SRI SHAKTHI

INSTITUTE OF ENGINEERING AND TECHNOLOGY,
(AUTONOMOUS)
L&T BYPASS ROAD, COIMBATORE - 62

DEPARTMENT OF MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI
M.E in CAD/CAM

REGULATION 2021

SRI SHAKTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

(AUTONOMOUS)

R 2021

M.E – CAD/CAM

CURRICULUM

SEMESTER I								
S.No	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY								
1	21MS101	Applied Mathematics for Mechanical Engineers	BS	4	3	1	0	4
2	21CC101	Computer Applications in Design	PC	3	3	0	0	3
3	21CC102	Advanced Finite Element Analysis	PC	3	3	0	0	3
4	21CC103	Computer Aided Tools for Manufacturing	PC	3	3	0	0	3
5	21CC104	Mechanical Behaviour of Materials	PC	3	3	0	0	3
6	21CC105	Industrial Robotics and Expert Systems	PC	3	3	0	0	3
7	21AC101	Audit Course - 1(Research Paper writing)	HS	2	2	0	0	0
LABORATORY								
8	21CC111	Advanced Analysis and Simulation Lab	PC	4	0	0	4	2
9	21CC112	CAD Laboratory	PC	4	0	0	4	2

SEMESTER - II								
S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21CC201	Research Methodology	ES	3	3	0	0	3
2	21CC202	Design for Manufacture, Assembly and Environments	PC	3	3	0	0	3
3	21CC203	Additive Manufacturing and Tooling	PC	3	3	0	0	3
4	21PCC12	Elective I(Metrology and Non Destructive Testing)	PE	3	3	0	0	3
5	21PCC14	Elective II(Composite Materials and Mechanics)	PE	3	3	0	0	3
6	21PCC17	Elective III(Design for Internet of Things)	PE	3	3	0	0	3
LABORATORY								
7	21CC211	Design Project	PC	4	0	0	4	2
8	21CC212	CAM Laboratory	PC	4	0	0	4	2
9		Audit Course –II	ES	2	2	0	0	0

SEMESTER III								
S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	21CC301	Optimization Techniques in Design	PC	3	3	0	0	3
2	21PCC13	Elective IV (Quality Management Techniques)	PE	3	3	0	0	3
3	21PCC16	Elective V(Product Lifecycle Management)	PE	3	3	0	0	3
LABORATORY								
4	21CC311	Dissertation Phase I	EEC	12	0	0	12	6
5	21CC312	Technical Seminar	EEC	2	0	0	2	1

SEMESTER - IV								
S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21CC411	Dissertation Phase II	EEC	24	0	0	24	12

PROFESSIONAL ELECTIVES

S.NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	21PCC01	Competitive Manufacturing Systems	PE	3	3	0	0	3
2	21PCC02	Computer Control in Process Planning	PE	3	3	0	0	3
3	21PCC03	Advanced Mechanics of Materials	PE	3	3	0	0	3
4	21PCC04	Information Analytics	PE	3	3	0	0	3
5	21PCC05	Mechatronics Applications in Manufacturing	PE	3	3	0	0	3
6	21PCC06	Advanced Tool Design	PE	3	3	0	0	3
7	21PCC07	Mechanisms Design and Simulation	PE	3	3	0	0	3
8	21PCC08	Computational Fluid Dynamics	PE	3	3	0	0	3
9	21PCC09	Reliability in Engineering Systems	PE	3	3	0	0	3
10	21PCC10	Integrated Product Design and Process Development	PE	3	3	0	0	3
11	21PCC11	Performance Modelling and Analysis of Manufacturing System	PE	3	3	0	0	3
12	21PCC12	Metrology and Non Destructive Testing	PE	3	3	0	0	3
13	21PCC13	Quality Management Techniques	PE	3	3	0	0	3
14	21PCC14	Composite Materials and Mechanics	PE	3	3	0	0	3
15	21PCC15	Design of Material Handling Equipment’s	PE	3	3	0	0	3
16	21PCC16	Product Lifecycle Management	PE	3	3	0	0	3
17	21PCC17	Design for Internet of Things	PE	3	3	0	0	3
18	21PCC18	Artificial Intelligent Systems	PE	3	3	0	0	3

AUDIT COURSES*

Semester	Course code	Course Title	Category	Contact Periods	L	T	P	C
I or II	21AC01	English for Research Paper Writing	AC	2	2	0	0	0
I or II	21AC02	Disaster Management	AC	2	2	0	0	0
I or II	21AC03	Stress Management by Yoga	AC	2	2	0	0	0
I or II	21AC04	Personality Development through Life Enlightenment Skills.	AC	2	2	0	0	0

Any two audit courses during I & II semester

21MS101 APPLIED MATHEMATICS FOR MECHANICAL ENGINEERS

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

This course is designed to enrich the knowledge in various advanced mathematical techniques such as Matrix theory, Calculus of variations, Probability and random variables, Laplace transforms and Boundary value problems. The fundamental concepts in these areas will be more useful for the students to model the engineering problems and solving them by applying these methods.

PRE-REQUISITES:

- Basics concepts of Matrices
- System of linear equation
- Basic Probability and Trigonometric functions
- Basic concepts of Differentiation
- Basic concepts of Integration

UNIT I – MATRIX THEORY **9+3**

The Cholesky decomposition – Generalized Eigenvectors – QR factorization – Least squares method – Singular value decomposition.

UNIT II – CALCULUS OF VARIATIONS **9+3**

Variation and its properties – Euler's equation – Functionals dependent on first and higher order derivatives – Functionals dependent on functions of several independent variables – Variational problems with moving boundaries.

UNIT III – PROBABILITYAND RANDOM VARIABLES **9+3**

Probability – Axioms of probability – Conditional probability – Baye's theorem – Random variables – Probability function – Moments – Moment generating functions and their properties – Binomial, Poisson, Uniform, Exponential and Normal distributions (Problems only).

UNIT IV– LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS **9+3**

– Bessel's function – Dirac delta function – Unit step function – Convolution theorem (Problems only) – Inverse Laplace transform: Complex inversion formula – Solutions to partial differential equations: Heat equation – Wave equation.

UNIT V – NUMERICAL SOLUTION OF DIFFERENTIAL EQUATIONS **9+3**

Boundary value problems for ODE – Numerical solution of PDE – Finite difference methods – Solution of Poisson equation – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula – Solution of one dimensional wave equation.

Theory: 45 **Tutorial:15** **Practical:0** **Total: 60 Periods**

COURSE OUTCOMES:

After completing this course, a student will be able to

CO1. Apply various methods in matrix theory to solve system of linear equations.

CO2. Maximizing and minimizing the functional that occur in various branches of engineering disciplines.

CO3. Compute the probability and moments, standard distributions of discrete and continuous random variables in the Engineering problems.

CO4. Apply the Laplace Technique to solve the Partial Differential equations with initial and boundary conditions.

CO5. Solve the Partial Differential equations using different Numerical Techniques.

CO/PO/MAPPING (S/M/W indicates strength of correlation 3 – Strong , 2 – Moderate , 1 – Fair)													**CO/PSO MAPPING**	
COs	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2									2	2	2
CO2	3	2	2									2	2	2
CO3	3	2	2									2	2	2
CO4	3	2	2									2	2	2
CO5	3	2	2									2	2	2

REFERENCE BOOKS :

R1.Bronson, R. “Matrix Operations”, Schaum’s outline series, 2nd Edition, McGraw-Hill, 2011.

R2. Gupta, A.S., “Calculus of variations with applications”, Prentice Hall of India Pvt. Ltd., New Delhi, 1997.

R3. Johnson, R.A., Miller, I and Freund J., “Miller and Freund’s probability and Statistics for Engineers”, Pearson education, Asia, 8th Edition, 2015.

R4. Andrews L.C. and Shivamoggi, B. “Integral Transforms for Engineers”, Prentice Hall of India Pvt. Ltd., New Delhi, 2003.

R5.James, G., “Advanced Modern Engineering Mathematics”,3rd Edition, Pearson Education, 2004.

R6.O'Neil, P.V., “Advanced Engineering Mathematics”, Thomson Asia Pvt., Ltd., Singapore, 2003.

R7. Sankara Rao, K., “Introduction to Partial Differential Equations”, Prentice Hall of India Pvt. Ltd., New Delhi,1997.

R8. Rajasekaran S, “Numerical Methods in Science and Engineering –A Practical Approach”, Wheeler Publishing, 2nd Edition, 1999,

21CC101	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To impart knowledge on computer graphics which are used routinely in diverse areas as science, engineering, medicine, etc.

UNIT I	INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS	9

Output primitives (points, lines, curves etc.,), 2-D & 3-D transformation (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 bicubic surface- Bezier surface and B-Spline surface- surface manipulations.

