SONA COLLEGE OF TECHNOLOGY, SALEM-5

(An Autonomous Institution)

M.E- Engineering Design

(Dept of Mechanical Engineering)

CURRICULUM and SYLLABI

[For students admitted in 2023-2024]

PG Regulations 2023

Approved by BOS and Academic Council meetings

END

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E/M.Tech. Semester I under Regulations 2023 (CBCS)
Branch: Engineering Design

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
Theory courses										
1	P23END101	FINITE ELEMENT ANALYSIS	2	1	0	0	3	PC	45	TT
2	P23END102	COMPUTER APPLICATIONS IN DESIGN	3	0	0	0	3	PC	45	T
3	P23END103	CONCEPTS OF ENGINEERING DESIGN	3	0	0	0	3	PC	45	T
4	P23END502	**Elective:-** DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	0	3	PE	45	T
5	P23END503	**Elective:-** RAPID PROTOTYPING AND TOOLING	3	0	0	0	3	PE	45	T
6	P23GE101	RESEARCH METHODOLOGY AND IPR	3	0	0	0	3	PC	45	T
7	P23GE701	**Audit Course:-** ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0	0	AC	30	T
Practical courses										
8	P23END104	CAD LABORATORY	0	0	4	2	3	PC	90	LP
Total Credits							21			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

Chairperson, Mechanical Engineering BoS	**Member Secretary, Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr. D. Senthilkumar	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-
HOD/ Mechanical Engineering, First Semester M.E. END Students and Staff, COE

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E/M.Tech. Semester II under Regulations 2023 (CBCS)
Branch: Engineering Design

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
Theory courses										
1.	P23END201	MECHANICAL VIBRATIONS	2	1	0	0	3	PC	45	TT
2.	P23END202	INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	3	0	0	0	3	PC	45	T
3.	P23END203	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEM	3	0	0	0	3	PC	45	T
4.	P23END504	**Elective:** PRODUCT DATA MANAGEMENT	3	0	0	0	3	PE	45	T
5.	P23END505	**Elective:** MECHANICS OF COMPOSITE MATERIALS	3	0	0	0	3	PE	45	T
6.	P23GE702	**Audit Course:** STRESS MANAGEMENT BY YOGA	2	0	0	0	0	AC	30	T
Practical courses										
7.	P23END204	ANALYSIS AND SIMULATION LABORATORY	0	0	4	2	3	PC	90	LP
						Total Credits	**18**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

Chairperson -- BoS	**Member Secretary/ Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
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Copy to:-

HOD/ Mech, Second Semester ME END Students and Staff, COE

END

Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E/M.Tech. Semester I under Regulations 2023 (CBCS)
Branch: Engineering Design

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
Theory courses										
1	P23END101	FINITE ELEMENT ANALYSIS	2	1	0	0	3	PC	45	TT
2	P23END102	COMPUTER APPLICATIONS IN DESIGN	3	0	0	0	3	PC	45	T
3	P23END103	CONCEPTS OF ENGINEERING DESIGN	3	0	0	0	3	PC	45	T
4	P23END502	**Elective:-** DESIGN FOR MANUFACTURE AND ASSEMBLY	3	0	0	0	3	PE	45	T
5	P23END503	**Elective:-** RAPID PROTOTYPING AND TOOLING	3	0	0	0	3	PE	45	T
6	P23GE101	RESEARCH METHODOLOGY AND IPR	3	0	0	0	3	PC	45	T
7	P23GE701	**Audit Course:-** ENGLISH FOR RESEARCH PAPER WRITING	2	0	0	0	0	AC	30	T
Practical courses										
8	P23END104	CAD LABORATORY	0	0	4	2	3	PC	90	LP
Total Credits							21			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

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HOD/ Mechanical Engineering, First Semester M.E. END Students and Staff, COE

Sona College of Technology, Salem
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Courses of Study for M.E/M.Tech. Semester I under Regulations 2023 (CBCS)
Branch: Engineering Design
Syllabus

P23END101	FINITE ELEMENT ANALYSIS	L	T	P	J	C
		2	1	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Apply finite element analysis to solve practical 1D complex engineering problem.
CO2:	Solve complex two-dimensional engineering problems in areas such as heat transfer, structural analysis, and elasticity.
CO3:	Develop a finite element model for a given problem using isoparametric elements.
CO4:	Analyze structural dynamics applications using various methods.
CO5:	Analyze non-linear problems in structural analysis using material non-linearity and geometric non-linearity with error norms and convergence rates.

Pre-requisite: Engineering Mathematics, Numerical Methods, Strength of Materials Heat and mass transfer and Finite Element Analysis

CO/PO Mapping
(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	2	2
CO2	2	2	3	2	2
CO3	2	2	3	2	2
CO4	2	2	3	2	2
CO5	2	2	3	2	2

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION & ONE-DIMENSIONAL PROBLEMS	**9 Hours**

Relevance of finite element analysis in design - Variational principles and methods – Weighted-Integral statements – Weak formulations – Ritz method – Method of weighted residuals – Applications of FEA - Finite element modeling – Co-ordinates and shape functions - Potential energy approach – Galerkin's approach – One dimensional finite element models in Solid mechanics and Heat transfer – Finite element model for beams.

Unit 02: TWO-DIMENSIONAL PROBLEMS	9 Hours

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Axi-symmetric problems – Principle of virtual displacement.

Unit 03: ISOPARAMETRIC ELEMENTS	9 Hours

Introduction – Bilinear quadrilateral elements – Quadratic quadrilaterals – Hexahedral elements - Numerical integration – Gauss quadrature – Static condensation – Load considerations – Stress calculations – Examples of 2D and 3D applications.

