing System	3	0	0	3
6.	19PCD506	Optimization Techniques in Design	3	0	0	3
7.	19PCD507	Industrial Safety Management	3	0	0	3
8.	19PCD508	Integrated manufacturing system	3	0	0	3
9.	19PCD509	Vibration Analysis and Control	3	0	0	3
10.	19PCD510	Metrology and Non Destructive Testing	3	0	0	3
11.	19PCD511	Advanced Mechanics of Materials	3	0	0	3
12.	19PCD512	Design of Material Handling Equipment’s	3	0	0	3
13.	19PCD513	Advanced Tool Design	3	0	0	3
14.	19PCD514	Mechanisms Design and Simulation	3	0	0	3
15.	19PCD515	Computational Fluid Dynamics in Manufacturing	3	0	0	3
16.	19PCD516	Reliability Engineering Models	3	0	0	3
17.	19PCD517	Maintenance Engineering and Management	3	0	0	3
18.	19PCD518	Industrial Robotics and Expert Systems	3	0	0	3
19.	19PCD519	Lean Manufacturing	3	0	0	3
20.	19PCD520	Design for Cellular Manufacturing Systems	3	0	0	3
21.	19PCD521	Integrated Product Design And Processes	3	0	0	3
22	19PCD522	Additive Manufacturing	3	0	0	3

19PCD501 MECHATRONICS IN MANUFACTURING SYSTEMS	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To get knowledge about sensors and Transducers
- To study about microprocessors and programmable logic controllers
- To understand the design principles of Mechatronics

UNIT I INTRODUCTION **9**

Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems - Control Systems - Traditional design and Mechatronics Design.

UNIT II SENSORS AND TRANSDUCERS **9**

Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion -Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

UNIT III MICROPROCESSORS IN MECHATRONICS **9**

Introduction - Architecture - Pin configuration - Instruction set - Programming of Microprocessors using 8085instructions - Interfacing input and output devices - Interfacing D/A converters and A/D converters – Applications - Temperature control - Stepper motor control - Traffic light controller.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS **9**

Introduction - Basic structure - Input / Output processing - Programming –Mnemonics Timers, Internal relaysand counters - Data handling - Analog input / output - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS **9**

Designing - Possible design solutions - Case studies of Mechatronics systems

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Distinguish Traditional design and Mechatronics Design
- Select the suitable sensors for deferent application and components
- Construct a Program for traffic control by using 8085 instructions
- Discuss about the operation of timers
- Sketch a mechatronics system for Pick and place robot

REFERENCES:

1. Michael B.Histand, David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw-Hill, International Editions, 1999.
2. Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, “Mechatronics”, Chapman and Hall, 1993.
3. Ramesh.S, Gaonkar, “Microprocessor Architecture, Programming and Applications”, Wiley Eastern, 1998.
4. Lawrence J. Kamm, “Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ”, Prentice-Hall, 2000.
5. Ghosh, P.K., Sridhar, P.R, “Introduction to Microprocessors for Engineers and Scientists”, Prentice Hall, Second Edition, 1995.
6. W. Bolton, “Mechatronics”, Pearson Education, 2006.

19PCD502	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the principles of wear, tear and friction
- To learn understand the different types of lubrication

UNIT I SURFACE INTERACTION AND FRICTION 9

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 AND SURFACE TREATMENT 9

Types of wear – Mechanism of various types of wear – Laws of wear –Theoretical wear models-Wear of Metalsand Non metals – Surface treatments – Surface modifications –surface coatings methods- Surface Topography measurements –Laser methods – instrumentation - International standards in friction and wear measurements.

UNIT III LUBRICANTS AND LUBRICATION REGIMES 9

Lubricants and their physical properties- Viscosity and other properties of oils –Additives and selection of Lubricants- Lubricants standards ISO,SAE,AGMA, BIS standards – Lubrication Regimes –Solid Lubrication- Dry and marginally lubricated contacts- Boundary Lubrication-Hydrodynamic lubrication –– Elasto and plasto hydrodynamic – Magneto hydrodynamic lubrication – Hydro static lubrication – Gas lubrication.

UNIT IV THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION 9

Reynolds Equation,-Assumptions and limitations-One and two dimensional Reynolds Equation-Reynolds and Summerfield boundary conditions- Pressure wave, flow, load capacity and friction calculations in Hydrodynamic bearings-Long and short bearings-Pad bearings and Journal bearings-Squeeze film effects-Thermal considerations-Hydrostatic lubrication of Pad bearing- Pressure , flow , load and friction calculations-Stiffness considerations- Various types of flow restrictors in hydrostatic bearings.

UNIT V HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION 9

Rolling contacts of Elastic solids- contact stresses – Hertzian stress equation- Spherical and cylindrical contacts- Contact Fatigue life- Oil film effects- Elasto Hydrodynamic lubrication Theory-Soft and hard EHL-Reynolds equation for elasto hydrodynamic lubrication- - Film shape within and outside contact zones-Film thickness and friction calculation- Rolling bearings-Stresses and deflections-Traction drives.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- List the Properties of Surface features
- Categorize Wear of Metals and Non metals
- Formulate the one and two dimensional Reynolds Equation
- Solve the problems for bearings to find Stresses and deflections
- Discus the oil properties like viscosity etc…

REFERENCES:

1. Rabinowicz. E, “Friction and Wear of materials”, John Willey &Sons, UK, 1995.
2. Cameron, A, “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1981.
3. Halling J, “Principles of Tribology”, Macmillian, 1984.
4. Williams J.A, “Engineering Tribology”, Oxford Univ. Press, 1994.
5. S. K .Basu S .N. Sengupta and B.B. Ahuja, “Fundamentals of Tribology”, Prentice – Hall of India Pvt Ltd, New Delhi, 2005.
6. G. W. Stachowiak, A.W .Batchelor, “Engineering Tribology”, Butterworth-Heinemann, UK, 2005.

19PCD503	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the Hydraulic and pneumatic systems used in industries
- To learn about the installation and maintenance of hydraulic and pneumatic systems

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and RotaryActuators – selection, specification and characteristics.

UNIT II CONTROL AND REGULATION ELEMENTS 9

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems

UNIT III HYDRAULIC CIRCUITS 9

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits -industrial circuits - presscircuits - hydraulic milling machine - grinding, planning, copying,- forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 9

Pneumatic fundamentals - control elements, position and pressure sensing - logic circuits - switching circuits - fringe conditions UNITs and these integration - sequential circuits -cascade methods - mapping methods - step counter method - compound circuit design -combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 9

Pneumatic equipments- selection of components - design calculations – application –fault finding - hydropneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Illustrate the specification, characteristics, and selection of pumps and accelerators
2. Explain the application and working principles of valves
3. Describe about the illustration and maintenance of circuits
4. Design the hydraulic circuit for real time applications
5. Design the pneumatic circuit for real time applications.
6. Develop specific design, application, and functions of hydraulic and pneumatic systems.

