JANSONS INSTITUTE OF TECHNOLOGY

(Autonomous)

Accredited by NAAC 'A Grade' and ISO 9001: 2015 Certified Institution

Approved by AICTE and Affiliated to Anna University

Coimbatore – 641 659, Tamil Nadu, India.

M.E. Computer Aided Design

Curriculum and Syllabi

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Regulations 2024
Choice Based Credit System
M.E. Computer Aided Design
Curriculum and Syllabi for Semesters I and II

Semester - I

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Courses								
1	P24CD2101	Advanced Mechanics of Materials	PC	3	1	0	4	4
2	P24CD2102	Computer Applications in Design	PC	3	0	0	3	3
3	P24CD2103	Concepts of Engineering Design	PC	3	0	0	3	3
4	P24CD2104	Design for Sustainability	PC	3	0	0	3	3
5	P24CD4101	Research Methodology and IPR	RMC	2	0	0	2	2
6		Professional Elective - I	PE	3	0	0	3	3
7		Audit Course – I*	AC	2	0	0	2	0
Practical Courses								
8	P24CD2105	Computer Aided Design Laboratory	PC	0	0	4	4	2
9	P24CD5101	Technical Seminar	EE	0	0	2	2	1
			Total	**19**	**1**	**6**	**26**	**21**

***Audit course is optional**

Semester – II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Courses								
1	P24CD2201	Product Lifecycle Management	PC	3	0	0	3	3
2	P24CD2202	Finite Element Methods in Mechanical Design	PC	3	1	0	4	4
3	P24CD2203	Vibration Analysis and Control	PC	3	0	0	3	3
4	P24CD2204	Solid Freeform Manufacturing	PC	3	0	0	3	3
5		Professional Elective - II	PE	3	0	0	3	3
6		Professional Elective - III	PE	3	0	0	3	3
7		Audit Course - II*	AC	2	0	0	2	0
Practical Courses								
8	P24CD2205	Vibration Laboratory	PC	0	0	4	4	2
9	P24CD2206	Simulation and Analysis Laboratory	PC	0	0	4	4	2
			Total	**20**	**1**	**8**	**29**	**23**

***Audit course is optional**

PROFESSIONAL ELECTIVES
SEMESTER I, ELECTIVE I

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Courses								
1	P24CD3101	Integrated Product Development	PE	3	0	0	3	3
2	P24CD3102	Composite Materials and Mechanics	PE	3	0	0	3	3
3	P24CD3103	Design of Hydraulic and Pneumatic Systems	PE	3	0	0	3	3
4	P24CD3104	Quality Concepts in Design	PE	3	0	0	3	3
5	P24CD3105	Applied Probability and Statistics for Design Engineers	PE	3	0	0	3	3

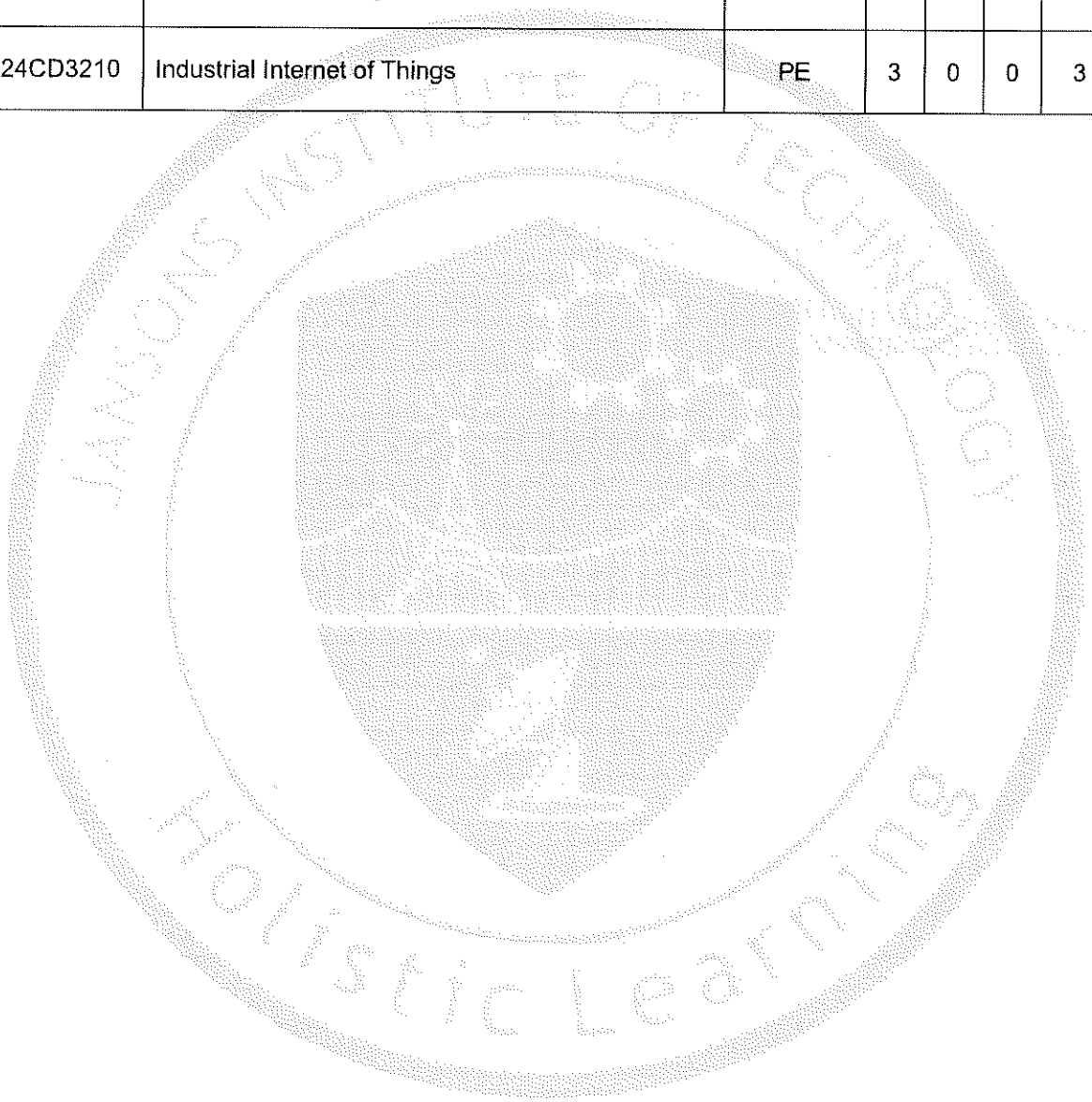
PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE II

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Courses								
1	P24CD3201	Tribology in Design	PE	3	0	0	3	3
2	P24CD3202	Advanced Finite Element Analysis	PE	3	0	0	3	3
3	P24CD3203	Advanced Mechanisms in Design	PE	3	0	0	3	3
4	P24CD3204	Artificial Intelligence and Machine Learning	PE	3	0	0	3	3
5	P24CD3205	Advanced Computer Manufacturing	PE	3	0	0	3	3

PROFESSIONAL ELECTIVES
SEMESTER II, ELECTIVE III

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		

Theory Courses								
1	P24CD3206	Optimization Techniques in Design	PE	3	0	0	3	3
2	P24CD3207	Bio Materials	PE	3	0	0	3	3
3	P24CD3208	Mechanical Measurements and Analysis	PE	3	0	0	3	3
4	P24CD3209	Wearable Technologies	PE	3	0	0	3	3
5	P24CD3210	Industrial Internet of Things	PE	3	0	0	3	3



AUDIT COURSES (AC)

Registration for any of these courses is optional to students

Sl. No.	Course Code	Course Title	Category	Periods per Week			Contact Hours	Credits
				L	T	P		
Theory Courses								
1	P24AC7001	English for Research Paper Writing	AC	2	0	0	2	0
2	P24AC7002	Disaster Management	AC	2	0	0	2	0
3	P24AC7003	Constitution of India	AC	2	0	0	2	0
4	P24AC7004	நற்தமிழ் இலக்கியம்	AC	2	0	0	2	0

P24CD2101	ADVANCED MECHANICS OF MATERIALS	L	T	P	C
		3	1	0	4
Course Objectives:	To learn the concepts of theory of elasticity in three-dimensional stress system, shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending, stresses in flat plates and curved members, torsional stress of non-circular sections, stresses in rotating members, contact stresses in point and line contact applications.				
Unit - I	**ELASTICITY**			**9+3**	
Stress-Strain relations and general equations of elasticity in Cartesian, Polar and curvilinear coordinates, differential equations of equilibrium-compatibility-boundary conditions representation of three-dimensional stress of a tension generalized hook's law - St. Venant's principle - plane stress - Airy's stress function. Energy methods.					
Unit - II	**SHEAR CENTRE AND UNSYMMETRICAL BENDING**			**9+3**	
Location of shear centre for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.					
Unit - III	**STRESSES IN FLAT PLATES AND CURVED MEMBERS**			**9+3**	
Circumference and radial stresses – deflections - curved beam with restrained ends - closed ring subjected to concentrated load and uniform load - chain links and crane hooks. Solution of rectangular plates – pure bending of plates – deflection – uniformly distributed load – various end conditions.					
Unit – IV	**TORSION of NON-CIRCULAR SECTIONS**			**9+3**	
Torsion of rectangular cross section - St.Venants theory - elastic membrane analogy -Prandtl's stress function - torsional stress in hollow thin walled tubes.					
Unit - V	**STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES**			**9+3**	
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds. Methods of computing contact stress-deflection of bodies in point and line contact applications..					
	Total Periods:			**60**	

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Solve using the theory of elasticity in a three-dimensional stress system.	K3
CO2	Identify the shear centre of various cross-sections and deflections in beams subjected to unsymmetrical bending.	K3
CO3	Solve the stresses in flat plates and curved members.	K3
CO4	Apply various torsional stress theory and functions in non-circular sections.	K3
CO5	Solve the stresses in rotating members, contact stresses in point and line contact applications.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	3
CO2	2	1	3
CO3	2	1	3
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24CD2102	COMPUTER APPLICATIONS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the fundamental concepts of computer graphics and its tools in a generic framework, parametric fundamentals to create and manipulate geometric models using curves, surfaces, and solids, create & modify geometric models using NURBS and solids, CAD systems for 3D modeling and assembly.