UNIT III	NURBS AND SOLID MODELING	9

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

UNIT IV	VISUAL REALISM	9

Hidden – Line – Surface – solid removal algorithms shading – coloring. Introduction to parametric and variational geometry based software's and their principles creation of prismatic and lofted 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.

Theory:45	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the fundamentals of computer graphics
CO2 :	Apply different techniques for geometric modelling

CO3 :	Apply different algorithm to create prismatic and lofted parts
CO4 :	Discuss tolerance analysis and mass property calculations
CO5 :	Explain data exchange standards and communication standards

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	1	3		1								2		
CO2	3	3	1		3								2		
CO3	2	2	3		3								2		
CO4	2	2	2		2								2		
CO5	2	1	2		1								2		

REFERENCE BOOKS

R1.	David F. Rogers, James Alan Adams “Mathematical elements for computer graphics” second edition, Tata McGraw-Hill edition.
R2.	Donald Hearn and M. Pauline Baker “Computer Graphics”, Prentice Hall, Inc., 1992.
R3.	Foley, Wan Dam, Feiner and Hughes – Computer graphics principles & practices, Pearson Education – 2003.
R4.	Ibrahim Zeid Mastering CAD/CAM – McGraw Hill, International Edition, 2007.
R5.	William M Neumann and Robert F.Sproul “Principles of Computer Graphics”, Mc Graw Hill Book Co. Singapore, 1989.

21CC102	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

COURSE 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.

Theory:45	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	The students will understand the Finite Element Formulation of Plate and Shell Elements and its application.
CO2 :	The students will be able to gain knowledge in material & geometric non-and plasticity.

CO3 :	The students will be able to solve problems under dynamic conditions by applying various techniques.
CO4 :	The students can arrive at the solutions for fluid mechanics and heat transfer problems.
CO5 :	The students will acquire knowledge in error norms, convergence rates and refinement.
	The students will solve the real world engineering problems using FEA.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	1	2	3		2			2	3				2		
CO2	2	2	2		1			2	1				2		
CO3	1	2	2		3			2	3				2		
CO4	3	1	3		2			1	2				2		
CO5	1	2	2		2			2	2				2		

REFERENCE BOOKS

R1.	Bathe K.J., “Finite Element Procedures in Engineering Analysis”, Prentice Hall, 1990.
R2.	Cook R.D., “Concepts and Applications of Finite Element Analysis”, John Wiley and Sons Inc., New york, 1989.
R3.	Zienkiewicz, O.C. and Taylor, R.L., “The Finite Element Method”, Fourth Edition, Volumes 1 & 2, McGraw Hill International Edition, Physics Services, 1991.

Total Hours:

Theory: 45 Periods	**Tutorial: 0**	**Practical: 0**	**Total: 45 Periods**

21CC103	COMPUTER AIDED TOOLS FOR MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The purpose of this course is to make the students to get familiarized with various computer aided tools that can be implemented in various industrial applications

UNIT I	COMPUTER AIDED MANUFACTURING	9

Manufacturing Processes – Removing, Forming, Deforming and joining – Integration equipments. Integrating CAD and CAM – Machine tools – Point to point and continuous path machining, CNC and DNC –Programming – Basics, Languages, G Code, M Code, – Tool path generation and verification – CAD/CAM– Production Control – Cellular Manufacturing

UNIT II	COMPUTER AIDED PROCESS PLANNING	9

Role of process planning in CAD/CAM Integration – Computer Aided Process Planning – Development, Benefits, Model and Architecture – CAPP Approaches – Variant, Generative and Hybrid – Process and Planning systems – CAM-I, D-CLASS and CMPP – Criteria in selecting a CAPP System.

UNIT III	COMPUTER AIDED INSPECTION	9

Engineering Tolerances – Need for Tolerances – Conventional Tolerances – FITS and LIMITS – Tolerance Accumulation and Surface quality – Geometric Tolerances – Tolerances Practices in design, Drafting and manufacturing – Tolerance Analysis – Tolerance synthesis – Computer Aided Quality control – Contact Inspection Methods – Non Contact Inspection Methods - Non optical.

UNIT IV	REVERSE ENGINEERING	9

Scope and tasks of Reverse Engineering – Domain Analysis – Process Duplicating – Tools for RE – Developing Technical data – Digitizing techniques – Construction of surface model – Solid part model – Characteristic evaluation – Software's and its application – CMM and its feature capturing – surface and solid modeling.

UNIT V	DATA MANAGEMENT	9

Strategies for Reverse Engineering Data management – Software application – Finding renewable software components – Recycling real time embedded software – Design experiments to evaluate a RE tools – Rule based detection for RE user interface – RE of assembly programs

Theory:45	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES	
At the end of the course students should be able to	
CO1 :	Understand and explain the important concepts in manufacturing system
CO2 :	Apply the concepts of Computer Aided Process Planning in manufacturing
CO3 :	Apply computer aided quality control and inspection methods in manufacturing
CO4 :	Apply the reverse engineering concepts for manufacturing
CO5 :	Design and analysis of engineering components using softwares

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1			2			3		2	3				2		
CO2			2			2		3	2				2		
CO3			1			3		2	1				2		
CO4			2			1		1	2				2		
CO5			1			2		3	3				2		

REFERENCE BOOKS

R1.	Catherine A. Ingle, “Reverse Engineering”, Tata Mc Graw Hill Publication, 1994
R2.	David D. Bedworth, Mark R. Henderson, Philp M. Wolfe, “Computer Integrated Design and manufacturing”, Mc Graw Hill International series, 1991
R3.	Donald R. Honra, “Co-ordinate measurement and reverse Engineering, American Gear Manufacturers Association.
R4.	Ibrahim Zeid and R. Sivasubramanian, “CAD/CAM Theory and Practice”, Revised First special Indian Edition, Tata Mc Graw Hill Publication, 2007
R5.	Ibrahim Zeid, “Mastering CAD/CAM”, special Indian Edition, Tata Mc Graw Hill Publication, 2007
R6.	Linda Wills, “Reverse Engineering” Kluwer Academic Press, 1996.

21CC104	MECHANICAL BEHAVIOR OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To know the mechanical behavior of both metallic and non-metallic materials under different loading and temperature conditions.

UNIT I	BASIC CONCEPTS OF MATERIAL BEHAVIOR	9

Elasticity in metals and polymers– Strengthening mechanisms, 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 – High temperature fracture, creep.

UNIT II	FRACTURE AND FRACTURE MECHANICS	9

Types of fracture, basic mechanism of ductile and brittle fracture, Griffith's theory of brittle fracture, Orowan's modification. Izod and Charpy Impacts tests, Ductile to Brittle Transition Temperature (DBTT), Factors affecting DBTT, determination of DBTT. Fracture mechanics-introduction, modes of fracture, stress intensity factor, strain energy release rate, fracture toughness and determination of KIC, introduction to COD, J integral.

UNIT III	BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES	9

Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT IV	CREEP BEHAVIOUR AND TESTING	9

Creep curve, stages in creep curve and explanation, structural changes during creep, creep mechanisms, metallurgical factors affecting creep, high temperature alloys, stress rupture testing, creep testing machines, parametric methods of extrapolation. Deformation Mechanism Maps according to Frost/Ashby.

UNIT V	SELECTION OF MATERIALS	9

Motivation for selection, 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 –

Computer aided materials selection.			
Theory:45	**Tutorial:**	**Practical:**	**Total:45 Periods**

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the mechanical behavior of ductile and brittle materials
CO2 :	Analyze fracture mechanisms for various materials
CO3 :	Familiarize in the area of material behavior under dynamic loading and analyze the reasons for failure of materials
CO4 :	Analyze the creep behavior and testing
CO5 :	Select the materials for the design of engineering structures

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**	
COs	**PROGRAMME OUTCOMES (POs)**											**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3				2	1	2				2	
CO2	2	3	2				1	1	2				2	
CO3	3	3	3				2	1	2				2	
CO4	3	1	2				1	2	1				2	
CO5	2	2	1	1				2	2				1	

REFERENCE BOOKS

R1.	Ashby M.F., materials selection in Mechanical Design 2nd Edition, Butter worth 1999.
R2.	Charles, J.A., Crane, F.A.A. and Fumess, J.A.G., Selection and use of engineering materials, (34d edition), Butterworth-Heiremann, 1997.
R3.	Flinn, R.A., and Trojan, P.K., Engineering Materials and their Applications, (4th Edition) Jaico, 1999.
R4.	George E.Dieter, Mechanical Metallurgy, McGraw Hill, 1988
R5.	Metals Hand book, Vol.10, Failure Analysis and Prevention, (10th Edition), Jaico, 1999.
R6.	Thomas H. Courtney, Mechanical Behavior of Materials, (2nd edition), McGraw Hill, 2000

21CC105	INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To teach students the basics of robotics, construction features, sensor applications, robot cell design, robot programming and application of artificial intelligence and expert systems in robotics.