REFERENCES:

1. Antony Espossito, “Fluid Power with Applications”, Prentice Hall, 1980.
2. Dudleyt, A. Pease andJohn J. Pippenger, “Basic fluid power”, Prentice Hall, 1987.
3. Andrew Parr, “Hydraulic and Pneumatics ”, Jaico Publishing House, 1999.
4. Bolton. W, “Pneumatic and Hydraulic Systems”, Butterworth – Heinemann, 1997.
5. K.Shanmuga Sundaram, “Hydraulic and Pneumatic Controls: Understanding made Easy ” S. Chand and Co Book publishers, New Delhi, 2006.

CO/PO MAPPING

CO	POs					
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CO.1						
CO.2						
CO.3						
CO.4	2		2	3		
CO.5	2		2	3		
CO.6	2		2	3	2	2
19PCD503	**2**		**2**	**3**	**2**	**2**

19PCD504	DATA COMMUNICATION IN CAD / CAM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know about the basics of operating systems

UNIT I DIGITAL COMPUTERS & MICRO PROCESSORS **9**

Block diagram - register transfer language - arithmetic, logic and shift micro operations -instruction code - training and control instruction cycle - I/O and interrupt design of basic computer. Machine language - assemblylanguage - assembler. Registers ALU and Bus Systems - timing and control signals - machine cycle and timing diagram - functional block diagrams of 80 x 86 and modes of operation. Features of Pentium Processors.

UNIT II OPERATING SYSTEM & ENVIRONMENTS **9**

Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces. Compilers - Analysisof the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

UNIT III COMMUNICATION MODEL **9**

Data communication and networking - protocols and architecture - data transmission concepts and terminology - guided transmission media - wireless transmission – data encoding - asynchronous and synchronous communication - base band interface standards RS232C, RS449 interface.

UNIT IV COMPUTER NETWORKS **9**

Network structure - network architecture - the OSI reference model services – network standardization – example

- Managing remote systems in network - network file systems -net working in manufacturing.

UNIT V INTERNET **9**

Internet services - Protocols - intranet information services - mail based service – system and networkrequirements - Internet tools - usenet - e-mail - IRC - www - FTP - Telnet.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Describe the registers ALU and Bus Systems.
- Review the Graphical User Interface.
- Conclude the data transmission concepts and terminology
- Describe the three elements network protocol
- Practice the www, email

REFERENCES:

- Morris Mano. M, “Computer System Architecture”, Prentice Hall, Prentice Hall of India, 1996.
- Gaonkar R.S, “Microprocessor Architecture, Programming and Applications of 8085”, Penram International, 1997.
- Peterson J.L, Galvin PandSilberschaz, A, “Operating Systems Concepts”, Addison Wesley, 1997.
- Alfred V. Aho, Ravi Setjhi and Jeffrey D Ullman, “Compilers Principles Techniques and Tools”, Addison Wesley, 1986.
- William Stallings, “Data of Computer Communications”, Prentice Hall, Prentice Hall of India, 1997.
- Andrew S. Tanenbanum, “Computer Networks”, 3rd Edition, Prentice Hall of India, 1996.Christian Crumlish, “The ABC's of the Internet”, BPB Publication, 1996.

19PCD505	PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on modeling and analysis of manufacturing system

UNIT I MANUFACTURING SYSTEMS & CONTROL 9

Automated Manufacturing Systems - Modelling - Role of performance modelling -simulation models- Analytical models. Product cycle - Manufacturing automation -Economics of scale and scope - input/output model - plant configurations. Performance measures - Manufacturing lead-time - Work in process -Machine utilization - Throughput –Capacity - Flexibility - performability - Quality. Control Systems - Control system architecture - Factory communications - Local area networks - Factory net works – Open systems interconnection model - Net work to network interconnections – Manufacturing automation protocol - Database management system.

UNIT II COMPUTER AIDED PLANNING AND CONTROL MANUFACTURING PROCESSES 9

Examples of stochastic processes - Poisson process Discrete time Markov chain models - Definition and notation - Sojourn times in states - Examples of DTMCs in manufacturing - Chapman - Kolmogorov equation - Steady-state analysis. Continuous Time Markov Chain Models - Definitions and notation - Sojourn times in states - examples of CTMCs in manufacturing - Equations for CTMC evolution - Markov model of a transfer line. Birth and Death Processes in Manufacturing - Steady state analysis of BD Processes – Typical BD processes in manufacturing.

UNIT III QUEUING MODELS 9

Notation for queues - Examples of queues in manufacturing systems – Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

UNIT IV QUEUING NETWORKS 9

Examples of QN models in manufacturing - Little's law in queuing networks – Tandem queue - An open queuing network with feedback - An open central server model for FMS Closed transfer line – Closed server model - Garden Newell networks.

UNIT V PETRINETS 9

Classical Petri Nets - Definitions - Transition firing and reachability – Representational power - properties - Manufacturing models. Stochastic Petri Nets - Exponential timed Petri Nets - Generalized Stochastic Petri Nets - modelling of KANBAN systems – Manufacturing models.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Explain the Quality, Control Systems
- Derive the Equations for CTMC evolution
- Analyze the flexible machine center
- Compose the Generalized Stochastic Petri Net
- Arrange the cards for KAMBAN system

REFERENCES:

1. Tayfur Altiok, “Performance Analysis of Manufacturing Systems”, Springer, 1997.
2. Trivedi, K.S, “Probability and Statistics with Reliability, Queuing and Computer Science Applications”, Prentice Hall, New Jersey, 1982.
3. Gupta S.C., Kapoor V.K, “Fundamentals of Mathematical Statistics ”, Sultan Chand and Sons, 3rd Edition, New Delhi, 1988.
4. Viswanadham, N, Narahari, Y, “Performance Modelling of Automated Manufacturing Systems”, Prentice Hall of India, New Delhi, 1994.

19PCD506	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on various techniques ofmaterial characterization.

UNIT I INTRODUCTION 9

Classification of optimization problems, concepts of design vector, Design constraints, constrains surface,objective function surface and multi-level optimization, parametric linear programming

UNIT II EXPERIMENTAL DESIGN FUNDAMENTALS 9

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps inexperimentation, sample size, normal probability plot, linear regression model.

UNIT III DECISION ANALYSIS 9

Decision Trees, Utility theory, Game theory, Multi Objective Optimization, MCDM- Goal Programming,Analytic Hierarchy process.

UNIT IV NON-TRADITIONAL OPTIMIZATION 9

Introduction to Genetic algorithms-Applications- introduction to Simulated Annealing-application.

