Government College of Engineering, Salem – 636 011,

(An Autonomous Institution, Affiliated to Anna University, Chennai)

Regulations -2022

Autonomous Courses (For Students Admitted from 2022-2023)

M.E Computer Aided Design – Full Time

SI.No	Course code	Name of the Course	Hours/Week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
SEMESTER I										
THEORY										
1.	22CDC11	Concepts of Engineering Design	PC	3	0	0	3	40	60	100
2.	22CDC12	Computer Aided Modeling and Design	PC	3	0	0	3	40	60	100
3.	22CDC13	Advanced Mechanics of Materials	PC	3	0	0	3	40	60	100
4.	22CDE1X	Professional Elective-I	PE	3	0	0	3	40	60	100
5.	22CDE2X	Professional Elective-II	PE	3	0	0	3	40	60	100
6.	22MLC01	Research Methodology and IPR	**MC**	3	0	0	3	40	60	100
PRACTICAL										
7.	22CDC14	CAD Modeling and Drafting Laboratory	PC	0	0	4	2	60	40	100
8.	22CDC15	Technical Seminar-I	EEC	0	0	2	1	100	0	100
9.	22AC**XX**	Audit Course – 1	AC	2	0	0	0	100	0	100
	TOTAL			**20**	**0**	**6**	**21**	**500**	**400**	**900**
SEMESTER II										
THEORY										
1.	22CDC21	Finite Element Methods in Design	PC	3	0	0	3	40	60	100
2.	22CDC22	Mechanical Vibrations and Acoustics	PC	3	0	0	3	40	60	100
3.	22CDC23	Solid Freeform Manufacturing	PC	3	0	0	3	40	60	100
4.	22CDE3X	Professional Elective-III	PE	3	0	0	3	40	60	100
5.	22CDE4X	Professional Elective-IV	PE	3	0	0	3	40	60	100
PRACTICAL										
6.	22CDC24	Finite Element Analysis Laboratory	PC	0	0	4	2	60	40	100
7.	22CDC25	CAM and Robotics Laboratory	PC	0	0	4	2	60	40	100
8.	22CDC26	Technical Seminar-II	EEC	0	0	2	1	100	0	100
9.	22AC**XX**	Audit Course-2	AC	2	0	0	0	100	0	100
	TOTAL			**17**	**0**	**10**	**20**	**520**	**380**	**900**

SI.No	Course code	Name of the Course	Hours/Week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
SEMESTER III										
THEORY										
1.	22CDE5X	Professional Elective-V	PE	3	0	0	3	40	60	100
2.	22CDE6X	Professional Elective-VI	PE	3	0	0	3	40	60	100
3.	22CDE7X	Professional Elective-VII	PE	3	0	0	3	40	60	100
PRACTICAL										
4.	22CDC31	Dissertation Phase – I	EEC	0	0	20	6	120	80	200
	TOTAL			**9**	**0**	**20**	**15**	**240**	**260**	**500**
SEMESTER IV										
PRACTICAL										
1.	22CDC41	Dissertation Phase – II	EEC	0	0	32	14	240	160	400
	TOTAL					**32**	**14**	**240**	**160**	**400**

Total Credits for the Programme = 21 + 20 + 15 + 14 = 70

LIST OF ELECTIVES FOR M.E COMPUTER AIDED DESIGN

Professional Electives (PE)

SI.No	Course code	Name of the Course	Hours/Week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
Elective - I										
1.	22CDE11	Advanced Mathematical Methods in Engineering	PE	3	0	0	3	40	60	100
2.	22CDE12	Advanced Composite Materials	PE	3	0	0	3	40	60	100
3.	22CDE13	Product Lifecycle Management	PE	3	0	0	3	40	60	100
4.	22CDE14	Advanced Engineering Materials	PE	3	0	0	3	40	60	100
5.	22CDE15	Experimental Stress Analysis	PE	3	0	0	3	40	60	100
Elective - II										
6.	22CDE21	Advanced Kinematics of Mechanisms	PE	3	0	0	3	40	60	100
7.	22CDE22	Advanced Tool Design	PE	3	0	0	3	40	60	100
8.	22CDE23	Industry 4.0	PE	3	0	0	3	40	60	100
9.	22CDE24	Mechanics of Fracture	PE	3	0	0	3	40	60	100
10.	22CDE25	Design for Manufacturing, Assembly	PE	3	0	0	3	40	60	100
Elective - III										
11.	22CDE31	Productivity Management and Re-engineering	PE	3	0	0	3	40	60	100
12.	22CDE32	Theory of Plates and Shells	PE	3	0	0	3	40	60	100
13.	22CDE33	Optimization Techniques in Design	PE	3	0	0	3	40	60	100
14.	22CDE34	Computational Fluid Dynamics	PE	3	0	0	3	40	60	100
15.	22CDE35	Supply Chain Management	PE	3	0	0	3	40	60	100
Elective - IV										
16.	22CDE41	Experimental Techniques and Data analysis	PE	3	0	0	3	40	60	100
17.	22CDE42	CAD/CAM tools	PE	3	0	0	3	40	60	100
18.	22CDE43	Contact Mechanics	PE	3	0	0	3	40	60	100
19.	22CDE44	Advanced Automotive Systems	PE	3	0	0	3	40	60	100
20.	22CDE45	Design of Material Handling Equipment	PE	3	0	0	3	40	60	100

Elective - V										
21.	22CDE51	MEMS & NEMS Technology	PE	3	0	0	3	40	60	100
22.	22CDE52	Enterprise Resource Planning	PE	3	0	0	3	40	60	100
23.	22CDE53	Mechatronics System Design	PE	3	0	0	3	40	60	100
24.	22CDE54	Failure Analysis	PE	3	0	0	3	40	60	100
25.	22CDE55	Maintenance Engineering	PE	3	0	0	3	40	60	100
Elective - VI										
26.	22CDE61	Integrated Product and Processes Development	PE	3	0	0	3	40	60	100
27.	22CDE62	Industrial Safety Management	PE	3	0	0	3	40	60	100
28.	22CDE63	Reliability in Engineering Systems	PE	3	0	0	3	40	60	100
29.	22CDE64	Mechanical Measurement and Analysis	PE	3	0	0	3	40	60	100
30.	22CDE65	Ergonomics in Manufacturing	PE	3	0	0	3	40	60	100
Elective - VII										
31.	22CDE71	Quality concepts in design	PE	3	0	0	3	40	60	100
32.	22CDE72	Design of Pressure Vessels	PE	3	0	0	3	40	60	100
33.	22CDE73	Plasticity and Metal Forming	PE	3	0	0	3	40	60	100
34.	22CDE74	Nano Materials Technology	PE	3	0	0	3	40	60	100
35.	22CDE75	Tribology in design	PE	3	0	0	3	40	60	100

Audit Courses (AC)

SI.No	Course code	Name of the Course	Hours/Week					Maximum Marks		
			Category	Lecture	Tutorial/ Demo*	Practical	Credits	CA	FE	Total
1.	22AC01	English for Research Paper Writing	PE	2	0	0	0	100	0	100
2.	22AC02	Disaster Management	PE	2	0	0	0	100	0	100
3.	22AC03	Sanskrit for Technical Knowledge	PE	2	0	0	0	100	0	100
4.	22AC04	Value Education	PE	2	0	0	0	100	0	100
5.	22AC05	Constitution of India	PE	2	0	0	0	100	0	100
6.	22AC06	Pedagogy Studies	PE	2	0	0	0	100	0	100
7.	22AC07	Stress Management by Yoga	PE	2	0	0	0	100	0	100
8.	22AC08	Personality Development through Life Enlightenment Skills	PE	2	0	0	0	100	0	100

REGULATIONS – 2022

SEMESTER - I

22CDC11	CONCEPTS OF ENGINEERING DESIGN		SEMESTER I			
PREREQUISITES		CATEGORY	PC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES

1. To learn the engineering codes and standards to design the product
2. To design the customer-oriented product with the concern of ergonomics aspect as well as environmental friendly.
3. To learn the various design methods to create the complicated engineering product.
4. Select the materials based on various design methodology.
5. To optimize the design based on quality and reliability.

UNIT-I	DESIGN FUNDAMENTALS	9	0	0	9

Design process – Consideration of good design - Morphology of design – Drawings – Computer Aided Engineering – Designing to codes and Standards – Concurrent Engineering – Product life cycle – Technological Forecasting – Market Identification – Competition Bench marking – Systems Engineering – Life Cycle Engineering – Human Factors in industrial Design.

UNIT-II	CUSTOMER - ORIENTED DESIGN & SOCIETAL CONSIDERATIONS	9	0	0	9

Identification of customer needs- customer requirements- Quality Function Deployment- Product Design Specifications - Human Factors in Design –Ergonomics and Aesthetics, Societal consideration - Contracts – Product liability – Protecting intellectual property – Legal and ethical domains – Codes of ethics - Ethical conflicts – Environment responsible design-future trends in interaction of engineering with society.

UNIT-III	DESIGN METHODS	9	0	0	9

Creativity and problem solving–Creativity methods – TRIZ: Theory of Inventive Problem Solving – Axiomatic Design– Decision Making - Evaluation methods - Embodiment Design - Product Architecture - Configuration Design - Parametric Design. Role of models in Engineering design - Mathematical Modeling – Simulation.

UNIT-IV	MATERIALS SELECTION	9	0	0	9

Material Selection process - Performance characteristics of materials _ Material selection in conceptual, embodiment and detail design - Economics - Material Performance indices - Decision Matrices - Pugh method and weighted property Index - recycling in material selection - Design with materials - Design for Manufacturing - Design for Assembly - Design for Castings, Forgings, Machining, Metal forming

UNIT-V	RELIABILITY AND QUALITY ENGINEERING	9	0	0	9

Reliability Theory – Design for Reliability – Failure Mode and Effect Analysis (FMEA) Defects and Failure Modes - Design for Safety - Reliability centered Maintenance - Total Quality Concept – Quality Control and Assurance – Statistical Process Control – Taguchi Method – Robust Design – Optimization methods.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1. Dieter George E, “Engineering Design - A Materials and Processing Approach”, McGraw Hill International Editions, Singapore, 2000.
2. Karl T. Ulrich and Steven D. Eppinger, “Product Design and Development”, 4th Edition, McGraw Hill, 2008.
3. Pahl, G, and Beitz, W.,” Engineering Design”, Springer – Verlag, NY. 2007
4. Suh, N.P., “The principles of Design”, Oxford University Press, NY.1990
5. Ray M.S., “Elements of Engineering Design”, Prentice Hall Inc. 1985.
6. A.K. Govil, “Reliability Engineering”, Tata McGraw-Hill Publishing Co. Ltd., 1983.

COURSE OUTCOMES: On completion of the course the student will be able to	Bloom’s Taxonomy Mapped

CO1	Apply the design principles for quality products to create economically viable products.	Apply
CO2	Create a customer-oriented quality product that adheres to the environmental and ethical standards	Create
CO3	Identify the various design methods suitable to improve the quality of the product.	Understand
CO4	Synthesize the principles of design for machinability, accessibility, and assembly.	Understand
CO5	Apply the reliability engineering parameters and optimization techniques to develop quality of the product.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO2	2	-	-	-	-	2	2	2	2	2	3	2	2	2
CO3	-	-	3	-	3	-	-	-	-	-	-	2	2	2
CO4	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO5	-	-	-	-	-	-	-	-	2	2	3	2	2	2
Avg	**1.2**	**0.8**	**1.4**	**0.8**	**1.4**	**0.4**	**0.4**	**0.4**	**0.8**	**0.8**	**1.2**	**2.0**	**2.0**	**2.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC12	**COMPUTER AIDED MODELING AND DESIGN**		**SEMESTER I**		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**	**3**

		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES:

1.	To learn fundamental concepts of computer graphics and its tools in a generic framework.
2.	To understand the designing of synthetic surfaces and solid modelling.
3.	To study about advanced aspects of enabling computer aided technologies used in design.
4.	To create strong skills of assembly modelling and prepare the student to be an effective user of a standards in CAD system.
5.	To provide clear understanding of CAD systems for 3D modelling and viewing.

UNIT I	**INTRODUCTION TO COMPUTER GRAPHICS**	**9**	**0**	**0**	**9**

Definition of CAD Tools - Types of system - functional areas of CAD - Graphics standards - Modeling and viewing, Output primitives - Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm - 2-D & 3-D transformation (translation, scaling, rotating) - windowing - view ports - clipping transformation.

UNIT II	**CURVES AND SURFACES**	**9**	**0**	**0**	**9**

Mathematical and Parametric representation of analytical and synthetic curves - Hermite cubic splines, Bezier curves, B-Splines, rational curves

Introduction to surfaces- Analytical surfaces – plane, ruled surface, surface of revolution and tabulated cylinder, Synthetic surface – Hermite, Bi-cubic, Bezier and B-Spline surface, COONs surface, Surface manipulation,

UNIT III	**NURBS AND SOLID MODELING**	**9**	**0**	**0**	**9**

NURBS- basics, curves, lines, circle, arcs and bi linear surfaces. Fundamentals of solid modeling - Boundary Representation (B-rep), Constructive Solid Geometry (CSG) and other methods – Sweep representation - Coordinate system.

UNIT IV	**DRAFTING AND ASSEMBLY**	**9**	**0**	**0**	**9**

Drafting features - Customization, 3D sketches, Feature manipulation, Datum features - Modeling operation Strategy, Modeling aids and tools - Generalized views, Presentation of dimensioning / tolerances/symbols & annotation. Different approaches of creating an assembly - Associatively, Parent child relationship - Parametric design, Concept of computer animation.

UNIT V	**VISUAL REALISM**	**9**	**0**	**0**	**9**

Feature Based, Assembly and Behavioral modeling - Conceptual Design - Top-down Design. Techniques for visual realism - Hidden line removal – Hidden Surface removal - Algorithms for shading and Rendering. Parametric and Variational modeling - Feature recognition, Design by features, Assembly and Tolerance Modeling, Tolerance representation - specification, analysis and synthesis, AI in Design.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Ibrahim Zeid, R.Sivasubramanian, "CAD/CAM Theory and Practice", McGraw Hill international. 2007.
2	AnupamSaxena, Birendrasahay, "Computer Aided Engineering and Design", Springer, 2005.
3	P.N. Rao, *"CAD / CAM Principles and Applications"*, TMH, 2nd Edition, 2008.
4	Martenson, E. Micheal, Geometric Modelling, John Wiley & Sons, 1995.
5	Foley, Van Dam, Feiner and Hughes, Computer Graphics Principles and Practice, second edition, Addison–Wesley, 2000.
6	Hill Jr, F.S., Computer Graphics using Open GL, Pearson Education, 2003.
7	M.P. Groover and E.W. Zimmers, "CAD/CAM", PHI, 1st Edition, 1995.

COURSE OUTCOMES: Upon completion of this course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve 2D and 3D transformations for the basic entities like line and circle.	Apply
CO2	Formulate the basic mathematics fundamental to CAD system.	Create
CO3	Apply basic concepts to develop construction techniques and solid modelling concepts.	Apply
CO4	Use computer and CAD software for design and modelling.	Apply
CO5	Create geometric models through animation and transform them into real world systems	Create

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	1	2	3	-	3	-	1	-	1	-	-	2	2	3
CO2	3	2	-	2	3	-	-	-	1	-	-	2	3	2
CO3	3	3	2	2	2	2	1	-	1	-	-	2	2	2
CO4	1	2	2	2	2	-	1	1	1	-	-	2	2	2
CO5	1	2	2	2	2	-	1	1	1	-	-	3	2	3
Avg	**1.8**	**2.2**	**1.8**	**1.6**	**2.4**	**0.4**	**0.8**	**0.4**	**1.0**	**0.0**	**0.0**	**2.2**	**2.2**	**2.4**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDC13	ADVANCED MECHANICS OF MATERIALS		SEMESTER I		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**	**3**

	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To learn the concepts of the theory of elasticity in three-dimensional stress system.
2.	To study the shear-Centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.
3.	To learn the stresses on flat plates and curved members.
4.	To study the torsional stress of non-circular sections.
5.	To learn about the contact stresses and finite element method.

UNIT-I	**ELASTICITY**	**9**	**0**	**0**	**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 Hooke's law - St. Venant's principle - plane stress - Airy's stress function - Energy methods.

UNIT-II	**SHEAR CENTRE AND UNSYMMETRICAL BENDING**	**9**	**0**	**0**	**9**

Location of shear-Centre for various thin sections, curved beams - shear flows. Bending stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.

UNIT-III	**STRESSES IN FLAT PLATES AND CURVED MEMBERS**	**9**	**0**	**0**	**9**

Stresses in Flat plate of various shapes - problems – Stress strain temperature Relation – Strain Energy of Plate – various end conditions – Stresses in curved beams - circumference and radial stresses – deflections of curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks.

UNIT-IV	**TORSION OF NON-CIRCULAR SECTIONS**	**9**	**0**	**0**	**9**

Torsion of rectangular cross section - St.Venants theory, semi inverse method – prandtl's elastic membrane analogy - Prandtl's stress function - torsional stress in hollow thin walled tubes.

UNIT-V	**CONTACT STRESSES AND FINITE ELEMENT METHOD**	**9**	**0**	**0**	**9**

Methods of computing contact stress-deflection of bodies in point and line Contact applications. Finite Element Method – Plane Elasticity – Bilinear rectangle – Linear Isoparametric quadrilateral – plane frame element.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Arthur P Boresi, Richard J.Schmidt, "Advanced Mechanics of Materials", Wiley India Pvt.Ltd., 2009.
2	Srinath. L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, 2009.
3	Hibbeler. R.C., "Mechanics of Materials", Prentice-Hall, 2018.
4	Robert D.Cook, Warren C.Young, "Advanced Mechanics of Materials", Prentice Hall, 1999.
5	Timoshenko and Goodier, "Theory of Elasticity", Tata McGraw Hill, 2010.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of the theory of elasticity to a three-dimensional stress system.	Apply
CO2	Determine the shear center of various cross-sections and deflections in beams subjected to unsymmetrical bending	Evaluate
CO3	Evaluate the stresses in flat plates and curved members.	Evaluate
CO4	Compute the torsional stress of non-circular sections.	Understand
CO5	Apply the concept of contact stresses in point and line contact applications and apply the concept of FEA in linear elasticity.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO2	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO3	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO4	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO5	3	3	3	3	3	-	-	-	-	-	-	3	1	1
Avg	**3.0**	**3.0**	**3.0**	**3.0**	**2.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**3.0**	**1.0**	**1.0**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22MLC01	RESEARCH METHODOLOGY AND IPR	SEMESTER I

PREREQUISITES		CATEGORY	MC	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES:

To develop the subject of the research, encourage the formation of higher level of trained intellectual ability, critical analysis, rigor and independence of thought, foster individual judgement and skill in the application of research theory and methods and develop skills required in writing research proposals, reports and dissertations.

UNIT I	INTRODUCTION TO RESEARCH	9	0	0	9

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of the research problem, Approaches to investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II	EFFECTIVE LITERATURE STUDIES APPROACHES, ANALYSIS	9	0	0	9

Developing the theoretical framework of research - Developing operational statements of the problem - Criteria for evaluating research approach - Hypotheses: Parametric and non-parametric testing- Establishing the reliability and validity of findings with literature review and experiments – documentation, Plagiarism, Research ethics.

UNIT III	EFFECTIVE TECHNICAL WRITING, HOW TO WRITE REPORT, PAPER	9	0	0	9

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

UNIT IV	NATURE OF INTELLECTUAL PROPERTY	9	0	0	9

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

UNIT V	PATENT RIGHTS AND IPR	9	0	0	9

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

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science & Engineering students”
2	Wayne Goddard and Stuart Melville, “Research Methodology: An Introduction”
3	Ranjit Kumar, 2 nd Edition, “Research Methodology: A Step by Step Guide for beginners”
4	Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd, 2007.
5	Mayall, “Industrial Design”, McGraw Hill, 1992.
6	Niebel, “Product Design”, McGraw Hill, 1974.
7	Asimov, “Introduction to Design”, Prentice Hall, 1962.
8	Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property in the New Technological Age”, 2016.
9	T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand, 2008

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	understand research problem formulation	Understand
CO2	analysis research related information	Analysis
CO3	follow research ethics	Remembering
CO4	understand that today’s world is controlled by computer, Information technology, but tomorrow’s world is ruled by ideas, concepts and creativity.	Understand
CO5	understand that IPR production provides an incentive to inventors for further research work and investment in R& D, which leads to creation of new and better products, and in turn brings about economic growth and social benefits.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	3	1	-	-	-	-	-	1	2	1	-
CO2	-	3	2	2	1	1	-	3	-	1	-	2	1	-
CO3	-	-	2	-	-	1	1	1	-	3	1	-	-	-
CO4	-	-	-	2	1	-	-	-	-	2	1	-	-	2
CO5	-	-	-	-	2	1	-	1	-	-	1	-	-	3
Avg	**0.4**	**1.0**	**1.0**	**1.4**	**1.0**	**0.6**	**0.2**	**1.0**	**0.0**	**1.2**	**0.8**	**0.8**	**0.4**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PREREQUISITES	CATEGORY	PC	Credit		2
	Hours/Week	L	T	P	TH
		0	0	4	4

COURSE OBJECTIVES:

1. To impart knowledge on the commercially available computer-aided drafting software's and their features.
2. To learn the modeling of 2D part drawings.
3. To model the 3D mechanical components.
4. To assemble the 3D parts and drafting it using software assistance.
5. To generate part drawings from the assembly.