Unit - I	**INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS**	**9**

Overview of Graphics systems: Video Display Devices, Raster-Scan System, Random-Scan Systems, Graphics Monitors and Workstations, Input Devices, Hard-Copy Devices, Graphics Software.Output primitives: Line Drawing Algorithm - DDA, Bresenham's and Parallel Line Algorithm. Circle generating algorithm – Midpoint Circle Algorithm. Geometric Transformations: Coordinate Transformations, Windowing and Clipping, 2D Geometric transformations- Translation, Scaling, Shearing, Rotation and Reflection, Composite transformation, 3D transformations.

Unit - II	**CURVES AND SURFACES MODELLING**	**9**

Introduction to curves - Analytical curves: line, circle and conics – synthetic curves: Hermite cubic spline- Bezier curve and B-Spline curve – curve manipulations.Introduction to surfaces - Analytical surfaces: Plane surface, ruled surface, surface of revolution and tabulated cylinder – synthetic surfaces: Hermitebicubic surface- Bezier surface and B-Spline surface- surface manipulations.

Unit - III	**NURBS AND SOLID MODELING**	**9**

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

Unit – IV	**VISUAL REALISM**	**9**

Hidden Line removal, Hidden Surface removal, – Hidden Solid Removal algorithms - Shading – Coloring. Animation - Conventional, Computer animation, Engineering animation - types and techniques.

Unit - V	**ASSEMBLY OF PARTS AND PRODUCT LIFE CYCLE MANAGEMENT**	**9**

Assembly modeling – Design for manufacture – Design for assembly – computer aided DFMA - inferences of positions and orientation - tolerances analysis –Center of Gravity and mass property calculations - mechanism simulation. Graphics and computing standards - Data Exchange standards. Product development and management – new product development –models utilized in various phases of new product development – managing product life cycle.

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Solve 2D and 3D transformations for the entities like line and circle.	K3
CO2	Model the curves and surfaces using the CAD system.	K3
CO3	Select the different geometric modeling techniques for nurbs and solid modeling	K3
CO4	Model the geometric models through animation and transform them into real world systems	K3
CO5	Apply the concepts of DFMA and PLM in product development	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	2
CO2	2	1	3
CO3	2	1	2
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24CD2103	CONCEPTS OF ENGINEERING DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To impart knowledge on the basic concepts in engineering design, develop a product to a customer on quality & societal aspects, design methods, materials & manufacturing a robust and reliable product.

Unit - I	**DESIGN FUNDAMENTALS**	**9**

Importance of design- The design process-Considerations of Good Design – Morphology of design–Organization for design–Computer-Aided Engineering–Designing to codes and standards–Concurrent Engineering–Product and process cycles–Technological Forecasting – Market Identification –Competition Benchmarking

Unit - II	**CUSTOMER-ORIENTED DESIGN & SOCIETAL CONSIDERATIONS**	**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**

Creativity and problem solving–Creativity methods-Theory of Inventive Problem Solving (TRIZ)– Conceptual decomposition-Generating design concepts-Axiomatic Design–Evaluation methods- Embodiment Design-Product Architecture-Configuration Design- Parametric Design. Role of models in design-Mathematical Modeling – Simulation – Geometric Modeling –Rapid prototyping-Finite Element Analysis– Optimization–Search Methods

Unit – IV	**MATERIAL SELECTION PROCESSING AND DESIGN**	**9**

Material Selection Process–Economics–Cost Vs Performance–Weighted property Index–Value Analysis–Role of Processing in Design–Classification of Manufacturing Process–Design for Manufacture – Design for Assembly – Designing for castings, Forging, Metal Forming, Machining and Welding– Residual Stresses–Fatigue, Fracture, and Failure

Unit - V	**PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY**	**9**

Probability–Distributions–Test of Hypothesis–Design of Experiments–Reliability Theory–Design for Reliability–Reliability centered Maintenance-Robust Design-Failure mode Effect Analysis

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Utilize the design standards for the design processes and concurrent engineering.	K3
CO2	Apply the concepts of legal, human, and marketing factors in product design.	K3
CO3	Identify the suitable design methods for components.	K3
CO4	Make use of the material selection process and design procedures for product design.	K3
CO5	Choose the tools for improving quality, reliability, and performance of a product.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
CO	**3**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt.Ltd.,2013
2	Pahl.G,Beitz.W,"Engineering Design- A systematic approach", Springer–Verlag, 2005
3	Ray,M.S.,"Elements of Engineering Design", Prentice Hallinc.1985
4	Nam P. Suh, Ralph & Eloise F. Cross, "The Principles of Design", Oxford University Press,1990
5	Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, Tata Mcgraw-Hill Education, 2015

P24CD2104	DESIGN FOR SUSTAINABILITY	L	T	P	C
		3	0	0	3

Course Objectives:	To ascertain knowledge on general design principles for manufacturability, GD&T while designing the cast & welded components, machined components, assembled systems with considerations on environmental issues

Unit - I	INTRODUCTION	9

Introduction - Economics of process selection - General design principles for manufacturability; Geometric Dimensioning & Tolerance (GD&T)– Form tolerancing: straightness, flatness, circularity, cylindricity – Profile tolerancing: profile of a line, and surface – Orientation tolerancing: angularity, perpendicularity, parallelism – Location tolerancing: position, concentricity, symmetry – runout tolerancing: circular and total–Supplementary symbols.

Unit - II	CAST & WELDED COMPONENTS DESIGN	9

Design considerations for: Sand cast – Die cast – Permanent mold parts. Arc welding – Design considerations for: Cost reduction – Minimizing distortion – Weld strength – Weldment. Resistance welding–Design considerations for: Spot–Seam–Projection–Flash &Upset weldment.

Unit - III	FORMED &MACHINED COMPONENTS DESIGN	9

Design considerations for: Metal extruded parts – Impact/Cold extruded parts – Stamped parts –Forged parts. Design considerations for: Turned parts– Drilled parts – Milled, planned, shaped and slotted parts–Ground parts.

Unit – IV	DESIGN FOR ASSEMBLY	9

Design for assembly – General assembly recommendations – Minimizing the no. of parts – Design considerations for: Rivets – Screw fasteners – Gasket & Seals – Press fits – Snap fits – Automatic assembly– Computer Application for DFMA.

Unit - V	DESIGN FOR ENVIRONMENT	9

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

	Total Periods:	45

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Compare design principles for manufacturability and GD&T.	K2
CO2	Make use of design considerations in cast and welded components.	K3
CO3	Make use of design considerations in formed and machined components.	K3
CO4	Select the assembly recommendations for fasteners	K3
CO5	Choose appropriate assessment method for DFE	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	3
CO2	2	1	3
CO3	2	1	3
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Boothroyd, G, 2nd Edition 2002, Design for Assembly Automation and Product Design. New York, Marcel Dekker.
2	Bralla, Design for Manufacture handbook, McGrawhill,1999
3	3.Boothroyd, G,Heartz and Nike, Product Design for manufacture, Marcel Dekker, 1994
4	Dickson, John.R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach,Field Stone Publisher,USA,1995
5	Fixel, J. Design for the Environment McGraw Hill., 2nd Edition 2009
6	Graedel T.Allen By.B, Design for the Environment Angle Wood Cliff, Prentice Hall.ReasonPub.,1996
7	Kevin Otto and Kristin Wood, Product Design. Pearson Publication,(Fourth Impression) 2009
8	Harry Peck, Designing for manufacture, Pitman–1973

P24CD4101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2
Course Objectives:	To provide a comprehensive understanding of the essential aspects of research methodology and the critical realm of Intellectual Property Rights (IPR).				
Unit - I	**RESEARCH DESIGN**				**6**
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.					
Unit - II	**DATA COLLECTION AND SOURCES**				**6**
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.					
Unit - III	**DATA ANALYSIS AND REPORTING**				**6**
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation					
Unit – IV	**INTELLECTUAL PROPERTY RIGHTS**				**6**
Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.					
Unit - V	**PATENTS**				**6**
Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.					
	Total Periods:				**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Identify and formulate the research problem.	K3
CO2	Summarize the literature review and find research gaps to finalize research objectives.	K3
CO3	Develop solutions with data analysis.	K3
CO4	Select the need of IPR for research projects towards right of the property.	K3
CO5	Extend the research solution towards patenting.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	1	3	1
CO2	2	3	2
CO3	2	3	2
CO4	1	3	1
CO5	1	3	1
CO	1	3	1

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2	Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3	David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

P24CD2105	COMPUTER AIDED DESIGN LABORATORY	L	T	P	C
		0	0	4	2
Course Objectives:	To impart knowledge on how to prepare drawings for various mechanical components using any commercially available 3D modeling software.				

Part	Description
Part I	Exercises in modeling and drafting of mechanical components-assembly using parametric and feature-based packages like PRO-E/SOLIDWORKS /CATIA/NX • CAD Introduction • Sketcher • Solid modeling–Extrude, Revolve, Sweep and variational sweep, Loft • Surface modeling–Extrude, Sweep, Trim and Mesh of curves, Freeform. • Feature manipulation–Copy, Edit, Pattern, Suppress, History operations etc. • Assembly-Constraints, Exploded Views, Interference check • Drafting-Layouts, Standard & Sectional Views, Detailing & Plotting.
	Total Periods: 60

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Make use of the modern engineering tools for engineering drawing practice	K3
CO2	Construct 2D part drawings, sectional views, and assembly drawings as per standards.	K3
CO3	Develop a 3D Model on using CAD software.	K3
CO4	Demonstrate the ability to assemble components accurately in a virtual environment.	K3
CO5	Apply layout techniques to arrange multiple views of a component or assembly effectively.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	3
CO2	2	1	3
CO3	2	1	3
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

P24CD5101	TECHNICAL SEMINAR	L	T	P	C
		0	0	2	1
Course Objectives:	To work on a specific technical topic in Engineering design related topics to acquire the skills of oral presentation, technical writing and presenting in seminars and conferences.				