Unit 04: STRUCTURAL DYNAMICS APPLICATIONS	9 Hours

Dynamic equations – Mass and damping matrices – Natural frequencies and modes – Reduction of number of DOF-response history – Model methods – Ritz vectors – Component mode synthesis – Harmonic response – Direct integration techniques – Explicit and implicit methods – Analysis by response spectra – Example problems.

Unit 05: NON-LINEAR PROBLEMS & ERROR ESTIMATES	9 Hours

Introduction – Material non-linearity – Elasto Plasticity – Plasticity – Visco plasticity – Geometric non-linearity – Large displacement – Error norms and convergence rates – H-refinement with adaptivity – adaptive refinement.

Theory: 30 Hrs	Tutorial: 15Hrs	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Two-dimensional mesh generation – advancing front method
02	Three-dimensional mesh generation – Delaunay triangulation
03	Coupled problems

References:

01	Reddy J.N., "An Introduction to the Finite Element Method", McGraw Hill, International Edition 2019, 4th Edition, ISBN-13:9781259861901.
02	Logan D.L, "A First Course in the Finite Element Method", Fifth Edition, Cengage Learning, 2010, ISBN-13: 978-8131517307.
03	Robert Davis Cook, Davis S. Malkus, "Concepts and Applications of Finite Element Analysis", Wiley, John & Sons, Forth Edition 2007, ISBN-13: 978-8126513369.
04	Larry J.Segerlind, "Applied Finite Element Analysis", Second Edition, John Wiley, 2010, ISBN-13: 978-8126528806.
05	S.S.Rao, "The Finite Element Analysis in Engineering", Butterworth-Heinemann; 6th edition, 2017, ISBN-13: 978-0-12-811768-2.

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P23END102	COMPUTER APPLICATIONS IN DESIGN	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Integrate design principles and utilize data exchange formats for effective new product design.
CO2:	Implement solid modeling, design, analyze, and assemble mechanical components effectively.
CO3:	Design molds, jigs, fixtures, check interferences, analyze mechanisms, and explore rapid tooling.
CO4:	Implement software customization to design engineering applications using various programming languages.
CO5:	Apply version control, standardize design, and facilitate collaborative design validation.

Pre-requisite: Engineering Graphics, CAD/CAM/CIM, Design of Machine Elements and Design of Jigs, Fixtures, Press tools and Moulds.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1	1
CO2	2	1	3	1	1
CO3	2	1	1	2	2
CO4	2	1	2	2	3
CO5	2	2	3	2	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN	9 Hours

Concept design – parametric sketching – constraints – computer graphics principles- 2D transformation, scaling, rotation – windowing, view ports – clipping – data exchange formats.

Unit 02: COMPUTERS IN DESIGN	9 Hours
Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations	
Unit 03: COMPUTERS IN TOOLING DESIGN	**9 Hours**
Mould design – jigs and fixtures design – check for interferences – mechanism design and analysis – Rapid tooling.	
Unit 04: COMPUTERS IN DESIGN PRODUCTIVITY	**9 Hours**
Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.	
Unit 05: MANAGING PRODUCT DESIGN DATA	**9 Hours**
Version control – library creation – catalog making – standardization for design – collaborative design among peer groups – Design optimization for geometry - Design check, approval and validation.	

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Advances in AUTOCAD.
02	Interchangeability in Design.
03	Design of Casting.

References:	
01	William M. Neumann and Robert Sproul " Principles of interactive Computer Graphics" Tata McGraw Hill Publishing Co. Ltd, 21st Reprint 2008,ISBN 13 –978-0-07-463293-2.
02	Ibrahim Zeid "CAD/CAM – Theory and Practice" – McGraw Hill, Special Indian Edition, Fifth reprint 2010 ISBN 13 – 978-0-07-015134-5.
03	P N Rao "CAD/CAM :Principles and Applications" Tata McGraw Hill Education Pvt Ltd, Third Edition. 2011 ISBN-13-978-0-07-068793-4
04	Schlechtendahl, E. G, CAD – Data transfer for Solid Models, Springer Verlag, Berlin, 1989, ISBN 9783540518266
05	Donald Hearn and M Pauline Baker "Computer Graphics" Prentice Hall Inc , Second Edition, 2002,ISBN-13: 978-8177587654

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P23END103	CONCEPTS OF ENGINEERING DESIGN	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Apply the engineering design process, including need identification, design requirements, product life cycle, and design morphology.
CO2:	Execute various design methods and tools to design and develop products, including conceptual design, embodiment design, detailed design, concurrent engineering, CAD & CAM, and human factors engineering.
CO3:	Evaluate and select the best design solutions based on technical, economic, and social criteria.
CO4:	Employ their knowledge of materials, manufacturing processes, and legal, ethical, environmental, and safety issues to design safe, reliable, and sustainable products.
CO5:	**Design and manufacture reliable, long-lasting products using your expertise in materials, manufacturing, ethics, morality, environment, and safety.**

Pre-requisite: Finite element Analysis, CAD/CAM/CIM, Engineering materials and Metallurgy, Manufacturing Technology I & II, Product Quality Development.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	3	3	3
CO2	2	2	3	3	3
CO3	2	2	3	3	3
CO4	2	2	3	3	3
CO5	2	2	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: THE DESIGN PROCESS	**9 Hours**

The Design Process - need identification – Design requirements – Product Life Cycle – Morphology of Design steps of Product Design – Conceptual Design, Embodiment Design, detailed Design – Concurrent Engineering – CAD & CAM, Human factors in Design.

Unit 02: TOOLS IN ENGINEERING DESIGN	9 Hours

Creativity and problem-solving, Decision Theory, Modeling – Role of models in Engineering Design, Mathematical modeling, Geometric modeling, finite element modeling, Rapid Prototyping – Simulation Finite Difference method, Monte Carlo method – Optimization – Search methods, Geometric programming, Structural and shape optimization.