UNIT V MECHANICAL TESTING – DYNAMIC TESTS 9

Artificial neural network – Activation function –Supervised COURSE – unsupervised COURSE-backpropagation network- self organized network- hop-field network.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Review the fundamentals experimental design
- Analyze the Utility theory, Game theory.
- Describe the decision analyze method
- Illustrate the GA,SA
- Explain the Activation functions

REFERENCES:

- Rao, Singaresu, S, “Engineering Optimization – Theory & Practice”, John wilely and sons, 1996.
- Kalyanamoy Deb, “Optimization for Engineering design”, Prentice Hall of India Pvt, 2003
- Ravindran Phillips Solberg, “Operations Research – Principles and Practice”, John Wiley India, 2006.
- Fredrick S.Hillier and G.J.Liberman, “Introduction to Operations Research”, McGraw Hill Inc., 1995.
- Christos H. Papadimitriou, Kenneth Steiglitz, “Combinatorial Optimization”, PHI, 2006.

19PCD507	INDUSTRIAL SAFETY MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

To understand the basic concepts and Principles in the area Safety, health and hazards.

UNIT I SAFETY MANAGEMENT 9

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

UNIT II OPERATIONAL SAFETY 9

Hot metal Operation - Boiler, pressure vessels - heat treatment shop - gas furnace operation – electroplating-hotbending pipes - Safety in welding and cutting. Cold-metal Operation - Safety in Machine shop - Cold bending and chamfering of pipes – metal cutting - shot blasting, grinding, painting - power press and other machines.

UNIT III SAFETY MEASURES 9

Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrialfires and prevention - Road safety - highway and urban safety -Safety of sewage disposal and cleaning - Controlof environmental pollution – Managing emergencies in Industries - planning, security and risk assessments, on-site and off site. Control of major industrial hazards.

UNIT IV ACCIDENT PREVENTION 9

Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP – Training and development of employees - First Aid-Fire fighting devices - Accident reporting, investigation.

UNIT V SAFETY, HEALTH, WELFARE & LAWS 9

Safety and health standards - Industrial hygiene - occupational diseases prevention -Welfare facilities - History of legislations related to Safety-pressure vessel act-Indian boiler act - The environmental protection act - Electricity act - Explosive act.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Demonstrate about personal safety devices
- Summarize the First Aid- Firefighting devices
- Identify the Safety rules for Machine shop
- Prepare the planning, security and risk assessments.
- Estimate the accident cost using supervisors report and data.
- Evaluate the safety performance of an organization from accident records.

REFERENCES:

1. John V. Grimaldi and Rollin H. Simonds, “Safety Management”, All India Travellers bookseller, New Delhi, 1989.
2. Krishnan N.V, “Safety in Industry”, Jaico Publisher House, 1996.
3. Naseer Elahi, “Industrial safety management”, Gyan Publishing House, 2006.
4. “Industrial safety and the law”, P.M.C. Nair Publisher's, Trivandrum.
5. “Managing emergencies in industries”, Loss Prevention of India Ltd., 1996.
6. Singh, U.K., Dewan, J.M , “Safety, Security and risk management ”, APH Publishing Company, New Delhi, 1996.

CO/PO MAPPING

CO	POs					
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19PCD507			**3**		**3**	**3**

19PCD508 INTERGRATED MANUFACTURING SYSTEM

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basic concepts and Principles in the area Computer Aided Planning And Control, Manufacturing Systems and Computer Monitoring

UNIT I INTRODUCTION **9**

Objectives of manufacturing system-Production system facilities, Automation of productionsystems, manufacturing operations. Product/production relationship

UNIT II COMPUTER AIDED PLANNING AND CONTROL **9**

Production planning and control-cost planning and control-inventory management-Material requirements planning (MRP) - MRP II, ERP - shop floor control-Factory data collection system-Automatic identification system-barcode technology- automated data collection system

UNIT III MANUFACTURING SYSTEMS **9**

Introduction about Flexible manufacturing systems, Manual assembly lines – fundamentals, alternative systems, design for assembly, mixed model assembly and other considerations in assembly line design. Transfer lines – fundamentals, applications, analysis of transfer lines with no internal storage and storage buffers. Automated assembly systems – fundamentals, design andquantitative analysis

UNIT IV COMPUTER MONITORING **9**

Types of production monitoring systems-structure model of manufacturing process -process control & strategies- direct digital control-supervisory computer control-computer in QC - contactinspection methods non-contact inspection method - computer-aided testing - integration of CAQC with CAD/CAM

UNIT V INTEGRATED MANUFACTURING SYSTEM **9**

Definition - application - features - types of manufacturing systems- computer control system - DNC systems manufacturing cell. Overview of material handling equipment, considerations in material handling system design, principles of material handling-CAD/CAM system – human labor in the manufacturing system-computer integrated manufacturing system benefits. Rapid prototyping - Artificial Intelligence and Expert system in CIM

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Name the Objectives of manufacturing system
- Plan the Material requirements (MRP) - MRP II, ERP
- Analysis of transfer lines with no internal storage and storage buffers
- Describe the Artificial Intelligence and Expert system in CIM

REFERENCES:

1. David Bedworth," Computer Integrated Design and Manufacturing ", TMH, New Delhi, 1998.
2. YoremKoren," Computer Integrated Manufacturing Systems ", McGraw Hill,1983.
3. Ranky, Paul G.," Computer Integrated Manufacturing ", Prentice Hall International, 1986.
4. Yeomamas R.W. ,Choudry A. andTen Hagen P.J.W., " Design rules for a CIM system ", North Holland Amsterdam, 1985.

19PCD509	VIBRATION ANALYSIS AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understands the Fundamentals of Vibration and its practical applications.
- To understand the working principle and operations of various vibrations Measuring instruments
- To understand the various Vibration control strategies

UNIT I FUNDAMENTALS OF VIBRATION **9**

Introduction -Sources Of Vibration-Mathematical Models- Displacement, velocity and Acceleration-Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response to Arbitrary andnon- harmonic Excitations Transient Vibration –Impulse loads-Critical Speed of Shaft-Rotor systems.

UNIT II TWO DEGREE FREEDOM SYSTEM **9**

Introduction-Free Vibration of Undamped And Damped- Forced Vibration With Harmonic Excitation System –Coordinate Couplings And Principal Coordinates.

UNIT III MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM **9**

Multi Degree Freedom System –Influence Coefficients and stiffness coefficients-Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method –Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space,Lanczos method - Continuous System: Vibration of String, Shafts and Beams.

UNIT IV VIBRATION CONTROL **9**

Specification of Vibration Limits –Vibration severity standards- Vibration as condition Monitoring tool-Vibration Isolation methods- -Dynamic Vibration Absorber, Torsional and Pendulum Type Absorber-Damped Vibration absorbers-Static and Dynamic Balancing-Balancing machines-Field balancing – Vibration Control by Design Modification- - Active Vibration Control.