MODULE I	LIST OF SOLID EDGE EXPERIMENTS	0	0	20	20

i. 2D Drawing of machine elements
ii. 3D drawing of machine elements
iii. 3D assembly drawing of machine elements
iv. Detail Drawing of machine elements

MODULE II	LIST OF CATIA EXPERIMENTS	0	0	25	25

i. Sketcher exercises
ii. Part design
iii. Assembly drawing of machine element
iv. Sheet metal design

Total(45P) = 45 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Use the modern engineering tools for engineering practice.	Apply
CO2	Draw 2D part drawings, sectional views, and assembly drawings as per standards.	Analysis
CO3	Model the 3D mechanical components with dimensioning	Create
CO4	Generate Assembly drawing of a given mechanical component using software assistance.	Create
CO5	Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.	Analysis

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO3
CO1	-	1	2	3	-	1	3	-	1	1	-	1	2	3
CO2	-	2	3	3	-	2	3	-	2	1	-	2	1	3
CO3	-	2	3	3	-	2	3	-	2	2	-	3	2	-
CO4	-	2	3	3	-	2	3	-	3	2	-	1	3	-
CO5	-	2	3	3	-	2	3	-	3	2	-	2	1	-
Avg	**0.0**	**1.8**	**2.8**	**3.0**	**0.0**	**1.8**	**3.0**	**0.0**	**2.2**	**1.6**	**0.0**	**1.8**	**1.8**	**1.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC15	TECHNICAL SEMINAR - I	SEMESTER I

PREREQUISITES	CATEGORY	EEC	Credit		1
	Hours/Week	L	T	P	TH
		0	0	2	2

COURSE OBJECTIVES:

1.	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation.
2.	To acquire technical writing abilities for seminars and conferences.
3.	To Identify and compare technical and practical issues related to the area of course specialization.
4.	To Outline annotated bibliography of research demonstrating scholarly skills.
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

MODULE		0	0	30	30

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Engineering design, and search relevant journal paper/white paper on the selected topics for presentation and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic along with the journal reference copy. They will also answer the queries on the topic. The students as the audience also should interact.
Evaluation will be based on the technical presentation and their port and also on the interaction during the seminar using the specific rubrics.

Total(30P) = 30 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Generate motivation for any topic of interest and develop a thought process for technical presentation.	Create
CO2	Express communicative skills (e.g. speaking, listening, reading, and/ or writing).	Remembering
CO3	Make use of new and recent technology for creating technical reports	Apply
CO4	Organize a detailed literature survey and build a document with respect to technical publications.	Understand
CO5	Analyse and comprehend the proof-of-concept and related data.	Analysis

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	1	3	3	1	1	-	3	-	-
CO2	-	-	-	-	-	-	3	2	2	3	-	-	-	3
CO3	-	-	-	-	1	-	3	1	2	2	-	-	2	-
CO4	-	-	-	-	-	-	3	3	3	2	-	2	-	-
CO5	-	1	-	3	-	-	3	-	3	2	-	-	-	2
Avg	**0.0**	**0.2**	**0.0**	**0.6**	**0.2**	**0.2**	**3.0**	**1.8**	**2.2**	**2.0**	**0.0**	**1.0**	**0.4**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

SEMESTER-II

22CDC21	FINITE ELEMENT METHODS IN DESIGN	SEMESTER II

PREREQUISITES	CATEGORY	PC	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To develop a thorough understanding of the advanced finite element analysis techniques.
2.	An ability to effectively use the tools of the analysis for solving practical problems arising in engineering design.
3.	To understand and solve the Finite Element 1-D structural and 2-D structural problems.
4.	To develop and understand the dynamic problems in structures
5.	To Gain the knowledge of FEM for heat transfer analysis and flow analysis

UNIT I	INTRODUCTION	9	0	0	9

Classification of problems – Dimensionality, time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear,etc., Historical Perspective of FEM and applicability to mechanical engineering design problems. Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions, Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss- Legendre scheme of numerical integration, Nodal degrees of freedom. Compatibility conditions, Assembly and boundary considerations.

UNIT II	ONE DIMENSIONAL PROBLEMS	9	0	0	9

Structural problems with one dimensional geometry. Formulation of stiffness matrix, consistent and lumped load vectors. Boundary conditions and their incorporation: Elimination method, Penalty Method, Introduction to higher order elements and their advantages and disadvantages. Formulation for Truss elements, Case studies with emphasis on boundary conditions and introduction to contact problems. Beams and Frames: Review of bending of beams, higher order continuity (C0 and C1 Continuity), interpolation for beam elements and formulation of FE characteristics, Plane and space frames and examples problems involving hand calculations. Algorithmic approach for developing computer codes involving 1-D elements.

UNIT III	TWO DIMENSIONAL PROBLEMS	9	0	0	9

Interpolation in two dimensions, natural coordinates, Isoparametric representation, Concept of Jacobian. Finite element formulation for plane stress plane strain and axi-symmetric problems; Triangular and Quadrilateral elements, higher order elements, subparametric, Isoparametric and superparametric elements. General considerations in finite element analysis of two dimension problems. Introduction plate bending elements and shell elements.

UNIT IV	DYNAMIC ANALYSIS	9	0	0	9

FE formulation in dynamic problems in structures using Lagragian Method, Consistent and lumped mass models, Formulation of dynamic equations of motion and introduction to the solution procedures. Modelling of structural damping and formulation of damping matrices, Model analysis, Mode superposition methods and reduction techniques.

UNIT V	FEM IN HEAT TRANSFER & FLUID MECHANICS	9	0	0	9

Finite element solution for one dimensional heat conduction with convective boundaries. Formulation of element characteristics and simple numerical problems. Formulation for 2-D and 3-D heat conduction problems with convective boundaries. Introduction to thermo-elastic contact problems. Finite element applications in potential flows; Formulation based on Potential function and stream function. Design case studies

Total(45L) =45 Periods

REFERENCE BOOKS:

1	K. J. Bathe, Finite Element Procedures, Prentice-Hall of India Private Limited, New Delhi, 1996
2	J. C. Simo and T. J. R. Hughes, Computational Inelasticity, Springer-Verlag New York, Inc., New York, 1998
3	Cook and Robert Davis etal, "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley and Sons, 2001.
4	Segerlind L.J, "Applied Finite Element Analysis", 2nd Edition, John Wiley, 1984.
3.	O. C. Zienkiewicz and R. L. Taylor, Finite Element Method: Volume 2 Solid Mechanics, Fifth Edition, Butterworth-Heinemann, Oxford,
4.	D. R. J. Owen and E. Hinton, Finite Elements in Plasticity: Theory and Practice, Pineridge Press Ltd
5.	T. Belytschko and W. K. Liu and B. Moran, Nonlinear Finite Elements for Continua and Structures, John Wiley & Sons Ltd., England

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the concept of finite element method for soling design problems.	Understand
CO2	Formulate and solve manually problems in 1-D structural systems involving bars, trusses, beams and frames.	Create
CO3	Develop 2-D FE formulations involving triangular, quadrilateral elements and higher order elements	Create
CO4	Apply the knowledge of FEM for stress analysis, model analysis, heat transfer analysis and flow analysis	Apply
CO5	Apply the knowledge of FEM for heat transfer analysis and flow analysis	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	3	1	-	-	-	1	1	-	-	1	2	-
CO2	3	1	3	3	3	-	-	1	1	-	-	-	-	3
CO3	3	1	3	3	2	-	-	1	1	-	-	-	-	-
CO4	3	2	3	3	2	-	2	2	1	-	-	1	2	-
CO5	3	1	1	1	1	-	-	-	1	-	-	1	1	-
Avg	**3.0**	**1.2**	**2.6**	**2.2**	**1.6**	**0.0**	**0.4**	**1.0**	**1.0**	**0.0**	**0.0**	**0.6**	**1.0**	**0.6**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC22	**MECHANICAL VIBRATIONS AND ACOUSTICS**		**SEMESTER II**		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**	**3**

	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the Fundamentals of Vibration and its practical applications
2.	To understand the working principle and operations of various vibration measuring instruments.
3.	To be creative problem solvers whilst dealing with machinery involving periodic phenomena.
4.	To understand the working principle and operations of various vibration measuring instruments.
5.	Gain knowledge about the basic of sound waves and noise and its propagation

UNIT I	VIBRATION FUNDAMENTALS	9	0	0	9

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers- System Identification from frequency response-Support motion – Two-degree freedom system -Free vibration of spring-coupled system – mass coupled system – Forced Vibration of two-degree freedom system.

UNIT II	MULTI DEGREE FREEDOM SYSTEM	9	0	0	9

Multi Degree Freedom System-Free Vibration equation of motion- Influence Coefficient - Stiffness Coefficient- Flexibility Coefficient- Generalized coordinates- and Coordinate couplings. Langranges Equations- Matrix Method- Eigen Values - Eigen Vector problems. Modal Analysis- Forced Vibrations of undamped system and modal analysis. Multi Degree System Numerical Methods-Raleigh's Method- Rayleigh-Ritz Method- Holzer`s Method- Methods of Matrix iterations- Transfer Matrix Method- Impulse response and frequency response-functions.

UNIT III	CONTINUOUS SYSTEM AND TRANSIENT- RANDOM VIBRATIONS	9	0	0	9

Continuous System - vibrations of String- Bars- Shafts and beams- free and forced vibration of continuous systems. Transient vibrations- Response of a single degree of freedom system to step and any arbitrary excitation- convolution (Duhamel's) integral-impulse response functions. Random Vibrations- Expected values auto and cross correlation function- Spectral density- response of linear systems- wide band and narrow band processes.

UNIT IV	VIBRATION CONTROL AND VIBRATION MEASUREMENT	9	0	0	9

Balancing of rotating machine- Whirling of rotating shafts-Balancing of reciprocating engines-- control of natural frequency-Introduction of damping- vibration isolation and vibration absorbers. Vibration Measurement- FFT analyzer- vibration exciters-signal analysis- Dynamic Testing of Machines and structures- Experimental modal analysis-Machine Condition Monitoring and diagnosis.

UNIT V	NOISE AND ACOUSTICS	9	0	0	9

Sound waves- governing equation and its propagation- Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media-Fundamentals of Noise - Decibel- Sound Pressure level- Sound Intensity- Sound fields- reflection- absorption and transmission. Noise measurement - Sound meter - Allowed exposure levels and time limit by B.I.S.- Octave Band analysis of sound-Fundamentals of Noise control- source control- path control - enclosures-noise absorbers- noise control at receiver.

Total(45L) =45 Periods

REFERENCE BOOKS:

1	Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 2005.
2	Thomson, W.T. – "Theory of Vibration with Applications", CBS Publishers and Distributors, New Delhi, 2000.
3	Ramamurti. V, "Mechanical Vibration Practice with Basic Theory", Narosa, New Delhi, 2010.
4	A H Church, "Mechanical Vibrations", 2ndEdition, John Wiley & Sons Inc, 1973.
5	Srinivasan, "Mechanical Vibration Analysis", 2ndEdition,-McGraw Hill, 1982.
6	KewalPujara, "Vibration and Noise for Engineers", DhanpatRai& Co

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understand the effects of vibration in mechanical systems and their classification.	Understand

CO2	Develop schematic models for physical systems and formulate governing equations of motion.	Create
CO3	Determine a complete solution to mechanical vibration problems using mathematical or numerical techniques.	Apply
CO4	Identify the various vibration measuring instruments, vibration control and analysis techniques	Understand
CO5	Analysis noise and acoustics to control and reduce vibration effects in machinery.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	1	1	-	-	-	-	-	1	-	-	1
CO2	1	3	1	1	2	2	-	-	-	-	1	-	-	-
CO3	2	1	2	1	-	1	1	-	-	-	1	1	2	-
CO4	1	3	2	1	1	-	-	-	-	-	1	-	-	-
CO5	1	1	2	1	1	-	-	-	-	-	-	1	1	-
Avg	**1.6**	**1.8**	**1.6**	**1.0**	**1.0**	**0.6**	**0.2**	**0.0**	**0.0**	**0.0**	**0.8**	**0.4**	**0.6**	**0.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC23	**SOLID FREEFORM MANUFACTURING**		**SEMESTER II**	
PREREQUISITES	**CATEGORY**	**PC**	**Credit**	**3**

		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES:

1.	To acquaint the students with the evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM).
2.	To gain knowledge on Design for Additive Manufacturing (DFAM) and its importance in quality improvement of fabricated parts.
3.	To acquaint with polymerization and sheet lamination processes and their applications.
4.	To acquaint with material extrusion and powder bed fusion processes.
5.	To gain knowledge on jetting and direct energy deposition processes and their applications.

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

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

UNIT II	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**	**0**	**0**	**9**

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

UNIT III	**VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES**	**9**	**0**	**0**	**9**

Stereolithography Apparatus (SLA): Principles – Photo Polymerization of SL Resins - Pre Build Process – Part-Building and Post-Build Processes - Part Quality and Process Planning, Recoating Issues - Materials - Advantages - Limitations and Applications. Digital Light Processing (DLP) - Materials - Process - Advantages and Applications. Laminated Object Manufacturing (LOM): Working Principles - Process - Materials, Advantages, Limitations and Applications. Ultrasonic Additive Manufacturing (UAM) - Process - Parameters - Applications. Case Studies.

UNIT IV	**MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES**	**9**	**0**	**0**	**9**

Fused deposition Modeling (FDM): Working Principles - Process - Materials and Applications. Design Rules for FDM. Selective Laser Sintering (SLS): Principles - Process - Indirect and Direct SLS - Powder Structure – Materials - Surface Deviation and Accuracy - Applications. MultiJet Fusion. Selective Laser Melting (SLM) and Electron Beam Melting (EBM): Principles – Processes – Materials – Advantages - Limitations and Applications. Case Studies.

UNIT V	**JETTING AND DIRECT ENERGY DEPOSITION PROCESSES**	**9**	**0**	**0**	**9**

Binder Jetting: Three dimensional Printing (3DP): Principles – Process - Physics of 3DP - Types of printing: Continuous mode – Drop on Demand mode - Process – Materials - Advantages - Limitations - Applications. Material Jetting: Multi Jet Modelling (MJM) - Principles - Process - Materials - Advantages and Limitations. Laser Engineered Net Shaping (LENS): Processes- Materials- Advantages - Limitations and Applications. Case Studies.

Total(45L) =45 Periods

REFERENCE BOOKS:

1	Andreas Gebhardt and Jan-Steffen Hotter, "Additive Manufacturing:3D Printing for Prototyping and Manufacturing", Hanser publications Munchen, Germany, 2015. ISBN:978-1-56990-582-1.
2	Ben Redwood, Brian Garret, Filemon Schöffer, and Tony Fadel, "The 3D Printing Handbook: Technologies, Design and Applications", 3D Hubs B.V., Netherland, 2017. ISBN-13: 978- 9082748505.
3	Ian Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing" Springer - New York, USA, 2nd Edition, 2015. ISBN13: 978-1493921126.
4	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 1st Edition, 2007 FL, USA. ISBN- 9780849334092.
5	Milan Brandt., "Laser Additive Manufacturing 1st Edition Materials, Design, Technologies, and Applications", Woodhead Publishing, UK, 2016. ISBN- 9780081004333.

COURSE OUTCOMES: On completion of the course the student will be able to	**Bloom's Taxonomy Mapped**

CO1	Recognize the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on supply chain.	Understand
CO2	Evaluate the design for AM and its importance in the quality of fabricated parts.	Evaluate
CO3	Acquire knowledge on principles and applications of polymerization and sheet lamination processes with case studies.	Understand
CO4	Acquire knowledge on principles of material extrusion and powder bed fusion processes and design guidelines.	Understand
CO5	Perceive jetting and direct energy deposition processes and their applications.	Apply

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	1	3	3	2	-	-	-	2	-	2	-	-
CO2	3	2	3	3	3	2	1	2	-	-	-	3	3	-
CO3	3	3	2	3	1	3	1	-	-	-	-	-	-	-
CO4	3	3	2	3	2	1	-	-	-	-	-	-	-	-
CO5	3	3	2	3	1	1	-	-	-	2	-	3	-	1
Avg	2.8	2.8	2.0	3.0	2.0	1.8	0.4	0.4	0.0	0.8	0.0	1.6	0.6	0.2

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC24	**FINITE ELEMENT ANALYSIS LABORATORY**		**SEMESTER II**		
PREREQUISITES		**CATEGORY**	**PC**	**Credit**	**2**

	Hours/Week	L	T	P	TH
		0	0	4	4

COURSE OBJECTIVES:

1.	To impart knowledge of Finite Element method using Analysis Software
2.	To solve simple static structural analysis and calculating stresses
3.	To know the Steady-state Thermal Analysis of different shapes
4.	To understand the Transient state of Thermal Analysis
5.	To recognize the CFD/ Coupled field analysis.

LIST OF EXPERIMENTS	**0**	**0**	**45**	**45**

FE Analysis using ANSYS Package for different structures that can be Discredited with 1-D, 2-D & 3-D elements to perform the following 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 axisymmetric components.
5. Analysis of bracket using ANSYS.
6. Buckling analysis of linear materials using ANSYS.
7. Vibration analysis of spring-mass systems.
8. Modal analysis of Beams.
9. Thermal stress and heat transfer analysis of plates.
10. Thermal stress analysis of cylindrical shells.
11. Thermal analysis of temperature distribution in a 2-D fin cooled electronic components.
12. Temperature distribution in a 3-D fin cooled electronic component.
13. Heat flux analysis of a composite slab.
14. Heat flux analysis of a cylindrical rod.
15. CFD Analysis of a circular tube
16. Coupled structural/Thermal analysis.

Total(45P) = 45 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Apply the concept of FEM for solving static structural problems.	Apply
CO2	Apply the concept of FEM for modal analysis.	Apply
CO3	Apply the FEM technology for Thermal stress analysis.	Apply
CO4	Apply the FEM technology for Fluid Flow Analysis.	Apply
CO5	Solve the coupled field analysis problems using FEA software.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	1	2	1	3	-	2	-	-	1	-	-	1	2	1
CO2	3	1	2	1	-	2	-	-	2	1	-	1	2	3
CO3	3	2	1	2	3	2	-	-	2	1	-	2	2	3
CO4	3	1	1	1	3	2	-	-	2	2	-	3	2	1
CO5	3	1	1	1	3	2	-	-	2	2	-	3	2	1
Avg	**2.6**	**1.4**	**1.2**	**1.6**	**1.8**	**2.0**	**0.0**	**0.0**	**1.8**	**1.2**	**0.0**	**2.0**	**2.0**	**1.8**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC25	**CAM AND ROBOTICS LABORATORY**		**SEMESTER II**			
PREREQUISITES		**CATEGORY**	**PC**	**Credit**		**2**
		Hours/Week	**L**	**T**	**P**	**TH**

		0	**0**	**4**	**4**

COURSE OBJECTIVES:

1.	To understand Features and Selection of CNC machines.
2.	To learn CNC programming for a variety of products using APT language.
3.	To impart CNC part programming skills for turning and milling applications.
4.	To give a good exposure of CAM software in order to perform Simulation and to generate CL data.
5.	To learn robot programming and simulation of machining processes.

MODULE I	**LIST OF CNC EXPERIMENTS**	**0**	**0**	**30**	**30**

Features and selection of CNC turning and milling centers.
Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles mentioned below:
CNC Turning
1. Facing Cycle
2. Turning Cycle
3. Drilling Cycle
4. Grooving Cycle
5. Taper Turning Cycle
6. Step Turning Cycle

CNC Milling
1. Linear & circular interpolation
2. Mirroring
3. Circular pocketing
4. Rotation
5. Rectangular pocketing

Exercise in CNC lathe & Milling
1. Machine the given stock as per the component specification drawing using CNC lathe.
2. Machine the given stock as per the component specification drawing using CNC Milling machine.

MODULE II	**LIST OF ROBOTICS EXPERIMENTS**	**0**	**0**	**15**	**15**

Practice in Robot programming and its languages
1. Robotics: Introduction to online programming.
2. Robotics: Motion control
3. Robotics: Pick & Place
4. Robotics: Interface with external equipment

Total(45P) = 45 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Identify the features and selection of CNC machines.	Understand
CO2	Apply the basic concepts in NC technology for turning and milling applications.	Apply
CO3	Make familiar with the use of CAE and CAM Software.	Create
CO4	Practice in part programming and operating a machining center.	Remembering
CO5	Program and control robot path for industrial applications.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO7**	**PO8**	**PO 9**	**PO1 0**	**PO1 1**	**PSO 1**	**PSO 2**	**PSO3**
CO1	-	2	1	3	-	2	-	-	1	-	-	1	2	1
CO2	1	1	2	1	-	2	-	-	2	-	-	1	2	3
CO3	-	2	1	2	1	2	-	-	2	-	-	2	1	3
CO4	-	1	1	1	1	2	-	-	2	-	-	3	2	1
CO5	-	1	1	1	1	2	-	-	2	-	-	3	1	1
Avg	**0.2**	**1.4**	**1.2**	**1.6**	**0.6**	**2.0**	**0.0**	**0.0**	**1.8**	**0.0**	**0.0**	**2.0**	**1.6**	**1.8**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDC26	**TECHNICAL SEMINAR - II**		**SEMESTER II**		
PREREQUISITES		**CATEGORY**	**EEC**	**Credit**	**1**

	Hours/Week	L	T	P	TH
		0	0	2	2

COURSE OBJECTIVES:

1.	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation.
2.	To acquire technical writing abilities for seminars and conferences.
3.	To Identify and compare technical and practical issues related to the area of course specialization.
4.	To Outline annotated bibliography of research demonstrating scholarly skills.
5.	Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

MODULE		0	0	30	30

The students will work for two hours per week guided by a group of staff members. They will be asked to talk on any topic of their choice related to Engineering design topics and to engage in dialogue with the audience. A brief copy of their talk also should be submitted. Similarly, the students will have to present a seminar of not less than fifteen minutes and not more than thirty minutes on the technical topic. They will also answer the queries on the topic. The students as the audience also should interact.
Evaluation will be based on the technical presentation and their port and also on the interaction during the seminar using the specific rubrics.