Unit 03: MATERIAL SELECTION AND MATERIALS IN DESIGN	9 Hours

The Classification and properties of Engineering materials, material standards, and specifications – Methods of material selection – Ashby Chart and method of weight factors, Derivation of material indices, Use of material selection Chart, Pugh selection method, selection with computed aided databases – Design for brittle fracture, Design for fatigue failure, Design for corrosion resistance, Designing with plastics.

Unit 04: MATERIAL PROCESSING AND DESIGN	9 Hours

Classification of manufacturing processes and their role in the design, Factors determining the process selection, use of process selection chart and computerized database – Design for manufacturing, Design for forging and sheet metal forming, Design for casting, Design for machining, welding, and assembly, design for residual stresses and heat – treatment

Unit 05: LEGAL, ETHICAL ENVIRONMENTAL, AND SAFETY ISSUES IN DESIGN AND QUALITY ENGINEERING	9 Hours

The origin of laws, Contracts, - Liability – Tort Law- Product Liability – Design aspects of product liability, Codes of ethics, solving ethical conflicts. Design for environment – Life Cycle assessment – Material recycling and remanufacture, Design for safety – Potential Dangers and Guidelines for design for safety, Design for reliability failure mode effect analysis, robust Design.

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Quality concepts.
02	Design procedures.
03	Design application in industries.

References:	
01	Dieter, George E, Engineering Design –"A materials and processing Approach", Paperback, McGraw Hill Higher Education,5th International edition,2012, ISBN-13: 9780071326254.
02	Karl T. Vlrich and Steven D. Eppinger "Product design and Development", Mc Graw Hill, International Edition, 5th Edition,2000,ISBN: 0073404772.
03	Pahlgand Beitz W "Engineering Design" Springer – London,3rd Edition, 2006,ISBN-13: 9781846283185.
04	Suh. N. P. "The principles of design",Oxford University Press USA 1990, ISBN-13: 9780195043457.
05	Ray M.S. "Elements of Engineering Design", Printice Hall Inc.,1st Edition, 1985, ISBN-13: 9780132641852.

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P23END502	DESIGN FOR MANUFACTURE AND ASSEMBLY	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Integrate design for manufacturability principles and process capability analysis to create optimized, high-quality, and cost-effective products.
CO2:	Develop the expertise to design forms tailored to materials, including and welded members, and forgings.
CO3:	Discuss design strategies to optimize machining processes, reduce costs, enhance accessibility, improve assembly, and ensure efficient use of resources.
CO4:	Develop castings by minimizing core usage, identifying uneconomical designs, applying group technology, and utilizing DFMA computer applications.
CO5:	Implement environmentally responsible design principles, lifecycle assessment, and regulatory compliance to create sustainable, low-impact products.

Pre-requisite: Design of Machine Elements, Design of Jigs, fixtures, press tools and Moulds, CAD/CAM/CIM, Manufacturing Technology I & II, Product Quality Development and Concepts of Engineering design.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	2
CO2	2	2	2	3	3
CO3	2	3	3	3	3
CO4	3	3	3	3	3
CO5	2	2	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION	9 Hours

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

Unit 02: FACTORS INFLUENCING FORM DESIGN	9 Hours
Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.	
Unit 03: COMPONENT DESIGN - MACHINING CONSIDERATION	**9 Hours**
Design features to facilitate machining - drills - milling cutters - keyways - Doweling procedures, counter sunk screws - Reduction of machined area- simplification by separation - simplification by amalgamation - Design for machinability - Design for economy - Design for clampability - Design for accessibility - Design for assembly.	
Unit 04: COMPONENT DESIGN - CASTING CONSIDERATION	**9 Hours**
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA.	
Unit 05: DESIGN FOR THE ENVIRONMENT	**9 Hours**
Introduction – Environmental objectives – Global issues – Regional and local issues – Basic DFE methods – Design guide lines Example application – Lifecycle assessment – Basic method – AT&T's environmentally responsible product assessment - Weighted sum assessment method – Lifecycle assessment method – Techniques to reduce environmental impact – Design to minimize material usage – Design for disassembly – Design for recyclability – Design for remanufacture – Design for energy efficiency – Design to regulations and standards.	

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Stress concentration
02	Basics of environmental engineering

References:

01	Boothroyd, G, "Design for Assembly Automation and Product Design", Marcel Dekker, NewYork., 3rd Edition, 2010 ISBN:0750673419
02	Bralla, "Design for Manufacture handbook", McGraw hill, 2nd Edition, 2013. ISBN-13: 9780070071391
03	Boothroyd, G, Heartz and Nike," Product Design for Manufacture", Marcel Dekker, 3rd Edition 1994. ISBN: 0-8247-0584-X.
04	Dickson, John R, and Corroda Poly, "Engineering Design and Design for Manufacture and Structural Approach", Field Stone Publisher, USA, 1995.
05	Fixel, J. Design for the Environment McGraw hill.,2nd Edition,2011 ,ISBN-13: 978-0071776226

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P23END503	RAPID PROTOTYPING AND TOOLING	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Classify different types of rapid prototyping system and discuss the time compression in product development.
CO2:	Demonstrate the processes of stereo lithography RP systems and selective laser sintering RP system.
CO3:	Investigate the process parameters of fusion deposition modeling.
CO4:	Discuss the laminated object manufacturing and LENS rapid prototyping system.
CO5:	Analyze the factors influencing for accuracy of rapid manufacturing product.

Pre-requisite: Manufacturing Process, Engineering Material and metallurgy and CAD/CAM

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1		1			1
CO2		1	2		1
CO3	2		1	1	
CO4		1			1
CO5	2				2

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION	9 Hours

Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems.