Part	Description
Part I	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.
	Total Periods: 30

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Apply research skills to gather relevant information and data on the chosen technical topic.	K3
CO2	Demonstrate the ability to apply theoretical knowledge to real-world scenarios or case studies.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	3	2
CO2	2	3	2
CO	**2**	**3**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

P24CD2201	PRODUCT LIFE CYCLE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the history, concepts, terminology, functions & features of PLM/PDM tools for industrial applications.

Unit - I	**HISTORY, CONCEPTS AND TERMINOLOGY OF PLM**	**9**
Introduction to PLM, Need for PLM, opportunities of PLM, Different views of PLM - Engineering Data Management (EDM), Product Data Management (PDM), Collaborative Product Definition Management (cPDm), Collaborative Product Commerce (CPC), Product Lifecycle Management (PLM).PLM/PDM Infrastructure – Network and Communications, Data Management, Heterogeneous data sources and applications.		
Unit - II	**PLM/PDM FUNCTIONS AND FEATURES**	**9**
User Functions – Data Vault and Document Management, Workflow and Process Management, Product Structure Management, Product Classification and Programme Management. Utility Functions – Communication and Notification, data transport, data translation, image services, system administration and application integration.		
Unit - III	**DETAILS OF MODULES IN APDM/PLM SOFTWARE**	**9**
Case studies based on top few commercial PLM/PDM tools		
Unit – IV	**ROLE OF PLM IN INDUSTRIES**	**9**
Case studies on PLM selection and implementation (like auto, aero, electronic) - other possible sectors, PLM visioning, PLM strategy, PLM feasibility study, change management for PLM, financial justification of PLM, barriers to PLM implementation, ten step approach to PLM, benefits of PLM for–business, organization, users, product or service, process performance.		
Unit - V	**BASICS ON CUSTOMISATION/INTEGRATION OF PDM/PLM SOFTWARE**	**9**
PLM Customization, use of EAI technology (Middleware), Integration with legacy database, CAD, SLM and ERP		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Summarize the history, concepts and terminology of PLM.	K2
CO2	Apply PLM/PDM functionalities to organize and manage product data	K3
CO3	Utilize specific modules to solve real-world product lifecycle management challenges.	K3
CO4	Apply PLM/PDM approaches for industrial applications.	K3
CO5	Develop PLM/PDM with legacy databases, CAx& ERP systems.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	1	2	3
CO2	2	2	3
CO3	2	1	3
CO4	2	1	2
CO5	2	1	2
CO	2	1	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24CD2202	FINITE ELEMENT METHODS IN MECHANICAL DESIGN	L	T	P	C
		3	1	0	4

Course Objectives:	To learn mathematical models for one dimensional problems & solutions, two dimensional scalar and vector variable problems, Iso-parametric transformation & numerical integration, solution techniques to solve Eigen value problems and non-linear problems

Unit - I	**FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS**	**9+3**

Historical Background – Weighted Residual Methods - Basic Concept of FEM – Variational Formulation of B.V.P. – Ritz Method – Finite Element Modelling – Element Equations – Linear and Higher order Shape functions – Bar, Beam Elements –Applications to Heat Transfer problems.

Unit - II	**FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS**	**9+3**

Basic Boundary Value Problems in two-dimensions – Linear and higher order Triangular, quadrilateral elements – Poisson's and Laplace's Equation – Weak Formulation – Element Matrices and Vectors – Application to scalar variable problems - Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach

Unit - III	**ISO-PARAMETRIC FORMULATION**	**9+3**

Natural Co-ordinate Systems – Lagrangian Interpolation Polynomials – Iso parametric Elements – Formulation – Shape functions -one dimensional , two dimensional triangular and quadrilateral elements -Serendipity elements- Jacobian transformation - Numerical Integration – Gauss quadrature – one, two and three point integration

Unit – IV	**EIGEN VALUE PROBLEMS**	**9+3**

Dynamic Analysis – Equations of Motion – Consistent and lumped mass matrices – Free Vibration analysis – Natural frequencies of Longitudinal, Transverse and torsional vibration – Solution of Eigenvalue problems - Introduction to transient field problems

Unit - V	**NON-LINEAR ANALYSIS**	**9+3**

Introduction to Non-linear problems - some solution techniques- computational procedure-material non-linearity- Plasticity and viscoplasticity, stress stiffening, contact interfaces- problems of gaps and contact - geometric non-linearity - modeling considerations - Free and Mapped meshing -Mesh quality- Error estimate

	Total Periods:	**60**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Develop mathematical models for one dimensional problems and their numerical solutions	K3
CO2	Make use of the field variables for two dimensional scalar and vector variable problems	K3
CO3	Apply Isoperimetric transformation and numerical integration for evaluation of element matrices	K3
CO4	Apply various solution techniques to solve Eigen value problems	K3
CO5	Model the solution techniques to solve non-linear problems	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	3
CO2	3	2	3
CO3	3	1	3
CO4	3	1	2
CO5	3	1	2
CO	3	1	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Seshu.P, "Text Book of Finite Element Analysis", PHI Learning Pvt. Ltd., New Delhi, 2012.
2	Tirupathi R. Chandrupatla and Ashok D.Belegundu, "Introduction to Finite Elements in Engineering", International Edition, Pearson Education Limited, 2014.
3	Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall, 1990
4	David Hutton, "Fundamentals of Finite Element Analysis", Tata McGrawHill, 2005
5	Rao, S.S., "The Finite Element Method in Engineering", 6th Edition, Butterworth- Heinemann,2018.
6	Reddy,J.N. "Introduction to the Finite Element Method", 4 edition, Tata McGrawHill,2018

P24CD2203	VIBRATION ANALYSIS AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:	To acquire knowledge on the basic concepts of vibration in damped and undamped systems, natural frequencies in two degree freedom systems, multi degree freedom and continuous systems, control techniques of vibration and noise levels and measuring instruments.

Unit - I	**FUNDAMENTALS OF VIBRATION**	**9**
Introduction -Sources of Vibration-Mathematical Models- Displacement, velocity and Acceleration- Review Of Single Degree Freedom Systems -Vibration isolation Vibrometers and accelerometers - Response To Arbitrary and non-harmonic Excitations – Transient Vibration –Impulse loads- Critical Speed Of Shaft-Rotor systems		
Unit - II	**TWO DEGREE FREEDOM SYSTEM**	**9**
Introduction-Free Vibration Of Undamped And Damped - Forced Vibration With Harmonic Excitation System – Coordinate Couplings And Principal Coordinates.		
Unit - III	**MULTI-DEGREE FREEDOM SYSTEM AND CONTINUOUS SYSTEM**	**9**
Multi Degree Freedom System –Influence Coefficients and stiffness coefficients- Flexibility Matrix and Stiffness Matrix – Eigen Values and Eigen Vectors-Matrix Iteration Method –Approximate Methods: Dunkerley, Rayleigh's, and Holzer Method -Geared Systems-Eigen Values & Eigen vectors for large system of equations using sub space, Lanczos method - Continuous System: Vibration of String, Shafts and Beams		
Unit – IV	**VIBRATION AND NOISE CONTROL**	**9**
Specification of Vibration Limits – Vibration severity standards- Vibration as condition Monitoring Tool-Vibration Isolation methods - Dynamic Vibration Absorber - Static and Dynamic Balancing machines – Field balancing - Major sources of noise – Noise survey techniques – Measurement technique for vehicular noise – Road vehicle noise standards – Industrial noise sources – Control Strategies – Noise control at the source and along the path – use of acoustic barriers – Noise control at the receiver.		
Unit - V	**EXPERIMENTAL METHODS IN VIBRATION ANALYSIS**	**9**
Vibration Analysis Overview - Experimental Methods in Vibration Analysis.-Vibration Measuring Instruments - Selection of Sensors- Accelerometer Mountings. -Vibration Exciters-Mechanical, Hydraulic, Electromagnetic And Electrodynamics –Frequency Measuring Instruments-. System Identification from Frequency Response -Testing for resonance and mode shapes		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply the basic concepts of vibration in damped and undamped systems	K3
CO2	Illustrate the natural frequencies and mode shapes of the two degree freedom systems.	K2
CO3	Solve the natural frequencies and mode shapes of the multi degree freedom and continuous systems	K3
CO4	Select the suitable techniques to control vibration and noise levell	K3
CO5	Analyze and measure the vibration levels in a body	K4

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	3	2	2
CO3	3	1	3
CO4	3	1	3
CO5	3	1	3
CO	**3**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Singiresu S. Rao,"Mechanical Vibrations,"Pearson Education Incorporated, 2017
2	WilliamT.Thomson,"TheoryofVibrationwithApplications",Taylor&Francis,2018
3	Graham Kelly, Sand Shashidhar K. Kudari, "Mechanical Vibrations", Tata McGraw – Hill Publishing Com. Ltd., 2007
4	Ramamurti.V, "Mechanical Vibration Practice with Basic Theory", Narosa Publishing House, 2010

P24CD2204	SOLID FREEFORM MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:	To acquaint the students with evolution of Solid Freeform Manufacturing (SFM) / Additive Manufacturing (AM), Design for Additive Manufacturing (DFAM) techniques, polymerization, sheet lamination processes, material extrusion, powder bed fusion processes, jetting, direct energy deposition processes and their applications.