Total(30P) = 30 Periods

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Generate motivation for any topic of interest and develop a thought process for technical presentation.	Create
CO2	Express communicative skills (e.g. speaking, listening, reading, and/ or writing).	Understand
CO3	Make use of new and recent technology for creating technical reports	Create
CO4	Organize a detailed literature survey and build a document with respect to technical publications.	Understand
CO5	Analyse and comprehend the proof-of-concept and related data.	Analysis

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO3
CO1	-	-	-	-	-	1	3	3	1	1	-	3	-	-
CO2	-	-	-	-	-	-	3	2	2	3	-	-	-	3
CO3	-	-	-	-	1	-	3	1	2	2	-	-	2	-
CO4	-	-	-	-	-	-	3	3	3	2	-	2	-	-
CO5	-	1	-	3	-	-	3	-	3	2	-	-	-	2
Avg	**0.0**	**0.2**	**0.0**	**0.6**	**0.2**	**0.2**	**3.0**	**1.8**	**2.2**	**2.0**	**0.0**	**1.0**	**0.4**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

SEMESTER-III

22CDC31	DISSERTATION PHASE – I	SEMESTER III

PREREQUISITES	CATEGORY	EEC	Credit		6
	Hours/Week	L	T	P	TH
		0	0	20	20

COURSE OBJECTIVES:

1.	To develop the ability to solve a specific problem right from its identification and literature review until the successful solution of the same.
2.	To train the students in preparing project reports and to face reviews and viva voce examination

CONTENTS:

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.

The seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. E.

The examination shall consist of the preparation of a report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiner's panel set by Headland PG coordinator.

The candidit has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.	Understand
CO2	Students will be able to use different experimental techniques.	Remembering
CO3	Students will be able to use different software/ computational/analytical tools.	Remembering
CO4	Students will be able to design and develop an experimental set up/ equipment/test rig.	Create
CO5	Students will be able to conduct tests on existing setups/equipment and draw logical conclusions from the results after analyzing them.	Analysis

SEMESTER IV

22CDC41	DISSERTATION PHASE - II			SEMESTER IV		
PREREQUISITES		**CATEGORY**	**EEC**	**Credit**		**14**
		Hours/Week	**L**	**T**	**P**	**TH**
			0	**0**	**32**	**32**

COURSE OBJECTIVES:

1.	To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
2.	To train the students in preparing project reports and to face reviews and viva voce examination

CONTENTS:

- The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.
- The seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E.
- The examination shall consist of the preparation of a report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiner's panel set by Head and PG coordinator.
- The candidate has to be in regular contact with his guide and the topic of the dissertation must be mutually decided by the guide and student.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Students will learn to survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.	Understand
CO2	Students will be able to use different experimental techniques.	Remembering
CO3	Students will be able to use different software/ computational/analytical tools.	Remembering
CO4	Students will be able to design and develop an experimental set up/ equipment/test rig.	Create
CO5	Students will be able to conduct tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them.	Analysis

PROFESSIONAL ELECTIVE-I

22CDE11	ADVANCED MATHEMATICAL METHODS IN ENGINEERING	SEMESTER I

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To implement the knowledge about the vector spaces, inverse of a linear transformation and composition of linear maps.
2. To analyze the solution of wave equation by method of Eigen function.
3. To illustrate the solutions of diffusion and wave equations by using techniques of Laplace and Fourier transforms.
4. To examine the significance of central limit theorem and testing of hypothesis.
5. To analyze the variance of factors by one way and two-way classification and some standard design of experiments.

UNIT I	LINEAR ALGEBRA	9	0	0	9

Vector space - linear dependence of vectors, basis and dimension- Linear transformations (maps) - range and kernel of linear transformation- rank and nullity- Inverse of linear transformation- rank-nullity theorem – Composition of linear maps- Matrix associated with linear map.

UNIT II	PARTIAL DIFFERENTIAL EQUATIONS	9	0	0	9

Classification of second order PDE- Solution of PDE by separation of variables- Solution of Parabolic, Elliptic and Hyperbolic equation in cylindrical and spherical co-ordinates- Initial and Boundary value problems for two-dimensional wave equation by the method of Eigen function- D Alembert's solution for the wave equation.

UNIT III	FOURIER AND LAPLACE TRANSFORMS	9	0	0	9

Maximum-Minimum principle for Elliptic equations- Solution of diffusion equation and wave equation by Laplace transform technique – Solution of Diffusion equation, wave equation and Laplace equation by Fourier transform technique.

UNIT IV	STANDARD DISTRIBUTIONS AND TESTING OF HYPOTHESIS	9	0	0	9

Random variables- Standard discrete and continuous distributions (Binomial, Poisson, Normal, uniform and Exponential) – Central limit theorem and its significance- Testing a statistical hypothesis Sampling distribution (t-test, F-test and Chi-square test).

UNIT V	ANALYSIS OF VARIANCE AND DESIGN OF EXPERIMENTS	9	0	0	9

Analysis of variance –One way and Two-way classifications- Principles of Design of Experiments- Some standard designs (Completely Randomized Design, Randomized Block design and Latin square design).

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Gilbert Strang, "Linear Algebra and its applications", Cengage Learning, New Delhi, 4th edition, 2006.
2. K.Sankara Rao, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
3. Veerarajan.T, "Probability, Statistics and Random process", Tata McGraw- Hill publications, second edition, New Delhi, 2002.
4. V. Krishnamurthy, V. P. Mainra and J. L. Arora, "An introduction to Linear Algebra", East-West press Reprint 2005
5. Grewal, B.S., "Higher Engineering Mathematics", 43rd edition, Khanna Publishers, New Delhi 2014.
6. J.B.Joshi, "Differential equations for Scientists and Engineers", Narosa Publications, 2010.
7. Gupta, S.C. and Kapur, V.K., "Fundamentals of Mathematical Statistics", S.Chand and Sons, New Delhi, 11th Edition 2014
8. Devore, Jay L., "Probability and Statistics for Engineering and the Sciences", 5th Edition, Brooks- Cole, 1999.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Demonstrate the vector spaces and linear transformations	Understand
CO2	Analyze the solution of wave equation by method of Eigen function	Analysis
CO3	Implement the Laplace and Fourier transform techniques for the solutions of diffusion and wave equation involved in engineering problems.	Apply
CO4	Experiment various tests of statistics for the samples.	Analysis
CO5	Analyze the variance of factors by one way and two-way classification and some standard design of experiments.	Analysis

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	2	0	0	0	0	0	0	0	0	2	0
CO2	3	2	0	2	0	0	0	0	0	0	0	0	2	0
CO3	3	2	0	2	0	0	0	0	0	0	0	0	2	0
CO4	3	2	0	2	0	0	0	0	0	0	0	0	2	0
CO5	3	2	0	2	0	0	0	0	0	0	0	0	2	0
Avg	**3.0**	**2.0**	**0.0**	**2.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**0.0**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand composite material, reinforcements, and their selection.
2.	To develop and processing of metal- matrix, ceramic -matrix and carbon- carbon Composites.
3.	To understand engineering mechanics, analysis and design, micro mechanics and fabrication techniques of composites
4.	To understand and analyze the properties and performance of composite
5.	To understand the basics of nanocomposite materials.

UNIT I	INTRODUCTION	9	0	0	9

Definition and Classification of Composites, MMC, PMC, CMC. Reinforcing fibres- Natural fibres (cellulose, jute, coir etc), boron, carbon, ceramic glass, aramids etc. Particulate fillers-importance of particle shape and size. Matrix resins-thermoplastics and thermosetting matrix resins. Coupling agents-surface treatment of fillers and fibres, significance of interface in composites. Short and continuous fibre reinforced composites, critical fibre length, and anisotropic behaviour.

UNIT II	PROPERTIES AND PERFORMANCE	9	0	0	9

Properties and microstructure of high-strength fiber materials (glass, carbon, polymer, ceramic fibers) and matrix materials (polymer, metal, ceramic, and carbon matrices). Specific strength and stiffness of high-performance composites. Rule of mixtures. Stress, strain transformations.

UNIT III	MECHANICS AND MANUFACTURING	9	0	0	9

Engineering mechanics- analysis and design- concepts of Isotropy vs. Anisotropy, composite micromechanics (effective stiffness/strength predictions, load-transfer mechanisms), Classical Lamination Plate Theory (CLPT). Fabrication techniques- pultrusion, filament winding, prepreg technology, injection and compression moulding, bag moulding, resin transfer moulding, reaction injection moulding.

UNIT IV	FAILURE CRITERIA AND APPLICATIONS	9	0	0	9

Hydrothermal stresses, bending of composite plates, analysis of sandwich plates, buckling analysis of laminated composite plates, inter-laminar stresses, First Order Shear Deformation Theory (FSDT). Applications: Industrial, aerospace, automobile, house hold etc.

UNIT V	NANO COMPOSITIES	9	0	0	9

Introduction-Types of Nanocomposites (i.e., metal oxide, ceramic, glass and polymer based) - Core-Shell structured nanocomposites-Super hard nanocomposite-Synthesis and applications.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Mallick P.K., "Fiber-Reinforced Composites: Materials- Manufacturing and Design", Maneel Dekker Inc, 1993.
2	Krishan K. Chawla, Composite Materials, Science and Engineering, Springer, 2001.
3	Steven L. Donaldson, ASM Handbook Composites Volume 21, 2001.
4	Nanocomposite science and technology – P.M. Ajayan, L.S. Schadler, P.V. Braun, Wiley, New York, 2003.
5	Suresh G. Advani, E. Murat Sozer, Process Modelling in Composites Manufacturing, 2nd Ed. CRC Press, 2009.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Choose and select the suitable composite material and their reinforcements	Evaluate
CO2	Select constituent materials glass, carbon, aramid, ceramic fibers and resins	Evaluate
CO3	Apply engineering mechanics, analysis and design and micro mechanics to fabricate the FRP composites in different manufacturing techniques.	Apply
CO4	Analyze thermo-mechanical behavior and evaluate the residual stresses in different types of laminates.	Analysis
CO5	Highlight the appropriate use of composites and Nano composite structures in the industry.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO7	PO8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	-	2	-	1	2	1	2	2	1
CO2	3	2	2	2	2	-	2	-	1	-	1	2	2	2
CO3	1	1	1	1	1	1	1	-	1	-	1	2	2	3
CO4	1	2	2	2	2	-	-	-	2	-	-	2	2	2
CO5	3	1	1	1	1	-	-	-	1	2	3	3	2	3
Avg	**2.2**	**1.6**	**1.6**	**1.6**	**1.6**	**0.2**	**1.0**	**0.0**	**1.2**	**0.8**	**1.2**	**2.2**	**2.0**	**2.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE13	PRODUCT LIFECYCLE MANAGEMENT	SEMESTER I

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To understand history, concepts, and terminology of PLM
2. To learn functions and features of PLM/PDM
3. To study different modules offered in commercial PLM/PDM tools
4. To learn PLM/PDM implementation approaches
5. To study integration of PLM/PDM with other applications

UNIT I	HISTORY, CONCEPTS AND TERMINOLOGY OF PLM	9	0	0	9

Introduction to PLM, Need for PLM, Components / Elements of PLM, Emergence of PLM, Significance of PLM, Customer Involvement, Threads of PLM- Computer aided design (CAD), Engineering Data Management (EDM), Product data management (PDM), Collaborative Product Definition Management (CPDM), Collaborative Product Commerce (CPC). PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.

UNIT II	PRODUCT LIFECYCLE ENVIRONMENT	9	0	0	9

Product Data and Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Developing a PLM strategy, Strategy identification and selection, PLM System Architecture (2tier/3tier/4tier etc). Concept of cloud PLM.

UNIT III	ROLE OF PLM IN INDUSTRIES	9	0	0	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, organization, users, product or service, process performance

UNIT IV	PRODUCT DATA MANAGEMENT (PDM)	9	0	0	9

Product Data Management (PDM) Concepts, Benefits and Terminology, reason for implementing a PDM system, financial justification of PDM, barriers to PDM implementation.

UNIT V	CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE	9	0	0	9

PLM Customization, use of EAI technology (Middleware), Integration with legacy data base, CAD, SLM and ERP, Case study examples based on top few commercial PLM/PDM tools.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1. Antti Saaksvuori and Ansel miImmonen, “Product Lifecycle Management”, Springer Publisher (3rd Edition), 2008.
2. Ivica Crnkovic, Ulf Asklund and Annita Persson Dahlqvist, “Implementing and Integrating Product Data Management and Software Configuration Management”, Artech House Publishers, 2003.
3. John Stark, “Global Product: Strategy, Product Lifecycle Management and the Billion Customer Question”, Springer Publisher, 2007.
4. John Stark, “Product Lifecycle Management: 21st Century Paradigm for Product Realisation”, Springer Publisher (2nd Edition), 2011.
5. Michael Grieves (2006), “Product Life Cycle Management”, Tata McGraw Hill, 2006.
6. International Journal of Product Lifecycle Management, Inderscience Publishers.
7. Fabio Giudice, Guido La Rosa, “Product Design for the environment-A life cycle approach”, Taylor & Francis, 2006.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Realize the history, concepts, and terminology of PLM.	Remembering
CO2	Analyse the product life cycle environment.	Analysis
CO3	Apply PLM/PDM implementation approaches in industry.	Apply
CO4	Integrate PLM/PDM with other lifetime applications.	Apply
CO5	Analyze the case studies.	Analysis

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	-	1	-	-	-	1	-	1	1	-	1	2	1
CO2	2	-	3	1	-	1	2	-	2	-	1	1	2	-
CO3	2	3	1	2	1	-	3	-	1	-	1	2	2	2
CO4	-	1	2	-	1	-	2	-	3	1	-	1	1	1
CO5	2	2	2	2	1	-	-	-	-	-	-	2	2	1
Avg	**1.4**	**1.2**	**1.8**	**1.0**	**0.6**	**0.2**	**1.6**	**0.0**	**1.4**	**0.4**	**0.4**	**1.4**	**1.8**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE14	ADVANCED ENGINEERING MATERIALS	SEMESTER I

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To identify fundamental issues and establish directions for investigation of materials
2.	To familiarize various types of characterization tools used in material study
3.	To understand structure-properties properties relationships
4.	To impart knowledge about the fundamentals of micro/Nano, smart materials, devices and electronics, in particular those related to the development of smart structures and products
5.	To increase the skills, knowledge and motivation in the design, analysis and manufacturing of smart structures and products.

UNIT I	INTRODUCTION	9	0	0	9

Introduction- advanced metallic materials - ceramic materials and polymeric materials - processing of materials - interaction between materials characteristics – applications - effects of processing on their subsequent structure and properties- design for use.

UNIT II	CHARACTERIZATION OF MATERIALS	9	0	0	9

Particle / material interactions & wave / material interactions-the experimental process- crystallography- defects- reciprocal space & diffraction. Instrumentation- vacuum systems- electron sources and detectors etc with the techniques of SEM- TEM- XRD- XRF and XPS. Surface analysis techniques and ion beam techniques - Aspects of sample preparation.

UNIT III	HIGH STRENGTH, LOW AND TEMPERATURE MATERIALS	9	0	0	9

Methods of strengthening of alloys - Materials available for high strength applications - Properties required for high strength materials - Applications of high strength materials. Properties required for low and high temperature applications - Requirements of materials and materials availability for low and high Temperature applications.

UNIT IV	SMART MATERIALS	9	0	0	9

Overview of Smart Materials -Physical Properties-Piezoelectric Materials-Electrorestrictive Materials - Magneto restrictive Materials -Magneto electric Materials -Magnetorheological Fluids - Electrorheological Fluids- Shape Memory Materials - Sensor Arrays -Smart Actuators

UNIT V	NANOMATERIALS	9	0	0	9

Definition - Types of nanomaterials, nanocomposites – synthesis methods of nano materials - Physical and mechanical properties - Applications of nanomaterials.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	D. R. Askeland and P. P. Phule, “The Science and Engineering of Materials”, Thomson Publication, 2015.
2	Gregory Tirp, “Nano Technology”, , Springer Publication 2012.
3	Van Vlack, “Elements Of Material Science And Engineering”, Pearson Education India 1989
4	A.V. Srinivasan, “Smart Structures Analysis and Design”, Cambridge University Press, Cambridge, 2001.
5	V.D. Kodgire, “Material science and Metallurgy”, Everest Publishing House 2002.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Identify fundamental issues and establish directions for selection of materials	Understand
CO2	Describe the characterization techniques for materials	Understand
CO3	Prepare high strength materials and Suggest materials for low and high temperature applications.	Apply
CO4	Integrate knowledge of different types of advanced engineering materials	Understand
CO5	Analyse problem and find appropriate solution for use of materials.	Analysis

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	-	1	-	2	1	-	-	-	1	-	-	-
CO2	2	1	-	1	2	1	-	1	2	1	-	-	-	1
CO3	1	2	3	1	1	1	2	-	1	-	1	-	1	1
CO4	-	-	2	1	-	2	1	-	2	-	1	1	2	1
CO5	1	1	1	1	-	-	2	-	-	1	1	1	2	-
Avg	**1.0**	**1.0**	**1.2**	**1.0**	**0.6**	**1.2**	**1.2**	**0.2**	**1.0**	**0.4**	**0.8**	**0.4**	**1.0**	**0.6**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE15	EXPERIMENTAL STRESS ANALYSIS	SEMESTER I
	(Use of approved Data Book and Charts may be permitted)	

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To use indicial notation to represent the compatibility, equilibrium, and constitutive equations of mechanics
2.	To use alternate definitions of stress to solve problems involving large deformations
3.	To use alternate definitions of strain to solve problems involving large deformations
4.	To compute bending stresses in circular plate
5.	To perform stress calculations in thick walled cylinders and rotating disk

UNIT I	THEORY OF ELASTICITY	9	0	0	9

Analysis of stress – Analys is of stain - Elasticity problems in two dimension and three dimensions - Mohr's circle for three dimensional stresses - Stress tensor - Airy's stress function in rectangular and polar coordinates - Energy method for analysis of stress - Strain and deflection - The three theorem's - Theorem of virtual work - Theorem of least work - Castigliano's theorem - Rayleigh Ritz method - Galekin's method - Elastic behaviour of anisotropic materials like fiber reinforced composites.

UNIT II	THEORY OF TORSION	9	0	0	9

Torsion of prismatic bars of solid section and thin walled section - Analogies for torsion - Membrane analogy - Fluid flow analogy and electrical analogy - Torsion of conical shaft, bar of variable diameter - Thin walled members of open cross section in which some sections are prevented from warping - Torsion of noncircular shaft.

UNIT III	UNSYMMETRICAL BENDING	9	0	0	9

Concept of shear centre in symmetrical and unsymmetrical bending - Stress and deflections in beams subjected to unsymmetrical bending - Shear centre for thin wall beam cross section - Open section with one axis of symmetry- General open section and closed section.

UNIT IV	PLATE BENDING	9	0	0	9

Bending of plate to cylindrical surface - Bending of a long uniformly loaded rectangular plate - Pure bending in two perpendicular directions - Bending of circular plates loaded symmetrically w. r. t. center - Bending of circular plates of variable thickness - Circular plate with circular hole at centre symmetrically loaded and load distributed along inner and outer edges.

UNIT V	PRESSURIZED CYLINDERS AND ROTATING DISKS	9	0	0	9

Governing equations - Stress in thick walled cylinder under internal and external pressure - Shrink fit compound cylinders- Stresses in rotating flat solid disk - Flat disk with central hole -Disk with variable thickness - Disk of uniform strength - Plastic action in thick walled cylinders and rotating disc.

Total(45L) =45 Periods

REFERENCE BOOKS:

1	Timoshenko and Goodier, "Theory of Elasticity", McGraw Hill, 1970.
2	Timoshenko, "Advanced Strength of Materials", Vol. 1,2, CBS publishers, 2004.
3	Den Harteg, "Advanced Strength of Materials",Dover Publications Inc., 1987.
4	Dally & Riley, "Experimental Stress Analysis", McGraw-Hill College, 1991.
5	Timoshenko, "Theory of Plates and Shells", McGraw Hill, 1964.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	To explain the concept of elasticity and the difference between stress and strain	Understand
CO2	Explain the term as plane stress and plane strain	Understand
CO3	Conduct the transformation of plane stress or plane strain components using Mohr's circle, the method of Eigenvalues and eigenvectors, the method of quadratic form of ellipsoids, and the method of Stress or strain trajectories	Rememberi ng
CO4	Apply basic concepts of elastic stability and buckling of elastic	Apply

CO5	To study about the stresses developed in thick cylinder and discs	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	-	1	-	-	1	-	-	-	-	2	1	2
CO2	1	3	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	3	1	1	3	-	1	-	-	-	-	3	-	1
CO4	3	2	1	2	2	-	1	-	-	-	-	3	2	1
CO5	2	3	-	3	1	-	1	-	-	-	-	3	-	1
Avg	**2.2**	**2.6**	**0.6**	**1.6**	**1.2**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.6**	**0.6**	**1.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PROFESSIONAL ELECTIVE-II

22CDE21	ADVANCED KINEMATICS OF MACHANISMS		SEMESTER I			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**
		Hours/Week	**L**	**T**	**P**	**TH**
			3	**0**	**0**	**3**

COURSE OBJECTIVES

1.	Analyze the motion of mechanisms, the design of mechanisms to produce motion and the forces in machines
2.	To become familiar with a variety of complex mechanisms involving motion in complex curvature.
3.	To synthesize four-bar and slider crank mechanisms.
4.	To analyze the spatial mechanism related to motion of robots.
5.	To study the coupler curve theory.

UNIT-I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Basic Concepts - Definitions and assumptions - planar and spatial mechanisms - kinematic pairs - Degree of freedom - equivalent mechanisms - Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanism - analysis of complex mechanisms by the normal acceleration and auxiliary-point methods.

UNIT-II	**CURVATURE THEORY**	**9**	**0**	**0**	**9**

Fixed and moving centrodes - inflection circle - Euler-Savary equation - Bobillier constructions, cubic of stationary curvature - Ball's point - Applications in dwell mechanisms.

UNIT-III	**SYNTHESIS OF MECHANISMS**	**9**	**0**	**0**	**9**

Number synthesis-degrees of freedom of planar kinematic chains, dimensional synthesis graphical methods -pole and relative pole of four bar and slider crank mechanism - design of slider crank and four bar mechanism, analytical method Chebyshev's spacing of accurate points - function generation by mechanism - Freudenstein equation for four bar slider crank chain for three accuracy points, mechanism for position guidance - body guidance - Bloch's method - cognate linkages.