Unit 02: STEREOLITHOGRAPHY SYSTEMS	9 Hours
Principle, Process parameters, Process details, Data preparation, Data files and Machine details, Applications. SELECTIVE LASER SINTERING - Types of machines, Principle of operation, Process parameters, Data preparation for SLS, Applications.	
Unit 03: FUSION DEPOSITION MODELING	**9 Hours**
Principle, Process parameters, Path generation, Applications. SOLID GROUND CURING: Principle of operation, Machine details, Applications.	
Unit 04: LAMINATED OBJECT MANUFACTURING	**9 Hours**
Principle of operation, LOM materials, Process details, Applications. CONCEPT MODELERS - Principle, Thermo jet printer, Sander's model market, 3-D printer, Genisys Xs printer, JP system 5, Object Quadra System. LASER ENGINEERED NET SHAPING (LENS) – principle –applications.	
Unit 05: RAPID TOOLING SOFTWARE FOR RAPID PROTOTYPING	**9 Hours**
Indirect Rapid Tooling - Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc. Direct Rapid Tooling Direct AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, soft tooling vs hard tooling. STL files, Overview of Solid view, Magics, mimics, magics communicator, etc. Internet based softwares, Collaboration tools. RAPID MANUFACTURING PROCESS OPTIMIZATION - Factors influencing accuracy, Data preparation errors, Part building errors, Errors in finishing, Influence of part build orientation. ALLIED PROCESSES - Vacuum Casting, Surface Digitizing, Surface Generation from point cloud, Surface modification, data transfer to solid models	

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Laser 3D printing
02	Smart materials used in RPT
03	Advanced Treatment for cleaning the prototypes

References:

01	Paul. F. Jacobs, "Stereo lithography and other RP & M Technologies", Society of Manufacturing Engineers, NY, 1996, ISBN-9780872634671.
02	Pham. D. T. & Dimov. S. S., "Rapid Manufacturing", Springer, 2001, ISBN- 9781852333607.
03	Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs. "Rapid Tooling: Technologies and Industrial Applications", Marcel Dekker, Inc, 2003, ISBN- 0824741595.
04	Terry Wohlers,"Wohlers Report 2006",Wohlers Associates, 2006, ISBN 0-9754429-2-9.
05	Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", World Scientific Publishing Company; 3 Har/Dvdr edition (January 14, 2010), ISBN-13: 978-9812778970.

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P23END104	CAD LABORATORY	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Demonstrate the basic concepts of modeling and analysis softwares like PRO-E / SOLID WORKS /SOLID EDGE/CATIA / NX / ANSYS / NASTRAN etc.
CO2:	Develop a part models using sectioning concepts, drawing standards and sketching.
CO3:	Create a detailed drawing assembly to understand the 2D views and Assemble the part models.

Pre-requisite: Engineering Graphics and Machine Drawing

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1		1			
CO2	2	1	3	3	3
CO3	2		3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) – Laboratory Quiz 1 (5) CIE test II (10) – Laboratory Quiz 2 (5)	CIE III (10) – Project Record (10) Total CIE: 50 marks Semester End Examination: 50 marks SEE : Laboratory	Course end survey

LIST OF EXPERIMENTS	90 Hours

1. Introduction to CAD and solid works
2. Study of Sectional views and types of keys
3. Study of drawing standards
4. Split muff coupling – Part, Assembly and Detail drawing
5. Protected type Flange coupling – Part, Assembly and Detail drawing
6. Pipe vice – Part, Assembly and Detail drawing
7. Screw jack – Part, Assembly and Detail drawing
8. Simple eccentric – Part, Assembly and Detail drawing
9. Universal coupling – Part, Assembly and Detail drawing
10. Plummer block – Part, Assembly and Detail drawing
11. Claw coupling – Part, Assembly and Detail drawing
12. Knuckle joint – Part, Assembly and Detail drawing
13. Bushed Pin type Flexible Coupling – Part, Assembly and Detail drawing
14. Oldham's coupling – Part, Assembly and Detail drawing
15. Machine Vice – Part, Assembly and Detail drawing

Theory: 0	Tutorial: 0	Practical: 60 Hrs	Project: 30 Hrs	Total Hours: 90 Hrs

List of Equipment:	
01	Computer workstation - 10
02	Software requirement: CREO /SOLID WORKS /SOLID EDGE/CATIA / NX / NASTRAN

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P23GE101 **RESEARCH METHODOLOGY AND IPR** **3 0 0 0 3**
(Common to all M.E /M.Tech Programmes)

COURSE OUTCOMES:

At the end of the course, the student will be able to

1. Review the literature of the research problem
2. Choose appropriate data collection and sampling method according to the research problem.
3. Interpret the results of research and communicate effectively with their peers
4. Explain the Importance of intellectual property rights
5. Evaluate trade mark, develop and register patents.

CO/PO, PSO Mapping (3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak COs Programme Outcomes (POs) and Programme Specific Outcomes (PSOs)					
COs	PO1	PO2	PO3	PO4	PO5
CO1	2	3	3	3	3
CO2	2	3	3	3	3
CO3	2	3	3	3	3
CO4	2	3	3	3	3
CO5	3	3	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) (Theory) CIE test II (10) (Theory) CIE test III (10) (Theory)	Assignment / Problem –Solving /Seminar (10) Total CIE: **40 Marks** Semester End Examination : **60 Marks**	Course end survey

UNIT I INTRODUCTION TO RESEARCH METHODS 9

Definition and Objective of Research, Various steps in Scientific Research, Types of Research, Criteria for Good Research, Defining Research Problem, Research Design , Case Study Collection of Primary and Secondary Data, Collection Methods: Observation, Interview, Questionnaires, Schedules,

UNIT II SAMPLING DESIGN AND HYPOTHESIS TESTING 9

steps in Sampling Design, Types of Sample Designs, Measurements and Scaling Techniques -Testing of hypotheses concerning means (one mean and difference between two means -one tailed and two tailed tests), concerning variance — one tailed Chi-square test.