UNIT I	INTRODUCTION AND ROBOT KINEMATICS	9

Definition need and scope of Industrial robots – Robot anatomy and configurations – 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 vision system – 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 machine interference – 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 – 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.

Theory:45 Periods	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES	
At the end of the course students should be able to	
CO1 :	Apply the working principle of robotics
CO2 :	Demonstrate the different components used in robots
CO3 :	Understand About the robot programming and AI
CO4 :	Understand the applications of robots
CO5 :	Build a robot

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	3			2							2		
CO2	2	1	3	2		1							1		
CO3	3	2	2			2							2		
CO4	3	2	2		1	2							2		
CO5	3	1	2		2								2		

REFERENCE BOOKS

R1.	Deb, S.R." Robotics Technology and Flexible Automation", Tata Mc Graw-Hill, 1994.
R2.	K.S.Fu, R.C. Gonzalez and C.S.G. Lee, "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill, 1987.
R3.	Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey," Industrial Robotics Technology, Programming and Applications", Mc Graw-Hill, Int. 1986.
R4.	Richard. D, Klafter, Thomas, A, Chmielewski, Michael Negin, "Robotics Engineering – An Integrated Approach", Prentice-Hall of India Pvt. Ltd., 1984.
R5.	Timothy Jordanides et al ,"Expert Systems and Robotics ", Springer –Verlag, New York, May 1991.

21CC111	ADVANCED ANALYSIS AND SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To give exposure to software tools needed to analyze engineering problems.
- To expose the students to different applications of simulation and analysis tools.

	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	Force and Stress analysis using link elements in Trusses, cables etc.
2	Stress and deflection analysis in beams with different support conditions.
3	Stress analysis of flat plates and simple shells.
4	Stress analysis of axi – symmetric components.
5	Thermal stress and heat transfer analysis of plates.
6	Thermal stress analysis of cylindrical shells.
7	Vibration analysis of spring-mass systems.
8	Model analysis of Beams.
9	Harmonic, transient and spectrum analysis of simple systems.

COURSE OUTCOME

Upon completion of this course the student can able to

- Create model, analyse and simulate experiments to meet real world system and evaluate the performance.

Total Hours:

Theory: 0	Tutorial: 0	Practical: 60 Periods	Total: 60 Periods

21CC112	CAD LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software's.

CAD LABORATORY

SYLLABUS

- CAD Introduction.
- Sketcher
- Solid modeling –Extrude, Revolve, Sweep, etc and Variational sweep, Loft ,etc
- Surface modeling –Extrude, Sweep, Trim ..etc and Mesh of curves, Free form etc
- Feature manipulation – Copy, Edit, Pattern, Suppress, History operations etc.
- Assembly-Constraints, Exploded Views, Interference check
- Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
- CAD data Exchange formats- IGES, PDES, PARASOLID, DXF and STL

Exercises in Modeling and drafting of Mechanical Components - Assembly using Parametric and feature based Packages like PRO-E / SOLID WORKS /CATIA / NX etc

COURSE OUTCOME

Upon completion of this course the student can able to

- With laboratory classes, it helps the students to get familiarized with the computer applications in design and preparing drawings for various mechanical components.

Total Hours:

Theory: 0	Tutorial: 0	Practical: 45 Periods	Total: 45 Periods

21CC201	RESEARCH METHODOLOGY (Common to all PG Programmes)	L T P C 3 0 0 3

Objectives:

1. Ability to critically evaluate current research and propose possible alternate methods for further work.
2. Ability to develop hypothesis / Problem Statement and methodology for research.
3. Ability to comprehend and deal with complex research issues in order to communicate their scientific results clearly for peer review.

Unit I: Introduction to research methodology

Meaning of Research, Types of Research, Research Process, Problem definition, Objectives of Research, Research Questions, Research design, Approaches to Research, Quantitative vs. Qualitative Approach, Understanding Theory, Building and Validating Theoretical Models, Exploratory vs. Confirmatory Research, Experimental vs Theoretical Research, Importance of reasoning in research.

Unit II: Literature review

Problem Formulation, Understanding Modeling & Simulation, Conducting Literature Review, Referencing, Information Sources, Information Retrieval, Role of libraries in Information Retrieval, Tools for identifying literatures, Indexing and abstracting services, Citation indexes

Unit III: Data collection and sampling design

Experimental Research: Cause effect relationship, Development of Hypothesis, Measurement Systems Analysis, Error Propagation, Validity of experiments, Statistical Design of Experiments, Field Experiments, Data/Variable Types & Classification, Data collection, Numerical and Graphical Data Analysis: Sampling, Observation, Surveys, Inferential Statistics, and Interpretation of Results

Unit IV: Research reports

Preparation of Dissertation and Research Papers, Tables and illustrations, Guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript. References, Citation and listing system of documents

Unit V: Intellectual property rights (IPR) and Patents

Intellectual property rights (IPR) - patents-copyrights-Trademarks-Industrial design geographical indication. Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Plagiarism, Unscientific practices in thesis work, Ethics in science

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Recognize the importance of literature review.

CO2: Identify the different types of research.

CO3: Formulate problem statement and develop mathematical models for different problems.

CO4: Formulate methodology of research and experimental analysis.

CO5: Analyze the results using statistical methods, interpretation of results with reference to similar research outcomes.

CO6: Prepare technical reports and research papers.

Text Books

T1 C.R. Kothari, Research Methodology Methods and Techniques, 2nd Revised edition, New Age

T2 R. Panneerselvam, "Research Methodology", PHI 2004.

Reference Books

R1. Deepak Chawla, Neena Sodhi "Research Methodology concepts and cases " 2nd edition, Vikas Publishing house pvt ltd.

R2. Michael Quinn Patton "Qualitative Research & Evaluation Methods" 3rd edition, Sage Publications .

R3. Paul D. Leedy, Jeanne Ellis Ormrod "Practical Research: Planning and Design", Prentice Hall

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21CC202	DESIGN FOR MANUFACTURE, ASSEMBLY AND ENVIRONMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- To know the concept of design for manufacturing, assembly and environment.
- To know the computer application in design for manufacturing and assembly.

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 – Product design for manual assembly - Product design for automatic assembly – Robotic assembly..

UNIT IV	COMPONENT DESIGN – CASTING CONSIDERATION	9

Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V	DESIGN FOR THE ENVIRONMENT	9

Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines – Example application – Lifecycle assessment – Basic method – AT&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 manufacture – Design for energy efficiency – Design to regulations and standards.

Theory:45	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Select of material, manufacturing process and mechanism for a product
CO2 :	Design a component by considering the form design and machining
CO3 :	Design a component by considering machining process
CO4 :	Design a component based on casting considerations
CO5 :	Design a eco-friendly product

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
COs	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	3				2		2					2	
CO2	2	2	3				2		2					2	
CO3	2	2	3				2		2					2	
CO4	2	2	3				2		2					2	
CO5	2	2	3				3		2					2	

REFERENCE BOOKS

R1.	Boothroyd, G, 1980 Design for Assembly Automation and Product Design. New York, Marcel Dekker.
R2.	Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994.
R3.	Bralla, Design for Manufacture handbook, McGraw hill, 1999.
R4.	Dickson, John. R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995.
R5.	Fixel, J. Design for the Environment McGraw Hill., 1996.
R6.	Graedel T. Allen By. B, Design for the Environment Angle Wood Cliff, Prentice Hall. Reason Pub., 1996.
R7.	Harry Peck , Designing for manufacture, Pitman– 1973
R8.	Kevin Otto and Kristin Wood, Product Design. Pearson Publication, (Fourth Impression) 2009.

21CC203	ADDITIVE MANUFACTURING AND TOOLING	L	T	P	C
		3	0	0	3

COURSE 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	CAD MODELING	9

Basic concept-– 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– Electron Beam melting- Case Studies.

UNIT V	TOOLING	9

Classification, Soft tooling, Production tooling, Bridge tooling, direct and indirect tooling, Fabrication processes, Applications Case studies automotive, aerospace and electronics

industries			
Theory:45	**Tutorial:**	**Practical:**	**Total:45 Periods**

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand history, concepts and terminology of additive manufacturing
CO2 :	Apply the cad modelling concepts for design development
CO3 :	Understand the variety of additive manufacturing techniques
CO4 :	Design and develop newer tooling models
CO5 :	Analyse the cases relevant to mass customization and some of the important research challenges associated with AM and its data processing tools

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2		3		2			2	2				2		
CO2	2		2		3			2	2				2		
CO3	2		1		3			2	1				2		
CO4	2		1		2			3	1				2		
CO5	2		2		2			3	2				2		

REFERENCE BOOKS

R1.	Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
R2.	Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.
R3.	Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
R4.	Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
R5.	Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 2006.
R6.	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2011.

21CC211	DESIGN PROJECT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

- It is proposed to carryout detailed design calculations and analysis of any mechanical component or mechanical system. This helps the students to get familiar with respect to the design methodologies applied to any component or mechanical system subjected to static, dynamic and thermo-mechanical loads.