UNIT V EXPERIMENTAL METHODS IN VIBRATION ANALYSIS **9**

Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. –Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments - System Identification from Frequency Response -Testing for resonance and mode shapes.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Calculate the critical speed of shaft.
- Analyze the vibration of undammed and damped.
- Analyze the Vibration of String, Shafts and Beams.
- Describe about the selection of sensors.
- Experiment on vibration analyze

REFERENCES:

1. Rao, S.S, “Mechanical Vibrations”, Addison Wesley Longman, 1995.
2. Thomson W.T, “Theory of Vibration with Applications”, CBS Publishers and Distributors, New Delhi, 1990.
3. Ramamurti .V, “ Mechanical Vibration Practice with Basic Theory”, Narosa, New Delhi, 2000.
4. Graham Kelly.S and Shashidar K. Kudari, “Mechanical Vibrations”, Tata McGraw–Hill Publishing Com. Ltd., New Delhi, 2007.
5. V. Rao Dukkipati, and J. Srinivas , “Reference book of Mechanical Vibrations”, PHI COURSE private Ltd., New Delhi, 2007.
6. R. N. Iyengar, “Elements of Mechanical Vibration”, I.K International publishing house private Ltd., New Delhi, 2010.

19PCD510 METROLOGY AND NON DESTRUCTIVE TESTING	L	T	P	C
	3	0	0	3

OBJECTIVES:

- To introduce different types of sensors, transducers and strain gauges used for Measurement.
- To give knowledge about Statistical measures and tools
- To familiarize students with non destructive testing on machine components

UNIT I MEASURING MACHINES 9

Tool Maker's microscope - Co-ordinate measuring machines - Universal measuring machine - Laser viewers for production profile checks - Image shearing microscope – Use of computers - Machine vision technology - Microprocessors in metrology.

UNIT II STATISTICAL QUALITY CONTROL 9

Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Reliability and life testing.

UNIT III LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS 9

Characteristics of liquid penetrants - different washable systems - Developers -applications - methods of production of magnetic fields - Principles of operation of magnetic particle test - Applications –Advantages and limitations.

UNIT IV RADIO GRAPHY 9

Sources of ray-x-ray production - properties of d and x rays - film characteristics -exposure charts - contrasts - operational characteristics of x ray equipment -applications.

UNIT V ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES 9

Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques Advantages and limitations - Instrumentation - applications.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Discuss the principles and operation of various measuring machines used in metrology and NDT.
2. Apply Process capability, Confidence and tolerance limits in quality control processes.
3. Utilize developers effectively in liquid penetrant tests to enhance defect visibility.
4. Apply and analyze the operational characteristics of x-ray equipment and its applications.
5. Analyze the principles and applications of the pulse echo method (A, B, C scans).
6. Analyze the advantages and limitations of Ultrasonic and acoustic emission techniques in Structural health monitoring.

REFERENCES:

1. Jain R.K, “Engineering Metrology”, Khanna Publishers, 1997.
2. Barry Hull and Vernon John, “Non Destructive Testing”, MacMillan, 1988.
3. American Society for Metals, “Metals Hand Book”, 1976.
4. Progress in Acoustic Emission, “Proceedings of 10th International Acoustic Emission Symposium”, Japanese Society for NDI, 1990.

CO/PO MAPPING

CO	POs					
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CO.2			2			
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CO.4	2		3	3	3	3
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19PCD510	**3**		**3**	**3**	**3**	**3**

19PCD511	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on advanced mechanics of materials

UNIT I INTRODUCTION 9

Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions-representation of three-dimensional stress of a tension generalized hook's law- St. Venant's principle - plane stress - Airy's stress function. Energy methods.

UNIT II SHEAR CENTER AND UNSYMMETRICAL BENDING 9

Location of shear center for various thin sections - shear flows. Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT III CURVED FLEXIBLE MEMBERS AND STRESSES IN FLAT PLATES 9

Circumference and radial stresses – deflections - curved beam with restrained ends -closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions.

UNIT IV TORSION OF NON-CIRCULAR SECTIONS 9

Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy - Prandtl's stress function -torsional stress in hollow thin walled Stress

UNIT V STRESSES IN ROTARY SECTIONS AND CONTACT STRESSES 9

Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress deflection of bodies in point and line contact applications.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Calculate the stress-strain relation.
- Locate the shear center for various thin sections.
- Calculate the Tensional stress in hollow thin walled Stress.
- Evaluate the Torsion of rectangular cross section
- List the application of Methods of computing contact stress deflection of bodies in point and line contact.

REFERENCES:

- Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”, John Wiley, 2002.
- Timoshenko and Goodier, “Theory of Elasticity”, McGraw Hill.
- Robert D. Cook, Warren C. Young, “Advanced Mechanics of Materials”, Mcmillan pub. Co., 1985.
- Srinath L.S, “Advanced Mechanics of solids”, Tata McGraw Hill , 1992..
- Ryder G.H, “Strength of Materials”, Macmillan, India Ltd., 2007.

		L	T	P	C
19PCD512	**DESIGN OF MATERIAL HANDLING EQUIPMENTS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- This course aims at imparting knowledge on Design of material handling equipments

UNIT I MATERIALS HANDLING EQUIPMENT **9**

Types, selection of material handling equipment and applications.

UNIT II DESIGN OF HOISTS **9**

Design of hoisting elements: Welded and roller chains - Hemp and wire ropes - Design of ropes, pulleys, pulley systems, sprockets and drums, Load handling attachments. Design of forged hooks and eye hooks – crane grabs - lifting magnets - Grabbing attachments -Design of arresting gear - Brakes: shoe, band and cone types.

UNIT III DRIVES OF HOISTING GEAR **9**

Hand and power drives - Traveling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing,jib and luffing gear - cogwheel drive - selecting the motor ratings.

UNIT IV CONVEYORS **9**

Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumaticconveyors, Screw conveyors and vibratory conveyors.

UNIT V ELEVATORS **9**

Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaft way, guides, counterweights, hoisting machine, safety devices - Design of fork lift trucks.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Define the material handling equipments
- Discuss the about Brakes, shoe, band and cone types.
- Select the motor rating.
- Differentiate the Pneumatic conveyors, Screw conveyors
- Design the fork lift trucks

REFERENCES:

1. Rudenko N, “Materials handling equipment”, ELnvee Publishers, 1970.
2. Spivakovsy A.O and Dyachkov V.K., “Conveying Machines”, Volumes I and II, 1985.
3. Alexandrov M, “Materials Handling Equipments”, MIR Publishers,1981.
4. Boltzharol A, “Materials Handling Handbook”, The Ronald Press Company, 1958.
5. P.S.G. Tech, “Design Data Book”, Kalaikathir Achchagam, Coimbatore, 2003.
6. Lingaiah. K. and Narayana Iyengar, “Machine Design Data Hand Book”, Suma Publishers, Vol. 1 and 2, Bangalore, 1983.