UNIT II INTERPRETATION AND REPORT WRITING 9

Techniques of Interpretation, Precaution in Interpretation, Layout of Research Report, Types of Reports, Oral Presentation, Mechanics of Writing Research Report

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY 9

Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights, Innovations and Inventions trade related intellectual property rights.

UNIT V TRADE MARKS, COPY RIGHTS AND PATENTS 9

Purpose and function of trade marks, acquisition of trade mark rights, trade mark registration processes, trademark claims —trademark Litigations- International trademark law Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

Lecture: 45, Tutorial: 0, Total: 45 Hours

TEXT BOOKS

1. C.R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques An Edition, New Age International Publishers, 2019.
2. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets", Delmar Cengage Learning, 4" Edition, 2012.
3. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", Tata Mc Graw Hill Education, 1" Edition, 2008.

REFERENCE BOOKS

1. Panneerselvam, R., Research Methodology, Second Edition, Prentice-Hall of India, New Delhi, 2013.
2. Ranjith Kumar, Research Methodology — A step by step Guide for Begineers, 4" edition, Sage publisher, 2014.
3. D Llewelyn & T Aplin W Cornish, "Intellectual Property: Patents, Copyright, Trade Marks and Allied Rights", Sweet and Maxwell, 1" Edition, 2016.
4. Ananth Padmanabhan, "Intellectual Property Rights-Infringement and Remedies", Lexis Nexis, 1" Edition, 2012.
5. Ramakrishna B and Anil Kumar H.S, "Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers", Notion Press, 1" Edition, 2017.
6. M.Ashok Kumar and Mohd. Iqbal Ali :"Intellectual Property Rights" Serials Pub

S. Padma 4.8.23

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P23GE701	English for Research Paper Writing	L	T	P	J	C
		2	0	0	0	0

Course Outcomes

At the end of the course, the student will be able to

CO1:	Demonstrate research writing skills both for research articles and thesis
CO2:	Frame suitable title and captions as sub-headings for articles and thesis
CO3:	Write each section in a research paper and thesis coherently
CO4:	Use language appropriately and proficiently for effective written communication
CO5:	Exhibit professional proof-reading skills to make the writing error free

Course Assessment methods

Direct		Indirect
CIE test I (30) CIE test II (30) CIE test III (40)	Total CIE: 100 marks Semester End Examination: NIL	Course end survey

Unit 01:	**6 Hours**
Planning and preparation, word order, breaking up long sentences, organising ideas into paragraphs and sentences, being concise and avoiding redundancy, ambiguity and vagueness	
Unit 02:	**6 Hours**
Interpreting research findings, understanding and avoiding plagiarism, paraphrasing sections of a paper/ abstract.	
Unit 03:	**6 Hours**
Key skills to frame a title, to draft an abstract, to give an introduction	
Unit 04:	**6 Hours**
Skills required to organise review of literature, methods, results, discussion and conclusions	
Unit 05:	**6 Hours**
Usage of appropriate phrases and key terms to make the writing effective - proof-reading to ensure error-free writing	

Theory: 30 Hrs	Tutorial: --	Practical: --	Project:--	Total Hours: 30 Hrs

TEXT BOOKS

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

REFERENCES

1. Martin Cutts, Oxford Guide to Plain English, Oxford University Press, Second Edition, 2006

HOD

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Sona College of Technology, Salem
(An Autonomous Institution)
Courses of Study for M.E/M.Tech. Semester II under Regulations 2023 (CBCS)
Branch: Engineering Design

S.No	Course Code	Course Title	L	T	P	J	C	Category	Total Contact Hours	Course Type*
Theory courses										
1.	P23END201	MECHANICAL VIBRATIONS	2	1	0	0	3	PC	45	TT
2.	P23END202	INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	3	0	0	0	3	PC	45	T
3.	P23END203	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEM	3	0	0	0	3	PC	45	T
4.	P23END504	**Elective:** PRODUCT DATA MANAGEMENT	3	0	0	0	3	PE	45	T
5.	P23END505	**Elective:** MECHANICS OF COMPOSITE MATERIALS	3	0	0	0	3	PE	45	T
6.	P23GE702	**Audit Course:** STRESS MANAGEMENT BY YOGA	2	0	0	0	0	AC	30	T
Practical courses										
7.	P23END204	ANALYSIS AND SIMULATION LABORATORY	0	0	4	2	3	PC	90	LP
						Total Credits	**18**			

*T- Theory, TT- Theory with Tutorial, TL- Theory with Laboratory,TP- Theory with Project, TLP- Theory with Laboratory and Project, L-Laboratory, LT- Laboratory with Theory, LP- Laboratory with Project

Approved By

Chairperson -- BoS	**Member Secretary/ Academic Council**	**Dean-Academics**	**Chairperson, Academic Council & Principal**
Dr.D.Senthilkumar	**Dr.R.Shivakumar**	**Dr.J.Akilandeswari**	**Dr.S.R.R.Senthil Kumar**

Copy to:-

HOD/ Mech, Second Semester ME END Students and Staff, COE

P23END201	MECHANICAL VIBRATIONS	L	T	P	J	C
		2	1	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Understand fundamentals of vibrations and virtual work.
CO2:	Gain knowledge on two degree freedom system, vibration absorber and isolator.
CO3:	Impart knowledge on multi degree freedom system and numerical methods for fundamental frequencies.
CO4:	Comprehensive understand of wave dynamics and structural vibration principles.
CO5:	Provide the experimental methods in measuring vibration.