Unit - I	**INTRODUCTION**	**9**

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

Unit - II	**DESIGN FOR ADDITIVE MANUFACTURING**	**9**

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

Unit - III	**VAT POLYMERIZATION AND SHEET LAMINATION PROCESSES**	**9**

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

Unit – IV	**MATERIAL EXTRUSION AND POWDER BED FUSION PROCESSES**	**9**

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

Unit - V	**JETTING AND DIRECT ENERGY DEPOSITION PROCESSES**	**9**

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

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Relate the importance in the evolution of SFM/AM, proliferation into the various fields and its effects on the supply chain.	K2
CO2	Apply DfAM guidelines and best practices to create optimized designs for additive manufacturing processes.	K3

COs	Statements	K-Level
CO3	Identify the key components of the equipment used in vat polymerization and sheet lamination processes.	K3
CO4	Explain the principles of material extrusion and powder bed fusion processes and design guidelines.	K2
CO5	Select jetting and direct energy deposition processes for respective applications.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	1	2
CO2	2	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
CO	**3**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24CD2205	VIBRATION LABORATORY	L	T	P	C
		0	0	4	2
Course Objectives:	To acquire knowledge through experimentation on the stiffness, natural frequency, radius of gyration of a body under damped, undamped, torsional vibrations, critical speed of shafts, natural frequency and damping coefficient of models under free and forced vibrations.				

Exp. No	Title
1	Determination of stiffness and natural frequency of undamped spring-mass systems arranged in series, parallel and series-parallel fashions
2	Determination of effective radius of gyration of an irregular body through torsional oscillation of tri filar suspension
3	Determination of natural frequency a single rotor un damped shaft system
4	Determination of natural frequency a single rotor damped shaft system
5	Determination of critical speed of shaft
6	Determination of natural frequency and mode shapes of specimens supported at its ends through modal analysis
7	Determination of damping coefficient of specimens supported at its ends
8	Forced vibration of specimens supported under simply supported and cantilever boundary conditions – Determination of natural frequency
	Total Periods: **60**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Experiment with stiffness and natural frequency of spring-mass systems.	K3
CO2	Identify the natural frequencies of damped and undamped torsional vibrations of single rotor systems	K3
CO3	Identify the factors that influence the critical speed of a shaftt supported at its ends.	K3
CO4	Utilize vibration analysis to measure the dynamic characteristics of vibrating systems.	K3
CO5	Identify the natural frequency of specimens under forced vibrations.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

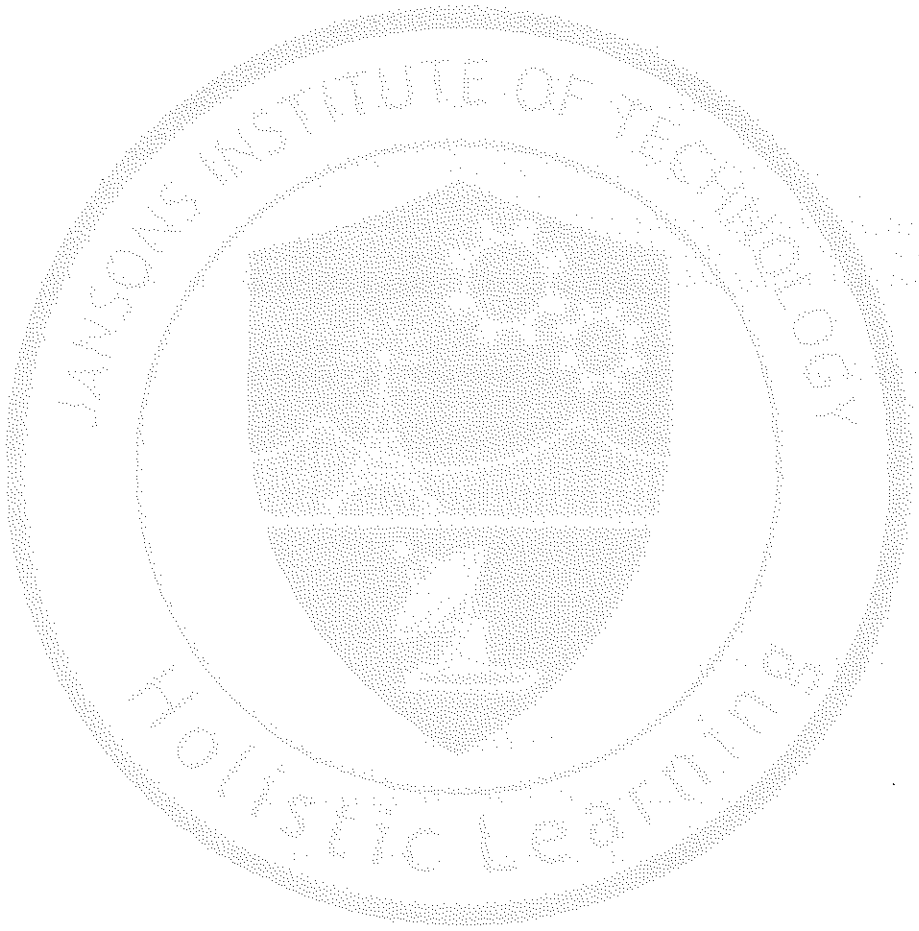
CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	1	2
CO2	3	1	2

	Programme Outcomes		
	01	**02**	**03**
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
CO	**3**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)



P24CD2206	SIMULATION AND ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

Course Objectives:	To give exposure to software tools needed to analyze engineering problems.

Exp. No	Title
1	Force and Stress analysis using link elements in Trusses.
2	Stress and deflection analysis in beams with different support conditions.
3	Stress analysis of flat plates.
4	Stress analysis of axi–symmetric components.
5	Thermal stress and heat transfer analysis of plates.
6	Thermal stress analysis of cylindrical shells.
7	Vibration analysis of spring-mass systems.
8	Modal analysis of Beams.
9	Harmonic, transient and spectrum analysis of simple systems.
10	Analysis of machine elements under dynamic loads
11	Analysis of non-linear systems
	Total Periods: **60**

Course Outcomes

On completion of the course, the student can

COs	Statements	K - Level
CO1	Solve engineering problems numerically using Computer Aided Finite Element Analysis packages	K3
CO2	Apply the force, stress, deflection in mechanical components.	K3
CO3	Analyze thermal stress and heat transfer in mechanical components	K4
CO4	Identify the vibration of mechanical components.	K3
CO5	Develop the modal, harmonic, transient and spectrum concepts in mechanical components	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

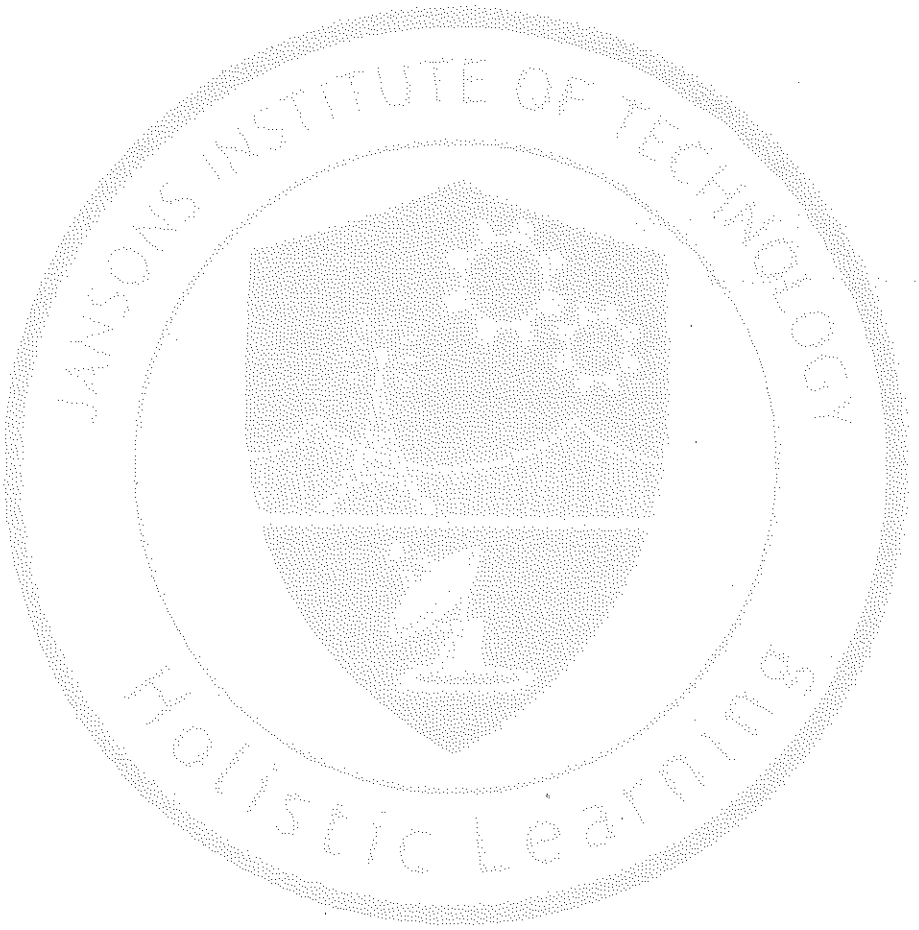
CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	2	2
CO2	3	2	2

	Programme Outcomes		
	01	02	03
CO3	3	2	2
CO4	3	2	2
CO5	3	2	2
CO	**3**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)



P24CD3101	INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the principles of generic development process, product planning, customer need analysis, setting product specifications test concepts for new product design and development. principles of product architecture, industrial design principles, DFM, different Prototyping techniques, develop a robust design, economic principles and project management practices in development of new product..

Unit - I	**INTRODUCTION TO PRODUCT DESIGN**	**9**

Characteristics of Successful Product development –Duration and Cost of Product Development – Challenges of Product Development - Product Development Processes and Organizations – Product Planning Process - Process of Identifying Customer Needs

Unit - II	**PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING**	**9**

Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.

Unit - III	**PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN**	**9**

Product Architecture – Implications and establishing the architecture – Delayed Differentiation – Platform Planning – Related system level design issues - Need and impact of industrial design - Industrial design process - management of the industrial design process - assessing the quality of industrial design

Unit – IV	**DESIGN FOR MANUFACTURE, PROTOTYPING AND ROBUST DESIGN**	**9**

DFM Definition - Estimation of Manufacturing cost- Reducing the component costs, costs of supporting function and assembly costs – Impact of DFM decision on other factors - Prototype basics - Principles of prototyping – Prototyping technologies - Planning for prototypes - Robust design –Robust Design Process

Unit - V	**PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS**	**9**

Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks Baseline Project Planning - Accelerating the project - Project execution – Post mortem project evaluation.