19PCD513	ADVANCED TOOL DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- This course aims at imparting knowledge on advanced tool design

UNIT I INTRODUCTION TO TOOL DESIGN 9

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives –Tool Design in manufacturing-Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Non ferrous Tooling Materials- Carbides, Ceramics and Diamond –Non metallictool materials-Designing with relation to heat treatment.

UNIT II DESIGN OF CUTTING TOOLS 9

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-pointcutting tools – Milling cutters – Hole making cutting tools-Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

UNIT III DESIGN OF JIGS AND FIXTURES 10

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages –Indicating Gages – Automaticgages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – Chip formation in drilling – General considerations in the design of drill jigs – Drill bushings – Methods of construction – Thrust and Turning Moments in drilling - Drill jigs and modern manufacturing- Types of Fixtures - Vise Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures – Lathe Fixtures – Grinding Fixtures - Modular Fixtures – Cutting Force Calculations.

UNIT IV DESIGN OF PRESS TOOL DIES 10

Types of Dies –Method of Die operation–Clearance and cutting force calculations-Blanking and Piercing diedesign – Pilots – Strippers and pressure pads- Presswork materials – Strip layout – Short-run tooling for Piercing
– Bending dies – Forming dies Drawing dies-Design and drafting.

UNIT V DESIGN FOR CNC MACHINE TOOLS 8

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changersand tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Select the materials for cutting tools
- Explain about the Oblique and orthogonal cutting
- Describe the design procedure for jig
- Calculate the Clearance and cutting force of press die.
- List out the tool holding methods.

REFERENCES:

1. Cyrll Donaldson, George H.LeCain and, Goold V.C, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000. Hoffman E.G, “Jig and Fixture Design”, Thomson Asia Pvt Ltd., Singapore, 2004.
2. Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000.
3. Venkataraman K, “Design of Jigs, Fixtures and Press tools”, TMH, 2005.
4. Haslehurst M, “Manufacturing Technology”, the ELBS, 1978.

		L	T	P	C
19PCD514	**MECHANISMS DESIGN AND SIMULATION**	**0**	**0**	**3**	**3**

OBJECTIVES:

- This course aims at imparting knowledge on mechanisms design and simulation

UNIT I INTRODUCTION **9**

Review of fundamentals of kinematics-classifications of mechanisms-components of mechanisms – mobility analysis – formation of one D.O.F. multi loop kinematic chains, Network formula – Gross motion concepts-Basickinematic structures of serial and parallel robot manipulators-Compliant mechanisms-Equivalent mechanisms.

UNIT II KINEMATIC ANALYSIS **9**

Position Analysis – Vector loop equations for four bar, slider crank, inverted slider crank, geared five bar and six bar linkages. Analytical methods for velocity and acceleration Analysis– four bar linkage jerk analysis. Plane complex mechanisms-auxiliary point method. Spatial RSSR mechanism-Denavit-Hartenberg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III PATH CURVATURE THEORY, COUPLER CURVE **9**

Fixed and moving centroides, inflection points and inflection circle. Euler Savary equation, graphical constructions – cubic of stationary curvature. Four bar coupler curve-cuspcrunode-coupler driven six-bar mechanisms-straight line mechanisms.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISMS **9**

Type synthesis – Number synthesis – Associated Linkage Concept. Dimensional synthesis – function generation, path generation, motion generation. Graphical methods-Pole technique-inversion technique-point position reduction-two, three and four position synthesis of four- bar mechanisms. Analytical methods- Freudenstein’s Equation-Bloch’s Synthesis.

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS **9**

Cognate Lingages-parallel motion Linkages. Design of six bar mechanisms-single dwell double dwell-double stroke. Geared five bar mechanism-multi-dwell. Cam Mechanisms determination of optimum size of cams. Mechanism defects. Study and use of Mechanism using Simulation Soft-ware packages. Students should designand fabricate a mechanism model as term project.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Derive the formation of one D.O.F. multi loop kinematic chains, Network formula. -
- Analyze the methods for velocity and acceleration.
- Solve the Euler Savory equation, graphical constructions.
- Design a six bar mechanisms.
- Describe the analytical method for four bar mechanism

REFERENCES:

1. Robert L Norton, “Design of Machinery”, Tata McGraw Hill, 2005.
2. Sandor G.N and Erdman A.G, “Advanced Mechanism Design Analysis and Synthesis”, Prentice Hall, 1984.
3. Uicker J.J, Pennock G. R and Shigley J.E, “Theory of Machines and Mechanisms”, Oxford University Press, 2005.
4. Amitabha Ghosh,and Asok Kumar Mallik, “Theory of Mechanism and Machines”, EWLP, Delhi, 1999.
5. Kenneth J, Waldron and Gary L. Kinzel, “Kinematics, Dynamics and Design of Machinery”, John Wiley-sons, 1999.
6. Ramamurti V, “Mechanics of Machines”, Narosa , 2005.

19PCD515	COMPUTATIONAL FLUID DYNAMICS IN MANUFACTURING	L	T	P	C
		0	0	3	3

UNIT I GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD **9**

Classification, Initial and Boundary conditions – Initial and Boundary Value problems –Finite difference method, Central, Forward, Backward difference, Uniform and nonuniform Grids, Numerical Errors, Grid Independence Test.

UNIT II CONDUCTION HEAT TRANSFER **9**

Steady one-dimensional conduction, Two and three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

UNIT III INCOMPRESSIBLE FLUID FLOW **9**

Governing Equations, Stream Function – Verticity method, Determination of pressure for viscous flow , SIMPLE Procedure of Patankar and Spalding, Computation of Boundary layer flow, finite difference approach.

UNIT IV CONVECTION HEAT TRANSFER AND FEM **9**

Steady One-Dimensional and Two-Dimensional Convection – diffusion, Unsteady one dimensional convection – diffusion, Unsteady two-dimensional convection – Diffusion –Introduction to finite element method –solution of steady heat conduction by FEM –Incompressible flow – simulation by FEM.

UNIT V TURBULENCE MODELS **9**

Algebraic Models – One equation model, K – º Models, Standard and High and Low Reynolds number models,Prediction of fluid flow and heat transfer using standard codes

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Solve the Initial and Boundary Value problems.
- Describe about the Two-dimensional Transient Problems.
- Estimate the Solution of steady heat conduction by FEM.
- Apply the standard code for heat transfer
- Describe the one dimensional method for convection heat transfer

REFERENCES:

1. Muralidhar.K and Sundararajan.T, “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 1995.
2. Ghoshdasdidar P.S, “Computer Simulation of flow and heat transfer”, Tata McGraw- Hill Publishing Company Ltd., 1998.
3. Subas and Patankar.V, “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 1980.
4. Taylor.C and Hughes J.B, “Finite Element Programming of the Navier- Stokes Equation”, Pineridge Press Ltd., U.K,1981.
5. Anderson D.A, Tannehill J.I. and Pletcher R.H, “Computational fluid Mechanics and Heat Transfer”, Hemisphere Publishing Corporation, New York, 1984.
6. Fletcher C.A.J, “Computational Techniques for Fluid Dynamics 1- Fundamental and General Techniques”, Springer – Verlag, 1987.
7. Fletcher C.A.J, “Computational Techniques for Fluid Dynamics 1-Specific Techniques for Different Flow Categories”, Springer – Verlag, 1987.
8. Bose T.X, “Numerical Fluid Dynamics”, Narosa Publishing House, 1997.