Each student is required to select any new component or an integrated mechanical system that involves various sub components which are to be designed as per design standards and further required to be analyzed for optimum dimensions with respect to the strength and stiffness.

COURSE OUTCOME

- It helps the students to get familiarized with respect to design standards, design calculations and analysis in designing any mechanical component or system.

Total Hours:

Theory: 0	Tutorial: 0	Practical: 60 Periods	Total: 60 Periods

21CC212	CAM LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

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

CAM LABORATORY

SYLLABUS

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.

EQUIPMENTS FOR CAM LAB

1	Computers 30
2	CAM Software for 3 axis machining or more

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

Total Hours:

Theory: 0	**Tutorial: 0**	**Practical: 45 Periods**	**Total: 45 Periods**

SEMESTER III

21CC301	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To impart knowledge on various categories of existing engineering problems and solutions to such problems through different optimization techniques and approaches.

THEORY COMPONENT CONTENTS

UNIT I UNCONSTRAINED OPTIMIZATION TECHNIQUES 10

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization, Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT II CONSTRAINED OPTIMIZATION TECHNIQUES 10

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

UNIT III ADVANCED OPTIMIZATION TECHNIQUES 10

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

UNIT IV STATIC APPLICATIONS 8

Structural applications – Design of simple truss members - Design applications – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members – Design of springs

UNIT V DYNAMIC APPLICATIONS 7

Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms – Optimum design of simple linkage mechanisms

Theory:45 Tutorial:0 Practical:0 Project:0 Total:45 periods

COURSE OUTCOMES

It helps the students to get familiarized with the different approaches of optimizing (maximizing or minimizing) an engineering problem or a function

REFERENCE BOOKS

1. Goldberg, D.E., “Genetic algorithms in search, optimization and machine”, Barnen, Addison-Wesley, New York, 1989.
2. Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.
3. Kalyanamoy Deb, “Optimization for Engineering design algorithms and Examples”, Prentice Hall of India Pvt. 1995.
4. Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.

20ME302	DESIGN FOR CELLULAR MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

At the end of this course the student should be able to understand

- Concepts and applications of Cellular manufacturing systems
- Traditional and non-traditional approaches of Problem-solving Performance measurement
- Human and economic aspects of CMS.

THEORY COMPONENT CONTENTS

UNIT I INTRODUCTION 2

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

UNIT II CMS PLANNING AND DESIGN 10

Problems in GT/CMS - Design of CMS - Models, traditional approaches and non-traditional approaches -Genetic Algorithms, Simulated Annealing, Neural networks.

UNIT III IMPLEMENTATION OF GT/CMS 10

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 8

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

UNIT V ECONOMICS OF GT/CMS 5

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

Theory:45 Tutorial:0 Practical:0 Project:0 Total:45 periods

COURSE OUTCOMES

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

REFERENCE BOOKS

1. Askin, R.G. and Vakharia, A.J., G.T " Planning and Operation, in the automated factory-Hand
2. Book: Technology and Management ", Cleland.D.I. and Bidananda, B (Eds), TAB Books, NY, 1991
3. Burbidge, J.L. Group "Technology in Engineering Industry", Mechanical Engineering pub.London, 1979.
4. Irani, S.A. " Cellular Manufacturing Systems ", Hand Book
5. Kamrani, A.K, Parsaei, H.R and Liles, D.H. (Eds), " Planning, design and analysis of cellular manufacturing systems ", Elsevier, 1995

20ME303 INDUSTRIAL SAFETY MANAGEMENT L T P C

3 0 0 3

COURSE OBJECTIVES

To achieve an understanding of principles of safety management.

- To enable the students to learn about various functions and activities of safety department.
- To enable students to conduct safety audit and write audit reports effectively in auditing situations.
- To have knowledge about sources of information for safety promotion and training.
- To familiarize students with evaluation of safety performance

THEORY COMPONENT CONTENTS

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-hot bending 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 - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on- site and off site. Control of major industrial hazards.

UNIT 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- Firefighting 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.

Theory:45 Tutorial:0 Practical:0 Project:0 Total:45 periods

COURSE OUTCOMES

- To understand the functions and activities of safety engineering department.
- To carry out a safety audit and prepare a report for the audit.
- To prepare an accident investigation report.
- To estimate the accident cost using supervisors report and data.
- To evaluate the safety performance of an organization from accident records.
- To identify various agencies, support institutions and government organizations involved in safety training and promotion.

REFERENCE BOOKS

1. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum
2. John V. Grimaldi and Rollin H. Simonds, "Safety Management", All India Travellers bookseller, New Delhi-1989.
3. Krishnan N.V., "Safety in Industry", Jaico Publisher House, 1996
4. Managing emergencies in industries, Loss Prevention of India Ltd., Proceedings,1999.
5. Occupational Safety Manual BHEL.
6. Safety security and risk management by U.K. Singh & J.M. Dewan, A.P.H. Publishing company, New Delhi, 1996.
7. Singh, U.K. and Dewan, J.M., "Safety, Security and risk management", APH Publishing Company, New Delhi, 1996.

21PCC01	COMPETITIVE MANUFACTURING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To emphasize the knowledge on the quality improvement, automation, and advanced manufacturing techniques to create the highest-caliber products quickly, efficiently, inexpensively, and in synchronization with the marketing, sales, and customer service of the company.

UNIT I	MANUFACTURING IN A COMPETITIVE ENVIRONMENT	9

Automation of manufacturing process - Numerical control - Adaptive control - material handling and movement - Industrial robots - Sensor technology - flexible fixtures - Design for assembly, disassembly and service.

UNIT II	GROUP TECHNOLOGY & FLEXIBLE MANUFACTURING SYSTEMS	9

Part families - classification and coding - Production flow analysis - Machine cell design - Benefits. Components of FMS - Application work stations - Computer control and functions - Planning, scheduling and control of FMS - Scheduling - Knowledge based scheduling - Hierarchy of computer control - Supervisory computer.

UNIT III	COMPUTER SOFTWARE, SIMULATION AND DATABASE OF FMS	9

System issues - Types of software - specification and selection - Trends - Application of simulation - software - Manufacturing data systems - data flow - CAD/CAM considerations - Planning FMS database.

UNIT IV	LEAN MANUFACTURING	9

Origin of lean production system – Customer focus – Muda (waste) – Standards – 5S system – Total Productive Maintenance – standardized work –Man power reduction – Overall efficiency - Kaizen – Common layouts - Principles of JIT - Jidoka concept – Poka-Yoke (mistake proofing) - Worker Involvement– Quality circle activity – Kaizen training - Suggestion Programmes – Hoshin Planning System (systematic planning methodology) – Lean culture.

UNIT V	JUST IN TIME	9

Characteristics of JIT - Pull method - quality -small lot sizes - work station loads - close supplier ties – flexible work force - line flow strategy - preventive maintenance - Kanban

system - strategic implications - implementation issues - Lean manufacture.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand and explain automation of manufacturing processes
CO2 :	Explain about part families
CO3 :	Discuss the components of FMS and the selection and specification of FMS software
CO4 :	To impart knowledge on the pace of changes in the manufacturing technology
CO5 :	Understand and discuss JIT

CO/PO MAPPING (S/M/W indicates strength of correlation)
3-Strong, 2-Moderate, 1-Fair

CO/PSO Mapping

CO s	PROGRAMME OUTCOMES (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3		2			3							3		
CO2	2		2			3							2		
CO3	2		3			2							3		
CO4	3		2			3							1		
CO5	2		3			3							2		

REFERENCE BOOKS

R1.	Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing ", Third Edition, Prentice-Hall, 2007.
R2.	Jha, N.K. “Handbook of Flexible Manufacturing Systems ", Academic Press Inc., 1991.
R3.	Kalpkjian, “Manufacturing Engineering and Technology ", Addison-Wesley Publishing Co., 1995.
R4.	Pascal Dennis, “Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System”, (Second edition), Productivity Press, New York, 2007.
R5.	Taiichi Ohno, Toyota Production System Beyond Large-Scale Production, Productivity Press, 1988

21PCC02	COMPUTER CONTROL IN PROCESS PLANNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To provide the student with an understanding of the importance of process planning role in manufacturing and the application of Computer Aided Process Planning tool in the present manufacturing scenario.

UNIT I	INTRODUCTION	9

The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning – Process Planning and Concurrent Engineering, CAPP, Group Technology.

UNIT II	PART DESIGN REPRESENTATION	9

Design Drafting - Dimensioning - Conventional tolerance - Geometric tolerance - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MICLASS system.

UNIT III	PROCESS ENGINEERING AND PROCESS PLANNING	9

Experienced, based planning - Decision table and decision trees - Process capability analysis - Process Planning - Variant process planning - Generative approach - Forward and Backward planning, Input format, Al.