Pre-requisite: Engineering Mechanics, Strength of materials, Kinematics and Dynamics of Machinery

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1	1	1
CO2	1	3	1	1	1
CO3	1	2	2	1	2
CO4	2	2	1	1	3
CO5	2	1	1	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: FUNDAMENTALS OF VIBRATION — **9 Hours**

Introduction – Single degree freedom free vibration systems – Damped vibrations – Single degree freedom forced vibration with elastically coupled viscous dampers, System Identification from frequency response, Duhamel's Integral – Impulse Response function – Virtual work – Lagrange's equation-– Transient Vibration

Unit 02: TWO DEGREE FREEDOM SYSTEM — **9 Hours**

Poisson equation – Laplace equation – Weak form – Element matrices for triangular and rectangular elements – Evaluation of integrals – Assembly – Axi-symmetric problems – Applications – Conduction and

convection heat transfer - Torsional cylindrical member – Transient analysis - Theory of elasticity – Plane strain – Plane stress – Principle of virtual displacement.

Unit 03: MULTI-DEGREE FREEDOM SYSTEM	**9 Hours**
Normal mode of vibration – Flexibility Matrix and Stiffness matrix – Eigen values and eigen vectors – Modal Analysis – Forced Vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.	

Unit 04: VIBRATION OF CONTINUOUS SYSTEMS	**9 Hours**
Systems governed by wave equations – Vibration of strings – vibration of rods – Euler Equation for Beams – Effect of Rotary inertia and shear deformation – Vibration of plates.	

Unit 05: EXPERIMENTAL METHODS IN VIBRATION ANALYSIS	**9 Hours**
Vibration instruments – Vibration exciters Measuring Devices – Analysis – Vibration Tests – Free and Forced Vibration tests. Examples of Vibration tests – Industrial, case studies.	

Theory: 30 Hrs	**Tutorial: 15Hrs**	**Practical: 0**	**Project: 0**	**Total Hours: 45 Hrs**

Content Beyond Syllabus:	
01	Basics mechanics
02	Basics of matrix

References:	
01	Benson H. Tongue, Principles of Vibration, 2nd edition., Oxford University Press, NY, 2002 ISBN: 9780195142464
02	Thomson, W.T. – "Theory of Vibration with Applications", (5th Edition) CBS Publishers and Distributors, New Delhi, 1990. ISBN-13: 978-0136510680.
03	Rao, J.S., & Gupta, K. – "Ind. Course on Theory and Practice Mechanical Vibration", New Age International (P) Ltd., 1984. ISBN:978-81-224-1215-4 Publication Year Edition:2nd Reprint : Aug, 2014
04	Den Hartog, J.P, "Mechanical Vibrations," Dover Publications, 4th Edition, 1990. ISBN 0-486-65407-9,
05	Rao, S.S.," Mechanical Vibrations," Addison Wesley Longman, 13th Edition, 1995. ISBN 13: 9780201
06	Dewey H. Hodges and G. Alvin Pierce, "Introduction to Structural Dynamics and Aero elasticity" : 15 - Cambridge Aerospace Series, 2014

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P23END202	INTEGRATED PRODUCT AND PROCESSES DEVELOPMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Impart knowledge on product development processes and organizations.
CO2:	Identify customer needs, product planning processes and allocating resources and timing.
CO3:	Apply knowledge on product specifications.
CO4:	Define the concept selection and measure customer response.
CO5:	Provide product architecture and level design issues.

Pre-requisite: Process planning and cost estimation, Concept of Engineering design, Industrial Management and Engineering.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1			1	1	1
CO2		1	2	3	3
CO3	1	2	1	2	3
CO4	1	2	2	1	3
CO5	1	1	2	1	2

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION	**9 Hours**

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

Unit 02: PRODUCT PLANNING	**9 Hours**

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

Unit 03: PRODUCT SPECIFICATIONS	**9 Hours**
Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.	

Unit 04: CONCEPT SELECTION	**9 Hours**
Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format- Communicate the Concept-Measure Customer Response-Interpret the Results- Reflect on the Results and the Process.	

Unit 05: PRODUCT ARCHITECTURE	**9 Hours**
Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues	

Theory: 45 Hrs	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total Hours: 45 Hrs**

Content Beyond Syllabus:	
01	Supply chain mechanism
02	Cost estimation

References:	
01	Product Design and Development, Karl T. Ulrich and Steven .D Epinger, McGraw-Hill International Edns. 6th edition 2016. ISBN 978-0-07-802906-6
02	Kevien Otto and Kristin Wood, "Product Design" Pearson Publication,3rd Edition, 2020, ISBN-13: 9780130212719
03	Stuart Pugh, "Tool Design – Integrated Methods for successful Product Engineering", Addison Wesley Publishing, Neyork, 1991,ISBN: 020141639.
04	Stephen Rosenthal, Business One Orwin "Effective Product Design and Development", Homewood, 1992,ISBN:1-55623-603-4
05	Kemnneth Crow,"Concurrent Engg. /Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569,Workshop Book.

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P23END203	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEM	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1 :	To impart knowledge on hydraulic systems and select the suitable pump and actuator and for hydraulic systems.
CO2 :	To understanding on the need and use of various control and regulating elements in hydraulic systems
CO3 :	To gain knowledge of hydraulic equipment and independently design hydraulic circuit for industrial applications
CO4 :	To expose them to the different components of pneumatic systems and enable them to design pneumatic systems and circuits - cascade methods - mapping methods - step counter method
CO5 :	To make them understand the need of Plc, cascade, step counter and k-v mapping methods and to design low cost automation systems

Pre-requisite: Fluid mechanics, Hydraulic and pneumatics and Mechatronics

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	2	2
CO2	2	1	2	3	3
CO3	2	2	1	2	3
CO4	2	3	2	1	3
CO5	2	2	2	1	2

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS	**9 Hours**
Hydraulic Power Generators – Selection and specification of pumps, pump characteristics- Determination of volumetric, mechanical and overall efficiencies of positive displacement pumps. Linear and Rotary Actuators – selection, specification and characteristics.	
Unit 02: CONTROL AND REGULATION ELEMENTS	**9 Hours**
Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.	