UNIT-IV	**SPATIAL MECHANISMS AND KINEMATICS OF ROBOT**	**9**	**0**	**0**	**9**

Introduction – Mobility - Position analysis - Velocity analysis - Acceleration analysis - Eulerian angles - Denavit-Hartenberg parameters – Kinematic analysis of spatial RSSR mechanism- Forward and inverse kinematics of robotic manipulators - Study and use of Mechanism using simulation software packages.

UNIT-V	**COUPLER CURVES**	**9**	**0**	**0**	**9**

Four bar linkage - Equation of coupler curve - double points and symmetry - Robert-Chebyshev theorem - straight line mechanism - approximate and exact.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	R.L. Norton , "Design of Machinery", Tata McGraw Hill, 2004
2	J. J.Uicker, G. R. Pennock & J.E.Shigley, "Theory of Machines and Mechanisms", Oxford University Press, New York, 2003
3	R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, New York, 1980.
4	J. Kenneth, Waldron, L.Gary&Kinzel, "Kinematics, Dynamics and Design of machinery", John Wiley& Sons,2003.
5	J.S. Rao, "The Theory of Machines Through Solved Problems", New Age International Publishers, 2006
6	N.G. Sandor& G.A. Erdman, "Advanced Mechanism Design", Volume-I, Prentice Hall India Pvt. Ltd, 2001
7	Michael J.Rider,"Design and analysis of Mechanism",John Wiley & Sons,2015

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Create a graphical and analytical method for analyzing the velocity and acceleration of complex Mechanisms.	Create
CO2	Interpret the curvature theory of complex kinematic mechanism	Understand
CO3	Develop the various approaches for generating the kinematic mechanism.	Create
CO4	Analyze simple spatial mechanisms such as RSSR for robotic manipulators.	Analysis
CO5	Create a coupler curve equation for four bar linkages.	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	-	1	-	2	1	-	-	-	1	-	-	-
CO2	2	1	-	1	2	1	-	1	2	1	-	-	-	1
CO3	1	2	3	1	1	1	2	-	1	-	1	-	1	1
CO4	-	-	2	1	-	2	1	-	2	-	1	1	2	1
CO5	1	1	1	1	-	-	2	-	-	1	1	1	2	-
Avg	**1.0**	**1.0**	**1.2**	**1.0**	**0.6**	**1.2**	**1.2**	**0.2**	**1.0**	**0.4**	**0.8**	**0.4**	**1.0**	**0.6**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE22	ADVANCED TOOL DESIGN				SEMESTER I			
PREREQUISITES		**CATEGORY**	**PE**	**Credit**		**3**		
		Hours/Week	**L**	**T**	**P**	**TH**		
			3	**0**	**0**	**3**		

COURSE OBJECTIVES

1.	To enable the student to make the complete design of tooling, based on the design of a product
2.	To understand the design of tools based on various machining processes.
3.	To know about the various standards available in data book and usage of tool design data book.
4.	To improve the design of tools relevant to vibrations induced in the machining process.
5.	To improve the design of tools for manual machining as well as NC and automatic screw cutting machines.

UNIT-I	**TOOL-DESIGN METHODS**	**9**	**0**	**0**	**9**

Introduction – Design Procedure – Statement of the problem –Needs Analysis — Tentative Design Solutions –Finished Design – Drafting and Design – drafting practice - Tool making Practice - Tools of the Toolmaker - Screws and Dowels – Hole location – Jig-boring practice– Punch and Die Manufacture – Electro-discharge machining for cavity.

UNIT-II	**TOOL MATERIALS AND DESIGN OF CUTTING TOOLS**	**9**	**0**	**0**	**9**

Properties of Materials – Ferrous Tooling Materials – Nonferrous Tooling Materials - Nonmetallic Tooling Materials. Design of Metal-cutting Tools – Single-point cutting tools – Milling cutters – Drill, Tap, Reamer, Jigs and Fixtures : Design Consideration - the selection of carbide cutting tools and its inserts –- advanced heat treatment methods for composite materials, cryo treatment of steels, plasma equipment.

UNIT-III	**DESIGN OF SPINDLES AND SPINDLE BEARINGS**	**9**	**0**	**0**	**9**

Design of Spindles, Bearing and Power Screws: Design of spindles subjected to combined bending and torsion. The layout of bearings. Pre-loading. Anti-friction slideways. Rolling contact, hydrodynamic, hydrostatic, aerostatics and magnetic bearings, their relative performance. Hydrodynamic design of journal bearings. Power Screws, Recirculating ball screws.

UNIT-IV	**MACHINE TOOL VIBRATIONS**	**9**	**0**	**0**	**9**

Effect of vibration on the machine tool; Forced vibrations. Machine tool chatter. Self-excited vibration and dynamic stability single and two-degree freedom analysis. Completely coefficient. Elimination of vibration. Vibration analysis of machine tool structures.

UNIT-V	**TOOL DESIGN FOR NC MACHINES**	**9**	**0**	**0**	**9**

Introduction to numerical control machine tools - Fixture design for numerically controlled machine tools – Cutting tools and Tool holding methods for numerical control – Automatic tool changers and tool positioners – Tool presetting – Introduction to Automatic Screw machine and its tooling – General explanation of the Brown and sharp machine. Concepts of aesthetic and ergonomics applied to machine tools - latest trends in Machine Tool Design

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Cyril Donaldson, George H.LeCain and V.C. Goold, “Tool Design”, Tata McGraw Hill, 2000
2	Prakash Hiralal Joshi, “Tooling data”, Wheeler Publishing, 2000
3	Mehta- N.K, “Machine Tool Design”, Tata McGraw Hill, 1989.
4	Koenisbergaer F, “Design Principles of Metal Cutting Machine Tools”, Pergamon Press, 1964.
5	Acherkan N, “Machine Tool Design- Vol. 3 & 4”, MIR Publishers, Moscow, 1968.
6	Sen. G and Bhattacharya A, “Principles of Machine Tools Vol.2”, NCB, Calcutta, 1973.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	Apply design principles to tool design and to create economically viable products.	Apply
CO2	Recognize tool material properties, tool nomenclature and cutting tool Properties.	Understand
CO3	Analyze the design of various bearings as it relates to spindles and power screws.	Analysis
CO4	Integrate the tooling design analysis with machine tool vibration.	Analysis
CO5	Create tool designs for variety machining processes using NC machines and automatic screw cutting machine.	Create

COURSE ARTICULATION MATRIX														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO2	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO3	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO4	3	3	3	3	2	-	-	-	-	-	-	3	1	1
CO5	3	3	3	3	3	-	-	-	-	-	-	3	1	1
Avg	3.0	3.0	3.0	3.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	3.0	1.0	1.0
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE23	**INDUSTRY 4.0**		**SEMESTER I**		
PREREQUISITES		**CATEGORY**	**PE**	**Credit**	**3**

		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES:

1.	To understand the Smart Factory paradigm
2.	To learn the strategic framework to exploit new technologies to enable Industry 4.0.
3.	To gain deep insights into how smartness is being harnessed from data.
4.	To familiarize in Industry 4.0 in robotic technology.
5.	To implement Virtual/Augmented Reality applications.

UNIT I	**INTRODUCTION TO INDUSTRY 4.0**	**9**	**0**	**0**	**9**

Introduction- Digitalization and the Networked Economy - concept of industry 4.0 - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - Industry 4.0 production system, current state of industry 4.0 Technologies - Comparison of Industry 4.0 Factory and today's Factory - How is India preparing for Industry 4.0

UNIT II	**TECHNOLOGY ROADMAP FOR INDUSTRY 4.0**	**9**	**0**	**0**	**9**

Introduction- Components of Industry 4.0 - Supportive Technologies - Proposed Framework for Technology Roadmap - Strategy Phase-Strategy Phase - New Product and Process Development Phase

UNIT III	**INTERNET OF THINGS**	**9**	**0**	**0**	**9**

Internet of Things (IoT) - Industrial Internet of Things (IIoT) - Internet of Services - Smart Manufacturing -Smart Devices and Products - Smart Logistics - Cloud Computing - Trends of Industrial Big Data and Predictive Analytics for Smart Business- Architecture of Industry 4.0

UNIT IV	**ROBOTICS IN THE ERA OF INDUSTRY 4.0**	**9**	**0**	**0**	**9**

Introduction- Recent Technological Components of Robots- Advanced Sensor Technologies - Internet of Robotic Things - Cloud Robotics and Cognitive Architecture for Cyber-Physical Robotics - Industrial Robotic Applications- Manufacturing, Maintenance and Assembly

UNIT V	**ROLE OF AUGMENTED REALITY**	**9**	**0**	**0**	**9**

Introduction- AR systems and functionality -AR Hardware and Software Technology- Augmented reality methods- visualization techniques for augmented reality- enhancing interactivity in AR environments- Industrial Applications of AR

Total(45L) = 45 Periods

REFERENCE BOOKS:

1.	Kiran Kumar Pabbathi, "Quick Start Guide to Industry 4.0: One-Stop Reference Guide for Industry 4.0", Createspace Independent Publishing Platform, 2018.
2.	Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things, APress, 2016.
3.	Diego Galar Pascual, Pasquale Daponte and Uday Kumar, Handbook of Industry 4.0 and SMART Systems, 1st Edition, 2020
4.	Duato J, Yalamanchili S, and Lionel Ni, "Interconnection Networks: An Engineering Approach", Morgan Kaufmann Publishers, 2004.
5.	Grigore C. Burdea, Philippe Coiffet , Virtual Reality Technology, Wiley 2016

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Realize the need of industry 4.0 and its inter-connectivity.	Understand
CO2	Implement a strategic framework to exploit new technologies to enable Industry 4.0.	Apply
CO3	Interpret the architecture of IOT and Recognize the uses of cloud computing.	Understand
CO4	Apply the robotic systems used in a manufacturing plant and their role in an Industry 4.0 world.	Apply
CO5	Implement Virtual/Augmented Reality applications.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO 2	PSO3
CO1	3	-	-	-	2	2	-	-	3	2	3	3	-	-
CO2	2	2	2	-	2	2	2	3	-	-	-	-	-	-
CO3	2	3	-	2	-	-	-	-	2	2	2	-	3	-
CO4	2	3	2	2	--	-	3	2	2	-	-	-	-	3
CO5	-	2	2	2	3	3	-	-	-	2	-	-	-	-
Avg	**1.8**	**2.0**	**1.2**	**1.2**	**1.4**	**1.4**	**1.0**	**1.0**	**1.4**	**1.2**	**1.0**	**0.6**	**0.6**	**0.6**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand about the fundamental of fracture mechanics and fatigue.
2.	To understand about the fundamental of LEFM.
3.	To consider fatigue and fracture aspects in design
4.	To consider failure regimes for fatigue and creep crack
5.	To know the test methods to measure material fracture toughness

UNIT I	INTRODUCTION	9	0	0	9

Theory of Elasticity - Stress Concentration Factor – Notch Strengthening – External variables affecting fracture – Nomenclature of the fracture process - Griffith Crack Theory – Irwin's modification - Strain-Energy Release Rate – Crack resistance curves, Plane stress and plane strain cases - Crack stability and instability conditions - Grain-Size Refinement.

UNIT II	LINEAR ELASTIC FRACTURE MECHANICS	9	0	0	9

Modes of Loading – Crack tip stress (mode I, II, III) –Stress Intensity Factor –Crack tip plasticity – Fracture Toughness – Fatigue crack growth – Crack growth life Integration – Mean stress effect – Cyclic Plastic zone – Crack Closure –Irwin's correction - Small fatigue cracks and LEFM limitations

UNIT III	ELASTIC-PLASTIC FRACTURE MECHANICS	9	0	0	9

Plastic zone models – J integral – crack tip opening displacement - Path independence, Stress-Strain relation, Engineer Approach. Crack Tip Plasticity – Crack tip opening displacement Relationship between CTOD, K_I, G_I for small scale yielding, Equivalence between CTOD and J.

UNIT IV	FATIGUE CRACK AND CREEP CRACK	9	0	0	9

Fatigue regimes – S-N, P-S-N curves – Fatigue crack growth models – crack initiation, crack propagation - effect of overload, variable amplitude fatigue load - paris law –Fracture Toughness. Dynamics of moving crack tip, process zone size, crack speed – crack path instabilities. Creep crack growth, failure at high temperatures.

UNIT V	EXPERIMENTAL METHODS AND NUMERICAL APPROACHES	9	0	0	9

Test methods to measure material fracture toughness and critical J integral value –Correlations between impact energy and fracture toughness - Finite element modelling of crack and evaluation of J integral and stress intensity parameter-Direct and indirect methods.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	T.L. Anderson, "Fracture mechanics: Fundamentals and Applications", 4th Edition. CRC Press, Taylors& Francis, 2017.
2	KareHellan, "Introduction of Fracture Mechanics", McGraw Hill Book Company, 1985.
3	Richard W.Hertzberg, "Deformation and Fracture Mechanics of Engineering Materials" John wiley& sons, Inc., 1996
4	Nestor Perez, "Fracture Mechanics", Kluwer Academic Publishers, 2004
5	David Broek, "Elementary Engineering Fracture Mechanics", Fifthoff and Noerdhoff International Publisher, 1978.
6	M.F. Kanninen and C.H. Popelar, Advanced Fracture Mechanics, Oxford Press, 1985.
7	S. Murakami, Continuum Damage Mechanics, Springer Netherlands, Dordrecht, 2012.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Explain the concepts about the fundamental of fracture mechanics and fatigue	Understand
CO2	Use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, J integral, Crack tip opening displacement.	Apply
CO3	Manage singularity at crack tip using complex variable.	Remembering
CO4	Calculate the fatigue life of a component with or without crack in it.	Evaluate
CO5	Apply modern sophisticated experimental techniques to determine fracture toughness and stress intensity factor.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO3
CO1	1	2	2	2	2	-	-	-	-	-	-	1	-	-
CO2	2	1	2	2	2	-	-	-	-	-	-	2	-	2
CO3	2	2	2	3	3	-	-	-	-	-	-	-	1	-
CO4	2	1	2	3	3	-	-	-	-	-	-	-	-	-
CO5	2	2	2	2	2	-	-	-	-	-	-	-	2	1
Avg	**1.8**	**1.6**	**2.0**	**2.4**	**2.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.6**	**0.6**	**0.6**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To apply fundamental principles in the design and production of engineered products including the factors that control the rate of production and influence the quality, cost and flexibility of processes
2.	To study about the various assembly methods and processes and design for assembly guidelines
3.	To Understand the complex interrelationships between design and manufacturing
4.	To study the various factors influencing the manufacturability of components and the use of tolerances in manufacturing
5.	Critique product designs for ease of assembly

UNIT I	INTRODUCTION	9	0	0	9

Introduction: Design philosophy – steps in design process – general design rules for manufacturability – basic principles of designing for economical production – creativity in design, application of linear and non-linear optimization techniques. Materials: Selection of materials for design – developments in material technology – criteria for material selection – material selection interrelationship with process selection – process selection charts.

UNIT II	MACHINING PROCESS	9	0	0	9

Machining process: Overview of various machining processes – general design rules for machining - dimensional tolerance and surface roughness – design for machinability, ecocnomy and accessibility – redesigning of components for machining ease with suitable examples, general design recommendations for machined parts.

UNIT III	METAL JOINING	9	0	0	9

Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines – pre and post treatment of welds – effects of thermal stresses in weld joints – design of brazed joints.

UNIT IV	METAL CASTING AND FORGING	9	0	0	9

Metal casting: Appraisal of various casting processes, selection of casting process, - general design considerations for casting – casting tolerances – use of solidification simulation in casting design – product design rules for sand casting.Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.

UNIT V	ASSEMBLY AND ENVIRONMENT	9	0	0	9

Assembly: Compliance analysis and interference analysis for the design of assembly – DFA Guidelines, DFA Tools - concurrent engineering- Redesign, DFA-index, poke-yoke, design for manual and automatic assembly. Environment: Introduction to environment; motivations for environment principles of environment- eco-efficiency,product life cycle perspective, environment tools and processes, environment design guidelines.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	A K Chitale and R C Gupta, “Product Design and Manufacturing”, PHI, New Delhi, 2013.
2	George E Deiter, “Engineering Design”, McGrawHill, International, 2012.
3	Boothroyd G, “Product design for Manufacture and Assembly”, First Edition, Marcel Dekker Inc., New York, 2010.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	Describe the design rules and principles for economical production and select the materials.	Understand
CO2	Use Design for Manufacture and Assembly tools for minimizing effort and cost in manufacturing a product by machining processes	Apply
CO3	Apply design considerations to minimize difficulty in fabrication of components by welding.	Apply
CO4	Apply the design considerations to minimize difficulty in fabrication of components by casting, forming processes.	Apply
CO5	Design components taking into consideration the environmental impact it have while manufacturing and during its lifecycle	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	1	2	-	1	1	1	1	1	-	-	2	1	1
CO2	1	1	2	1	1	2	1	1	-	-	1	2	-	3
CO3	2	1	1	2	1	1	1	1	-	-	-	3	1	1
CO4	2	1	1	2	1	1	1	1	-	-	-	3	1	1
CO5	1	1	2	1	1	2	3	1	-	-	-	2	-	1
Avg	**1.2**	**1.0**	**1.6**	**1.2**	**1.0**	**1.4**	**1.4**	**1.0**	**0.2**	**0.0**	**0.2**	**2.4**	**0.6**	**1.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PROFESSIONAL ELECTIVE - III

22CDE31	PRODUCTIVITY MANAGEMENT AND RE-ENGINEERING	SEMESTER II			
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms.
2.	To develop skills necessary to effectively analyze and synthesize the many inter-relationships inherent in complex socio-economic productive systems
3.	To ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy
4.	To understand the managerial responsibility for Operations, even when production is outsourced, or performed in regions far from corporate headquarters
5.	To recognize the need for, and problems associated with, change in organizations.

UNIT I	**PRODUCTIVITY**	**9**	**0**	**0**	**9**

Productivity Concepts - Macro and Micro factors of productivity - Dynamics of Productivity - Productivity Cycle Productivity Measurement at International - National and Organization level - Productivity measurement models.

UNIT II	**SYSTEMS APPROACH TO PRODUCTIVITY MANAGEMENT**	**9**	**0**	**0**	**9**

Conceptual framework, Management by Objectives (MBO) - Performance objectives- Productivity (POP) - Methodology and application to manufacturing and service sector.

UNIT III	**ORGANISATIONAL TRANSFORMATION**	**9**	**0**	**0**	**9**

Elements of Organizational Transformation and Reengineering-Principles of organizational transformation and re-engineering, fundamentals of process reengineering, preparing the workforce for transformation and re-engineering, methodology, guidelines, LMI CIP Model – DSMC Q and PMP model.

UNIT IV	**RE-ENGINEERING PROCESS AND IMPROVEMENT MODELS**	**9**	**0**	**0**	**9**

PMI models - PASIM Model - Moen and Nolan Strategy for process improvement - LMICIP Model - NPRDC Model.

UNIT V	**TOOLS FOR RE-ENGINEERING**	**9**	**0**	**0**	**9**

Analytical and process tools and techniques - Information and Communication Technology-Implementation of Reengineering Projects – Success Factors and common implementation Problem - Cases.

Total(45L) =45 Periods

REFERENCE BOOKS:

1	*Handbook on Industrial Engineering equations, formulas and calculations*, Adedeji B. Badiru and Olufemi A. Omitaomu, 2011, CRC Press.
2	"Industrial Engineering and Management", O.P.Khanna, 17th edition, DhanpatRai publications.
3	"Productivity Engineering and Management', Sumanth, D.J. TMH, New Delhi, 1994.
4	"Organisational Transformation and Process Re-engineering", Edosomwan, J.A.,Library Cataloging in Pub.Data, 1995.
5	"Productivity Management – A, Systems Approach", Premvrat, Sardana, G.D. and Sahay, B.S., Narosa Publishing House. New Delhi, 1998.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Realize the Macro, Micro, Dynamics, Productivity cycle and Measurement	Understand
CO2	Demonstrate the need for change in organizations to apply appropriate strategies.	Apply
CO3	Apply guidelines and principles of organizational transformation and re-engineering in industry	Apply
CO4	Apply re-engineering process and improvement models for improving the productivity	Apply
CO5	Apply techniques, skills and modern engineering tools for necessary engineering practical application.	Apply

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	1	-	-	-	1	-	-	2	2	2
CO2	1	1	1	1	2	2	1	-	-	-	-	2	1	2
CO3	1	1	1	1	1	2	3	-	-	3	-	1	1	1
CO4	2	2	2	2	2	-	2	-	2	2	-	1	3	2
CO5	3	3	2	3	3	-	-	-	-	-	2	3	2	2
Avg	**1.8**	**1.8**	**1.6**	**1.8**	**1.8**	**0.8**	**1.2**	**0.0**	**0.6**	**1.0**	**0.4**	**1.8**	**1.8**	**1.8**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE32	THEORY OF PLATES AND SHELLS	SEMESTER II
	(Use of approved Data Book and Charts may be permitted)	

PREREQUISITES	CATEGORY	PE	Credit	3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the concepts of rectangular plates, shells and frames and their analyzation techniques.
2. To apply the FEM in analyzing the Plates and shells.
3. To understand the creation of Frames with basic principle.
4. Gain knowledge about the shells and membrane theory
5. To understand the creation of Frames with basic principle.

UNIT I	INTRODUCTION	9	0	0	9

Thin Plates with small deflection. Laterally loaded thin plates- governing differential equation- various boundary conditions

UNIT II	PLATES	9	0	0	9

Rectangular plates. Simply supported rectangular plates- Navier solution and Levy's method- Rectangular plates with various edge conditions- plates on elastic foundation. Symmetrical bending of circular plates.

UNIT III	ANALYSIS METHODS	9	0	0	9

Energy methods- Finite difference and Finite element methods – Plates and Shells.