UNIT IV	COMPUTER AIDED PROCESS PLANNING SYSTEMS	9

Logical Design of a Process Planning - Implementation considerations -manufacturing system components, production Volume, No. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

UNIT V	AN INTERGRADED PROCESS PLANNING SYSTEMS	9

Totally integrated process planning systems - An Overview - Modulus structure - Data Structure, operation - Report Generation, Expert process planning.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Explain process planning techniques using computers Handle computer aided process planning tool
CO2 :	Discuss part design representation and process planning.
CO3 :	Have a sound knowledge in process planning

CO4 :	Understand and use latest process planning software.
CO5 :	Apply decision making process for appropriate planning idea about various process planning software

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3			3	2	3			3						
CO2	2			2	3	1			3						
CO3	2			1	3	2			3						
CO4	3			2	1	2			2						
CO5	3			2	2	3			3						

REFERENCE BOOKS

R1.	Chang, T.C., " An Expert Process Planning System ", Prentice Hall, 1985.
R2.	Gideon Halevi and Roland D. Weill, " Principles of Process Planning ", A logical approach, Chapman & Hall, 1995.
R3.	Nanua Singh, " Systems Approach to Computer Integrated Design and Manufacturing ", John Wiley & Sons, 1996.
R4.	Rao, “Computer Aided Manufacturing ", Tata McGraw Hill Publishing Co., 2000.
R5.	Tien-Chien Chang, Richard A.Wysk, "An Introduction to automated process planning systems ", Prentice Hall, 1985.

21PCC03	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To know the fundamentals of mechanics of materials under various loading conditions.

UNIT I	ELASTICITY	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	STRESSES IN FLAT PLATES AND CURVED MEMBERS	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 tubes.

UNIT V	STRESSES IN ROTATING MEMBERS 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.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand and explain the concept of stress – strain relationship and general equation of elasticity
CO2 :	Design and analyze the mechanism of shear flow and stresses and deflection in unsymmetrical loading condition.

CO3 :	Design shafts to transmit required power and to design the rotary sections in engineering application.
CO4 :	Analyze the problems in torsion of non circular cross sections
CO5 :	Analyze the problems in contact stresses

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3		1			2									
CO2	2		2			2									
CO3	2		3			3									
CO4	3		2			2									
CO5	3		2			3									

REFERENCE BOOKS

R1.	Allan F. Bower, “Applied Mechanics of Solids”, CRC press – Special Indian Edition - 2012, 2010
R2.	Arthur P Boresi, Richard J. Schmidt, “Advanced mechanics of materials”,John Wiley, 2002.
R3.	G H Ryder Strength of Materials Macmillan, India Ltd, 2007.
R4.	K. Baskar and T.K. Varadan, “Theory of Isotropic/Orthotropic Elasticity”, Ane Books Pvt. Ltd., New Delhi, 2009
R5.	Robert D. Cook, Warren C. Young, "Advanced Mechanics of Materials", Mc-millan pub. Co., 1985.
R6.	Srinath. L.S., “Advanced Mechanics of solids”, Tata McGraw Hill, 1992.
R7.	Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill.

21PCC04	INFORMATION ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To expose the students with fundamental concepts and the tools needed to understand emerging role of information analytics in the organisation.

UNIT I	DATA ANALYTICS LIFE CYCLE	9

Introduction to Big data Business Analytics - State of the practice in analytics role of data scientists - Key roles for successful analytic project - Main phases of life cycle - Developing core deliverables for stakeholders.

UNIT II	STATISTICS	9

Sampling Techniques - Data classification, Tabulation, Frequency and Graphic representation - Measures of central value - Arithmetic mean, Geometric mean, Harmonic mean, Mode, Median, Quartiles, Deciles, Percentile - Measures of variation – Range, IQR, Quartile deviation, Mean deviation, standard deviation, coefficient variance, skewness, Moments & Kurtosis.

UNIT III	PROBABILITY AND HYPOTHESIS TESTING	9

Random variable, distributions, two dimensional R.V, joint probability function, marginal density function. Random vectors - Some special probability distribution - Binomial, Poison, Geometric, uniform, exponential, normal, gamma and Erlang. Multivariate normal distribution - Sampling distribution – Estimation - point, confidence - Test of significance, 1& 2 tailed test, uses of t distribution, F-distribution, χ 2 distribution.

UNIT IV	PREDICTIVE ANALYTICS	9

Predictive modeling and Analysis - Regression Analysis, Multi collinearity, Correlation analysis, Rank correlation coefficient, Multiple correlation, Least square, Curve fitting and goodness of fit.

UNIT V	TIME SERIES FORECASTING AND DESIGN OF EXPERIMENTS	9

Forecasting Models for Time series: MA, SES, TS with trend, season - Design of Experiments, one way classification, two way classification, ANOVA, Latin square, Factorial Design.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the importance of data analysis in the design of new products.
CO2 :	Carry out statistical analysis.
CO3 :	Do probability analysis and hypothesis testing.
CO4 :	Perform predictive analysis.
CO5 :	Learn the effect of forecasting methods and to apply for business process.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3			2		2							2		
CO2	2			2		3							3		
CO3	2			3		2							3		
CO4	3			3		2							2		
CO5	3			3		2							3		

REFERENCE BOOKS

R1.	Alberto Cordoba, “Understanding the Predictive Analytics Lifecycle”, Wiley, 2014.
R2.	Chris Eaton, Dirk Deroos,Tom Deutsch et al.,“Understanding Big Data”,McGrawHIll, 2012.
R3.	James R Evans, “Business Analytics – Methods, Models and Decisions”, Pearson 2013.
R4.	R. N. Prasad, Seema Acharya, “Fundamentals of Business Analytics”, Wiley, 2015.
R5.	S M Ross, “Introduction to Probability and Statistics for Engineers and Scientists”, Academic Foundation, 2011.

21PCC05	MECHATRONICS APPLICATIONS IN MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To impart knowledge about the elements and techniques involved in Mechatronics systems Which are very much essential to understand the emerging field of automation.

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 8085 instructions - 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 relays and counters - Data handling - Analog input / output - Selection of PLC.

UNIT V	DESIGN AND MECHATRONICS	9

Designing - Possible design solutions - Case studies of Mechatronics systems.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Recognize and proficiently apply the relevant sciences and scientific methods to mechatronics engineering, to design solutions to complex problems
CO2 :	Identify, interpret and critically appraise current developments and advanced technologies and apply them to mechatronics engineering
CO3 :	Analyze and to apply theoretical and numerical analysis of phenomena to predict, design, control and optimize the performance of mechatronics engineering systems.
CO4 :	Understand and explain the working of sensors and transducers

CO5 :	Explain the structure of programme logic controllers

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3			3		2							3		
CO2	3			2		3							2		
CO3	3			2		2							2		
CO4	3			2		3							2		
CO5	3			3		2							3		

REFERENCE BOOKS

R1.	Bradley, D.A., Dawson, D, Buru, N.C. and Loader, AJ, "Mechatronics ", Chapman and Hall, 1993
R2.	Ghosh, P.K. and Sridhar, P.R., 0000 to 8085, “Introduction to Microprocessors for Engineers and Scientists ", Second Edition, Prentice Hall, 1995
R3.	Lawrence J.Kamm, " Understanding Electro-Mechanical Engineering, An Introduction to Mechatronics ", Prentice-Hall, 2000.
R4.	Michael B.Histand and David G. Alciatore, " Introduction to Mechatronics and Measurement Systems", McGraw-Hill International Editions, 1999.
R5.	Ramesh.S, Gaonkar, "Microprocessor Architecture, Programming and Applications” Wiley Eastern, 1998.

21PCC06	ADVANCED TOOL DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The purpose of this course is to make the students to get familiarized with the design of various tools that can be implemented for different mechanical operations

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 metallic tool 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-point cutting 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	9

Introduction – Fixed Gages – Gage Tolerances –selection of material for Gages – Indicating Gages – Automatic gages – 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	9

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – 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	TOOL DESIGN FOR CNC MACHINE TOOLS	9

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 changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	It helps the students to get familiarized with advanced tool design for various mechanical operations which includes cutting, jigs and fixtures, press tool dies and modern CNC machine tools.
CO2 :	It helps the students to get understand the Milling cutters
CO3 :	To provides students ability to design the jigs and fixtures which is used in various machines
CO4 :	It helps the students to get ability to calculate the cutting forces of pressed tools
CO5 :	It helps the students to get understand the CNC machine tools , jigs and fixture

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2									2		
CO2	3	2	2	2									2		
CO3	3	2	2	2									2		
CO4	3	2	2	2									2		
CO5	3	2	2	2									2		

REFERENCE BOOKS

R1.	Cyrll Donaldson, George H.LeCain, V.C. Goold, “Tool Design”, Tata McGraw Hill Publishing Company Ltd., 2000.
R2.	E.G. Hoffman,” Jig and Fixture Design”, Thomson Asia Pvt Ltd, Singapore, 2004
R3.	Haslehurst M., “Manufacturing Technology”, The ELBS, 1978
R4.	Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
R5.	Venkataraman K., “Design of Jigs, Fixtures and Press tools”, TMH, 2005

21PCC08	MECHANISMS DESIGN AND SIMULATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To develop a thorough understanding of the various mechanisms and its design and simulation with ability to effectively uses the various mechanisms in real life problems.