Electrical control solenoid valves, relays, Electro hydraulic servo valves.	
Unit 03: HYDRAULIC CIRCUITS	**9 Hours**
Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits - press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components - safety and emergency mandrels.	
Unit 04: PNEUMATIC SYSTEMS AND CIRCUITS	**9 Hours**
Pneumatic fundamentals - control elements, position and pressure sensing - 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.	
Unit 05: INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS	**9 Hours**
Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.	

Theory: 45 Hrs	**Tutorial: 0**	**Practical: 0**	**Project: 0**	**Total Hours: 45 Hrs**

Content Beyond Syllabus:	
01	PLC programming
02	SCADA

References:

01	Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 2019.
02	Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
03	Dudleyt, A. Pease and John J. Pippenger, Industrial Hydraulics, Tata MGraw Hill Prentice Hall, 2018.
04	Andrew Parr, "Hydraulic and Pneumatics" (HB), Jaico Publishing House, 2004.
05	Majumdar, S.R., Oil Hydraulic Systems, Principles and Maintenance, Tata MGraw Hill Prentice Hall, 2020.
06	James A. Sullivan, "Fluid Power Theory and Applications", Fourth Edition, Prentice Hall, 1997
07	Michael J, Prinches and Ashby J. G, "Power Hydraulics", Prentice Hall, 1989.

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P23END504	PRODUCT DATA MANAGEMENT	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Demonstrate the fundamentals of Project Data Management (PDM) and its significance in modern project environments
CO2:	Evaluate and select appropriate hardware and software components for designing and optimizing a PDM infrastructure tailored to specific organizational needs.
CO3:	Construct Configuration Management
CO4:	Demonstrate workflow and life cycle of products
CO5:	Apply generic product modeling techniques in configuration modelers to create versatile and adaptable product models suitable for various configurations and requirements.

Pre-requisite: Industrial Management and Engineering, Total Quality Management and Integrated product and process development.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1		1	1	1	1
CO2		1	2	3	2
CO3	1	3	2	2	3
CO4	1	1	1	2	3
CO5	1	3	2	2	3

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION	9 Hours
Introduction to PDM-present market constraints-need for collaboration - internet and developments in server-client computing.	

Unit 02: COMPONENTS OF PDM	9 Hours
Components of a typical PDM setup-hardware and software-document management-creation and viewing of documents-creating parts-versions and version control of parts and documents-case studies.	
Unit 03: CONFIGURATION MANAGEMENT	**9 Hours**
Base lines-product structure-configuration management-case studies.	
Unit 04: PROJECTS AND ROLES	**9 Hours**
Creation of projects and roles-life cycle of a product- life cycle management-automating information flow-work flows- creation of work flow templates-life cycle-work flow integration-case studies.	
Unit 05: CHANGE MANAGEMENT GENERIC PRODUCTS AND VARIANTS	**9 Hours**
Change issue- change request- change investigation- change proposal - change activity - case studies. Data Management Systems for FEA data - Product configurator - comparison between sales configuration and product configurator-generic product modeling in configuration modeler-use of order generator for variant creation-registering of variants in product register-case studies.	

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Basics of FEA
02	Cloud computing

References:	
01	Kevin Otto, Kristin Wood, "Product Design", Pearson, 2020.
02	Daniel Amor, "The E-Business Revolution", Prentice-Hall, 2019.
03	David Bed worth. Mark Henderson & Phillip Wolfe. "Computer Integrated Design and Manufacturing ". McGraw Hill Inc...1991.
04	Terry Quatrain. "Visual Modeling with Rational Rose and UML ". Addison Wesley...2020.
05	Wind-Chill R5.0Reference Manuals...2019.

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P23END505	MECHANICS OF COMPOSITE MATERIALS	L	T	P	J	C
		3	0	0	0	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Identify the significant characteristics of fibers and matrices
CO2:	Calculate the mechanical characteristic of composite materials
CO3:	Analyze the static mechanical properties of composite materials.
CO4:	Discuss the various manufacturing methods and inspection methods of composites.
CO5:	Design the bolted joints, bonded joints and members of laminated composite and analyze the laminated composite using Finite Element Method.

Pre-requisite: Engineering Materials and metallurgy, Engineering Mechanics, Manufacturing Technology – I & II

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1		1	1	1	
CO2	1		1	1	1
CO3	1	1	2	2	
CO4		2	1		1
CO5	2	1	2	2	2

Course Assessment methods

Direct		Indirect
CIE test I (10) CIE test II (10) CIE test III (10)	Assignment / Problem-solving / Seminar (10) Total CIE: 40 marks Semester End Examination: 60 marks	Course end survey

Unit 01: INTRODUCTION	**9 Hours**
Definition – Need – General Characteristics, Applications. Fibers – Glass, Carbon, Ceramic and Aramid fibers. Matrices – Polymer, Graphite, Ceramic and Metal Matrices – Characteristics of fibers and matrices. Fiber surface treatments, Fillers and additives, Fiber content, density and void content.	
Unit 02: MECHANICS	**9 Hours**
Rule of mixture -volume and mass fractions – density - void content, Evaluation of four elastic moduli based on strength of materials approach and Semi-Empirical model-Longitudinal Young's modulus-transverse Young's modulus–major Poisson's ratio-In-plane shear modulus, Ultimate strengths of a unidirectional lamina. Characteristics of Fiber-reinforced lamina–laminates–lamination theory, Interlaminar stresses	

Unit 03: PERFORMANCE	9 Hours
Static Mechanical Properties – Fatigue and Impact Properties – Environmental effects – Long term properties. Fracture Behavior and Damage Tolerance.	
Unit 04: MANUFACTURING	**9 Hours**
Bag Moulding – Compression Moulding – Pultrusion – Filament Winding – Other Manufacturing Processes Quality Inspection methods. Processing of MMC –diffusion bonding – stir casting – squeeze casting.	
Unit 05: DESIGN	**9 Hours**
Failure Predictions, Laminate Design Consideration-design criteria-design allowables -design guidelines, Joint design-Bolted and Bonded Joints, Design Examples-Design of a tension member – design of a compression member – design of a beam-design of a torsional member, Application of FEM for design and analysis of laminated composites.	