UNIT IV	SHELLS	9	0	0	9

Classification of shells- types of shells- structural action- membrane theory- shells of revolution and shells of translation- examples- limitations of membrane theory. Folded Plate structures- structural behavior- types- design by ACI - ASCE Task Committee method.

UNIT V	FRAMES	9	0	0	9

Space frames - configuration - types of nodes - general principles of design Philosophy - Behavior.

Total(45L)= 45Periods

REFERENCE BOOKS:

1. Szilard R, “Theory and Analysis of Plates”, Prentice Hall Inc., 1995.
2. Timoshenko S and Krieger S.W, “Theory of Plates and Shells”, McGraw Hill Book Company- New York 1990.
3. Timoshenko S, “Theory of Plates and Shells”, McGraw Hill, 1990.
4. Wilhelm Flügge, “Stresses in shells”, Springer, Verlag.
5. Ramasamy G.S, “Design and Construction of Concrete Shells Roofs”, CBS Publishers, 1986.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Develop the ability to obtain the various deflections in plates and shells.	Create
CO2	Identify the different types of plates under different boundary connections by various classical methods and approximate methods.	Understand
CO3	Illustrate and analyze the behavior and design principles of plate and shell structures	Analysis
CO4	Analyze and design the cylindrical shells through membrane & bending theory.	Analysis
CO5	Ability to Understand the behavior and general principles of frames.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	3	3	3	1	1	-	1	-	1	-	-	-
CO2	1	3	1	2	1	2	-	-	-	-	1	-	-	2
CO3	1	3	1	2	1	2	-	-	-	-	1	1	1	-
CO4	1	2	2	1	1	1						2	1	-
CO5	1	1	1	1	-	-	-	-	-			1	1	-
Avg	**1.2**	**2.0**	**1.6**	**1.8**	**1.2**	**1.2**	**0.2**	**0.0**	**0.2**	**0.0**	**0.6**	**0.8**	**0.6**	**0.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE33	OPTIMIZATION TECHNIQUES IN DESIGN	SEMESTER II
	(Use of approved Data Book and Charts may be permitted)	

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To create awareness about optimization techniques.
2.	To understand and apply optimization techniques to real life problems.
3.	Learn to geometric programming problems with constrained optimization problems
4	To understand the fundamentals constrained and un constrained optimization and their static and dynamic application.
5	To develop the optimal solution or design for engineering problems.

UNIT I	INTRODUCTION	9	0	0	9

General Characteristics of mechanical elements- adequate and optimum design- principles of optimization- formulation of objective function- design constraints – Classification of optimization problem

UNIT II	UNCONSTRAINED OPTIMIZATION	9	0	0	9

Single variable and multivariable optimization- Techniques of unconstrained minimization – Golden section- pattern and gradient search methods – interpolation methods.

UNIT III	CONSTRAINED OPTIMIZATION	9	0	0	9

Optimization with equality and inequality constraints – Indirect methods using penalty functions- Lagrange multipliers- Geometric programming- Constrained- mixed inequality and unconstrained minimization- Genetic algorithms

UNIT IV	STATIC APPLICATIONS	9	0	0	9

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

UNIT V	DYNAMIC APPLICATIONS	9	0	0	9

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

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	SingiresuS.Rao, “Engineering Optimization Theory and Practice”, New Age International (P) Limited, 1996.
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	Goldberg D.E, “Genetic algorithms in search- optimization and machine”, Barnen Addison-Wesley New York, 1989.
5	Saravanan.R, “Manufacturing optimization through intelligent techniques”, Taylor and Francis Publications, CRC Press, 2006.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Realistic the principles of optimization and solve optimization problem.	Understand
CO2	Familiar in solving unconstrained nonlinear optimization problems.	Apply
CO3	Familiar in solving constrained liner optimization problems	Apply
CO4	Apply these techniques to solve static and dynamic problems of day to day applications.	Apply
CO5	Develop the ability to obtain the optimal solution for engineering problems.	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	2	2	2	-	-	-	1	-	-	2	2	2
CO2	1	1	1	1	1	-	-	-	1	-	-	1	1	1
CO3	1	1	1	1	1	-	-	-	1	-	-	1	1	1
CO4	1	1	1	1	1	-	-	-	2	1	1	1	1	1
CO5	1	1	1	1	1	-	-	-	2	1	1	3	3	3
Avg	**1.0**	**1.2**	**1.2**	**1.2**	**1.2**	**0.0**	**0.0**	**0.0**	**1.4**	**0.4**	**0.4**	**1.6**	**1.6**	**1.6**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE34	COMPUTATIONAL FLUID DYNAMICS	SEMESTER II

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the basics of computational fluid dynamics and governing equation
2.	To develop finite difference and finite volume discredited forms of the CFD equations.
3	To formulate explicit & implicit algorithms for solving the Euler Eqns &Navier Stokes Eqns.
4	To formulate and solve conduction type problems using appropriate CFD technique.
5	Gain knowledge on different turbulence model and its practical applications.

UNIT I	INTRODUCTION AND GOVERNING EQUATIONS	9	0	0	9

Basics of computational fluid dynamics–Governing equations of fluid dynamics–Continuity, Momentum and Energy equations–Chemical species transport–Physical boundary conditions–Time-averaged equations for Turbulent Flow–Turbulent–Kinetic Energy Equations–Mathematical behaviour of PDEs on CFD-Elliptic, Parabolic and Hyperbolic equations.

UNIT II	FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION	9	0	0	9

Derivation of finite difference equations–Simple Methods–General Methods for first and second order accuracy– Finite volume formulation for steady state One, Two and Three – dimensional diffusion problems–Parabolic equations–Explicit and Implicit schemes–Example problems on elliptic and parabolic equations–Use of Finite Difference and Finite Volume methods.

UNIT III	CONDUCTION AND CONVECTIVE HEAT TRANSFER	9	0	0	9

One-Dimensional and Two-Dimensional Conduction - Convection – Diffusion problems, Unsteady one- dimensional convection – Diffusion, Unsteady two-dimensional convection – Diffusion – Introduction to finite element method – Solution of steady heat conduction by FEM

UNIT IV	FLUID FLOW	9	0	0	9

Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, SIMPLE Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach , Finite volume methods-Representation of the pressure gradient term and continuity equation–Staggered grid– Momentum equations–Pressure and Velocity corrections–Pressure Correction equation, SIMPLE algorithm and its variants–PISO Algorithms.

UNIT V	TURBULENCE MODELS	9	0	0	9

Algebraic Models – One equation model, K - ε Models, Standard, Reynolds number models, Prediction of fluid flow.

Total(45L) = 45Periods

REFERENCE BOOKS:

1	Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
2	Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw-Hill Publishing Company Ltd., 1998.
3	Subas, V.Patankar "Numerical heat transfer fluid flow", Hemisphere Publishing Corporation, 1980.
4	Taylor, C and Hughes, J.B. "Finite Element Programming of the Navier Stock Equation", Pineridge Press Limited, U.K., 1981.
5	Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., "Computational fluid Mechanics and Heat Transfer "Hemisphere Publishing Corporation, Newyork, USA, 1984.
6	Donald R. Honra, "Co-ordinate measurement and reverse Engineering", American Gear Manufacturers Association.1997.
7	Fletcher, C.A.J. "Computational Techniques for Fluid Dynamics 1" Fundamental and General Techniques, Springer – Verlag, 1987.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Illustrate the differential equations for flow phenomena and numerical methods for their solution.	Understand
CO2	Critically analyze the mathematical representation of governing equation for fluid flow and heat transfer simulations	Analysis
CO3	Solve one dimensional and two dimensional heat transfer problems	Apply
CO4	Ability to identify, formulate, and solve conduction type problems using appropriate CFD technique.	Understand
CO5	Ability to understand different turbulence model and able to apply appropriate models to various practical applications.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	1	2	1	-	-	-	-	-	1	-	-	3
CO2	1	2	2	2	1	-	-	-	1	-	1	1	-	-
CO3	1	3	1	3	1	-	-	1	2	-	1	3	2	-
CO4	1	1	1	1	1	-	-	-	-	-	1	-	1	1
CO5	1	1	1	1	1	-	-	-	-	-	1	-	1	1
Avg	**1.4**	**1.6**	**1.2**	**1.8**	**1.0**	**0.0**	**0.0**	**0.2**	**0.6**	**0.0**	**1.0**	**0.8**	**0.8**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE35	SUPPLY CHAIN MANAGEMENT	SEMESTER II

PREREQUISITES	CATEGORY	PE	Credit	3

	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To provide an insight on the fundamentals of supply chain networks, tools and techniques
2. To apply the tools and techniques in logistics in supply chain
3. To know about the role of supply chain development
4. To apply the supply chain concepts in supplier selection.
5. To attain the knowledge of E-Business in supply chain

UNIT I	INTRODUCTION	9	0	0	9

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

UNIT II	SUPPLY CHAIN NETWORK DESIGN	9	0	0	9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

UNIT III	LOGISTICS IN SUPPLY CHAIN	9	0	0	9

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

UNIT IV	SOURCING AND COORDINATION IN SUPPLY CHAIN	9	0	0	9

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

UNIT V	SUPPLY CHAIN AND INFORMATION TECHNOLOGY	9	0	0	9

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 2010.
2. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, 2002.
3. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI, 2010
4. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
5. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2000.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	The student would understand the framework and scope of supply chain networks and functions.	Understand
CO2	To apply the concept. Logistics In Supply Chain	Apply
CO3	To evaluate the supply chain and information technology	Evaluate
CO4	To make the student to know the obstacles in supply chain	Analysis
CO5	To evaluate the role of IT in supply chain	Evaluate

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-	1	-	-	1	-	-	-	-	1	1	2
CO2	1	3	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	1	1	1	2	-	1	-	-	-	-	3	-	1
CO4	2	2	1	2	2	-	1	-	-	-	-	3	2	1
CO5	2	3	-	3	1	-	1	-	-	-	-	2	-	1
Avg	**2.0**	**1.2**	**0.6**	**1.6**	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.2**	**0.6**	**1.2**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

PROFESSIONAL ELECTIVE - IV

22CDE41	EXPERIMENTAL TECHNIQUES AND DATA ANALYSIS		SEMESTER II			
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVES:

1	To understand the working principle of instruments used for cutting forces, temperature measurement and metallurgical studies.
2	Familiar to collection and analysis of data with scientific approach.
3	Understand the concept of design of experiment and Taguchi method.
4	To know about uncertainty analysis
5	To understand about RSM

UNIT I	MEASUREMENT OF CUTTING FORCES	9	0	0	9

Strain gauge and piezoelectric transducers – characteristics - Dynamometer construction, Bridge circuits - Instrumentation and calibration - Displacement and strain measurements by photo elasticity - Holography, interferometer, Moir techniques, strain gauge rosettes – Calibration of instruments.

UNIT II	TEMPERATURE AND FLOW MEASUREMENT	9	0	0	9

Circuits and instrumentation for different transducers - bimetallic, expanding fluid, electrical resistance, thermistor, thermocouples and pyrometers. Flow Measurement - Transducers for Non-compressible and compressible fluids - Obstruction and drag methods - Vortex shredding flow meters - Ultrasonic, Laser Dopler and Hotwire anemometer - Flow visualization techniques - Shadow graphs, Schlieren photography, Interferometer

UNIT III	CHARACTERIZATION TECHNIQUES	9	0	0	9

Optical and electron microscopy - X-Ray diffraction, Bragg's Law and its application for studying crystal structure and residual stresses - Electron spectroscopy, electron microprobe. Surface Measurements - Micro hardness, roughness, accuracy of dimensions and forms - 3-D co-ordinate measuring machines – Scanning Electron Microscope.

UNIT IV	EXPERIMENT DESIGN AND DATA ANALYSIS	9	0	0	9

Statistical methods - Randomized block design, Latin and orthogonal squares, factorial design - Replication and randomization - Data Analysis - Deterministic and random data, uncertainty analysis - Tests for significance - Chi- square, student's 't' test - Regression modeling - direct and interaction effects - ANOVA, F-test - Time Series analysis - Autocorrelation and autoregressive modeling – RSM Technique.

UNIT V	DESIGN OF EXPERIMENTS	9	0	0	9

Types of Experiments – Experiment Design Factor – Experiment design protocol and examples. Taguchi Methods - Experiment design and planning with Orthogonal arrays and linear graphs - Additive cause effect model - Optimization of response level - Identification of Design and noise factors - Performance evaluation and Optimization by signal to noise ratios - Concept of loss function and its application. Introduction to Response surface methodology (RSM).

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Holman, J.P., "Experimental Methods for Engineers", McGraw Hill Int., New York.
2	Venkatesh, V.C., and Chandrasekharan, "Experimental Methods in Metal Cutting", Prentice Hall of India,Delhi.
3	Davis, O.V., "The Design and Analysis of Industrial Experiments", Longman, London.
4	Box and Jenkins; "Time Series analysis, Forecasting and control", Holden Day, Sanfrancisco
5	Dove and Adams, "Experimental stress analysis and motion measurement", Prentice Hall of India, Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Develop an appropriate experimental research design for an engineering case study taking into account practical limitations.	Create
CO2	Apply knowledge of statistical analysis to assess a hypothesis by selecting appropriate statistical tests and by correctly interpreting the results of these tests.	Apply
CO3	Propose an appropriate statistical model for a given dataset and interpret the goodness of fit.	Remembering
CO4	Optimize the experimental result and correlated with analytical data by using taguchi method.	Evaluate
CO5	To develop ANOVA tables for research experiments	Create

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-	1	-	-	1	-	-	-	-	1	1	2
CO2	1	3	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	1	1	1	2	-	1	-	-	-	-	3	-	1
CO4	3	2	1	2	2	-	1	-	-	-	-	1	2	1
CO5	2	3	-	1	1	-	1	-	-	-	-	3	-	1
Avg	**2.2**	**2.2**	**0.6**	**1.2**	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**0.6**	**1.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE42	CAD/CAM TOOLS	SEMESTER II

PREREQUISITES	CATEGORY	PE	Credit	3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the basics of industrial automation.
2. To understand nature & significance of Machine tools
3. To develop skills for programming skills required for manufacturing.
4. To gain knowledge about CMM and its features
5. To develop new techniques of RE

UNIT I	COMPUTER AIDED MANUFACTURING	9	0	0	9

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

UNIT II	CAD/CAM HARDWARE	9	0	0	9

Introduction – Types of systems – CAD/CAM system evaluation criteria – Input devices – Output devices – Hardware integration and Networking – Programmable logic controllers – Hardware trends.

UNIT III	INSPECTION METHODS	9	0	0	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	0	0	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	0	0	9

Strategies for Reverse Engineering Data management – Software application – 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.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1. Ibrahim Zeid and R. Sivasubramanian, "CAD/CAM Theory and Practice", Revised 1stEdition, Tata McGraw Hill Publication, 2007.
2. Catherine A. Ingle, "Reverse Engineering", Tata McGraw Hill Publication, 1994.
3. Ibrahim Zeid, "Mastering CAD/CAM", special Indian Edition, Tata McGraw Hill Publication, 2007.
4. David D. Bedworth, Mark R. Henderson and Philp M. Wolfe, "Computer Integrated Design and Manufacturing", McGraw Hill International series, 1991.
5. Linda Wills, "Reverse Engineering", Kluwer Academic Press, 1996.
6. Donald R. Honra, "Co-ordinate measurement and reverse Engineering", American Gear Manufacturers Association.1997.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Explain computer aided tools for various industrial applications which includes manufacturing, process planning, inspection, data management and reverse engineering.	Understand
CO2	Apply the concept of geometric modelling and create new objects.	Apply
CO3	Evaluate the principle of synthesis of curves and create new 3D Objects.	Evaluate
CO4	Elaborate surface modelling	Understand
CO5	Apply the RE concepts	Apply

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	-	1	-	-	1	-	-	-	-	3	1	2
CO2	1	3	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	1	1	1	2	-	1	-	-	-	-	3	-	1
CO4	3	2	1	2	2	-	1	-	-	-	-	3	2	1
CO5	2	3	-	3	1	-	1	-	-	-	-	3	-	1
Avg	**2.0**	**2.2**	**0.6**	**1.6**	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.8**	**0.6**	**1.2**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE43	**CONTACT MECHANICS**	**SEMESTER II**

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To understand the concepts of mechanical properties of materials, elastic and brittle fracture of materials.
2.	To understand elastic-plastic indentation and testing methods
3.	To analyze the indentation stress distribution and formulate equation
4.	To understand elastic-plastic indentation and testing methods
5.	Gain knowledge on various indentation test methods

UNIT I	INTRODUCTION	9	0	0	9

Mechanical Properties of Materials- Elasticity -Hooke's law - Strain energy - Surface energy- Stress-Strain -Linear elasticity - 2-D Plane stress- plane strain -Principal stresses- Equations of equilibrium and compatibility- Saint- Venant's principle-Hydrostatic stress and stress deviation -Visualizing stresses- Plasticity -Equations of plastic flow - Stress Failure Criteria - Tresca failure criterion - Von Mises failure criterion.

UNIT II	LINEAR ELASTIC FRACTURE AND BRITTLE FRACTURE	9	0	0	9

Introduction- Stress Concentrations- Energy Balance Criterion - Linear Elastic Fracture Mechanics - Stress intensity factor - Determining Stress Intensity Factors- Calculating stress intensity factors from prior stresses - Determining stress intensity factors using the finite-element method -Delayed Fracture in Brittle Solids-Static Fatigue - The Stress Corrosion Theory of Charles and Hillig - Sharp Tip Crack Growth Model - Strength and failure probability - Effect of biaxial stresses - Determining the probability of delayed failure.

UNIT III	ELASTIC INDENTATION	9	0	0	9

Introduction- Hertz Contact Pressure Distribution - Analysis of Indentation Stress Fields -Line contact -Point contact- Analysis of stress and deformation - Indentation Stress Fields- Uniform pressure- Spherical indenter - Cylindrical roller (2-D) contact - Cylindrical flat punch indenter - Rigid cone-Elastic Contact- Hertz Contact Equations - Impact –Friction -Hertzian Fracture- Hertzian Contact Equations - Auerbach's Law- Auerbach's Law and the Griffith Energy Balance Criterion- Energy Balance.

UNIT IV	ELASTIC –PLASTIC INDENTATION	9	0	0	9

Elastic-Plastic Indentation Stress Fields –Introduction- Pointed Indenters - Indentation stress field - Indentation fracture- Fracture toughness- Berkovich indenter- Spherical Indenter-Elastic and Elastic-Plastic Contact.- Introduction- Geometrical Similarity- Indenter Types - Spherical- conical- and pyramidal indenters - Sharp and blunt indenters -Elastic-Plastic Contact - Elastic recovery –Compliance- The elastic-plastic contact surface.

UNIT V	DEPTH-SENSING INDENTATION TESTING METHODS	9	0	0	9

Indenter-Load-Displacement Curve-Unloading Curve Analysis-Experimental and Analytical Procedures - Corrections to the experimental Data-Application to Thin-Film Testing-Indentation Test Methods- Bonded-Interface Technique - Indentation Stress-Strain Response – Compliance Curves- Hardness Testing - Vickers hardness -Berkovich indenter -Depth-sensing (nano) Indentation - instruments - techniques -data analysis- test standards.

Total(45L)=45 Periods

REFERENCE BOOKS:

1	Fischer Cripps and Anthony C, "Introduction to Contact Mechanics", 2nd Edition, Springer Mechanical Engineering series, 2007.
2	Johnson.K.L, "Contact Mechanics", Cambridge University Press, Cambridge, 1985
3	Valentin L. Popov,"Contact Mechanics and Friction", 2nd Edition, Springer Mechanical Engineering series, 2007.
4	I.G.Goryacheva,"Contact Mechanics in Tribology", Springer-Science+Business Media, B.V.1998
5	K.L. Johnson, K. Kendall, A.D. Roberts,"Surface Energy and the Contact of Elastic Solid", *Proc. R. Soc.London, Ser. A* 1971, *324*, 301-313.
6	M.K. Chaudhury, T. Weaver, C.Y. Hui and E.J. Kramer "Adhesive contact of Cylindrical lens and a Flat Sheet", J. Appl.Phys. 1996, 80(1), 30-37

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Illustrate the various stress strain behaviour of elastic and plastic material	Understand
CO2	Identify and determine the mechanism of elastic fracture and brittle fracture	Understand
CO3	Analyze the stress indentation and pressure distribution in elastic contact.	Analysis
CO4	Illustrate the indenter type and elastic –plastic indentation fracture.	Understand
CO5	Ability to identify the indentation test methods.	Understand

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	1	-	-	-	-	-	1	1	-	-	-
CO2	1	1	1	1	-	-	1	-	-	1	1	-	-	1
CO3	1	1	1	1	-	-	-	-	-	-	1	1	2	-
CO4	1	2	1	1	-	-	-	-	-	-	1	1	-	1
CO5	1	1	1	-	-	-	-	-	-	-	-	1	1	-
Avg	**1.4**	**1.4**	**1.0**	**0.8**	**0.0**	**0.0**	**0.2**	**0.0**	**0.0**	**0.4**	**0.8**	**0.6**	**0.6**	**0.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE44	ADVANCED AUTOMOTIVE SYSTEMS	SEMESTER II

PREREQUISITES	CATEGORY	PE	Credit	3

	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1.	To impart knowledge about the need and role of chassis construction in the function of an Automobile.
2.	To study the function of various components and sub-systems in the working of an Automobile
3.	To Explain the fundamental design concepts in clutch and brakes in automobile.
4.	To Analyze the fundamental design concepts Transmission, suspension, steering systems.
5.	To identify the electronic systems on vehicle performance.

UNIT I	INTRODUCTION	9	0	0	9

Fundamentals of designing automobiles - performance of automobiles - general layout of the automobile - Types of chassis layout - various types of frames, constructional details, materials, unitized frame body construction - Design conditions - loading conditions.

UNIT II	ENGINE COMPONENTS	9	0	0	9

Choice of material for various engine components - design of cylinder, design of piston assembly, design of connecting rod, design of crankshaft under bending and twisting, balancing weight calculations - design of valves, valve springs and design of flywheel.

