K. S. Rangasamy College of Technology

(Autonomous Institution affiliated to Anna University, Chennai)

CURRICULUM & SYLLABI

FOR

M.E. Engineering Design

(For the batch admitted in 2022– 2023)

R 2022

Accredited by NAAC with A++ Grade,
Approved by AICTE, Affiliated to Anna University, Chennai.

KSR Kalvi Nagar, Tiruchengode – 637 215.
Namakkal District, Tamil Nadu, India.

Rev. No.1/w.e.f. 19.01.2023
Passed in BoS Meeting held on 24/12/2022
Approved in Academic Council Meeting held on 07/01/2023

BoS - Chairman
Mechanical Engineering (UG & PG)
K.S.Rangasamy College of Technology,
Tiruchengode - 637 215.

VISION OF THE DEPARTMENT

- To be a leader in providing skill sets for globally competent Engineers, Researchers, Entrepreneurs and Managers in Mechanical Engineering domain.

MISSION OF THE DEPARTMENT

- To offer quality education through experiential learning using ICT tools and socially –relevant projects.
- To engage Faculty and Students in fundamental, heavy engineering and applied research related to energy, environment and safety concerns.
- To groom students to venture into successful entrepreneurs and managers.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: Graduates of the programme will adapt to emerging technological challenges with core competence in mechanical engineering domain

PEO2: Graduate of the programme will exhibit their technical knowledge and skills to secure suitable positions in any technological organizations and to become successful entrepreneurs

PEO3: Graduates of the programme will pursue advanced studies in thrust areas of mechanical engineering to carryout scientific and industrial research to meet/satisfy current requirements in respective sectors ethically

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

PO1: Ability to individually carryout the STEM based (Science, Technology, Engineering, and Mathematics) research project.

PO2: Ability to write, present and publish technical articles in reputed international/national conferences and journals.

PO3: The skill developed by the student should be at a level of higher than the requirements in the appropriate bachelor program.

PO4: Ability to acquire in depth knowledge of engineering design concepts and application of the same to solve complex engineering problems.

PO5: Ability to find optimum safe and cost effective solutions in the development of mechanical systems taking into consideration sustainability, societal, environmental and public health aspects.

PO6: Ability to support professional ethics and social responsibilities consistent with their roles as design engineers.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

Engineering Graduates will be able to:

PSO1: Use modern tools in the design, analysis and manufacturing of mechanical components and systems.

PSO2: Solve multidisciplinary problems in manufacturing and allied industries.

PSO3: Adopt creative and innovative approaches to address real- time industrial challenges.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) WITH PROGRAMMEOUTCOMES (POs)

The M.E. Engineering Design Programme outcomes leading to the achievement of the objectives are summarized in the following Table.

Programme Educational Objectives	Programme Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
PEO 1	3	2	3	3	2	1
PEO 2	3	2	3	3	2	1
PEO 3	3	2	3	3	2	1

Contributions: 1- low, 2- medium, 3- high

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Year	Sem.	Course Name	PO					
			1	2	3	4	5	6
I	I	Computer Applications in Design	3	3	2	2.4	2	1
		Concepts of Engineering Design	3	3	2.8	2.4	2.4	1.4
		Finite Element Methods in Mechanical Design	3	3	3	3	2.4	1.6
		Advanced Stress Analysis	3	2.6	2.4	2.2	2.2	2
		Research Methodology and IPR	3	3	2	2	2	2
		Audit Course I - English For Research Paper Writing	3	3	2	2.4	2.6	1
		CAD Laboratory	1	3	3	2	3	2
		Computer Aided Analysis Laboratory I	3	3	3	2	3	2
	II	Advanced Vibrations and Acoustics	3		2.4	3	2	2
		Integrated Product Development	3	3	3	2	3	2
		Programme Elective – I						
		Programme Elective – II						
		Programme Elective – III						
		Programme Elective – IV						
		Audit Course II - Disaster Management	3	3	2	2.4	2.6	1
		Computer Aided Analysis Laboratory II	3	3	3	2	3	2
		Technical Report Preparation and Presentation	3	3	1	2	2.6	1
		Mini Project	3	2	1	2.4	2.6	1
II	III	Programme Elective –V						
		Programme Elective –VI						
		Project Work - Phase I	3	3	3	2	3	2
	IV	Project Work - Phase II	3	3	3	2	3	2

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K.S. RANGASAMY COLLEGE OF TECHNOLOGY

Credit Distribution for M.E (ED) Programme –2022 –2023 Batch

S. No.	Category	Credits Per Semester				Total Credits	Percentage %
		I	II	III	IV		
1	PC	19	07	-	-	**26**	**36.11**
2	PE	-	12	06	-	**18**	**25**
3	CG	-	04	08	16	**28**	**38.88**
4	AC	AC - I	AC - II	-	-	**-**	**-**
Total		**19**	**23**	**14**	**16**	**72**	**100**

PC - PROFESSIONALCORE
PE - PROFESSIONALELECTIVES
CG - CAREER GUIDANCE COURSES
AC- AUDIT COURSES

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CONCEIVE DEVELOP IMPLEMENT EXECUTE(CDIE)

PROFESSIONAL CORE COURSES (PC)