Theory: 45 Hrs	Tutorial: 0	Practical: 0	Project: 0	Total Hours: 45 Hrs

Content Beyond Syllabus:	
01	Smart Materials
02	Performance study

References:	
01	Mallick, P.K., "Fiber Reinforced Composites: Materials, Manufacturing and Design", Marcel Dekker Inc, 2020.
02	Autar K. Kaw, "Mechanics of Composite Materials" CRC Press, 2019
03	Agarwal, B.D., and Broutman L.J., "Analysis and Performance of Fiber Composites", John Wiley and Sons, New York, 2020.
04	Ronald Gibson, "Principles of Composite Material Mechanics", Tata McGraw Hill, 1994.
05	Chawla K.K., "Composite materials", Springer – Verlag, 2021

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P23END204	ANALYSIS AND SIMULATION LABORATORY	L	T	P	J	C
		0	0	4	2	3

Course Outcomes

At the end of the course, the student will be able to

CO1:	Demonstrate the basic concepts of modeling and analysis software like PRO-E / SOLID WORKS /SOLID EDGE/CATIA / NX / ANSYS / NASTRAN etc.
CO2:	Develop a part models using sectioning concepts, drawing standards and sketching.
CO3:	Analyze the stresses and strains induced in plates, brackets and beams and heat transfer problems.

Pre-requisite: Engineering Graphics.

CO/PO Mapping

(3/2/1 indicates the strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Programme Outcomes (POs)				
	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	2	2
CO2	2	2	3	3	3
CO3	2	1	3	3	3

Course Assessment methods

Direct		Indirect
CIE test I (10) – Laboratory Quiz 1 (5) CIE test II (10) – Laboratory Quiz 2 (5)	CIE III (10) – Project Record (10) Total CIE: 50 marks Semester End Examination: 50 marks SEE : Laboratory	Course end survey

LIST OF EXPERIMENTS	60 Hours

1. Nodal Displacement of 1-D Bar.
2. Displacement and thermal stress of taper Plate.
3. Nodal displacement of truss member.
4. Nodal displacement of thermal stress due to static and thermal load.
5. Stress and deflection analysis in beams with different support conditions.
6. Deflection of beam with roller.
7. Displacement and Von-Misses stress rectangular plate under plane stress.
8. Displacement in a thin plane with a circular hole.
9. Thermal analysis of a beam
10. Stress analysis of an Axi-Symmetric component.
11. Model analysis of a cantilever-2D plate.
12. Structural analysis of an L-Bracket.
13. Harmonic analysis of a cantilever beam.
14. Heat transfer in a fin.

Theory: 0	Tutorial: 0	Practical: 60 Hrs	Project: 30 Hrs	Total Hours: 90 Hrs

List of Equipment:	
01	Computer workstation - 10
02	Software requirement: ANSYS / NASTRAN/ADAMS/MATLAB

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P23GE702	Stress Management by Yoga	L	T	P	J	C
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Course Outcomes

At the end of the course, the student will be able to

CO1:	Develop physical and mental health thus improving social health
CO2:	Increase immunity power of the body and prevent diseases
CO3:	Accelerate memory power
CO4:	Achieve the set goal with confidence and determination
CO5:	Improve stability of mind, pleasing personality and work with awakened wisdom

Course Assessment methods

Direct		Indirect
CIE test I (30) CIE test II (30) CIE test III (40)	Total CIE: 100 marks Semester End Examination: NIL	Course end survey

Unit 01:	**6 Hours**
Yoga-Introduction - Astanga Yoga- 8 parts-Yam and Niyam etc.- Do`s and Don'ts in life-Benefits of Yoga and Asana- Yoga Exercise- and benefits- Pranayam Yoga- Nadi suthi, Practice and Spinal Sclearance Practice-Regularization of breathing techniques and its effects-Practice and kapalapathy practice.	
Unit 02:	**6 Hours**
Neuromuscular breathing exercise and Practice- Magarasa Yoga, 14 points Acupressure techniques and practice-Body relaxation practice and its benefits- Raja Yoga- 1.Agna –explanation and practice- Activation of Pituitary- Raja Yoga- 2. Santhi Yoga-Practice-Balancing of physical and mental power.	
Unit 03:	**6 Hours**
Raja Yoga- 3. Sagasrathara yoga –practice- Activation of dormant brain cells-Kayakalpa-theory- Kayakalpa –practice-Yogic exercise to improve physical and mental health and practice-Asanas –explanation-Practice-benefits	
Unit 04:	**6 Hours**
Sun namaskar- 12 poses-explanation and practice-Yoga –Asana-Padmasana, vajrasana,chakrasana, viruchasana etc-Stress management with Yoga-Role of women and Yoga Equality, nonviolence, Humanity, Self- control- Food and yoga Aware of self-destructive habits Avoid fault thinking (thought analysis-Practice)-Yoga Free from ANGER (Neutralization of anger)& practice	
Unit 05:	**6 Hours**
Moralisation of Desire & practice- Punctuality-Love-Kindness-Compassion Eradication of worries-Practice - Personality development, positive thinking-Good characters to lead a moral life How to clear the polluted mind- Benefits of blessing- Five- fold culture –explanation- Karma Yoga Practice In Geetha- Sense of duty-Devotion, self- reliance, confidence, concentration, truthfulness, cleanliness.	

Theory: 30 Hrs	**Tutorial: --**	**Practical: --**	**Project:--**	**Total Hours: 30 Hrs**

REFERENCES

1	'Yogic Asanas for Group Tarining-Part-I" Janardan Swami Yogabhyasi Mandal, Nagpur
2	"Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

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