UNIT III	CLUTCH AND BRAKES	9	0	0	9

Introduction - design diagrams of clutch - calculation of critical parameters of clutches- design calculation of standard elements of friction clutches - torsional vibration dampers - clutch control drives. Pressure distribution along shoe length - determining braking torque - design of drum and disk brakes - fundamentals of designing brake force regulators - anti-locking system.

UNIT IV	TRANSMISSION, SUSPENSION, STEERING SYSTEMS	9	0	0	9

Determining main parameters of transmission and its design - gear shift mechanisms – differential - differential housings - axle shafts - gear box - universal joint - propeller shaft. Suspension system - Oscillation and smoothness of ride - elastic elements of suspension - shock absorbers. Fundamentals of designing and calculating steering control linkage - steering gears - hydraulic booster.

UNIT V	AUTOMOTIVE ELECTRONIC SYSTEMS	9	0	0	9

Sensors in automobiles - Classification - sensors for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant and exhaust temperature, air mass flow for engine application. Solenoids, stepper motors and relay - engine management system - Gasoline / diesel systems – Electronic transmission control vehicle safety system – braking and traction.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	David A.Crolla, “Automotive Engineering, Powertrain, Chassis System and Vehicle Body”, 2009
2	William B. Ribbens, “Understanding Automotive Electronics”, 1998
3	Lukin P Gasparyants G and Rodionov V, “Automobile Chassis Design and Calculations”, Mir Publishers, 1989
4	Heinz Heisier, “Vehicle and Engine technology”, SAE New York, 1999.
5	Gillespie T D, “Fundamentals of Vehicle Dynamics”, SAE Inc. New York, 1992.
6	Schwaller A E, “Motor Automotive Technology” ,3rd Edition, Delman Publishers, New York.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Classify the chassis layout based on type of vehicles	Understand
CO2	Explain the various engine components in a vehicles	Understand
CO3	Compare the function and features of different braking and clutch systems for an automobile.	Analysis
CO4	Analyze the fundamental design concepts of transmission, suspension, steering systems	Analysis
CO5	Apply the automotive electronics to control the engine in order to reduce the emission level	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	2	1	2	-	-	-	1	1	-	2	2	2
CO2	2	1	2	1	2	-	-	-	1	1	-	2	2	2
CO3	2	-	2	-	2	-	-	-	-	-	-	2	2	1
CO4	1	3	-	3	2	-	-	-	2	-	1	2	2	2
CO5	3	-	-	-	2	-	-	-	-	-	-	2	1	2
Avg	**2.0**	**1.0**	**1.2**	**1.0**	**2.0**	**0.0**	**0.0**	**0.0**	**0.8**	**0.4**	**0.2**	**2.0**	**1.8**	**1.8**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE45	DESIGN OF MATERIAL HANDLING EQUIPMENT	SEMESTER II
	(Use of approved Data Book and Charts may be permitted)	

PREREQUISITES	CATEGORY	PE	Credit	3	
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To study different types of material handling systems used for engineering and process industries
2. To design of various hoisting gears and brakes for different material handling applications
3. To design various type of surface and overhead transportation equipment's.
4. To design of elevators for various manufacturing and service applications
5. To development of conveyer systems for material flow in different industrial production systems.

UNIT I	FLEXIBLE HOISTING APPLIANCES	9	0	0	9

Type- selection and applications of material handling equipment- choice of material handling equipment – hoisting equipment – components and theory of hoisting equipment – chain and ropes – selection of ropes- pulleys- pulley systems- sprockets and drums.

UNIT II	LOAD HANDLING EQUIPMENTS AND BRAKES	9	0	0	9

Forged standard hooks – forged Ramshorn hooks – solid triangular eye hooks –crane grabs- electric lifting magnetic– grabbing attachments for loose materials. Arresting gear – brakes: shoe- band and cone types – elements of shoe brakes –thermal calculation in shoe brakes.

UNIT III	SURFACE AND OVERHEAD TRANSPORTATION EQUIPMENTS	9	0	0	9

Hand operated trucks – powered trucks – tractors – electronically controlled tractors - hand truck on rails – industrial railroad equipments: locomotives - winches – capstans – turntables – monorail conveyors –pipe rail systems – flat bar monorails. Rail traveling mechanism- cantilever and monorail cranes- cogwheel drive- monocable tramways-reversible tramways.

UNIT IV	ELEVATING EQUIPMENTS	9	0	0	9

Continuous-motion vertical conveyors – reciprocating-motion vertical conveyors – stackers – work levelers and tail gates – industrial lifts – passenger lifts – freight elevators – mast type elevators – vertical skip hoist elevators-bucket elevators: design- loading and bucket arrangements.

UNIT V	CONVEYING EQUIPMENTS	9	0	0	9

Belt conveyors - chain conveyors – apron conveyors – escalators – flight conveyors – roller conveyors - oscillating conveyors - design of belt conveyors- screw conveyors and pneumatic conveyors.

Total(45L)=45 Periods

REFERENCE BOOKS:

1. Rudenko. N, "Materials Handling Equipment", MIR Publishers, 1969.
2. Spivakovsky. A.O and Dyachkov. V.K, "Conveying Machines- Volume I and II", MIR Publishers, 1985.
3. Alexandrov M, "Materials Handling Equipments", MIR Publishers, 1981.
4. Boltzharol A, "Materials Handling Handbook", The Ronald Press Company, 1958.
5. P.S.G Tech, "Design Data Book", KalaikathirAchchagam, 2008.
6. Lingaiah. K and NarayanaIyengar, "Machine Design Data Hand Book- Vol. 1 & 2", Suma Publishers, 1983.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Realize the selection of material handling equipment	Understand
CO2	Design various hoisting elements like, forged hooks, eye hooks, crane grabs and brakes shoe.	Create
CO3	Design the various types of overhead transportation equipment's	Create
CO4	Design the bucket, industrial and freight lift elevators for to and fro transportation of materials in vertical direction	Create
CO5	Design the different conveyor systems for material handling applications	Create

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	2	2	2	-	-	-	-	-	-	1	1	1
CO2	1	2	2	2	-	-	2	-	2	-	-	3	2	3
CO3	1	1	2	2	2	-	-	-	-	-	1	3	2	3
CO4	1	1	2	2	2	-	-	-	-	-	1	3	2	3
CO5	1	2	2	2	2	-	-	-	-	-	2	3	2	3
Avg	1.2	1.4	2.0	2.0	1.8	0.0	0.4	0.0	0.4	0.0	0.8	2.6	1.8	2.6

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PROFESSIONAL ELECTIVE – V

22CDE51	MEMS AND NEMS TECHNOLOGY	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit	3	
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES

1.	To introduce the concepts of micro and nano electromechanical devices
2.	To know the fabrication process of Microsystems
3.	To know the design concepts of micro sensors and micro actuators
4.	To introduce the concepts of quantum mechanics and nano systems

UNIT I	INTRODUCTION TO MEMS AND NEMS	9	0	0	9

Scaling laws - Scaling effect on physical properties, scaling effects on Electrical properties, scaling effect on physical forces - Intrinsic Characteristics of MEMS – Energy Domains -Nano and Microelectromechanical Systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals. Stress and strain analysis – Flexural beam bending- Torsional deflection.

UNIT II	MEMS FABRICATION TECHNOLOGIES	9	0	0	9

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.

UNIT III	MICRO SENSORS	9	0	0	9

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Parallel plate capacitors, Pressure sensors, Piezoresistive sensors, Tactile and Flow sensors, Thermal Sensing Case study: Piezoelectric energy harvester.

UNIT IV	MICRO ACTUATORS	9	0	0	9

Design of Actuators: Micro Grippers – Micro Motors , Actuation using thermal forces, Thermal Bimorph , Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Shape Memory Alloys -Actuation using Electrostatic forces, Case Study:RF Switch.

UNIT V	NEMS SYSTEMS	9	0	0	9

Atomic Structures and Quantum Mechanics, Quantum confinement in 3D, 2D, 1D and zero dimensional structures -Size effect and properties of nanostructures- nanotubes and nanowires for nano device fabrication – Single electron transistors, coulomb blockade effects in ultra-small metallic tunnel junctions - nanoparticles based solar cells.

Total(45L)= 45 Periods

REFERENCE BOOKS:

1	Marc Madou, Fundamentals of Microfabrication‖, CRC press 1997.
2	Stephen D.Senturia, Micro system Design‖, Kluwer Academic Publishers, 2001.
3	Tai Ran Hsu, MEMS and Microsystems Design and Manufacture,Tata Mcraw Hill, 2002.
4	Chang Liu, Foundations of MEMS‖, Pearson education India limited, 2006,
5	Sergey Edward Lyshevski, MEMS and NEMS: Systems, Devices, and Structures‖ CRC Press, 2002

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Interpret the basics of micro/nano electromechanical systems including their scope and recent development of science and technology.	Remembering
CO2	Recognize the use of materials in micro fabrication and describe the fabrication processes.	Understand
CO3	Analyze the key performance aspects of electromechanical sensors including sensors and actuators	Analysis
CO4	Gain a knowledge of basic approaches for various actuators design.	Understand
CO5	Comprehend the theoretical foundations of quantum mechanics and Nano systems.	Remembering

COURSE ARTICULATION MATRIX														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	3	-	-	-	2	2	-	-	3	2	3	3	-	-
CO2	2	2	2	-	2	2	2	3	-	-	-	-	-	-
CO3	2	3	-	2	-	-	-	-	2	2	2	-	-	-
CO4	2	3	2	2	-	-	3	2	2	-	-	-	-	-
CO5	-	2	2	2	3	3	-	-	-	2	-	3	2	-
Avg	**1.8**	**2.0**	**1.2**	**1.2**	**1.4**	**1.4**	**1.0**	**1.0**	**1.4**	**1.2**	**1.0**	**1.2**	**0.4**	**0.0**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE52	ENTERPRISE RESOURCE PLANNING				SEMESTER III
PREREQUISITES		CATEGORY	PE	Credit	3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVE :

1	Learn about the rationale for acquiring and implementing ERP systems, selection of ERP software, and integration of processes and transactions in the ERP system.
2	Understand the challenges associated with the successful implementation of Supply Chain ERP software with an emphasis on leadership and managerial implications/actions and generating business value for the firm.
3	Learn principles of leading very large change initiatives by focusing on the rational and emotional aspects of organizational transformation.
4	Develop the student's organizational and analytical skills through the use of business cases studies, articles and working in teams.
5	To gain knowledge of the hidden cost of a company.

UNIT I	**ENTERPRISE RESOURCE PLANNING**	**9**	**0**	**0**	**9**

Principle – ERP framework – Business Blueprint – Business Engineering vs. Business process Re-Engineering – Tools – Languages – Value chain – Supply and Demand chain – Extended supply chain management – Dynamic Models –Process Models

UNIT II	**TECHNOLOGY AND ARCHITECTURE**	**9**	**0**	**0**	**9**

Client/Server architecture – Technology choices – Internet direction – Evaluation framework – CRM – CRM pricing– chain safety – Evaluation framework.

UNIT III	**ERP SYSTEM PACKAGES**	**9**	**0**	**0**	**9**

SAP - People soft- Baan and Oracle – Comparison – Integration of different ERP applications – ERP as sales force automation – Integration of ERP and Internet – ERP Implementation strategies – Organizational and social issues.

UNIT IV	**ORACLE**	**9**	**0**	**0**	**9**

Overview – Architecture – AIM – applications – Oracle SCM. SAP: Overview – Architecture – applications -Before and after Y2k – critical issues – Training on various modules of IBCS ERP Package-Oracle ERP and MAXIMO- including ERP on the NET

UNIT V	**ERP PROCUREMENT ISSUES**	**9**	**0**	**0**	**9**

Market Trends – Outsourcing ERP – Economics – Hidden Cost Issues – ROI –Analysis of cases from five Indian Companies.

Total(45L) =45 Periods

REFERENCE BOOKS:

1	Sadagopan. S, “ERP-A Managerial Perspective”, Tata McGraw Hill, 1999.
2	Jose Antonio Fernandez, “The SAP R/3 Handbook”, Tata McGraw Hill, 1998.
3	Vinod Kumar Crag and Venkitakrishnan, N.K., “Enterprise Resource Planning Concepts and Practice”, Prentice Hall of India, 1998.
4	Garg and Venkitakrishnan, “ERPWARE- ERP Implementation Framework”, Prentice Hall, 1999.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	Differentiate between a business process and a business function and explain how a structured supply chain management planning process enhances efficiency and decision making	Analysis
CO2	Define integrated information systems and Describe the benefits of customer relationship management (CRM) software.	Remembering
CO3	Analyze the role of PLM, SCM and CRM in ERP.	Analysis
CO4	Analyze the role of Consultants, Vendors and Employees.	Analysis
CO5	Outline the accounting and management-reporting benefits that accrue from having an ERP system.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	1	2	-	2	1	-	1	-	1	1	1	1	1
CO2	1	1	2	1	2	2	1	-	-	1	1	-	1	-
CO3	1	1	2	2	2	1	1	-	1	1	1	1	2	1
CO4	-	1	1	2	1	2	1	2	2	-	1	1	1	1
CO5	-	1	1	-	1	1	1	1	1	2	1	1	2	2
Avg	**0.6**	**1.0**	**1.6**	**1.0**	**1.6**	**1.4**	**0.8**	**0.8**	**0.8**	**1.0**	**1.0**	**0.8**	**1.4**	**1.0**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE53	MECHATRONICS SYSTEM DESIGN				SEMESTER III
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVE :

1. To provide the interdisciplinary concepts of Electronics, Electrical, Mechanical and Computer Systems for the Control of Mechanical and Electronic Systems.
2. To know the basic working principle of sensors and transducers of use for manufacturing system
3. To know the features, modules and interfaces of microprocessors
4. To understand the concept of PLC system in industrial applications
5. To gain the knowledge of integration of mechatronic systems in automation of modern manufacturing systems

UNIT I	**INTRODUCTION**	**9**	**0**	**0**	**9**

Introduction to Mechatronics - Systems - Mechatronics in Products – Measurement Systems - Control Systems - Traditional design and Mechatronics Design- Advanced applications in Mechatronics -Measurement systemsControl Systems- PID Controllers.

UNIT II	**SENSORS AND TRANSDUCERS**	**9**	**0**	**0**	**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**	**0**	**0**	**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**	**0**	**0**	**9**

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

UNIT V	**MECHATRONICS SYSTEMS AND APPLICATIONS**	**9**	**0**	**0**	**9**

Intelligent Manufacturing – Condition Monitoring and Control - Robot for Automatic Assembly Process- Robot Vision – Material Handling and Inspection- Automotive Mechatronics: Electronic Ignition System – ABS – EBD – Automatic Cruise Control

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Michael B.Histand and David G. Alciatore, “Introduction to Mechatronics and Measurement Systems”, McGraw Hill International Editions, 1999.
2. Bradley- D.A, Dawson D, Buru N.C and Loader A J, “Macaronis”, Chapman and Hall, 1993.
3. Ramesh.SGaonkar, “Microprocessor Architecture- Programming and Applications”, Wiley Eastern, 1998. 2. Lawrence J.Kamm, “Understanding Electro-Mechanical Engineering- An Introduction to Mechatronics”, Prentice Hall, 2000.
4. Ghosh- P.K. and Sridhar- P.R. “0000 to 8085- Introduction to Microprocessors for Engineers and Scientists”, 2nd Edition, Prentice Hall, 1995.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	Generate conceptual design for Mechatronics products based on potential customer requirements	Create
CO2	Select appropriate sensors and transducers and devise an instrumentation system for collecting information about processes	Apply
CO3	Explain the features, modules and interfaces of microprocessors	Understand
CO4	Write PLC program for industrial applications	Apply
CO5	Apply the knowledge of integration of mechatronic systems in automation of modern manufacturing systems	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	2	2	2	-	-	1	2	-	1	3	-	-
CO2	1	-	2	2	-	1	-	2	2	-	1	2	-	-
CO3	2	3	3	-	2	-	-	2	1	-	2	-	-	-
CO4	-	2	3	2	1	-	-	1	1	2	-	2	2	-
CO5	1	2	1	-	-	1	1	-	-	-	-	2	3	3
Avg	**1.2**	**2.0**	**2.2**	**1.2**	**1.0**	**0.4**	**0.2**	**1.2**	**1.2**	**0.4**	**0.8**	**1.8**	**1.0**	**0.6**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE54	FAILURE ANALYSIS				SEMESTER III
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVE :

1. To Introduce the Basic Concept of Fracture Mechanics And Failure Analysis
2. Import Knowledge on Mechanics of Fracture During Static And Dynamic Loading
3. Understanding The Failure Mechanism of Creep Rupture.
4. Understand The Mechanism of Wear And Corrosion And Knowledge on Prevention
5. Gain knowledge on Reliability and condition monitoring

UNIT I	INTRODUCTION	9	0	0	9

Stages of failure analysis, classification and identification of various types of fracture. Overview of fracture mechanics, characteristics of ductile and brittle fracture.

UNIT II	CONCEPTS OF FAILURE	9	0	0	9

General concepts, fracture characteristics revealed by microscopy, factors affecting fatigue life Creep, stress rupture, elevated temperature fatigue, metallurgical instabilities, environmental induced failure. Some case studies failures.

UNIT III	TYPES OF FAILURE	9	0	0	9

Types of wear, analyzing wear failure. Corrosion failures- factors influencing corrosion failures, an overview of various types of corrosion stress corrosion cracking, sources, characteristics of stress corrosion cracking. Procedure for analyzing stress corrosion cracking, various types of hydrogen damage failures

UNIT IV	CAUSES OF FAILURE	9	0	0	9

Causes of failure in forging, failure of iron and steel castings, improper heat treatment, stress concentration and service conditions. Failure of weldments - reasons for failure procedure for weld failure analysis.

UNIT V	RELIABILITY	9	0	0	9

Reliability concept and hazard function, life prediction, condition monitoring, application of Poisson, exponential and Weibull distribution for reliability, bathtub curve, parallel and series system, mean time between failures and life testing

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Bradley- D.A, Daws ASM Metals Handbook "Failure Analysis and Prevention", ASM Metals Park. Ohio,Vol.10, 10th Edition, 1995.
2. Colangelo.V.J. and Heiser.F.A. "Analysis of Metallurgical Failures", John Wiley and Sons Inc. New York, USA, 1974. On D, Buru N.C and Loader A J, "Macaronis", Chapman and Hall, 1993.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Evaluating the mechanical behaviour includes tensile, fatigue and creep behaviour of materials.	Evaluate
CO2	Ability to Understand the micro mechanisms of brittle and ductile fracture	Understand
CO3	Analyze the fatigue and fracture behaviour of materials	Analysis
CO4	Apply the knowledge for failure analysis and case studies	Apply
CO5	Ability to Understand the concepts of Reliability and build system reliability models for different configurations.	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	-	-	-	-	1	1	-	-	1
CO2	3	2	2	2	1	-	-	-	-	1	-	-	-	1
CO3	2	3	2	1	1	1	-	-	-	1	-	3	2	-
CO4	2	3	2	1	1	1	1	-	-	1	1	3	2	-
CO5	2	1	1	1	2	1	-	-	-	-	-	1	1	-
Avg	**2.4**	**2.2**	**1.8**	**1.4**	**1.2**	**0.6**	**0.2**	**0.0**	**0.0**	**0.8**	**0.4**	**1.4**	**1.0**	**0.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE55	MAINTENANCE ENGINEERING				SEMESTER III			
PREREQUISITES		CATEGORY	PE		Credit		3	
		Hours/Week	L	T	P	TH		
			3	0	0	3		

COURSE OBJECTIVES:

1. To understand the concepts productivity and availability based on reliability and effectiveness.
2. To prevent or reduce the likelihood or frequency of failures of engineering components and systems.
3. To increase the quality, quantity of the product with minimal cost.
4. To identify and correct the causes of failures that does occur in engineering system.
5. To analyse about different failure modes

UNIT I	INTRODUCTION	9	0	0	9

Maintenance – Key to reliability & productivity. Basic elements of maintenance system – inspection, Planning & scheduling, job execution, record keeping, data analysis, learning & improvement. Preventive, operating and shutdown maintenance; Condition based maintenance and Application of Preventive maintenance for a system of equipment.

UNIT II	VIBRATION AND SIGNATURE ANALYSIS	9	0	0	9

Vibration and signature analysis; causes; remedy in rotating machinery. Fluid analysis for condition Monitoring, various methods of fluid analysis. Vibration monitoring – Data acquisition, Transducers, Time domain and frequency domain analysis, Phase signal analysis, Fault diagnosis of rotating Equipment, antifriction bearings and gears.

UNIT III	NON-DESTRUCTIVE TESTING	9	0	0	9

Non-destructive testing – Visual examination – optical aids, liquid penetrate testing, magnetic particle Testing, eddy current testing, radiography, ultrasonic testing, acoustic emission testing, thermo-graphy, leak testing, corrosion monitoring, standards for NDT.

UNIT IV	LUBRICATION	9	0	0	9

Lubrication: Introduction to lubrication engineering, types, classification of lubricants with their properties and characteristics. Bearing lubrication technique for minimization of friction and wear

UNIT V	RELIABILITY	9	0	0	9

The science of friction and wear; Different types of wear - abrasive, corrosive, seizure, scoring, Scuffing, pitting, spalling, adhesive, etc. and techniques for minimization of wear. Data collection and Analysis, Introduction to computer-aided maintenance management system.