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Select appropriate design thinking techniques to generate creative ideas and concepts for new products.	K3
CO2	Apply various techniques to generate innovative product concepts.	K3
CO3	Make use of product architecture principles to create a modular product design.	K3
CO4	Choose DFM principles to optimize a product design for manufacturability.	K3
CO5	Apply economic evaluation techniques to assess the financial viability of a product development project.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	2
CO2	2	1	3
CO3	2	1	3
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Karl T.Ulrich, Steven D.Eppinger, Anita Goyal, "Product Design and Development", McGraw –Hill Education (India) Pvt. Ltd, 4th Edition, 2012.
2	Kenneth Crow, "Concurrent Engineering/Integrated Product Development". DRM Associates, 6/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book
3	Kevin N Otto, Kristin L Wood, "Product Design – Techniques in Reverse Engineering and New Product Development", Pearson Education, Inc, 2016
4	Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin Homewood, 1992
5	Stuart Pugh, "Total Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyourk, NY, 1991.

P24CD3102	COMPOSITE MATERIALS AND MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives:	To study about different composite materials, mechanical strength, fabrication of FRP and other composites, stress analysis of fiber reinforced laminates, calculation of stresses & residual stresses in the lamina under thermo-mechanical load using the Classical Laminate Theory.

Unit - I	**INTRODUCTION TO COMPOSITE MATERIALS**	**9**

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

Unit - II	**MANUFACTURING OF COMPOSITES**	**9**

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

Unit - III	**LAMINA CONSTITUTIVE EQUATIONS**	**9**

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

Unit – IV	**LAMINA STRENGTH ANALYSIS AND ANALYSIS OF LAMINATED FLAT PLATES**	**9**

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

Unit - V	**THERMO-STRUCURAL ANALYSIS**	**9**

Fabrication stresses / Residual stresses in FRP laminated composites-Co-efficient of Thermal Expansion (C.T.E.) - Modification of Hooke's Law. Modification of Laminate Constitutive Equations. Orthotropic Lamina C.T.E's -Stress and Moment Resultants due cooling of the laminates during fabrication-Calculations for thermo-mechanical stresses in FRP laminates Case studies: Implementation of CLT for evaluating residual stresses in the components made with different isotropic layers such as electronic packages etc.

	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Identify suitable composite materials for applications in the engineering industry.	K3
CO2	Apply appropriate manufacturing techniques to create composite components.	K3

COs	Statements	K-Level
CO3	Solve stiffness matrix for a lamina using mathematical techniques	K3
CO4	Identify key concepts related to lamina strength analysis and laminated flat plates.	K3
CO5	Utilize material properties and boundary conditions to simulate realistic thermo-structural scenarios in composite structures.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	1	1	2
CO2	2	-	3
CO3	2	1	3
CO4	2	1	3
CO5	3	2	3
CO	**2**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Agarwal BD and Broutman LJ, "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York,1990.
2	Gibson RF, Principles of Composite Material Mechanics, CRC press,4th Edition,2015.
3	Hyer MW and Scott R White, "Stress Analysis of Fiber – Reinforced Composite Materials",McGraw-Hill,1998
4	Issac M Daniel and Orilshai, "Engineering Mechanics of Composite Materials", Oxford University Press - 2006, First Indian Edition-2007
5	Madhujit Mukhopadhyay,"Mechanics of Composite Materials and Structures", University Press(India)Pvt.Ltd.,Hyderabad,2004(Reprinted 2008)
6	Mallick PK, Fiber – Reinforced Composites: Materials, Manufacturing and Design, CRC Press, 3rd Edition,2007.

P24CD3103	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:	To acquire knowledge on different components of hydraulic systems, design, selection procedures, use of various control & regulating elements to enable them to design simple pneumatic systems under low cost to provide solution to simple industrial applications.

Unit - I	**OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS**	**9**
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics, Hydrostatic drives, types, selection.		
Unit - II	**CONTROL AND REGULATION ELEMENTS**	**9**
Pressure-direction and flow control valves-relief valves, non-return and safety valves-actuation systems, Proportional Electro hydraulic servo valves.		
Unit - III	**HYDRAULIC CIRCUITS**	**9**
Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits – industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits design methodology-design and selection of components-safety and Emergency mandrels–Cascade method.		
Unit – IV	**PNEUMATIC SYSTEMS AND CIRCUITS**	**9**
Pneumatic fundamentals-control elements, position and pressure sensing, Pneumatic equipments- selection of components - design calculations - logic circuits - switching circuits – fringe conditions modules and these integration-sequential circuits-cascade methods-mapping methods - step counter method - compound circuit design - combination circuit design Karnaugh-Veitch map		
Unit - V	**ELECTROMAGNETIC & ELECTRONIC CONTROL OF HYDRAULICS & PNEUMATIC CIRCUIT**	**9**
Electrical control of pneumatic circuits–use of relays, counters, timers, ladder diagrams, use of microprocessor in circuit design – use of PLC in hydraulic and pneumatic circuits – Fault finding–application-fault finding -hydro pneumatic circuits –use of microprocessors for Sequencing- PLC, Low cost automation- Robotic circuits		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply design principles to select suitable pumps for specific hydraulic and pneumatic applications.	K3
CO2	Explain the significance and role of pressure-direction and flow control valves in hydraulic and pneumatic systems.	K2
CO3	Interpret the operational characteristics and advantages of different types of hydraulic circuits	K2
CO4	Apply design principles to select appropriate components for pneumatic systems.	K3
CO5	Explain the significance and benefits of electromagnetic and electronic control in enhancing the performance and efficiency of hydraulic and pneumatic systems.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	-	3
CO2	2	1	2
CO3	2	1	2
CO4	2	-	3
CO5	2	1	2
CO	**2**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Anthony Esposito, "Fluid Power with Applications", Prentice Hall,2009.
2	Jagadeesha T, "Pneumatics Concepts, Design and Applications", Universities Press,2015
3	James A.Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997
4	Majumdar,S.R., "Oil Hydraulics Systems–Principles and Maintenance", Tata McGrawHill, 2001
5	Shanmuga Sundaram.K, "Hydraulic and Pneumatic Controls",Chand&Co,2006
6	Anthony Esposito, "Fluid Power with Applications", Prentice Hall,2009.

P24CD3104	QUALITY CONCEPTS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To impart knowledge on various concepts in engineering design, material selection and manufacturing methods, implementing quality in a product or services, use of failure mode effect analysis, six sigma, development of robust product, design of experiments, use of statistical tools and enforce methods to improve the quality and reliability of a product.

Unit - I	**DESIGN FUNDAMENTALS, METHODS AND MATERIAL SELECTION**	**9**

Morphology of Design – The Design Process – Computer Aided Engineering – Concurrent Engineering – Competition Benchmarking – 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**	**9**

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**	**9**

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	**DESIGN OF EXPERIMENTS**	**9**

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	**STATISTICAL CONSIDERATION AND RELIABILITY**	**9**

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 Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Identify design principles and methodologies to develop innovative product concepts.	K3
CO2	Utilize statistical methods to analyze and improve product quality.	K3
CO3	Identify statistical tools and techniques to optimize design parameters for Six Sigma performance.	K3

COs	Statements	K-Level
CO4	Select experiments to optimize process parameters and achieve desired quality outcomes.	K3
CO5	Interpret reliability data and metrics to evaluate the performance of systems and components.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	-	3
CO2	2	-	3
CO3	2	1	3
CO4	2	1	3
CO5	2	-	2
CO	2	1	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Amitava Mitra, "Fundamentals of Quality control and improvement", John Wiley & Sons, 2016
2	George E. Dieter, Linda C. Schmidt, "Engineering Design", McGraw Hill Education Pvt. Ltd., 2013
3	Karl T. Ulrich, Steven D. Eppinger, "Product Design And Development, ,Tata Mcgraw-Hill Education, 2015
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.

P24CD3105	APPLIED PROBABILITY AND STATISTICS FOR DESIGN ENGINEERS	L	T	P	C
		3	0	0	3

Course Objectives:	To compute moments of standard distributions, correlation and regression, estimator of the parameter in statistical inference, accept or reject specific value of a parameters, real-world problems fall naturally within the frame work of multivariate normal theory

Unit - I	**ONE DIMENSIONAL RANDOM VARIABLES**	**9**
Random variables - Probability functions – Moments – Moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a random variable.		
Unit - II	**TWO DIMENSIONAL RANDOM VARIABLES**	**9**
Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Correlation – Linear Regression		
Unit - III	**ESTIMATION THEORY**	**9**
Unbiased estimators – Method of moments – Maximum likelihood estimation - Principle of least squares – Regression lines.		
Unit – IV	**TESTING OF HYPOTHESIS**	**9**
Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions – Tests for independence of attributes and goodness of fit.		
Unit - V	**MULTIVARIATE ANALYSIS**	**9**
Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components - Population principal components – Principal components from standardized variables		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply knowledge of probability distributions to solve problems involving the probability of events associated with one-dimensional random variables.	K3
CO2	Solve the problems involving two dimensional random variables.	K3
CO3	Choose and apply Unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.	K3
CO4	Make use of statistical tests in testing hypotheses on data.	K3
CO5	Demonstrate the problems involving the interpretation and communication of results from multivariate analysis.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	-	2
CO2	2	-	2
CO3	2	-	2
CO4	2	-	2
CO5	2	-	2
CO	**2**	**-**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Devore, J. L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
2	Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury press, 1998.
3	Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", 12th Edition, Sultan and Sons, New Delhi, 2020.
4	Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers ", 9 th Edition, Pearson Education, Asia, 2016.
5	Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 6 th Edition, Pearson Education, Asia, 2012.
6	Devore, J. L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.

P24CD3201	TRIBOLOGY IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To study and measure the different types of surface features, types of wear mechanism, surface modification techniques, types of lubricants and lubrication system, deciding lubricants and lubrication regimes, different types of high-pressure contacts and rolling bearings.