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-Basic kinematic 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 - Harten berg Parameters – Forward and inverse kinematics of robot manipulators.

UNIT III	PATH CURVATURE THEORY, COUPLER CURVE	9

Fixed and moving centrodes, 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 design and fabricate a mechanism model as term project			
Theory:45	**Tutorial:**	**Practical:**	**Total:45 Hours**

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	It helps the students to get familiarized with the advanced mechanisms which are necessary to design and simulate mechanisms.
CO2 :	It helps the students to get understand the kinematic analysis of mechanism.
CO3 :	To provide students ability to familiarize the path curvature theory, coupler curve.
CO4 :	It helps the students to get ability to perform the synthesis of four bar mechanisms.
CO5 :	It helps the students to get understand the cam mechanisms.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2									2		
CO2	3	2	2	2									2		
CO3	3	2	2	2									2		
CO4	3	2	2	2									2		
CO5	3	2	2	2									2		

REFERENCE BOOKS

R1.	Amitabha Ghosh and Asok Kumar Mallik, “Theory of Mechanism and Machines”, EWLP, Delhi, 1999.
R2.	Kenneth J, Waldron, Gary L. Kinzel, “Kinematics, Dynamics and Design of Machinery”, John Wiley-sons, 1999.
R3.	Ramamurti, V., “Mechanics of Machines”, Narosa, 2005.
R4.	Robert L.Norton., “Design of Machinery”,Tata McGraw Hill, 2005.
R5.	Sandor G.N., and Erdman A.G., “Advanced Mechanism Design Analysis and Synthesis”, Prentice Hall, 1984.
R6.	Uicker, J.J., Pennock, G. R. and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2005.

21PCC08	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

This course aims to introduce numerical modelling and its role in the field of heat, fluid flow and combustion it will enable the students to understand the various discretisation methods and solving methodologies and to create confidence to solve complex problems in the field of heat transfer and fluid dynamics.

To develop finite volume discretized forms of the CFD equations.

To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Strokes Equations.

UNIT I	GOVERNING DIFFERENTIAL EQUATIONS AND DISCRETISATION TECHNIQUES	9

Basics of Heat Transfer, Fluid flow – Mathematical description of fluid flow and heat transfer – Conservation of mass, momentum, energy and chemical species - Classification of partial differential equations – Initial and Boundary Conditions – Discretisation techniques using finite difference methods – Taylor's Series - Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

UNIT II	DIFFUSION PROCESSES : FINITE VOLUME METHOD	9

Steady one-dimensional diffusion, Two and three dimensional steady state diffusion problems, Discretisation of unsteady diffusion problems – Explicit, Implicit and Crank- Nicholson's schemes, Stability of schemes.

UNIT III	CONVECTION - DIFFUSION PROCESSES : FINITE VOLUME METHOD	9

One dimensional convection – diffusion problem, Central difference scheme, upwind scheme – Hybrid and power law discretization techniques – QUICK scheme

UNIT IV	FLOW PROCESSES : FINITE VOLUME METHOD	9

Discretisation of incompressible flow equations – Pressure based algorithms, SIMPLE, SIMPLER & PISO algorithms

UNIT V	MODELING OF COMBUSTION AND TURBULENCE	9

Mechanisms of combustion and Chemical Kinetics, Overall reactions and intermediate reactions, Reaction rate, Governing equations for combusting flows. Simple Chemical Reacting System (SCRS), Turbulence - Algebraic Models, One equation model & k – □, k – ω models - Standard and High and Low Reynolds number models.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES	
At the end of the course students should be able to	
CO1 :	On successful completion of this course the student will be able to apply the concepts of CFD to analyse the fluid flow and heat transfer in thermal systems.
CO2 :	It helps the students to get understand the diffusion steady state one, two and three dimensional problems.
CO3 :	To provide students ability to familiarize the convection diffusion process.
CO4 :	It helps the students to get ability to perform the flow process algorithms.
CO5 :	It helps the students to get understand the modeling of combustion and turbulence.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	2	2									2		
CO2	3	2	2	2									2		
CO3	3	2	2	2									2		
CO4	3	2	2	2									2		
CO5	3	2	2	2									2		

REFERENCE BOOKS

R1.	Ghoshdastidar, P.S., “Computer Simulation of Flow and Heat Transfer”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998.
R2.	Jiyuan Tu, Guan Heng Yeoh, Chaogun Liu, “Computational Fluid Dynamics A Practical Approach” Butterworth – Heinemann An Imprint of Elsevier, Madison, U.S.A., 2008
R3.	John D. Anderson . JR. “Computational Fluid Dynamics The Basics with Applications” McGraw- Hill International Editions, 1995.
R4.	Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2003.
R5.	Subas and V.Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation,1980.
R6.	Versteeg and Malalasekera, N, “An Introduction to computational Fluid Dynamics The Finite Volume Method,” Pearson Education, Ltd., Second Edition, 2014.

21PCC09	RELIABILITY IN ENGINEERING SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The ability to use statistical tools to characterise the reliability of an item;

The working knowledge to determine the reliability of a system and suggest approaches to enhancing system reliability;

The ability to select appropriate reliability validation methods

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 tub curve – Useful life.

UNIT II	FAILURE DATA ANALYSIS	9

Data collection –Empirical methods: Ungrouped/Grouped, Complete/Censored data – Time to failure distributions: 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 tie sets – 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 of maintainability – System Availability – Replacement theory.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Analyze the interference between strength and stress, or life data for estimating reliability.
CO2 :	Apply the appropriate methodologies and tools for enhancing the inherent and actual reliability of components and systems, taking into consideration cost aspects; specify life test plans for reliability validation

CO3 :	Apply techniques such as design for complex systems
CO4 :	Explain how to use techniques such as reliability monitoring
CO5 :	Describe current trends in reliability improvement

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	2	2									2		
CO2	3	1	2	2									2		
CO3	3	1	2	2									2		
CO4	3	1	2	2									2		
CO5	3	1	2	2									2		

REFERENCE BOOKS

R1.	Charles E. Ebeling, "An introduction to Reliability and Maintainability engineering", TMH, 2000.
R2.	Roy Billington and Ronald N. Allan, "Reliability Evaluation of Engineering Systems", Springer, 2007.

21PCC10	INTEGRATED PRODUCT DESIGN AND PROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

UNIT I	INTRODUCTION	9

Need for IPPD-Strategic importance of Product development - integration of customer, designer, material supplier 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 - searchexternally 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 layout development - 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

Integrate process design - Managing costs - Robust design - Integrating CAE, CAD, CAM tools – Simulating product 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 – Minimize system complexity - Prototype basics - Principles of prototyping - Planning for prototypes - Economic Analysis - Understanding and representing tasks-baseline project

planning - accelerating the project-project execution.

Theory:45	Tutorial:	Practical:	Total:45 Periods

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the integration of customer requirements in product design
CO2 :	Apply structural approach to concept generation, selection and testing
CO3 :	Understand various aspects of design such as industrial design, design for manufacture ,economic analysis and product architecture
CO4 :	Discuss robust design and assess the selection of robust design
CO5 :	Explain design for manufacturing and product development

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2				3		1	2				2		
CO2	3	1				3		1	2				2		
CO3	2	2	3			3		2	2				1		
CO4	2	1				3		2	2				3		
CO5	2	2				3		1	2				1		

REFERENCE BOOKS

R1.	Concurrent Engg./Integrated Product Development. Kemnneth Crow, DRM Associates, 6/3, Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
R2.	Effective Product Design and Development, Stephen Rosenthal, Business One Orwin, Homewood, 1992,ISBN, 1-55623-603-4
R3.	Product Design and Development, Karl T.Ulrich and Steven D.Eppinger, McGraw –Hill International Edns.1999
R4.	Tool Design – Integrated Methods for successful Product Engineering, Stuart Pugh, Addison Wesley Publishing,Neyourk,NY,1991, ISBN 0-202-41639-5

21PCC11	PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEM	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To develop an understanding of the use and benefits of modeling and simulation in manufacturing systems design and operation.

To develop an understanding of techniques to assess factory performance and identify areas for improvement.

To develop an understanding of techniques to assess and manufacturing performance.

To develop an understanding of techniques to enable responsive manufacturing systems.