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Industrial Maintenance – H.P.Garg
2. Industrial Maintenance Management – S.K.Srivastava
3. Mishra, R. C. and Pathak, K., Maintenance Engineering and Management, Second Edition, Prentice Hall of India, New Delhi, 2004.
4. Dhillon B.S., Engineering Maintenance: A Modern Approach, Taylor & Francis Group, 2002.
5. Mobley R. K., An Introduction to Predictive Maintenance, Second Edition, Butterworth-Heinemann,

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Apply maintenance management skill and Explain the need of safety devices.	Apply
CO2	Apply the concept of tribology and conditioning monitoring in Vibration and Fluid analysis.	Apply
CO3	Select and apply appropriate Non-destructive testing for various measures of maintenance.	Apply
CO4	Identify the lubrication technique for minimization of friction and wear.	Understand
CO5	Analyze the failure modes of plant machineries to increase the productivity of the plant.	Analysis

COURSE ARTICULATION MATRIX

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	-	-	-	-	1	1	1	-	3
CO2	3	2	2	2	1	-	-	-	-	1	-	1	-	-
CO3	2	3	2	1	1	1	-	-	-	1	-	-	1	-
CO4	2	3	2	1	1	1	1	-	-	1	1	-	-	1
CO5	2	3	2	1	1	1	-	-	-	1	-	-	-	1
Avg	**2.4**	**2.6**	**2.0**	**1.4**	**1.0**	**0.6**	**0.20**	**0.0**	**0.0**	**1.0**	**0.4**	**0.4**	**0.20**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PROFESSIONAL ELECTIVE - VI

22CDE61	INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. Process planning and cost estimation, Concept of Engineering design, Industrial Management and engineering.
2. To generate the concept for new product
3. To know about the need of product specifications
4. To know the concept selection and measure customer response.
5. To gain knowledge in product architecture and level design issues.

UNIT I	INTRODUCTION	9	0	0	9

Characteristics of Successful Product Development-Interdisciplinary activity-Duration and Costs of Product Development-Challenges of Product Development –Development Processes and Organizations-A Generic Development Process-Concept Development: The Front-End Process Adapting the Generic Product Development Process- The AMF Development Process-Product Development Organizations-The AMF Organization

UNIT II	PRODUCT PLANNING	9	0	0	9

Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects- Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy- Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

UNIT III	PRODUCT SPECIFICATIONS	9	0	0	9

Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications- Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally- Explore Systematically-Reflect on the Results and the Process.

UNIT IV	CONCEPT SELECTION	9	0	0	9

Concept Selection- Overview of Methodology-Concept Screening-Concept Testing- Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format- Communicate the Concept- Measure Customer Response-Interpret the Results-Reflect on the Results and the Process..

UNIT V	PRODUCT ARCHITECTURE	9	0	0	9

Product Architecture-Implications of the Architecture-Establishing the Architecture- Delayed Differentiation- Platform Planning-Related System-Level Design Issues

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Product Design and Development, Karl T. Ulrich and Steven .D Epinger, McGraw-Hill International Edns. 4th edition 2013. ISBN-13: 978-0070658110.
2. Kevien Otto and Kristin Wood, “Product Design” Pearson Publication,3rd Edition, 2012, ISBN-13: 9780130212719.
3. Tuart Pugh, “Tool Design – Integrated Methods for successful Product Engineering”, Addison Wesley Publishing, Neyork, 1991,ISBN: 020141639.
4. Tephen Rosenthal, Business One Orwin “Effective Product Design and Development”, Homewood, 1992,ISBN:1-55623-603-4
5. KemnnethCrow,”ConcurrentEngg. /Integrated Product Development”, DRM Associates, 26/3,ViaOlivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Impart knowledge on product development processes and organizations.	Understand
CO2	Identify customer needs, product planning processes and allocating resources and timing.	Understand
CO3	Apply knowledge on product specifications.	Apply
CO4	Define the concept selection and measure customer response.	Remembering
CO5	Provide product architecture and level design issues.	Apply

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	-	1	-	-	1	-	-	-	-	2	1	2
CO2	1	3	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	1	1	1	2	-	1	-	-	-	-	3	-	1
CO4	3	2	1	2	2	-	1	-	-	-	-	1	2	1
CO5	2	3	-	3	1	-	1	-	-	-	-	3	-	1
Avg	**2.2**	**2.2**	**0.6**	**1.6**	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.2**	**0.6**	**1.2**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE62	INDUSTRIAL SAFETY MANAGEMENT	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit	3

	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To achieve an understanding of principles of safety management.
2. To enable the students to learn about various functions and activities of safety department.
3. To enable students to conduct safety audit and write audit reports effectively in auditing situations.
4. To have knowledge about sources of information for safety promotion and training.
5. To familiarize students with evaluation of safety performance.

UNIT I	SAFETY MANAGEMENT	9	0	0	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	0	0	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	0	0	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	0	0	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	0	0	9

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

Total(45L) =45 Periods

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.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the functions and activities of safety engineering department.	Understand
CO2	Carry out a safety audit for hot and metal operations and prepare a report for the audit.	Apply
CO3	Prepare an accident investigation report and estimate the accident cost using supervisors report and data.	Evaluate
CO4	Evaluate the safety performance of an organization from accident records.	Evaluate

CO5	Identify various agencies, support institutions and government organizations involved in safety training and promotion.	Understand

COURSE ARTICULATION MATRIX

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	-	1	-	-	-	3	2	-	-	-	-	-	2	1
CO2	-	1	1	1	1	2	2	1	1	2	1	1	1	2
CO3	1	1	1	1	3	2	2	-	-	2	1	1	1	1
CO4	1	1	1	-	3	2	1	1	1	1	1	-	1	2
CO5	1	1	1	1	2	2	2	-	1	-	-	-	-	1
Avg	**0.6**	**1.0**	**0.8**	**0.6**	**1.8**	**2.2**	**1.8**	**0.4**	**0.6**	**1.0**	**0.6**	**0.4**	**1.0**	**1.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE63	RELIABILITY IN ENGINEERING SYSTEMS	SEMESTER III			
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVE

The objectives of this course are:

1. To explain the basic concepts of Reliability Engineering and its Understand measures.
2. To Predict and estimate the reliability from failure data.
3. To assess system reliability using various measuring method.
4. To Predict the Reliability at system level using various models.
5. To develop and implement a successful Reliability programme.

UNIT I	RELIABILITY CONCEPT	9	0	0	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	0	0	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	0	0	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	0	0	9

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

UNIT V	RELIABILITY IMPROVEMENT	9	0	0	9

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

Total (45L)=45 Periods

REFERENCE BOOKS:

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

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of reliability engineering and its measures.	Understand
CO2	Estimate the reliability from failure data.	Evaluate
CO3	Assessment of system reliability using various measuring method.	Remembering
CO4	Apply various monitoring techniques to predict the reliability at system level.	Apply
CO5	Develop and implement a successful Reliability programme.	Create

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	2	-	-	-	-	2	-	2	1	2
CO2	1	2	1	1	1	-	-	-	-	-	1	1	1	1
CO3	1	2	-	2	-	-	1	-	-	-	2	2	1	-
CO4	1	2	-	-	-	-	2	-	-	-	1	1	2	1
CO5	2	1	1	1	-	-	-	-	-	-	2	2	2	1
Avg	**1.4**	**1.4**	**0.4**	**0.8**	**0.6**	**0.0**	**0.6**	**0.0**	**0.0**	**0.4**	**1.2**	**1.6**	**1.4**	**1.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE64	MECHANICAL MEASUREMENTS AND ANALYSIS	SEMESTER III			
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

Course Objectives:

1.	To provide knowledge on various Metrological equipment's available to measure the dimension of the components
2.	To provide knowledge on the correct procedure to be adopted to measure the dimension of the components.
3	To understand the measurements done in gear tooth profile
4	To know about the role of control charts in inspection
5	To provide the knowledge about six sigma

UNIT I	BASICS OF MEASUREMENT SYSTEM AND DEVICES	9	0	0	9

Definition of metrology, accuracy, precision and sensitivity, Abbe's principle. Three stages of generalized measurement system - mechanical loading - static characteristics of instruments - factors considered in selection of instruments - commonly used terms, error analysis and classification - sources of error. Principle of interferometry, laser interferometer.

UNIT II	CALIBRATION OF INSTRUMENTS AND QUALITY STANDARDS	9	0	0	9

Calibration of measuring instruments - principles of calibration, Calibration of Instruments - Vernier caliper, Micrometer, feeler gauges, dial indicator, surface plates, slip gauges, care of gauge blocks. General cares and rules in measurement, ISO 9000 quality standards. Comparators - mechanical, electrical, optical and pneumatic.

UNIT III	GEOMETRICAL MEASUREMENT AND MACHINE ELEMENTS	9	0	0	9

Angular measurement - optical protractors, sine bar, roundness measurement, limit gauge, design of plug gauge, Taylor's principle, three basic types of limit gauges, Tomlinson surface meter, computer controlled CMM. ISO metric thread, measurement of major, minor and effective diameters. Gear terminology; spur gear measurement, checking of composite errors, base pitch measurement.

UNIT IV	STATISTICAL QUALITY CONTROL	9	0	0	9

Surface finish- terminology and measurements - Optical measuring instruments- Acceptance test for machines Statistical Quality Control - Control charts - Sampling plans.

UNIT V	SIX SIGMA	9	0	0	9

Six sigma: define measure, analyse, improve and control phases. Analyse phase tools: Common Tools: Histogram, Box Plot, Control chart, Scatter chart, Cause and effect diagram, Pareto analysis, interrelations diagram. Special Tools: Regression Analysis, Hypothesis Testing, ANOVA, Multivariate analysis.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Gupta.I.C, ―A text book of Engineering Metrology‖, Dhanpat Rai publications, New Delhi, 2007
2	Beckwith.T.G,Roy D. Marangoni, John H. Lienhard, ―Mechanical Measurements‖, Prentice Hall, 2006
3	Jain.R.K, ―Mechanical and Industrial Measurements‖, Khanna Publishers, Delhi, 1999.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	The students can demonstrate different measurement technologies and use of them in industrial components	Apply
CO2	Evaluate the quality of job, machine and instruments.	Evaluate
CO3	Perform calibration of measuring instruments	Analysis
CO4	Differentiate the accuracy of instruments.	Create
CO5	To know about the control charts and various quality tools	Remembering

COURSE ARTICULATION MATRIX														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	-	1	-	-	1	-	-	-	-	2	1	2
CO2	1	2	1	1	-	-	1	-	-	-	-	2	-	1
CO3	3	1	1	1	2	-	1	-	-	-	-	3	-	1
CO4	3	2	1	2	2	-	1	-	-	-	-	1	2	1
CO5	2	3	-	3	1	-	1	-	-	-	-	3	-	1
Avg	**2.0**	**2.0**	**0.6**	**1.6**	**1.0**	**0.0**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.2**	**0.6**	**1.2**
3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)														

22CDE65	ERGONOMICS IN MANUFACTURING			SEMESTER III		
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVE:

1. To process of manufacturing Technology or equivalent
2. To Analyze the various factors affecting human performance in ergonomics
3. To develop the work space design and environments
4. To understand the types and manufacturing methods
5. To discuss climate, noise and motion affect the ergonomics design

UNIT I	**INTRODUCTION:**	**9**	**0**	**0**	**9**
Interdisciplinary nature of ergonomics, modern ergonomics.					
UNIT II	**HUMAN PERFORMANCE**	**9**	**0**	**0**	**9**
Information input and processing, factors affecting human performance, physical work load and energy expenditure, heat stress, manual lifting.					
UNIT III	**WORK SPACE DESIGN**	**9**	**0**	**0**	**9**
Anthropometry, Work-space design for standing and seated workers, arrangement of components within a physical space, interpersonal aspect of workplace design.					
UNIT IV	**DESIGN OF EQUIPMENT**	**9**	**0**	**0**	**9**
Ergonomic factors to be considered, design of displays and controls, design for maintainability.					
UNIT V	**DESIGN OF ENVIRONMENT**	**9**	**0**	**0**	**9**
Illumination – Climate – Noise – Motion.					
					Total(45L) =45 Periods

REFERENCE BOOKS:

1. Martin Helander, "A Guide to Ergonomics of Manufacturing", CRC Press, 2 edition, December 2005.
2. Bridger, R.S., "Introduction to Ergonomics, CRC Press, 3 edition, August 2008.
3. McCormick, J., "Human Factors in Engineering and Design", McGraw-Hill, 7 edition, January 1993.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Recognize the need, requirements and applications of ergonomics in design	Understand
CO2	Analyze the various factors affecting human performance in ergonomics	Analysis
CO3	Analyze various work space design	Analysis
CO4	Evaluate the influence of human performance over ergonomics	Evaluate
CO5	Evaluate climate, noise and motion affect the ergonomics design.	Evaluate

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	-	-	-	-	-	-	2	3	1	1
CO2	2	1	1	-	1	-	-	-	2	-	1	3	2	1
CO3	1	1	-	-	1	-	-	-	2	-	1	2	1	1
CO4	1	2	1	-	1	-	-	-	1	-	2	2	2	1
CO5	1	1	-	-	-	1	-	-	2	3	1	1	1	2
Avg	**1.4**	**1.2**	**0.8**	**0.2**	**0.6**	**0.2**	**0.0**	**0.0**	**1.4**	**0.6**	**1.4**	**2.2**	**1.4**	**1.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

PROFESSIONAL ELECTIVE – VII

22CDE71	QUALITY CONCEPTS IN DESIGN		SEMESTER III			
PREREQUISITES		CATEGORY	PE	Credit		3
		Hours/Week	L	T	P	TH
			3	0	0	3

COURSE OBJECTIVE:

1.	To impart knowledge on engineering design principles, material selection and manufacturing processes.
2.	To learn the principles of implementing quality in a product or services using different tools.
3.	To enhance the quality of the product by the use of failure mode effect analysis and implementing methods to uphold the status of six sigma.
4.	To develop a robust product or service using various strategies of design of experiments.
5.	To maintain the product quality through the use of statistical tools and enforcing methods to improve the product reliability.

UNIT I	DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION	5	0	0	5

Morphology of Design –Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Bench Marking – Creativity – Theory of Problem solving (TRIZ) – Value Analysis - Design for Manufacture, Design for Assembly – Design for casting, Forging, Metal Forming, Machining and Welding.

UNIT II	DESIGN FOR QUALITY	10	0	0	10

Quality Function Deployment -House of Quality-Objectives and functions-Targets-Stakeholders- Measures and Matrices-Design of Experiments –design process-Identification of control factors, noise factors, and performance metrics - developing the experimental plan- experimental design – testing noise factors- Running the experiments –Conducting the analysis-Selecting and conforming factor-Set points-reflecting and repeating.

UNIT III	FAILURE MODE EFFECTS ANALYSIS AND DESIGN FOR SIX SIGMA	10	0	0	10

Basic methods: Refining geometry and layout, general process of product embodiment - Embodiment checklist- Advanced methods: systems modeling, mechanical embodiment principles-FMEA method- linking fault states to systems modeling - Basis of SIX SIGMA – Project selection for SIX SIGMA- SIX SIGMA problem solving- SIX SIGMA in service and small organizations - SIX SIGMA and lean production –Lean SIX SIGMA and services.

UNIT IV	STATISTICAL CONSIDERATION AND RELIABILITY	10	0	0	10

Importance of Experiments, Experimental Strategies, Basic principles of Design, Terminology, ANOVA, Steps in Experimentation, Sample size, Single Factor experiments – Completely Randomized design, Randomized Block design, Statistical Analysis, Multifactor experiments - Two and three factor full Factorial experiments, 2K factorial Experiments, Confounding and Blocking designs, Fractional factorial design, Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design- Control and Noise factors, S/N ratios

UNIT V	DESIGN OF ENVIRONMENT	10	0	0	10

Frequency distributions and Histograms- Run charts –stem and leaf plots- Pareto diagrams- Cause and Effect diagrams-Box plots- Probability distribution-Statistical Process control–Scatter diagrams –Multivariable charts –Matrix plots and 3-D plots.-Reliability-Survival and Failure- Series and parallel systems-Mean time between failure-Weibull distribution

Total(45L) =45 Periods

REFERENCE BOOKS:

1	George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., `2013
2	Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, ,Tata Mcgraw-Hill Education, 2015
3	Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
4	Kevin N. Otto and Kristin L. Wood, "Product Design: Techniques in Reverse Engineering and New Product Development", Prentice Hall, 2001
5	Montgomery, D.C., "Design and Analysis of experiments", John Wiley and Sons, 2017.
6	Phillip J. Ross, "Taguchi techniques for quality engineering", Tata McGraw Hill, 2005

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Apply the fundamentals of design and material selection to develop a high-quality product	Apply
CO2	Apply the quality concepts to develop a durable product.	Apply
CO3	Conduct Failure Mode Effect Analysis on a product in order to improve its quality using six-sigma techniques.	Apply
CO4	Apply different experimental design methods in product- development.	Apply
CO5	Implement various statistical tools to improve the product quality and reliability.	Understand

COURSE ARTICULATION MATRIX

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**PSO1**	**PSO2**	**PSO3**
CO1	2	3	3	3	3	2	-	-	-	-	-	2	2	2
CO2	1	1	1	1	3	2	-	-	-	-	-	2	2	2
CO3	2	2	2	2	2	2	-	-	-	-	-	2	2	2
CO4	2	2	2	2	2	2	-	-	-	-	-	2	2	2
CO5	2	2	2	2	2	2	-	-	-	-	-	2	2	2
Avg	**1.8**	**2.0**	**2.0**	**2.0**	**2.4**	**2.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**2.0**	**2.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE72	DESIGN OF PRESSURE VESSELS	SEMESTER III			
PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To give exposure to engineering problems involved in the design of pressure vessel
2. To understand and apply the design considerations for pressure vessels.
3. To learn about the tests and analysis for various components of pressure vessels.
4. To understand the need for support structures and their design.
5. To familiarize the buckling and fracture analysis of pressure vessel under various load conditions

UNIT I	PRESSURE VESSELS	9	0	0	9

Definition-uses-methods of fabrication –materials of constructions –different specifications with special reference to BIS. Methods for determining stresses – Terminology and Ligament Efficiency – Applications.

UNIT II	DESIGN	9	0	0	9

Criteria for internal and external pressures-accessories to pressure vessels-connections to shell details-design criteria for pressure vessel access-inspection, tests and nondestructive examinations-supports.

UNIT III	STRESSES IN PRESSURE VESSELS	9	0	0	9

Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses – Discontinuity stresses in pressure vessels.

UNIT IV	DESIGN OF TALL CYLINDRICAL SELF SUPPORTING PROCESS COLUMNS	9	0	0	9

Supports for short vertical vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design

UNIT V	BUCKLING AND FRACTURE ANALYSIS IN VESSELS	9	0	0	9

Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – the collapse of thick-walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

Total(45L) =45 Periods

REFERENCE BOOKS:

1. John F. Harvey, “Theory and Design of Pressure Vessels”, CBS Publishers and Distributors, 1987.
2. Henry H. Bedner, “Pressure Vessels, Design Hand Book”, CBS Publishers and Distributors, 1987.
3. Stanley, M. Wales, “Chemical process equipment, selection and Design”, Butterworths series in Chemical Engineering, 1988.
4. William. J., Bees, “Approximate Methods in the Design and Analysis of Pressure Vessels and Piping”, Pre ASME Pressure Vessels and Piping Conference, 1997.
5. Hesse.H.C and Rushto J.H, “Process equipment design”, D.vanNostran Co. Inc, N.Y, 1945.
6. Brownell, L.E and Yound.E.H, “Process Equipment Design”, McGraw Hill Co. Inc, N.Y, 1959.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Apply the fundamental principles of loads and stresses as applied to pressure vessels.	Apply
CO2	Select and apply appropriate failure theories in the design of pressure vessels.	Apply
CO3	Identify various stresses in different components of pressure vessels.	Understand
CO4	Design a variety of different pressure vessels using standard codes.	Create
CO5	Design support members of pressure vessels.	Create

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	1	2	2	2	2	2	-	-	1	-	1	2	2	2
CO2	1	2	2	2	2	-	-	-	1	-	-	2	2	2
CO3	1	2	2	2	2	-	-	-	-	-	-	2	2	2
CO4	1	2	2	2	2	-	-	-	-	-	-	3	3	3
CO5	1	2	2	2	2	-	-	-	-	-	-	3	3	3
Avg	**1.0**	**2.0**	**2.0**	**2.0**	**2.0**	**0.4**	**0.0**	**0.0**	**0.4**	**0.0**	**0.2**	**2.4**	**2.4**	**2.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE73	PLASTICITY AND METAL FORMING	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES

1.	To understand plastic deformation during forming processes.
2.	To learn about the various tests that can be used to determine the plasticity of a material.
3.	To learn about the analytical method of metal forming design.
4.	To learn about the analysis of metal forming processes.
5.	To know about the various advanced metal forming processes.

UNIT-I	THEORY OF PLASTICITY	9	0	0	9

Theory of plastic deformation - Engineering stress and strain relationship – Stress tensor - Strain tensor - Yield criteria's - Plastic stress strain relationship – Plastic work - Equilibrium conditions - Incremental plastic strain. Plastic deformation in forging, rolling , extrusion, wire drawing , tube drawing and forming.

UNIT-II	CONSTITUTIVE RELATIONSHIPS AND INSTABILITY	9	0	0	9

Uniaxial tension test - Mechanical properties - Work hardening, Compression test, bulge test, plane strain compression stress, plastic instability in uniaxial tension stress, plastic instability in biaxial tension stress.

UNIT-III	ANALYSIS OF METAL FORMING	9	0	0	9

Slab analysis - Slip line method, upper bound solutions, statistically admissible stress field, numerical methods, contact problems, effect of friction, thermo elastic Elasto plasticity, elasto visco plasticity - Thermo mechanical coupling – Analysis of forging, rolling, extrusion and wire drawing processes - Experimental techniques for the evaluation of metal forming.

UNIT-IV	ANALYSIS OF SHEET METAL FORMING PROCESS	9	0	0	9

Bending theory - Cold rolling theory - Hill's anisotropic theory, Hill's general yield theory - Sheet metal forming - Elements used - Mesh generation and formulation Equilibrium equations - Consistent full set algorithm – Numerical solutions procedures - examples of simulation of simple parts - Bench mark tests – Forming limit diagrams.