Unit - I	**SURFACE INTERACTION AND FRICTION**	**9**

Surface Topography – Surface features-Properties and measurement – Surface interaction – Laws of friction-Adhesive Theory of Sliding Friction – Static friction -Rolling Friction – Friction in extreme conditions –Thermal considerations in sliding contact.

Unit - II	**WEAR AND SURFACE TREATMENT**	**9**

Types of wear mechanism – Laws of wear –Theoretical wear models- Abrasive wear – Adhesive wear – Fatigue wear – fretting wear – Cavitation wear - Wear of Metals and Nonmetals – Surface treatments – Surface modifications – Laser processing – instrumentation – International standards in friction and wear measurements

Unit - III	**LUBRICANTS AND LUBRICATION REGIMES**	**9**

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

Unit – IV	**THEORY OF HYDRODYNAMIC AND HYDROSTATIC LUBRICATION**	**9**

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

Unit - V	**HIGH PRESSURE CONTACTS AND ELASTO HYDRODYNAMIC LUBRICATION**	**9**

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

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Develop the knowledge on the surface features and its role on the friction behavior of metals and non-metals	K3
CO2	Identify the various types of wear mechanism and surface modification techniques	K3
CO3	Select appropriate lubricants for specific engineering applications	K3
CO4	Compare hydrodynamic and hydrostatic lubrication and their respective applications in engineering systems	K4

COs	Statements	K-Level
CO5	Analyze the behavior of EHL films and pressure distributions in lubricated contacts	K4

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	2
CO2	2	1	2
CO3	3	1	2
CO4	3	1	3
CO5	3	1	3
CO	3	1	2

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24CD3202	ADVANCED FINITE ELEMENT ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:	To study the concept of Finite Element Analysis to solve problems involving plate and shell elements, problems involving geometric & material non linearity, dynamic problems, fluid mechanics & heat transfer problems, error norms, convergence rates and refinement.

Unit - I	**BENDING OF PLATES AND SHELLS**	**9**
Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements – C0 and C1 Continuity Elements –Degenerated shell elements-Application and Examples.		
Unit - II	**NON-LINEAR PROBLEMS**	**9**
Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity – Visco Plasticity – Geometric Non linearity – large displacement Formulation – Solution procedure-Application in Metal Forming Process and Contact Problems		
Unit - III	**DYNAMIC PROBLEM**	**9**
Direct Formulation – Free, Transient and Forced Response – Solution Procedures – Eigen solution-Sub space Iterative Technique – Response analysis - Houbolt, Wilson, Newmark–Methods – Explicit & Implict Methods-Lanchzos, Reduced method for large size system equations.		
Unit – IV	**FLUID MECHANICS AND HEAT TRANSFER**	**9**
Governing Equations of Fluid Mechanics – Solid structure interaction - Inviscid and Incompressible Flow – Potential Formulations – Slow Non-Newtonian Flow – Metal and Polymer Forming–Navier Stokes Equation–Steady and Transient Solution.		
Unit - V	**ERROR ESTIMATES AND ADAPTIVE REFINEMENT**	**9**
Error norms and Convergence rates–h-refinement with adaptivity–Adaptive refinement.		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply concept of Finite Element Analysis to solve problems involving plate and shell elements	K3
CO2	Select the suitable Finite Element Analysis methods to solve problems involving geometric and material nonlinearity	K3
CO3	Solve dynamic problems using the solution techniques	K3
CO4	Select the Finite Element Analysis technique to solve fluid mechanics and heat transfer problems	K3
CO5	Apply error estimation techniques to assess the accuracy and reliability of finite element models and numerical solutions.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	1	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
CO	**3**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Bathe K.J., "Finite Element Procedures in Engineering Analysis", Prentice Hall,1990
2	Logan. D. L.,"A first course in Finite Element Method", Cengage Learning, 2012
3	Reddy, J.N. "An Introduction to Non linear Finite Element Analysis", 2 nd Edition, Oxford, 2015
4	Robert D.Cook, David S.Malkus, Michael E.Plesha, Robert J.Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2004.
5	Tirupathi R. Chandrupatla and Ashok D.Belegundu,"Introduction to Finite Elements in Engineering",InternationalEdition,PearsonEducationLimited,2014.
6	Zienkiewicz, O. C., Taylor, R. L. and Zhu. J .Z. ,"The Finite Element Method: Its Basis and Fundamentals",7th Edition, Butterworth-Heinemann,2013.

P24CD3203	ADVANCED MECHANISMS IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To learn the concepts of gross motion capability, develop multi loop kinematic chains, determine velocity and acceleration of output links, locate inflection points, draw the inflection circle, study the synthesis of planar mechanisms, design of six bar coupler driven mechanisms and cam mechanisms.

Unit - I	**INTRODUCTION**	**9**

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

Unit - II	**KINEMATIC ANALYSIS**	**9**

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

Unit - III	**PATH CURVATURE THEORY, COUPLER CURVE**	**9**

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

Unit – IV	**SYNTHESIS OF FOUR BAR MECHANISMS**	**9**

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

Unit - V	**SYNTHESIS OF COUPLER CURVE BASED MECHANISMS & CAM MECHANISMS**	**9**

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

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Develop multi loop kinematic chains and equivalent mechanisms using gross motion capability	K3
CO2	Solve the velocity and acceleration of complex mechanisms	K3
CO3	Identify the inflection points and draw the inflection circle	K3
CO4	Model synthesis planar mechanisms	K3
CO5	Develop the six bar coupler driven mechanisms and cam mechanisms	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	1	2
CO2	3	1	3
CO3	3	1	2
CO4	3	1	3
CO5	3	1	3
CO	**3**	**1**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi,1999.
2	Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 2016
3	Robert L.Norton., "Design of Machinery",Tata McGraw Hill, 2012
4	Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
5	Uicker, J.J., Pennock, G. R. and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.

P24CD3204	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course Objectives:	To gain knowledge on artificial intelligence, machine learning, supervised learning & applications, concepts & algorithms of unsupervised learning, theoretical and practical aspects of Probabilistic Graphical Models.

Unit - I	**ARTIFICIAL INTELLIGENCE**	**9**
Artificial intelligence – Basics – Goals of artificial intelligence– AI techniques–problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots.		
Unit - II	**INTRODUCTION TO MACHINE LEARNING**	**9**
Machine Learning–Types of Machine Learning –Machine Learning process- preliminaries, testing Machine Learning algorithms, turning data into Probabilities, and Statistics for Machine Learning Probability theory – Probability Distributions – Decision Theory		
Unit - III	**SUPERVISED LEARNING**	**9**
Linear Models for Regression – Linear Models for Classification- Discriminant Functions, Probabilistic Generative Models, Probabilistic Discriminative Models – Decision Tree Learning – Bayesian Learning, Naïve Bayes – Ensemble Methods, Bagging, Boosting, Neural Networks, Multi-layer Perceptron, Feed- forward Network, Error Back propagation - Support Vector Machines		
Unit – IV	**UNSUPERVISED LEARNING**	**9**
Clustering- K-means – EM Algorithm- Mixtures of Gaussians –Dimensionality Reduction, Linear Discriminant Analysis, Factor Analysis, Principal Components Analysis, Independent Components Analysis		
Unit - V	**PROBABILISTIC GRAPHICAL MODELS**	**9**
Graphical Models – Undirected Graphical Models – Markov Random Fields – Directed Graphical Models –Bayesian Networks – Conditional Independence properties – Markov Random Fields Hidden Markov Models – Conditional Random Fields (CRFs)		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Summarize the of AI technologies and their impact on various aspects of human life and society	K2
CO2	Outline the fundamental terminology used in machine learning	K2
CO3	Apply knowledge of supervised learning concepts and techniques to preprocess and prepare labeled datasets for model training and evaluation.	K3
CO4	Select unsupervised learning models to discover meaningful patterns and reduce the dimensionality of data	K3
CO5	Apply probabilistic graphical modeling concepts to represent uncertain relationships in real-world domains.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	1
CO2	2	1	1
CO3	2	1	1
CO4	2	1	1
CO5	2	1	1
CO	**2**	**1**	**1**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Christopher Bishop,"Pattern Recognition and Machine Learning" Springer, 2007.
2	Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Chapman and Hall, CRC Press, Second Edition,2014
3	Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
4	Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Third Edition, 2014.
5	Tom Mitchell, "MachineLearning", McGraw-Hill,1997.

P24CD3205	ADVANCED COMPUTER MANUFACTURING	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the impact of computer-integrated manufacturing (CIM) on productivity, product cost, quality, computer technologies for factory management & floor operations, industrial applications, evolution of cloud based design and manufacturing.