To provide the students with knowledge of a set of tools to enable them to assess the performance of a manufacturing facility

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 leadtime - 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	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	PETRI NETS	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.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Model and simulate the operation of a small manufacturing system.
CO2 :	Use simulation as a manufacturing system design technique.
CO3 :	Justify the use of manufacturing modelling and simulation.
CO4 :	Use techniques such as value stream mapping and IDEF to identify improvements required in a manufacturing system.
CO5 :	Apply techniques such as design for changeover to improve manufacturing system performance
CO6 :	Explain how to use techniques such as experimental design to assess process capability within a manufacturing system
CO7 :	Describe current trends in global manufacturing.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**		
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	1	2	2									2		
CO2	3	1	2	2									2		
CO3	3	1	2	2									2		
CO4	3	1	2	2									2		
CO5	3	1	2	2									2		

REFERENCE BOOKS

R1.	Gupta S.C., & Kapoor V.K., "Fundamentals of Mathematical Statistics", 3rd Edition, Sultan Chand and Sons, New Delhi, 1988.
R2.	Trivedi, K.S., "Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall, New Jersey, 1982.
R3.	Viswanadham, N and Narahari, Y. "Performance Modeling of Automated Manufacturing Systems", Prentice Hall of India, New Delhi, 1994.

21PCC12	METROLOGY AND NON DESTRUCTIVE TESTING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Impart the knowledge of quality assurance and inspection techniques.
- Familiarize with the various inspection and measurement techniques like contact and noncontact measurement by adapting Computer Aided Inspection.
- Impart the knowledge of working principles and calibration of various Systems.

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	RADIOGRAPHY	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.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Acquire the knowledge in CMM and Image Processing
CO2 :	Understand the concept statistical quality control and use of various control charts

CO3 :	Acquire knowledge of liquid penetration and magnetic particle testing
CO4 :	Understand the principles and applications of radiography test
CO5 :	Acquire knowledge of ultrasonic and Acoustic emission techniques

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**		
COs	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2			2									2		
CO2	2			2		2							2		
CO3	2			2									2		
CO4	2			2									2		
CO5	2			2									2		

REFERENCE BOOKS

R1.	American Society for Metals, " Metals Hand Book ", Vol.II, 1976.
R2.	Barry Hull and Vernon John, " Non Destructive Testing ", MacMillan, 1988.
R3.	JAIN, R.K. " Engineering Metrology ", Khanna Publishers, 1997.
R4.	Progress in Acoustic Emission, " Proceedings of 10th International Acoustic Emission Symposium ", Japanese Society for NDI, 1990.

21PCC13	QUALITY MANAGEMENT TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To provide student with the basic understanding of the approaches and techniques to assess and improve process and or product quality and reliability

UNIT I	INTRODUCTION	9

Need for TQM, evolution of quality, Definition of quality, TQM philosophy – Contributions of Deming Juran, Crosby And Ishikawa, TQM Models.

UNIT II	PLANNING	9

Vision, Mission, Quality policy and objective Planning and Organization for quality, Quality policy Deployment, Quality function deployment, introduction to BPR and analysis of Quality Costs.

UNIT III	TQM PRINCIPLES	9

Customer focus, Leadership and Top management commitment, Employee involvement – Empowerment and Team work, Supplier Quality Management, Continuous process improvement, Training, performance Measurement and customer satisfaction.

UNIT IV	TQM TOOLS AND TECHNIQUES	9

PDSA, The Seven Tools of Quality, New Seven management tools, Concept of six sigma, FMEA, Bench Marking, JIT, POKA YOKE, 5S, KAIZEN, Quality circles.

UNIT V	QUALITY SYSTEMS	9

Need for ISO 9000 Systems, clauses Documentation, Implementation, Introduction to ISO14000 and OSHAS18000, Implementation of TQM, Case Studies.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Demonstrate quality management philosophy and principles
CO2 :	Use quality policy deployment and quality function deployment to improve quality of product
CO3 :	Understand quality principles from top management level to customer
CO4 :	Familiarize with implementation of different quality tools
CO5 :	Understand the ISO 9000, ISO14000 and OSHAS18000 standards and implementations

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													CO/PSO Mapping		
COs	**PROGRAMME OUTCOMES (POs)**												**PSOs**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2			2		2		1					2		
CO2	2			2		2		1					2		
CO3	2			2		2		1					2		
CO4	2			2		2		1					2		
CO5	2			2		2	3	1					2		

REFERENCE BOOKS

R1.	Brain Rethery, ISO 9000, Productivity and Quality Publishing Pvt.Ltd., 1993.
R2.	D.Mills, Quality Auditing, Chapman and Hall, 1993.
R3.	Juran J.M and Frank M.Gryna Jr., “Quality Planning and Analysis”, TMH, India, 1982.
R4.	Narayana V. and Sreenivasan, N.S., “Quality Management – Concepts and Tasks”, New Age International 1996.
R5.	Oakland.J.S. “Total Quality Management”, Butterworth–Hcinemann Ltd., Oxford, 1989.
R6.	Zeiri. “Total Quality Management for Engineers”, Wood Head Publishers, 1991

21PCC14	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To understand the fundamentals of composite material strength and its mechanical behaviour.

Understanding the analysis of fiber reinforced Laminate design for combinations of plies with different orientations of the fiber.

Thermo-mechanical behavior and study of residual stresses in Laminates during processing. Implementation of Classical Laminate Theory (CLT) to study and analysis for residual stresses in an isotropic layered structure such as electronic chips.

PRE-REQUISITES:

UNIT I	INTRODUCTION TO COMPOSITE MATERIALS	9

Definition-Matrix materials-polymers-metals-ceramics - Reinforcements different: Particles, whiskers, inorganic fibers, metal filaments- ceramic fibers- fiber fabrication- natural composite wood, Jute - Advantages and drawbacks of composites over monolithic materials. Mechanical properties and applications of composites, Particulate-Reinforced composite Materials, Dispersion-Strengthened composite, Fiber-reinforced composites Rule of mixtures-Characteristics of fiber-Reinforced composites, Manufacturing fiber and composites,

UNIT II	MANUFACTURING OF COMPOSITES	9

Manufacturing of Polymer Matrix Composites (PMCs)-handlay-up, spray technique, filament winding, Pultrusion, Resin Transfer Moulding (RTM)-, bag moulding, injection moulding, Sandwich Mould Composites (SMC) - Manufacturing of Metal Matrix Composites (MMCs) – Solid state, liquid state,vapour state processing, Manufacturing of Ceramic Matrix Composites (CMCs) – hot pressing-reaction bonding process-infiltration technique, direct oxidation-interfaces

UNIT III	INTRODUCTION, LAMINA CONSTITUTIVE EQUATIONS	9

Lamina Constitutive Equations: Lamina Assumptions – Macroscopic Viewpoint. Generalized Hooke's Law. Reduction to Homogeneous Orthotropic Lamina – Isotropic limit case, Orthotropic Stiffness matrix (Qij), Definition of stress and Moment Resultants. Strain Displacement relations. Basic Assumptions of Laminated anisotropic plates. Laminate Constitutive Equations – Coupling Interactions, Balanced Laminates, Symmetric Laminates, Angle Ply Laminates, Cross Ply Laminates. Laminate Structural Moduli. Evaluation of Lamina Properties from Laminate Tests. Quasi-Isotropic Laminates. Determination of Lamina stresses

within Laminates.

UNIT IV	LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES	9

Introduction - Maximum Stress and Strain Criteria. Von-Misses Yield criterion for Isotropic Materials. Generalized Hill's Criterion for Anisotropic materials. Tsai-Hill's Failure Criterion for Composites. Tensor Polynomial (Tsai-Wu) Failure criterion. Prediction of laminate Failure Equilibrium Equations of Motion. Energy Formulations. Static Bending Analysis. Buckling Analysis. Free Vibrations – Natural Frequencies

UNIT V	THERMAL ANALYSIS	9

Assumption of Constant Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's. C.T.E's for special Laminate Configurations – Unidirectional, Off-axis, Symmetric Balanced Laminates, Zero C.T.E. laminates, Thermally Quasi-Isotropic Laminates.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the basics of composite materials.
CO2 :	Understand the different manufacturing methods available for composite material.
CO3 :	Understand the lamina constitutive equations.
CO4 :	Understand the stresses and strains relation in composites materials.
CO5 :	Understand the thermal analysis of composite materials.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair

CO/PSO Mapping

CO s	PROGRAMME OUTCOMES (POs)												PSOs		
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3					1		2				1	2		
CO2	3					2		3				2	2		
CO3	3	1				2		3				2	2		
CO4	3					2		3				2	2		
CO5	2					1		2				1	2		

REFERENCE BOOKS

R1.	Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites",

	John Wiley and Sons, New York, 1990.
R2.	Chung, Deborah D.L., "Composite Materials: Science and Applications", Ane Books Pvt. Ltd./Springer, New Delhi, 1st Indian Reprint, 2009
R3.	Gibson, R.F., Principles of Composite Material Mechanics, McGraw-Hill, 1994, Second Edition - CRC press in progress.
R4.	Halpin, J.C., "Primer on Composite Materials, Analysis", Techomic Publishing Co., 1984.
R5.	Hyer, M.W., "Stress Analysis of Fiber – Reinforced Composite Materials", McGraw-Hill, 1998
R6.	Issac M. Daniel and Ori Ishai, "Engineering Mechanics of Composite Materials", Oxford University Press-2006, First Indian Edition - 2007
R7.	Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures", University Press (India) Pvt. Ltd., Hyderabad, 2004 (Reprinted 2008)
R8.	Mallick, P.K. and Newman, S., (edition), "Composite Materials Technology: Processes and Properties", Hansen Publisher, Munish, 1990.
R9.	Mallick, P.K., Fiber –"Reinforced Composites: Materials, Manufacturing and Design", Maneel Dekker Inc, 1993.