		L	T	P	C
19PCD516	**RELIABILITY ENGINEERING MODELS**	**3**	**0**	**0**	**3**

OBJECTIVES:

- This course aims at imparting knowledge on reliability engineering models

UNIT I RELIABILITY CONCEPT **9**

Reliability definition – Quality and Reliability– Reliability mathematics – Reliability functions – Hazard rate – Measures of Reliability – Design life –A priori and posteriori probabilities – Mortality of a component –Bath tubcurve – Useful life.

UNIT II FAILURE DATA ANALYSIS **9**

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data –Time to failuredistributions: Exponential, Weibull – Hazard plotting – Goodness of fit tests.

UNIT III RELIABILITY ASSESSMENT **9**

Different configurations – Redundancy – m/n system – Complex systems: RBD – Baye's method – Cut and tiesets – Fault Tree Analysis – Standby system.

UNIT IV RELIABILITY MONITORING **9**

Life testing methods: Failure terminated – Time terminated – Sequential Testing –Reliability growth monitoring – Reliability allocation – Software reliability.

UNIT V RELIABILITY IMPROVEMENT **9**

Analysis of downtime – Repair time distribution – System MTTR – Maintainability prediction – Measures ofmaintainability – System Availability – Replacement theory.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Explain about the reliability.
- Solve reliability problem using Exponential, Weibull distributions
- Describe the Goodness of fit tests.
- Analyze the Sequential Testing.
- Explain the maintainability prediction.

REFERENCES:

1. Charles E. Ebeling, “An introduction to Reliability and Maintainability engineering”, TMH, 2000.
2. Roy Billington and Ronald N. Allan, “Reliability Evaluation of Engineering Systems”, Springer, 2000.
3. Joel A. Nachlas, “Reliability Engineering: Probabilistic Models and Maintenance Methods”, Tailor and Francis group 2005.
4. E. Balagurusamy , “Reliability Engineering”, Tata McGraw-Hill Education, 1984

	L	T	P	C
19PCD517 MAINTENANCE ENGINEERING AND MANAGEMENT	**3**	**0**	**0**	**3**

OBJECTIVES:

- This course aims at imparting knowledge on maintenance engineering and management in industrialapplications

UNIT I INTRODUCTION **9**

Maintenance definition – Maintenance objectives – Maintenance management –Functions of maintenancedepartment – Tero technology – Maintenance costs- The Tero technology system - The Tero technology process – introducing Tero technology into programmes – strategies for Tero technology.

UNIT II MAINTENANCE MODELS **9**

Maintenance policies – Imperfect maintenance – PM versus b/d maintenance – Optimal PM schedule and productcharacteristics – Inspection decisions: Maximizing profit –Minimizing downtime – Replacement models.

UNIT III MAINTENANCE LOGISTICS **9**

Maintenance staffing – Human factors –Resource requirements: Optimal size of service facility – Optimal repaireffort – Maintenance planning and scheduling – Spares planning –Capital spare.

UNIT IV MAINTENANCE QUALITY **9**

Five Zero concept –FMECA – Maintainability prediction– Design for maintainability –Maintainability allocation

– Reliability Centered Maintenance.

UNIT V TOTAL PRODUCTIVE MAINTENANCE **9**

TPM fundamentals – Chronic and sporadic losses – Six big losses – OEE as a measure TPM pillars Autonomousmaintenance –TPM implementation-

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- Define the objectives of Maintenance .
- Explain the preventive maintenance.
- Summarize the Maintenance scheduling methods
- Explain the Reliability Centered Maintenance.
- Describe the TBM implementation

REFERENCES:

1. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993. Andrew K.S.Jardine and Albert H.C.Tsang, “Maintenance, Replacement and Reliability”, Taylor and Francis, 2006.
2. Bikas Badhury and Basu S.K, “Tero Technology: Reliability Engineering and Maintenance Management”, Asian Books, 2003.
3. Seichi Nakajima, “Total Productive Maintenance”, Productivity Press, 1993.
4. R. C. Mishra and K. Pathak , “Maintenance Engineering And Management”, PHI COURSE private Ltd, 2012.

	L	T	P	C
19PCD518 INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	**3**	**0**	**0**	**3**

OBJECTIVES:

- This course is designed to provide students with the fundamental knowledge of robotics to be used in the various industrial applications.
- To give knowledge about the Industrial Robots programming software.
- Familiar with the application of sensors in robotics.

UNIT I INTRODUCTION AND ROBOT KINEMATICS 9

Definition need and scope of Industrial robots – Robot anatomy – Work volume –Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics –Methods for orientation and location of objects.

UNIT II ROBOT DRIVES AND CONTROL 9

Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers.

UNIT III ROBOT SENSORS 9

Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic visionsystem – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing -Image segmentation – Pattern recognition – Training of vision system.

UNIT IV ROBOT CELL DESIGN AND APPLICATION 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple Robots and machineinterference – Robot cycle time analysis. Industrial application of robots.

UNIT V ROBOT PROGRAMMING, ARTIFICIAL INTELLIGENCE AND EXPERT SYSTEMS 9

Methods of Robot Programming – Characteristics of task level languages lead through programming methods – textual robot languages - Motion interpolation. Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Classify different types of end effectors design as well as actuator and drives.
2. Classify various robot systems to be used in the various industrial applications.
3. Select the suitable sensors required for robots of specific applications.
4. Apply the knowledge of kinematics for robots.
5. Develop and analyze programming principles and languages for a robot control system.
6. Develop a robot for simple application to have controlled motion

REFERENCES:

1. K.S.Fu, R.C. Gonzalez and C.S.G. Lee, “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill, 1987.
2. Yoram Koren, “Robotics for Engineers”, McGraw-Hill, 1987.
3. Kozyrey.Yu, “Industrial Robots”, MIR Publishers Moscow,1985.
4. Richard. D, Klafter, Thomas. A, Chmielewski and Michael Negin, “Robotics Engineering – An Integrated Approach”, Prentice-Hall of India Pvt. Ltd., 1984.
5. Deb S.R, “Robotics Technology and Flexible Automation”, Tata Mc Graw-Hill, 1994.
6. Mikell P. Groover, Mitchell Weis, Roger, N. Nagel Nicholas and G. Odrey, “Industrial Robotics Technology, Programming and Applica tions”, McGraw-Hill, Int,1986.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2						
CO.3	2		3	2	3	2
CO.4			3	2	2	
CO.5	3	3	3	3	2	2
CO.6	3	2	3	3	3	2
19PCD518	**3**	**3**	**3**	**3**	**3**	**2**

19PCD519	LEAN MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The aim is to appreciate the students with the background, applications and current status of leanmanufacturing and to make them understand the relevant basic principles in this field.