Unit - I	**INTRODUCTION**	**9**
Introduction to Product life cycle management. Need of CAD/CAM integration through computers, Benefits of integration, Types of production systems and their automation, CAD/CAM integration. Concept of FMS and CIMS. DNC based factory management and control, Integrated CAD/CAM system and shared database.		
Unit - II	**ELEMENTS OF A GENERAL CIM SYSTEM**	**9**
Types of CIM systems, CAD-CAM link for CIMS, Benefits of CAM, FMS and CIMS, Automated material handling systems, equipment and their functions. Integration of Robots in CIMS, automated guided vehicle navigation system, Automatic Storage and Retrieval Systems (AS/RS), Carousel storage system, design of automatic material handling system, KWO analysis, work-part transfer mechanisms		
Unit - III	**APPLICATION OF COMPUTER INTEGRATED MANUFACTURING (CIM) SYSTEMS**	**9**
Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells. Group technology applications for computer integrated manufacturing, Computer-aided Tooling Design for Manufacturing Processes-Industrial Applications		
Unit – IV	**INTELLIGENT SYSTEMS IN MANUFACTURING**	**9**
Current Developments and Future Prospects-Artificial intelligence techniques and the components of an intelligent manufacturing system. Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing. key artificial intelligence technologies (fuzzy logic, artificial neural networks, expert systems and genetic algorithms)		
Unit - V	**CLOUD-BASED DESIGN AND MANUFACTURING**	**9**
Evolution of design and manufacturing systems, Characteristics and requirements for cloudbased design and manufacturing systems, Cloud-based design and manufacturing example scenario, Cloud-Based Desktop Factory.		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply the basics of CAD/CAM integration, PLM management and planning in manufacturing	K3
CO2	Apply the knowledge of Expert systems, Group technology and part representation for various applications	K3
CO3	Develop CIM for the various industrial applications	K3
CO4	Choose appropriate of AI techniques in manufacturing	K3
CO5	Summarize the challenges and considerations associated with cloud-based design and manufacturing	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	2
CO2	2	1	2
CO3	2	1	2
CO4	2	1	1
CO5	2	1	1
CO	**2**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	MikellGroover, (2016), Automation, Production Systems and Computer-Integrated Manufacturing, 4th. Ed., ISBN # 0-13-349961-8, Pearson, New Jersey
2	Intelligent Manufacturing Systems/ Andrew Kusiak/Prentice Hall.
3	Artificial Neural Networks/ Yagna Narayana/PHI/2006 3. Automation, Production Systems and CIM / Groover M.P./PHI/2007
4	Groover, M. P., Automation, Production systems and Computer Integrated Manufacturing, Pearson Education Asia (2009).
5	Rao, P. N., Tewari, N. K. and Kundra, T. K., Computer Integrated Manufacturing, McGraw Hill (1998)

P24CD3206	OPTIMIZATION TECHNIQUES IN DESIGN	L	T	P	C
		3	0	0	3

Course Objectives:	To understand the concepts of unconstrained optimization techniques, constrained optimization techniques, mathematical foundation of artificial neural networks, swarm intelligence for design problems, optimization approaches, appropriate solutions, optimization algorithms commonly used in static and dynamic applications.

Unit - I	**UNCONSTRAINED OPTIMIZATION TECHNIQUES**	**9**

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

Unit - II	**CONSTRAINED OPTIMIZATION TECHNIQUES**	**9**

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

Unit - III	**ARTIFICIAL NEURAL NETWORKS AND SWARM INTELLIGENCE**	**9**

Introduction–Activation functions, types of activation functions, neural network architectures, Single layer feed forward network, multi layer feed forward network, Neural network applications. Swarm intelligence-Various animal behaviors, Ant Colony optimization, Particle Swarm optimization.

Unit – IV	**ADVANCED OPTIMIZATION TECHNIQUES**	**9**

Multistage optimization–dynamic programming, stochastic programming Multi objective optimization Genetic algorithms and Simulated Annealing technique.

Unit - V	**STATIC AND DYNAMIC APPLICATIONS**	**9**

Structural applications – Design of simple truss members – Design of simple axial, transverse loaded members for minimum cost, weight – Design of shafts and torsionally loaded members –Design of springs. Dynamic Applications – Optimum design of single, two degree of freedom systems, vibration absorbers. Application in Mechanisms– Optimum design of simple linkage mechanisms.

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Develop unconstrained optimization techniques in engineering design application.	K3
CO2	Develop constrained optimization techniques for various applications	K3
CO3	Apply the neural network technique to real world design problems.	K3
CO4	Model genetic algorithms for combinatorial optimization problems.	K3
CO5	Solve design problems by using various optimization approaches.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	3	3	2
CO2	3	2	2
CO3	3	2	3
CO4	3	2	3
CO5	3	3	3
CO	**3**	**2**	**3**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Goldberg, David.E, "Genetic Algorithms in Search,Optimization and Machine Learning", Pearson, 2009.
2	Jang,J.S.R, Sun,C.T and Mizutani E.,"Neuro-Fuzzy and Soft Computing", Pearson Education. 2015
3	JohnsonRay,C., "Optimum design of mechanical elements", Wiley, 2 nd Edition 1980.
4	KalyanmoyDeb, "Optimization for Engineering Design: Algorithms and Examples", PHI Learning Private Limited, 2 nd Edition, 2012.
5	RaoSingiresu S., "Engineering Optimization – Theory and Practice", New Age International Limited, NewDelhi, 3 rd Edition, 2013.
6	Rajasekaran S and Vijayalakshmi Pai, G.A, "Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2011

P24CD3207	BIO MATERIALS	L	T	P	C
		3	0	0	3

Course Objectives:	To acquire the knowledge of selecting bio and smart materials, different electro-rheological, piezoelectric materials, different shape memory materials Application in biomedical engineering, special materials for actuators, sensors etc. Materials for oral and maxillofacial surgery, materials for cardiovascular ophthalmology and skin regeneration.

Unit - I	**INTRODUCTION**	**9**

Human anatomy- tissues- organs- repair- regeneration- Wolff's Law – biomaterial – compatibility – classification- Biomimetics – Material response: swelling and leaching, corrosion and dissolution, deformation and failure, friction and wear – host response: the inflammatory process – coagulation and hemolysis- in vitro and in vivo evaluation of biomaterials – Testing and validation- government regulatory bodies.

Unit - II	**DENTAL MATERIALS**	**9**

Teeth composition, formation and properties – temporary fixation devices -classification — biomaterials used- metals and alloys- Fillings and restoration materials – oral and maxillofacial surgery – dental cements and dental amalgams – dental adhesives.

Unit - III	**ORTHOPAEDIC MATERIALS**	**9**

Bone composition, formation and regeneration - properties – defects - temporary fixation devices – joint replacement – biomaterials used in bone and joint replacement metals and alloys- stress shielding effect- bone tissue engineering.

Unit – IV	**WOUND DRESSING MATERIALS AND SURGICAL AIDS**	**9**

Skin structure – defects (burn, ulcer, trauma etc) and disease- skin regeneration – classification of regenerative material – Sutures- Adhesives – classification – Surgical tools materials – sterilization – Laparoscopic tools

Unit - V	**CARDIOVASCULAR, OPHTHALMOLOGY AND DRUG DELIVERY MATERIALS**	**9**

Blood clotting – blood theology– approaches to thrombo resistance materials development– blood vessels – The heart – aorta and valves – geometry of blood circulation – cardiac pacemakers – extracorporeal blood circulation devices. lungs – vascular implants: vascular graft, cardiac valve prostheses – Eye- defects – correction- Biomaterials in opthalmology – drug delivery methods and materials.

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Select the suitable Biomaterials for cardiovascular Opthalmology and Skin Regeneration	K3
CO2	Choose Biomaterials for Dental and Bone application	K3
CO3	Utilize biomechanical principles to design fixation devices for stabilizing bone fractures	K3
CO4	Identify suitable biomaterials for surgical aids used in wound care	K3
CO5	Select appropriate materials and fabrication techniques for cardiovascular and ophthalmic biomaterials	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	1	1
CO2	2	1	1
CO3	2	1	2
CO4	2	1	3
CO5	2	1	3
CO	**2**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	M. V. Gandhi and B. S. Thompson, "Smart Materials and Structures", Chapman and Hall, London, First Edition, 1992.
2	Sujata V., Bhat., "Biomaterials", Narosa Publication House, New Delhi, 2002
3	Buddy D. Ratner (Editor), Allan S. Hoffman (Editor), Frederick J. Schoen (Editor), Jack E. Lemons, "Biomaterials Science: An Introduction to Materials in Medicine", Academic Press,2nd edition, 2004.
4	Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects of Shapememory Alloys", Butterworth – Heinemann, 1990.
5	Mohsen Shahinpoor and Hans-Jo¨rg Schneider "Intelligent Materials", RSC Publishing,2008.

P24CD3208	MECHANICAL MEASUREMENTS AND ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:	To acquire knowledge on the principle of force and strain measurement, vibration measurement & its applications. principle behind acoustics and wind flow measurements, distress measurements, non destructive testing principle and applications.

Unit - I	**FORCES AND STRAIN MEASUREMENT**	**9**
Strain gauge, principle, types, performance and uses. Photo elasticity–Principle and applications -Moire Fringe-Hydraulic jacks and pressure gauges–Electronic load cells–Proving Rings–Calibration of Testing Machines.		
Unit - II	**VIBRATION MEASUREMENTS**	**9**
Characteristics of Structural Vibrations–Linear Variable Differential Transformer (LVDT)– Transducers for velocity and acceleration measurements. Vibration meter– Seismographs – Vibration Analyzer – Display and recording of signals – Cathode Ray Oscilloscope – XY Plotter – Chart Plotters–Digital data Acquisition systems.		
Unit - III	**ACOUSTICS AND WIND FLOW MEASUREMENTS**	**9**
Principles of Pressure and flow measurements–pressure transducers–sound level meter– venturimeter and flow meters–wind tunnel and its use in structural analysis–structural modeling –direct and indirect model analysis		
Unit – IV	**DISTRESS MEASUREMENTS**	**9**
Diagnosis of distress in structures–crack observation and measurements–corrosion of reinforcement in concrete – Half-cell, construction and use – damage assessment – controlled blasting for demolition.		
Unit - V	**NON DESTRUCTIVE TESTING METHODS**	**9**
Load testing on structures, buildings ,bridges and towers–Rebound Hammer –acoustice mission –ultrasonic testing principles and application–Holography–use of laser for structural testing–Brittle coating		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Apply the appropriate device to measure physical quantities of forces and strains.	K3
CO2	Select the different vibration measurements techniques.	K3
CO3	Model the structural meters to measure physical quantities.	K3
CO4	Identify common factors and variables that influence crack formation and growth	K3
CO5	Choose the appropriate non-destructive testing methods for various engineering applications.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	3	-	2
CO2	3	1	2
CO3	3	1	2
CO4	3	1	2
CO5	3	1	2
CO	3	1	2

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Bray Don E and Stanley, R.K., "Non-destructive Evaluation", McGraw Hill Publishing Company, N.Y.1989
2	Garas,F.K.,Clarke,J.LandArmerGST,"Structuralassessment",Butterworths,London,1987
3	James W. Dally and William Franklin Riley, "Experimental Stress Analysis", McGraw Hill , 3 rdEdition,1991
4	Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, NewDelhi,2009.
5	SrinathLS, Raghavan Mr, Lingaiah K, Gargesha G, Pant Band Ramachandra,K, "Experimental Stress Analysis",TataMcGrawHillCompany,NewDelhi,1984
6	Sirohi,R.S.andRadhakrishna,H.C,"MechanicalMeasurements",NewAgeInternational (P)Ltd, 3rdEdition1997

P24CD3209	WEARABLE TECHNOLOGIES	L	T	P	C
		3	0	0	3

Course Objectives:	Proficient in identifying the motivation, guiding principles, and challenges of Wearable Computing, adapt at designing holistic interactive wearable systems integrating physical, digital, and human elements, equipped with a basic understanding of measurement.