UNIT-V	ADVANCES IN METAL FORMING	9	0	0	9

Orbital forging, Isothermal forging, worm forging, Hot and cold Isotropic pressing, high speed extrusion, rubber pad forming, micro blanking, super plastic forming – Overview of powder metal techniques- powder rolling- tooling and process parameters.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1	Hansford. W. F and Cad dell. RM., Metal Forming Mechanics and Metallurgy, Prentice Hall Eaglewood Cliffs, 1993.
2	Surender Kumar, " Technology of Metal Forming Processes", Prentice Hall of India, New Delhi, 2008
3	Narayanaswamy. R, Theory of Metal Forming Plasticity, Narosa Publishers, 1999.
4	Shiro Kobayashi, Altan. T, Metal Forming and Finite Element Method, Oxford University Press,1989.
5	Slater. R A. C., Engineering Plasticity - Theory & Applications to Metal Forming, John Wiely and Sons, 1987.
6	Wagoner. R H. and Chenot. J.J., Metal Forming analysis, Cambridge University Press, 2002.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of stress, strain tensor to evaluate the plasticity of materials.	Apply
CO2	Recognize the various experimental process, in order to access the formability nature of materials	Understand
CO3	Analyze the various metal forming processes with experimental techniques.	Analysis
CO4	Formulate the sheet metal forming process in the analytical method as well as numerical simulation	Create
CO5	Study of advanced methods in metal forming processes.	Remembering

COURSE ARTICULATION MATRIX

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO2	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO3	2	2	2	2	2	-	-	-	-	-	-	2	2	2
CO4	2	2	2	2	3	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	2	-	-	-	-	-	-	2	2	2
Avg	**2.2**	**2.2**	**2.2**	**2.2**	**2.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**2.0**	**2.0**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE74	NANOMATERIALS TECHNOLOGY	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit		3
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the concepts of Nanotechnology and behavior of nanomaterial and their properties.
2. To learn about the different routes for the synthesis and consolidation of nanoparticles and Nano crystalline materials.
3. To learn about the various properties and characteristics of nano-materials
4. To study about the various field of applications of Nano-materials.
5. To learn about the use of various nano-fluids in the fields of engineering.

UNIT I	INTRODUCTION	9	0	0	9

Importance of Nano-Technology - Emergence of Nano-Technology - Bottom-Up and Top-down approaches- challenges in Nano-Technology. Properties of materials and Nano-materials- role of size in Nano-materials- Electronic Properties- Magnetic Properties- Thermal Properties- Mechanical Properties- Optical Properties.

UNIT II	SYNTHESIS	9	0	0	9

Physical methods - Inert gas condensation - Arc discharge - RF plasma - Plasma arc technique - Ion sputtering - Laser ablation - Laser pyrolysis - Ball Milling - Molecular beam epitaxy - Chemical vapour deposition method and Electro deposition. Chemical Methods - Metal Nano-crystals by reduction – Solvothermal, Photochemical, Electrochemical synthesis - Nano crystals of semiconductors - Thermolysis routes - Sonochemical routes - Liquid-liquid interface - Hybrid methods - Solvated metal atom dispersion - Post-synthetic size-selective processing. Sol- gel- Micelles and micro emulsions - Cluster compounds.

UNIT III	CHARACTERIZATIONS	9	0	0	9

Scanning Electron Microscopy (SEM) - Scanning Probe Microscopy (SPM) - TEM and EDAX analysis - X-ray diffraction-Optical Microscope - Operational principle and application for analysis of Nano-materials- UV-VIS-IR Spectrophotometers- Principle of operation and application for band gap measurement. M based nanolithography and Nano-manipulation- E beam lithography and SEM based nanolithography and Nano-manipulation- Ion beam lithography- oxidation and metallization- Mask and its application. UV lithography- X-ray based lithography.

UNIT IV	APPLICATIONS	9	0	0	9

Micro and Nano-sensors - Fundamentals of sensors – biosensor- micro fluids- MEMS and NEMS - Packaging and characterization of sensors - Method of packaging at zero level - dye level and first level. Sensors for aerospace and defense: Accelerometer - Pressure Sensor- Night Vision System - Nano tweezers - Nano-cutting tools - Integration of sensor with actuators and electronic circuitry.

UNIT V	NANO FLUIDS	9	0	0	9

Preparation of Nano-fluids – Properties – Characterization of Nano-fluids - Role of Brownian Motion – Constraints for nano-fluids - Models for the measurements of thermal conductivities of Nano-fluids –Current applications – Issues with the Environment.

Total(45L) = 45 Periods

REFERENCE BOOKS:

1. B.S.Murthy, P.Shankar, Baldevraj, B.B.Rath and James Murday, “Text Book of Nanoscience and Nanotechnology”, Universities Press (India) Private Limited, 2013
2. Mark Ratneer, Daniel Ratner, “Nanotechnology” Pearson Education, Inc, 2003
3. Asim.K.Das ,Mohua Das An Introduction of Nanomaterals and Nano Science ,2020
4. M.A.Shah ,Tokar Ahmed ,Principle of Nanoscience and Nano technology.2020

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom’s Taxonomy Mapped
CO1	Knowledge about the processing techniques for nanomaterials.	Remembering
CO2	Interpret the creation and manipulation of nanoscale materials and to optimize the methods for specific material application.	Create
CO3	Knowledge about various properties and characteristics of nano-materials.	Understand
CO4	Use of Nano particles for the health, ecological and environmental hazards	Apply
CO5	Use of various nano-fluids in the fields of engineering.	Apply

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO1	PSO2	PSO3
CO1	1	2	3	-	1	-	1	-	1	1	-	2	2	1
CO2	1	2	2	2	2	1	1	-	1	-	1	2	2	2
CO3	1	1	2	-	2	-	-	-	2	-	-	2	2	2
CO4	1	-	-	-	-	-	1	-	3	3	2	2	2	1
CO5	1	-	1	-	-	-	1	-	2	2	-	2	2	1
Avg	**1.0**	**1.0**	**1.6**	**0.4**	**1.0**	**0.2**	**0.8**	**0.0**	**1.8**	**1.2**	**0.6**	**2.0**	**2.0**	**1.4**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

22CDE75	TRIBOLOGY IN DESIGN	SEMESTER III

PREREQUISITES	CATEGORY	PE	Credit	3	
	Hours/Week	L	T	P	TH
		3	0	0	3

COURSE OBJECTIVE:

1. To impart knowledge in the friction, wear and lubrication aspects of machine components.
2. To analyze the various types of lubricants and lubrication system in the tribology.
3. To understand the analytical behavior of different type's bearings and design of bearings based on analytical /theoretical approach.
4. To study the different types of high-pressure contacts and rolling bearings
5. To study and measure the different types of surface features associated with the friction.

UNIT I	SURFACES- FRICTION AND WEAR	9	0	0	9

Topography of Surfaces – Surface features – Surface interaction – Theory of Friction – Sliding and Rolling Friction- Friction properties of metallic and non-metallic materials – friction in extreme conditions – wear- types of wear – mechanism of wear – wear resistance materials – surface treatment – Surface modifications – surface coatings

UNIT II	LUBRICATION THEORY	9	0	0	9

Lubricants and their physical properties lubricants standards – Lubrication Regimes Hydrodynamic lubrication – Reynolds Equation- Thermal- inertia and turbulent effects – Elasto hydrodynamic and plasto hydrodynamic and magnetohydrodynamic lubrication – Hydrostatic lubrication – Gas lubrication.

UNIT III	DESIGN OF FLUID FILM BEARINGS	9	0	0	9

Design and performance analysis of thrust and journal bearings – Full- partial- fixed and pivoted journal bearings design – lubricant flow and delivery – power loss- Heat and temperature rotating loads and dynamic loads in journal bearings – special bearings – Hydrostatic Bearing design.

UNIT IV	ROLLING ELEMENT BEARINGS	9	0	0	9

Geometry and kinematics – Materials and manufacturing processes – contact stresses – Hertzian stress equation – Load divisions – Stresses and deflection – Axial loads and rotational effects- Bearing life capacity and variable loads – ISO standards – Oil films and their effects – Rolling Bearings Failures.

UNIT V	TRIBO MEASUREMENTS	9	0	0	9

Surface Topography measurements – Electron microscope and friction and wear measurements – Laser method – instrumentation - International standards – bearings performance measurements – bearing vibration measurement.

Total(45L) =45 Periods

REFERENCE BOOKS:

1. Cameron A, "Basic Lubrication Theory", Ellis Herward Ltd. UK, 1981.
2. Hulling J, "Principles of Tribology", MacMillan, 1984.
3. Williams J.A, "Engineering Tribology", Oxford University Press, 2005.
4. Neale M.J, "Tribology Handbook", 2nd Edition, Butterworth Heinemann, 1995.
5. Bharat Bhushan, "Modern Tribology Handbook Vol. I & II", CRC Press, 2001.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Develop the knowledge on the surface features and its role on the friction behavior of metals and nonmetals	Create
CO2	Analyze properties of lubrication on hydrodynamic, hydrostatic, Elasto- hydrodynamic condition	Analysis
CO3	Friction phenomena and select a suitable lubricant for a specific application.	Remembering
CO4	Develop processes of lubrication in all regimes and suggest an explanation to the cause of a tribological failure in rolling element.	Create
CO5	Determine wear processes in contacts between metallic and non-metallic surfaces	Understand

COURSE ARTICULATION MATRIX

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	1	2	2	2	1	-	-	-	-	-	-	2	2	2
CO2	1	1	1	1	1	-	-	-	-	-	-	1	1	1
CO3	1	1	1	1	1	-	-	-	1	-	1	2	2	1
CO4	1	1	1	1	1	-	-	-	1	-	1	1	2	1
CO5	1	1	1	1	1	-	-	-	1	-	-	2	2	1
Avg	**1.0**	**1.2**	**1.2**	**1.2**	**1.0**	**0.0**	**0.0**	**0.0**	**0.6**	**0.0**	**0.4**	**1.6**	**1.6**	**1.2**

3 / 2 / 1 -indicates strength of correction (3-High, 2-Medium, 1-Low)

AUDIT COURSE

22AC01	ENGLISH FOR RESEARCH PAPER WRITING				SEMESTER I/II
PREREQUISITES		CATEGORY	PE	Credit	0
		Hours/Week	L	T	P	TH
			2	0	0	2

COURSE OBJECTIVES:

1. To help the learners to realize the necessity of English in writing a Research paper
2. To enable the learners to write different sections of a research paper
3. To train the learners to become better writers of research papers

UNIT I	**6**	**0**	**0**	**6**
Research paper and its importance, Structure of a research paper, Planning and preparation.				
UNIT II	**6**	**0**	**0**	**6**
English in research papers, Basic word order, Collocation, Being concise, Redundancy, Common errors.				
UNIT III	**6**	**0**	**0**	**6**
Key factors that determine the style of a paper, Journal's background, Passive form, Right tense forms, Cohesion and coherence.				
UNIT IV	**6**	**0**	**0**	**6**
Hedging and criticizing, Paraphrasing, Plagiarism, Ensuring quality of the paper and Useful phrases.				
UNIT V	**6**	**0**	**0**	**6**
Key skills in writing Title, Abstract, Introduction, Review of Literature, Discussion and Conclusion, Highlighting findings.				
Total(30L) = 30 Periods				

REFERENCE BOOKS:

1	Adrian Wallwork, "English for Writing Research Papers," Springer New York Dorecht Heidelberg London, 2016
2	Howe, Stephen. "Phrase Book for Writing papers and Research in English," Cambridge University Press, 2012.
3	Goldbort R. "Writing for Science," Yale University press, 2006.
4	Gabor L Lovei. "Writing and Publishing Scientific Paper," Open Book Publishers, 2021

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	understand and appreciate the role of English in writing a good research paper	Understand
CO2	apply their knowledge in writing a research paper	Apply
CO3	analyze and assess the quality of their research paper	Analysis

22AC02	DISASTER MANAGEMENT	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit	0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

To have a critical understanding of key concepts in disaster risk reduction and humanitarian response and critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations and evaluate the strengths and weaknesses of disaster management approaches. Planning and programming in different countries, particularly their home country or the countries they work in.

UNIT I	INTRODUCTION	4	0	0	4

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.
Disaster Prone Areas in India: Study of Seismic Zones; Area Prone to floods and droughts, Landslides and avalanches; Areas prone to cyclonic and coastal hazards with special reference to Tsunami; Post- Disaster diseases and epidemics.

UNIT II	REPERCUSSIONS OF DISASTERS AND HAZARDS	4	0	0	4

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

UNIT III	DISASTER PREPAREDNESS AND MANAGEMENT	4	0	0	4

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

UNIT IV	RISK ASSESSMENT	4	0	0	4

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

UNIT V	DISASTER MITIGATION	4	0	0	4

Meaning, Concept And Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation In India.

Total(20L)= 20 Periods

REFERENCE BOOKS:

1	R. Nishith, Singh AK 2012 Disaster Management in India:Perspectives, issues and strategies New Royal Book Company, Lucknow
2	Sahni, PardeepEt.Al. (Eds.) 2002 Disaster Mitigation Experiences And Reflections. Prentice Hall Of India, New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.	Understand
CO2	Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.	Evaluate
CO3	develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations	Create
CO4	Critically understand the strengths and weaknesses of disaster management approaches.	Understand

22AC03	SANSKRIT FOR TECHNICAL KNOWLEDGE				SEMESTER I/II			
PREREQUISITES		**CATEGORY**	**PE**		**Credit**			**0**
		Hours/Week	**L**		**T**	**P**		**TH**
			2		**0**	**0**		**2**
COURSE OBJECTIVES								
To get a working knowledge in illustrious Sanskrit, the scientific language in the world. Learning Sanskrit to improve brain functioning. Learning Sanskrit to develop logic in mathematics, science & other subjects enhances the memory power. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.								
UNIT I	**ALPHABETS**		**8**	**0**		**0**		**8**
Alphabets in Sanskrit –Past/Present/Future Tense –Simple Sentences.								
UNIT II	**LITERATURE**		**8**	**0**		**0**		**8**
Order –Introduction of roots –Technical information about Sanskrit Literature								
UNIT III	**CONCEPTS**		**8**	**0**		**0**		**8**
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics								
Total(24L)= 24 Periods								

REFERENCE BOOKS:	
1	" Abhyasa Pustakam"- Dr.Vishwas, Samskrita- Bharati Publication,New Delhi
2	"Tech Yourself Sanskrit" PrathamaDeeksha-Vempatikutumbshastri,Rashtriya Sanskrit Sansthan,New Delhi Publication
3	India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Understanding basic Sanskrit language	Understand
CO2	Ancient Sanskrit literature about science & technology can be understood	Remembering
CO3	Being a logical language will help to develop logic in students	Apply

22AC04	VALUE EDUCATION	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

To understand the Importance of value education and self-development. To imbibe good values in students and also know about the importance of character.

UNIT I	BASIC VALUES	4	0	0	4

Values and self-development- Social values and individual attitudes-Work ethics, Indian vision of Humanism Moral and Non Moral valuation-Standards and principles-Value judgements.

UNIT II	CONFIDENCE	6	0	0	6

Importance of cultivation of values- Sense of Duty-Devotion-Self-reliance-Confidence-Concentration-Truthfulness-Cleanlines-Honesty-Humanity-Power of faith-National Unity-Patriotism-Love for nature-Discipline.

UNIT III	PERSONALITY DEVELOPMENT	6	0	0	6

Personality and Behavior Development-Soul and Scientific attitude - Positive – Thinking - Integrity and discipline -Punctuality – Love and Kindness - Avoid fault Thinking - Free from anger - Dignity of labor - Universal brotherhood and religious tolerance –True friendship –Happiness Vs suffering –love for truth – Aware of self destructive habits- Association and Cooperation –Doing best for saving nature.

UNIT IV	LOVE AND COMPASSION	6	0	0	6

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

Total (22L)= 22 Periods

REFERENCE BOOKS:

1 Chakraborty, S.K. “Values and Ethics for Organization Theory and Practice”, Oxford University Press, New Delhi, 1998.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom’s Taxonomy Mapped**
CO1	Knowledge of self-development	Understand
CO2	Learn the importance of Human values	Remembering
CO3	Developing the overall personality	Create

22AC05	CONSTITUTION OF INDIA	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit	0	
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I	HISTORY OF MAKING OF INDIAN CONSTITUTION	4	0	0	4

History, Drafting Committee (Composition & working)

UNIT II	PHILOSOPHY OF THE INDIAN CONSTITUTION	4	0	0	4

Preamble, Salient Features.

UNIT III	CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES	4	0	0	4

Fundamental rights, right to equality, right to freedom, right against exploitation, right to freedom of religion, cultural and education rights, right to constitutional remedies, directive principles of state policy, fundamental duties.

UNIT IV	ORGANS OF GOVERNANCE	4	0	0	4

Parliament, composition, qualifications and disqualifications, powers and functions, executive, president, governor, council of ministers, judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT V	LOCAL ADMINISTRATION	4	0	0	4

Districts administration head: role and importance, municipalities: introduction, mayor and role of elected representative, CEO of municipal corporation. Panchayati raj: introduction, PRI: zila panchayat. Elected officials and their roles, CEO zila panchayat: position and role. Block level: organizational hierarchy (different departments), village level: role of elected and appointed officials, importance of grass root democracy.

UNIT VI	ELECTION COMMISSION	4	0	0	4

Election Commission: role and functioning. Chief election commissioner and election commissioners. State election commission: role and functioning. Institute and bodies for the welfare of SC/ST/OBC and women.

Total (24 L)= 24 Periods

REFERENCE BOOKS:

1	The Constitution of India, 1950 (Bare Act), Government Publication.
2	Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3	M. P. Jain, Indian Constitution Law, 7th Edn., LexisNexis, 2014.
4	D.D. Basu, Introduction to the Constitution of India, LexisNexis, 2015.

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics	Understand
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	Understand
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution	Understand
CO4	Discuss the passage of the Hindu Code Bill of 1956.	Understand

22AC06	PEDAGOGY STUDIES	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit	0

	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

To Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers. Identify critical evidence gaps to guide the development.

UNIT I		4	0	0	4

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

UNIT II		2	0	0	2

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

UNIT III		4	0	0	4

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

UNIT IV		4	0	0	4

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

UNIT V		2	0	0	2

Research gaps and future directions, Research design, Contexts, pedagogy, teacher education, curriculum and assessment, dissemination and research impact

Total(16L)= 16 Periods

REFERENCE BOOKS:

1	Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2	Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3) 361-379.
3	Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID
4	Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic math and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272-282.
5	Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?	Create
CO2	What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?	Understand
CO3	How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?	Remembering

22AC07	STRESS MANAGEMENT BY YOGA				SEMESTER I/II
PREREQUISITES		**CATEGORY**	**PE**	**Credit**	**0**
		Hours/Week	**L**	**T**	**P**	**TH**
			2	**0**	**0**	**2**

COURSE OBJECTIVES

To create a healthy, strong willed and intelligent young society through yoga practices.

UNIT I	**PHYSICAL AND MENTAL HEALTH**	**4**	**0**	**0**	**4**

Pain and disease - free life, Simplified Physical Exercise- Pranayama. Concentration on Pituitary gland- Practical, Goal fixing.

UNIT II	**REJUVENATION OF LIFE FORCE AND WILL POWER**	**4**	**0**	**0**	**4**

Principle of kayakalpa yoga, mind, life force and Biomagnetism, Practical, Concentration on Muladhara- Practical, Analysis of thought –Will power

UNIT III	**DEVELOPMENT OF VIRTUES**	**4**	**0**	**0**	**4**

Activation of Dormant Brain cells- Practical, Moralization of dezire and its classification, Neutralization of Anger, Results of anger.

UNIT IV	**STREAM LINING OF MIND**	**4**	**0**	**0**	**4**

Definition of Mind-Worries, Eradication of Worries. The science behind blessings. Blessing techniques. Benefits, five basic duties

UNIT V	**CAUSE AND EFFECT SYSTEM**	**4**	**0**	**0**	**4**

Law of nature, Hereditary Imprints, Fivefold and Two-fold culture, good values and Resolution for world peace

Total (24L)= 24 Periods

REFERENCE BOOKS:

1	"Thirukkural" , Pearls of Inspiration, Translation by Rajaram, Publisher :RUPA
2	"Bharathiyar Poems", Amazon Asia – Pacific Holdings Private Limited.
3	"Yoga for Humane Excellence" , Vethathiri Maharishi, Vision for Wisdom, Vethathiri Publications

COURSE OUTCOMES: On completion of the course the student will be able to		**Bloom's Taxonomy Mapped**
CO1	Maintain good Physical health	Apply
CO2	Develop will power	Create
CO3	Take quick and right decisions	Evaluate
CO4	Maintain good relationship with everyone around them his creating a Health Society	Apply

22AC08	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	SEMESTER I/II

PREREQUISITES	CATEGORY	PE	Credit		0
	Hours/Week	L	T	P	TH
		2	0	0	2

COURSE OBJECTIVES

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

UNIT I		8	0	0	8

Neetisatakam – Holistics development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)
Verses- 26,28,63,65 (virtue)
Verses-52,53,59(dont"s)
Verses71,73,75,78(do''s)

UNIT II		8	0	0	8

Approach to day to day work and duties.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 41, 47, 48,
Chapter 3-Verses 13, 21, 27, 35,
Chapter 6-Verses 5,13,17,23,35,
Chapter 18-Verses 45, 46, 48

UNIT III		8	0	0	8

Statement of basic knowledge.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 56, 62, 68,
Chapter 12-Verses 13, 14, 15, 16, 17, 18
Personality of Role model.
Shrimad Bhagwad Geeta:
Chapter 2-Verses 17,
Chapter 3-Verses 36, 37, 42,
Chapter 4-Verses 18, 38, 42,
Chapter 18-Verses 37, 38, 63

Total(24L)= 24 Periods

REFERENCE BOOKS:

1	"Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2	Bhartrihari's Three Sataskam (Niti- Sringar – Vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

COURSE OUTCOMES: On completion of the course the student will be able to		Bloom's Taxonomy Mapped
CO1	Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve The highest goal in life	Understand
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity	Remembering
CO3	Study of Neetishatakam will help in developing the versatile personality of students.	Understand