UNIT I INTRODUCTION 9

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

UNIT II STABILITY OF LEAN SYSTEM 9

Standards in the lean system – 5S system – Total Productive Maintenance – standardized work –Elements of standardized work – Charts to define standardized work – Man power reduction – Overall efficiency - standardized work and Kaizen – Common layouts

UNIT III JUST IN TIME 9

Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role ofconveyance – Production leveling – Pull systems – Value stream mapping.

UNIT IV JIDOKA (AUTOMATION WITH A HUMAN TOUCH) 9

Jidoka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poka-Yoke systems – Implementation of Jidoka

UNIT V WORKER INVOLVEMENT AND SYSTEMATIC PLANNING METHODOLOGY 9

Involvement – Activities to support involvement – Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Phases of Hoshin Planning – Lean culture.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Discuss the components of the 5S system and their roles in maintaining a lean system.
2. Apply the principles of standardized work to optimize processes in a manufacturing setting.
3. Design a Kanban system for inventory management in a manufacturing environment.
4. Evaluate the effectiveness of various quality circle activities in promoting worker involvement.
5. Assess the impact of JIT production on reducing lead times and inventory costs.
6. Analyze case studies of successful lean implementations to identify key factors contributing to their success.

REFERENCES:

1. Jeffrey Liker, “The Toyota Way: Fourteen Management Principles from the World Greatest Manufacturer”, McGraw Hill, 2004.
2. Michael L. George, “Lean Six SIGMA: Combining Six SIGMA Quality with Lean Production Speed”, McGraw Hill, 2002.
3. Taiichi Ohno, “Toyota Production System: Beyond Large-Scale Production”, Taylor and Francis, Inc., 1988.
4. Pascal Dennis, “Lean manufacturing simplified”, Productivity Press New York, 2007.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2	2				3	3
CO.3	3		2	3	3	3
CO.4	3				3	3
CO.5	3		2		3	3
CO.6	3		2	3	3	3
19PCD519	**3**		**2**	**3**	**3**	**3**

19PCD520 DESIGN OF CELLULAR MANUFACTURING SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES:

To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

UNIT I INTRODUCTION **9**

Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and designof groups, benefits of GT and issues in GT.

UNIT II COMPUTER AIDED PLANNING AND CONTROL **9**

Problems in GT/CMS - Design of CMS - Models, traditional approaches and nontraditional approaches -GeneticAlgorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATION OF GT/CMS **9**

Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

UNIT IV PERFORMANCE MEASUREMENT AND CONTROL 9

Measuring CMS performance - Parametric analysis - PBC in GT/CMS, cell loading, GT and MRP - framework.

UNIT V ECONOMICS OF GT/CMS 9

Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Describe** the characteristics of groups.
- **Explain** about Traditional and non-traditional approaches of Problem solving.
- **Analyze the** Human and economical aspects of CMS.
- **Differentiate** the Conventional Vs group use of computer models in GT/CMS.
- **Prepare** the planning for material requirement

REFERENCES:

1. Askin R.G. and Vakharia A.J.G.T, “Planning and Operation, in The automated factory-Hand Book: Technology and Management”, Cleland.D.I and Bidananda.B, TAB Books, NY, 1991.
2. Kamrani, A.K, Parsaei, H.R and Liles, D.H, “Planning, design and analysis of cellularmanufacturing systems”, Elsevier,1995.
3. Burbidge J.L, “Group Technology in Engineering”, Mechanical Engineering publications,London, 1979.
4. Shahrukh A. Iran , “Hand book of Cellular Manufacturing Systems ”, john wiley and sonsCanada 1999.
5. N.Singh, and D.Rajamani, “Cellular Manufacturing Systems: Design, Planning and Control”,Springer London, Limited, 2011.

19PCD521	INTEGRATED PRODUCT DESIGN AND PROCESSES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To analysis of Customer need and feasibility of manufacturing the product.
- To analysis and Redesign the component by the influence of Experts and competitive behavior.
- To design the component by functional one and to satisfy the customer.

UNIT I INTRODUCTION 9

Need for IPPD-Strategic importance of Product development - integration of customer, designer, materialsupplier and process planner, Competitor and customer – behavior analysis. Understanding customer- promoting customer understanding- involve customer in development and managing requirements – Organization process management and improvement.

UNIT II CONCEPT GENERATION, SELECTION AND TESTING 9

Plan and establish product specifications. Task - Structured approaches - clarification - search-externally and internally-Explore systematically - reflect on the solutions and processes - concept selection - methodology - benefits. Implications - Product change - variety - component standardization - product performance - manufacturability – Concept Testing Methodologies.

UNIT III PRODUCT ARCHITECTURE 9

Product development management - establishing the architecture - creation - clustering -geometric layoutdevelopment - Fundamental and incidental interactions - related system level design issues – secondary systems
-architecture of the chunks - creating detailed interface specifications-Portfolio Architecture.

UNIT IV INDUSTRIAL DESIGN 9

Integrated process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulatingproduct performance and manufacturing processes electronically -Need for industrial design-impact – design process - investigation of customer needs - conceptualization - refinement – management of the industrial design process -technology driven products - user - driven products - assessing the quality of industrial design.

UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT **9**

Definition - Estimation of Manufacturing cost-reducing the component costs and assembly costs – Minimizesystem complexity - Prototype basics - Principles of prototyping -Planning for prototypes - Economic Analysis - Understanding and representing tasks baseline project planning - accelerating the project-project execution.

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Summarize the integration between the customer, the designer, the material supplier, the process planner and the competitor.
2. Identify various basics of product development, concept generation, selection and testing techniques.
3. Examine an acceptable aesthetic product using the basics of a product, including appearance, shape, colour, sensory attributes and relating to the consumers.
4. Select the stages of product architecture, the product prototypes and developing the process.
5. Develop the component with a functional focus and customer satisfaction in mind.
6. Organize the aspects of design such as industrial design, design for manufacture, assembly, service and quality.