Unit - I	**INTRODUCTION**	**9**

Attributes of wearables, Meta-wearable, Challenges and opportunities, Future of wearables - Social aspects of wearability and interaction: Social interpretation of Aesthetics - Case study: Google glass - Wearable haptics: Need for wearable haptic devices - Categories of wearable haptic and tactile display – Wearable sensorimotor enhancer.

Unit - II	**WEARABLE SENSORS**	**9**

Chemical and Biochemical sensors, System design, Challenges in chemical Bio-chemical sensing, Application areas - Inertia sensors, Parameters from inertia sensors - Applications for wearable motion sensors - Measurement of energy expenditure by body worn heat flow sensors.

Unit - III	**FLEXIBLE ELECTRONICS**	**9**

Introduction, Thin-film transistors: Materials and Technologies, Review of Semi-conductors in flexible electronics - Low-power Integrated Circuit Design for Bio-potential sensing: Analog circuit design techniques - Low- power design for ADCs - Digital circuit design techniques - Architectural design for low-power bio-potential acquisition, Practical considerations.

Unit – IV	**ENERGY HARVESTING SYSTEMS**	**9**

Energy harvesting from human body: Temperature gradient, Foot motion - Wireless energy transmission - Energy harvesting from light and RF energy - Energy and power consumption issues, Future considerations.

Unit - V	**MONITORING PHYSICAL AND PHYSIOLOGICAL PARAMETERS**	**9**

Wearable sensors for physiological signal measurement - Physical measurement: Cardiovascular diseases, Neurological diseases, Gastrointestinal diseases - Wearable and non-invasive assistive technologies: Assistive devices for individuals with severe paralysis, Wearable tongue drive system, Sensor signal-processing algorithm, Dual-mode tongue drive system.

Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the fundamentals of wearables, wearable design issues and user interfaces	K2
CO2	Identify the different types of sensors used in wearable devices	K3
CO3	Select the materials used in the field of flexible electronics technology and its power constraints	K3
CO4	Make use of the techniques and issues associated with energy harvesting from human body	K3
CO5	Identify the key physiological signals and biomarkers associated with different health conditions and disease states.	K3

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	1
CO2	2	1	1
CO3	2	1	1
CO4	2	1	1
CO5	2	1	1
CO	**2**	**1**	**1**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, USA, 2014.
2	Tom Bruno , "Wearable Technology: Smart Watches to Google Glass for Libraries", Rowman & Littlefield Publishers, Lanham, Maryland, 2015
3	Raymond Tong , "Wearable Technology in Medicine and Health Care", Academic Press, USA, 2018.
4	Haider Raad , "The Wearable Technology Handbook", United Scholars Publication, USA, 2017.

P24CD3210	INDUSTRIAL INTERNET OF THINGS	L	T	P	C
		3	0	0	3

Course Objectives:	To comprehend the fundamentals of the Internet of Things, gain proficiency in essential IoT protocols, construct a small-scale, cost-effective embedded system utilizing IoT technology, and proficiently apply IoT concepts in real-world scenarios

Unit - I	**INTRODUCTION AND ARCHITECTURE OF IoT**	**9**
Introduction – Definition and characteristics of IoT – Physical and Logical Design of IoT - Communication models and APIs – Challenges in IoT - Evolution of IoT- Components of IoT - A Simplified IoT Architecture – Core IoT Functional Stack.		
Unit - II	**INDUSTRIAL IoT**	**9**
IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT-Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking		
Unit - III	**IIOT ANALYTICS**	**9**
Big Data Analytics and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop		
Unit – IV	**IOT SECURITY**	**9**
Industrial IoT: Security and Fog Computing - Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT		
Unit - V	**CASE STUDY**	**9**
Industrial IOT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries		
	Total Periods:	**45**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Explain the basic concepts and Architectures of Internet of Things	K2
CO2	Summarize various IoT Layers and their relative importance.	K2
CO3	Outline the importance of Data Analytics in IoT.	K2
CO4	Interpret various IoT platforms and Security	K2
CO5	Summarize the potential benefits and risks of IoT adoption in various applications	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	1

	Programme Outcomes		
	01	02	03
CO2	2	1	1
CO3	2	1	1
CO4	2	1	1
CO5	2	2	1
CO	2	1	1

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Industry 4.0: The Industrial Internet of Things", by Alasdair Gilchrist (Apress), 2017
2	"Industrial Internet of Things: Cybermanufacturing Systems"by Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer), 2017
3	Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

P24AC7001	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0
Course Objectives:	Teach how to improve writing skills and level of readability and to impart the writing skills. Infer the skills needed when writing the Conclusion and ensure the quality of paper at very first-time submission.				

Unit - I	**INTRODUCTION TO RESEARCH PAPER WRITING**	**6**
Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness		
Unit - II	**PRESENTATION SKILLS**	**6**
Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction		
Unit - III	**TITLE WRITING SKILLS**	**6**
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check		
Unit – IV	**RESULT WRITING SKILLS**	**6**
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions		
Unit - V	**VERIFICATION SKILLS**	**6**
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Interpret writing meaningful sentences and coherent paragraphs.	K2
CO2	Outline the paraphrasing and plagiarism for presentation skills.	K2
CO3	Summarize about review literature, write methodology, results and conclusion.	K2
CO4	Illustrate how to write methodology, discussions, results and conclusion.	K2
CO5	Infer how to use useful phrases and checking plagiarism	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	02	03
CO1	2	1	3

	Programme Outcomes		
	01	02	03
CO2	2	2	3
CO3	3	2	2
CO4	2	1	3
CO5	3	2	2
CO	2	2	3

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

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

P24AC7002	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

Course Objectives:	To explain the critical understanding of key concepts in disaster risk reduction and humanitarian response and to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. To understand standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

Unit - I	**INTRODUCTION**	**6**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.		
Unit - II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**	**6**
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.		
Unit - III	**DISASTER PRONE AREAS IN INDIA**	**6**
Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.		
Unit – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**	**6**
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.		
Unit - V	**RISK ASSESSMENT**	**6**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Summarize the basics of disaster.	K2
CO2	Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.	K2
CO3	Illustrate the disaster risk reduction and humanitarian response policy.	K2
CO4	Summarize the standards of humanitarian response and practical relevance in disaster and conflict situations.	K2
CO5	Outline the disaster risk assessment approaches.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	2	2	2
CO2	2	1	2
CO3	1	2	2
CO4	2	1	3
CO5	1	2	2
CO	**2**	**2**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

Reference Books

1	Goel S. L., Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2	Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company, 2007.
3	Sahni, Pradeep Et.Al.," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, New Delhi, 2001.

P24AC7003	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

Course Objectives:	To understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitution. To infer the role and entitlement of civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.

Unit - I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION**	**3**
History, Drafting Committee, (Composition & Working)		
Unit - II	**PHILOSOPHY OF THE INDIAN CONSTITUTION**	**3**
Preamble, Salient Features		
Unit - III	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**	**5**
Fundamental Rights, Right to Equality, Right to Freedom, right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
Unit – IV	**ORGANS OF GOVERNANCE**	**5**
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 AND ELECTION COMMISSION**	**14**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy. Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.		
	Total Periods:	**30**

Course Outcomes

On completion of the course, the student can

COs	Statements	K-Level
CO1	Outline the history of the Indian constitution.	K2
CO2	Summarize the philosophy of the Indian constitution.	K2
CO3	Infer the concepts of fundamental rights and directive principles of state policy.	K2
CO4	Interpret the importance of organs of governance.	K2
CO5	Explain the local administration and election commission.	K2

Knowledge Level: K1 – Remember, K2 – Understand, K3 – Apply, K4 – Analyze, K5 – Evaluate, K6 – Create

CO – PO Articulation Matrix

	Programme Outcomes		
	01	**02**	**03**
CO1	1	1	2
CO2	1	1	2
CO3	2	2	3
CO4	2	1	2
CO5	1	2	2
CO	**1**	**1**	**2**

Correlation levels 1, 2 and 3 are as defined below:

1. Slight 2. Moderate 3. Substantial (High)

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.

P24AC7004	நற்றமிழ் இலக்கியம்	L	T	P	C
		2	0	0	0

Unit - I	சங்க இலக்கியம்	6

1 தமிழின் துவக்க நூல் தொல்காப்பியம்
- எழுத்து, சொல், பொருள்

2 அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்

3 குறிஞ்சிப் பாட்டின் மலர்க்காட்சி

4 புறநானூறு (95, 195)
- போரை நிறுத்திய ஔவையார்

Unit - II	அறநெறித் தமிழ்	6

1. அறநெறி வகுத்த திருவள்ளுவர்
   - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
   - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)

Unit - III	இரட்டை காப்பியங்கள்	6

1 கண்ணகியின் புரட்சி
- சிலப்பதிகார வழக்குரை காதை

2 சமூகசேவை இலக்கியம் மணிமேகலை
- சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

Unit – IV	அருள்நெறித் தமிழ்	6

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்திணை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்

Unit - V	நவீன தமிழ் இலக்கியம்	6

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்.
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

Total Periods:	30

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1	தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) www.tamilvu.org
2	தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) -https://ta.wikipedia.org
3	தர்மபுர ஆதீன வெளியீடு
4	வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.
5	தமிழ்க்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6	அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்.