21PCC15	DESIGN OF MATERIAL HANDLING EQUIPMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To impart students on the need, use, application and design of different material handling techniques, equipments and machines used in common use and in industrial sector

UNIT I	MATERIALS HANDLING EQUIPMENT	5

Types, selection and applications

UNIT II	DESIGN OF HOISTS	10

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	10

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	10

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

UNIT V	ELEVATORS	10

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

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	familiarize in types of material handling and to select suitable material handling equipment.
CO2 :	Design the hoisting element for required application
CO3 :	Design power transmission drives for hoist
CO4 :	Describe and design different conveyor system
CO5 :	Design bucket elevator and fork lift trucks

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												CO/PSO Mapping		
COs	**PROGRAMME OUTCOMES (POs)**											**PSOs**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3		3			2			2				3		
CO2	3		3			2			1				3		
CO3	3		3			2			1				3		
CO4	3		3			2			1				3		
CO5	3		3			2			1				3		

REFERENCE BOOKS

R1.	Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
R2.	Boltzharol, A., Materials Handling Handbook, The Ronald Press Company, 1958.
R3.	Lingaiah. K. and Narayana Iyengar, "Machine Design Data Hand Book", Vol.1 & 2, Suma Publishers, Bangalore, 1983
R4.	P.S.G. Tech., "Design Data Book", Kalaikathir Achchagam, Coimbatore, 2003.
R5.	Rudenko, N., Materials handling equipment, ELnvee Publishers, 1970.
R6.	Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.

21PCC16	PRODUCT LIFECYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To understand history, concepts and terminology of PLM

To understand functions and features of PLM/PDM

To understand different modules offered in commercial PLM/PDM tools

To understand PLM/PDM implementation approaches

To understand integration of PLM/PDM with other applications

UNIT I	HISTORY, CONCEPTS AND TERMINOLOGY OF PLM	9

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

UNIT II	PLM/PDM FUNCTIONS AND FEATURES	9

User Functions –Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.

UNIT III	DETAILS OF MODULES IN A PDM/PLM SOFTWARE	9

Case studies based on top few commercial PLM/PDM tools

UNIT IV	ROLE OF PLM IN INDUSTRIES	9

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

UNIT V	BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE	9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES	
At the end of the course students should be able to	
CO1 :	Understand history, concepts and terminology of PLM.
CO2 :	Apply the functions and features of PLM/PDM.
CO3 :	Understand different modules offered in commercial PLM/PDM tools.
CO4 :	Understand PLM/PDM implementation approaches.
CO5 :	Integrate PLM/PDM with other applications.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**	
CO s	**PROGRAMME OUTCOMES (POs)**											**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3		3			2							2	
CO2	3		3			2							2	
CO3	3		3			2							2	
CO4	3		3			2							2	
CO5	3		3			2							2	

REFERENCE BOOKS

R1.	Antti Saaksvuori and Anselmi Immonen, “Product Lifecycle Management”, Springer Publisher, 2008 (3rd Edition).
R2.	International Journal of Product Lifecycle Management, Inderscience Publishers
R3.	Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
R4.	John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
R5.	John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher, 2011 (2nd Edition).
R6.	Michael Grieves, “Product Life Cycle Management”, Tata McGraw Hill, 2006.

21PCC17	DESIGN FOR INTERNET OF THINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

To impart knowledge on state of art IoT architecture, data and knowledge management and use of devices in IoT technology.

PRE-REQUISITES:

UNIT I	INTRODUCTION	9

Machine to Machine (M2M) to IoT-The Vision-Introduction, From M2M to IoT, M2M towards IoTthe global context, A use case example, Differing Characteristics.

UNIT II	IoT STRUCTURE	9

M2M to IoT – A Market Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

UNIT III	IoT NETWORKING	9

M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management.

UNIT IV	IoT ARCHITECTURE	9

IoT Architecture-State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model.

UNIT V	ARCHITECTURE MODELING	9

IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control. Industrial Automation- Service-oriented architecture-based device integration, SOCRADES: realizing the enterprise integrated Web of Things, IMC-AESOP: from the Web of Things to the Cloud of Things, Commercial Building Automation- Introduction, Case study: phase one-commercial building automation today, Case study: phase two- commercial building automation in the future.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand the vision of IoT from a global context.
CO2 :	Determine the Market perspective of IoT.
CO3 :	Use of Devices, Gateways and Data Management in IoT.
CO4 :	Build state of the art architecture in IoT.
CO5 :	Apply of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair													**CO/PSO Mapping**	
CO s	**PROGRAMME OUTCOMES (POs)**												**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	3				2								2	
CO2	3				2								2	
CO3	3				2								2	
CO4	3		2		2								2	
CO5	3		2	2	2								2	

REFERENCE BOOKS

R1.	Francis da Costa, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1st Edition, A press Publications, 2013.
R2.	Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 1st Edition, Academic Press, 2014.
R3.	Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1stEdition, VPT, 2014.

21PCC18	ARTIFICIAL INTELLIGENCE SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

- Study the concepts of Artificial Intelligence.
- Learn the methods of solving problems using Artificial Intelligence.
- Introduce the concepts of Expert Systems and machine learning.

UNIT I	SCOPE OF ARTIFICIAL INTELLIGENCE	9

Games, theorem proving, natural language processing, vision and speech processing, robotics, expert systems, Artificial Intelligent techniques- search knowledge, abstraction

UNIT II	PROBLEM SOLVING	9

State space search, Production systems, search space control, depth-first, breadth-first search, heuristic search - Hill climbing, best-first search, branch and bound, Problem Reduction, Constraint Satisfaction End, Means-End Analysis

UNIT III	KNOWLEDGE REPRESENTATION	9

Predicate Logic - Unification, modus pones, resolution, dependency directed backtracking, Rule based Systems, Forward reasoning, conflict resolution, backward Reasoning, use of no backtrack, Structured Knowledge Representation, Semantic Nets, slots, exceptions and default frames, conceptual dependency, scripts.

UNIT IV	HANDLING UNCERTAINTY AND LEARNING	9

Non-Monotonic Reasoning, Probabilistic reasoning, use of certainty factors, fuzzy logic, Concept of learning, learning automation, genetic algorithm, learning by inductions, neural nets.

UNIT V	EXPERT SYSTEMS	9

Need and justification for expert systems, knowledge acquisition, Introduction to machine learning, Intelligence for manufacturing tools, manufacturing brain, eye and hand. Trends in robot intelligence. Case studies in the application of Artificial Intelligence in manufacturing.

Theory:45	Tutorial:	Practical:	Total:45 Hours

COURSE OUTCOMES

At the end of the course students should be able to

CO1 :	Understand and explain the issues related to simulate intelligence.
CO2 :	Discuss different type of AI
CO3 :	Explain the fundamentals of knowledge representation

CO4 :	Demonstrate working knowledge of reasoning in the process of incomplete or uncertain information.
CO5 :	Apply the Expert system for manufacturing process

CO/PO MAPPING (S/M/W indicates strength of correlation) 3-Strong, 2-Moderate, 1-Fair												**CO/PSO Mapping**	
CO s	**PROGRAMME OUTCOMES (POs)**											**PSOs**	
	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PSO 2**
CO1	2	2			3								2	
CO2	2	2			3								2	
CO3	2	2			3								2	
CO4	2	2			3								2	
CO5	2	2			3								2	

REFERENCE BOOKS

R1.	Elaine Rich and Kevin Knight “Artificial intelligence”, McGraw Hill Education (India) Private Limited; 3 edition, October 2008
R2.	Nilsson N.J., “Principles of Artificial Intelligent”, Morgan Kaufmann Publishers, Inc.; 1 edition, April, 1998)
R3.	Patterson D. "Introduction to Artificial Intelligence and Expert Systems", PHI, 1997
R4.	Stuart Russell "Artifical Intelligence: A Modern Approach: A Modern Approach" Pearson; Third edition, 2013
R5.	Peter Jackson, “Introduction to Expert Systems”, Addison-Wesley;December,1998
R6.	Schalkoff R.J., “Artificial Intelligence - an Engineering Approach”, McGraw Hill Int. Ed., Singapore, 1992.