REFERENCES:

1. Karl T. Ulrich, Steven D. Eppinger, “Product Design and Development”, McGraw – HillInternational Edns, 1999.
2. Kemnneth Crow, “Concurrent Engg. Integrated Product Development”, Palos Verdes.
3. Stephen Rosenthal, Business One Orwin, “Effective Product Design and Development”,Homewood, 1992.
4. Stuart Pugh, “Tool Design – Integrated Methods for successful Product Engineering”,Addison Wesley Publishing, Newyork, NY, 1991.
5. Clark, Kim B, and Takahiro fujimoto, “Product Development performance; strategy, organization and management in the work auto industry”, Harvard Business school press,Boston, 1991.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2			3			
CO.3			3			
CO.4			3			
CO.5		3	3			3
CO.6		3	3	2	2	3
19PCD521		**3**	**3**	**2**	**2**	**3**

Ref: 3-Strong 2-Medium 1 –Weak

19PCD522	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT I INTRODUCTION **9**

Need - Development of AM systems – AM process chain - Impact of AM on Product Development - Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes-Benefits-Applications..

UNIT II REVERSE ENGINEERING AND CAD MODELING **9**

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wire frame, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS **9**

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.

Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS **9**

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS **9**

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing

(BPM), Selective Laser Melting, Electron Beam Melting.

Total: 45 Periods

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

- **Develop** the additive manufacturing systems
- **Model** the Wire frame, surface and solid modeling by Geometric modeling techniques
- **Describe** the solid ground curing.
- **Formulate** the SDM
- **Summarize** the strength and weakness of 3DP systems.

REFERENCES:

1. Groover M.P, “Automation, Production System and CIM”, Prentice-Hall, India, 1998.
2. Gibson I, Rosen D.W, Choudry A and Stucker B, “Additive Manufacturing Methodologies Rapid prototyping to direct digital manufacturing”, Springer, 2011.
3. Chua C.K, Leong K.F and Lim C.S, “Rapid prototyping: Principles and applications”, second edition World Scientific Publishers, 2010.
4. Gebhardt A, “Rapid prototyping”, Hanser Gardener Publications, 2003.
5. Liou L.W and Liou F.W. “Rapid Prototyping And Engineering Applications: A tool box for prototype development ”, CRC Press, 2011.
6. Kamrani, A.K and Nasr E.A, “Rapid Prototyping: Theory and practice ”, Springer, 2006.
7. Hilton P.D and Jacobs P.F, “Rapid Tooling: Technologies and Industrial Applications”, CRC press, 2005.

LIST OF OPEN ELECTIVES

S. No.	Course Code	Course Name	L	T	P	C
1.	19PCD601	Industrial Safety	3	0	0	3

19PCD601	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the operational safety
- To understand the safety management

UNIT I ACCIDENT INVESTIGATION AND ANALYSIS 9

Concept of an Accident, reportable and non reportable accidents, reporting to statutory authorities. Principles of accident prevention-accident investigation and analysis-Unsafe act and unsafe condition- Domino sequence-cost of accidents-permanent total disabilities, Permanent partial disabilities, Temporary total disabilities-Calculation of frequency rate and severity rate of accidents.

UNIT II ERGONOMICS AND HUMAN BEHAVIOUR 9

Introduction to ergonomics and its area of application in the work system. Anatomy, Posture and body mechanics-low back pain, risk factors for musculoskeletal disorders in the work place-behavioral aspects of posture - effectiveness. Individual differences, Factors contributing to personality, fitting the man to the job. Motivation -job satisfaction - Frustration and conflicts, reaction to frustration, emotion and frustration. Attitudes - determination of attitudes- changing attitudes.

UNIT III HAZARDS AND THEIR CONTROL 9

Physical hazards-Noise, heat, vibration, ionizing and non-ionizing radiations, and effects. Chemical hazards-dusts, fumes, mist, vapor, fog, gases, types, concentration, exposure Vs dose, TLV. Mechanical hazards. Engineering control methods- use of personal protective equipments.

UNIT IV FIRE PREVENTION AND PROTECTION 9

Fire triangle-principles of fire extinguishing- various classes of fires- A, B, C, D types of fire extinguishers- Industrial fire protection systems. Sprinklers- Fire hydrants- Alarm and detection systems- other suppression systems- CO2 system, foam system and DCP system.

UNIT V SAFETY MANAGEMENT TECHNIQUES, EDUCATION AND TRAINING 9

Incident Recall Technique (IRT), disaster control, Job safety Analysis, Safety survey, safety inspection. Safety training programs, seminars, conferences, competitions- method of promoting safe practice- motivation- creating awareness, awards, celebrations, safety posters, safety displays, safety incentive scheme- domestic safety and training.

Total: 45 PERIODS

COURSE OUTCOMES:

After successful completion of this course, the Students will be able to

1. Understand the impact of posture and body mechanics on health.
2. Apply knowledge of exposure limits and engineering control methods, including the use of personal protective equipment, to reduce risk exposure.
3. Apply principles of fire extinguishing and identify appropriate types of fire extinguishers and industrial fire protection systems for different classes of fires.
4. Design or evaluate fire protection systems for a given industrial setting, including the selection of appropriate alarm, detection, and suppression systems.
5. Develop hazard control plans that integrate multiple strategies for hazard mitigation

and compliance with safety standards.

6. Develop comprehensive safety training programs and initiatives aimed at promoting safe practices, motivation, and awareness among employees.

TEXT BOOKS:

1. Heinrich.H.W. “Industrial Accident Prevention”, McGraw Hill Company, New York, 1980.
2. John V. Grimaldi and Rollin H. Simonds, “Safety Management” , All India Travellers Book Seller, New Delhi, 1989.
3. E.J.McCormick and M.S. Sanders “Human Factors in Engineering and Design”, TMH, New Delhi, 1982.
4. Hand Book of “Occupational Safety and Health”, National Safety Council, Chicago, 1982.
5. Derek, James, “Fire Prevention Hand Book”, Butter Worths and Company, London, 1986.

REFERENCES:

1. Krishnan.N.V. “Safety Management in Industry”, Jaico Publishing House, Bombay, 1997.
2. Lees, F. P. “Loss Prevention in Process Industries”, Butter Worth publications, London, 2nd Edition,1990.
3. Dan Peterson, “Techniques of Safety Management”, McGraw Hill Company, Tokyo, 1981.
4. “Accident Prevention Manual for Industrial Operations”, N.S.C. Chicago, 1982.
5. Hunter, Gomos, “Engineering Design for Safety”, McGraw Hill Inc., 1992.
6. Encyclopedia of “Occupational Health and Safety” Vol I and II, Published by International LabourOffice, Geneva, 1985.
7. Gupta. R.S., “Hand Book of Fire Technology”, Orient Longman, Bombay, 1977.

CO/PO MAPPING

CO	POs					
	1	2	3	4	5	6
CO.1						
CO.2	3		3	3		3
CO.3		2	2	2		3
CO.4		3	3			
CO.5					2	2
CO.6					2	2
19PCD601	3	3	3	3	2	3

Ref: 3-Strong 2-Medium 1 –Weak