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60 PED 101	Computer Applications in Design	PC	3	3	0	0	3	CAD/CAM
2.	60 PED 102	Concepts of Engineering Design	PC	3	3	0	0	3	-NIL-
3.	60 PED 103	Finite Element Methods in Mechanical Design	PC	3	3	0	0	3	-NIL-
4.	60 PED 104	Advanced Stress Analysis	PC	3	3	0	0	3	Strength of Materials
5.	60 PED 001	Research Methodology and IPR	PC	3	3	0	0	3	-NIL-
6.	60 PED 1P1	CAD Laboratory	PC	4	0	0	4	2	-NIL-
7.	60 PED 1P2	Computer Aided Analysis Laboratory I	PC	4	0	0	4	2	CAD Laboratory
8.	60 PED 201	Advanced Vibrations and Acoustics	PC	3	3	0	0	3	-NIL-
9.	60 PED 202	Integrated Product Development	PC	3	3	0	0	3	-NIL-
10.	60 PED 2P1	Computer Aided Analysis Laboratory II	PC	4	0	0	4	2	Computer Aided Analysis Laboratory I

PROFESSIONAL ELECTIVES (PE)

SEMESTER II, PROFESSIONAL ELECTIVE I

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E11	Advanced Machine Design	PE	3	3	0	0	3	Design of Machine Element
2.	60PED E12	Design for Manufacturing and Assembly	PE	3	3	0	0	3	-NIL-
3.	60PED E13	Mathematical Methods In Engineering	PE	3	3	0	0	3	-NIL-
4.	60PED E14	Fuels and Combustion	PE	3	3	0	0	3	-NIL-
5.	60PED E15	Bearing Design and Rotor Dynamics	PE	3	3	0	0	3	-NIL-

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SEMESTER II, PROFESSIONAL ELECTIVE II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E21	Advanced Engineering Materials	PE	3	3	0	0	3	Engineering Material and Metallurgy
2.	60PED E22	Supply Chain Management	PE	3	3	0	0	3	-NIL-
3.	60PED E23	Analysis and Synthesis of Mechanisms	PE	3	3	0	0	3	-NIL-
4.	60PED E24	Instrumentation for Thermal Engineering	PE	3	3	0	0	3	-NIL-
5.	60PED E25	Advanced Internal Combustion Engines	PE	3	3	0	0	3	Fuels and Combustion

SEMESTER II, PROFESSIONAL ELECTIVE III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E31	Tribology in Design	PE	3	3	0	0	3	-NIL-
2.	60PED E32	Robotics	PE	3	3	0	0	3	-NIL-
3.	60PED E33	Fracture Mechanics	PE	3	3	0	0	3	-NIL-
4.	60PED E34	Engine Pollution and Control	PE	3	3	0	0	3	Advanced Internal Combustion Engines
5.	60PED E35	Computational Fluid Dynamics	PE	3	3	0	0	3	-NIL-

SEMESTER II, PROFESSIONAL ELECTIVE IV

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E41	Multi-body Dynamics	PE	3	3	0	0	3	-NIL-
2.	60PED E42	Condition Based Monitoring	PE	3	3	0	0	3	-NIL-
3.	60PED E43	Optimization Techniques in Design	PE	3	3	0	0	3	-NIL-
4.	60PED E44	Alternative Fuels for IC Engines	PE	3	3	0	0	3	Engine Pollution and Control
5.	60PEDE45	Advanced Materials and Their Processing	PE	3	3	0	0	3	Advanced Engineering Materials

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SEMESTER III, PROFESSIONAL ELECTIVE V

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E51	Advanced Finite Element Method	PE	3	3	0	0	3	Finite Element Methods in Mechanical Design
2.	60PED E52	Advanced Metallurgy	PE	3	3	0	0	3	Advanced Materials and Their Processing
3.	60PED E53	Design of Material Handling Equipments	PE	3	3	0	0	3	-NIL-
4.	60PED E54	Advances in Casting and Welding Processes	PE	3	3	0	0	3	-NIL-
5.	60PED E55	Mechanics of Composite Materials	PE	3	3	0	0	3	-NIL-

SEMESTER III, PROFESSIONAL ELECTIVE VI

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60PED E61	Rapid Prototyping and Tooling	PE	3	3	0	0	3	-NIL-
2.	60PED E62	Design of Hydraulic and Pneumatic Systems	PE	3	3	0	0	3	-NIL-
3.	60PED E63	Applied Elasticity and Plasticity	PE	3	3	0	0	3	Advanced Stress Analysis
4.	60PED E64	Theory of Plates and Shells	PE	3	3	0	0	3	-NIL-
5.	60 PED E65	Materials Testing and Characterization Techniques	PE	3	3	0	0	3	-NIL-

AUDIT COURSES (AC)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60 PAC 001	English For Research Paper Writing	AC	2	2	0	0	0	-NIL-
2.	60 PAC 002	Disaster Management	AC	2	2	0	0	0	-NIL-
3.	60 PAC 003	Constitution Of India	AC	2	2	0	0	0	-NIL-

CAREER GUIDANCECOURSES (CG)

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C	Pre-requisite
1.	60 PED 2P2	Technical Report Preparation and Presentation	CG	4	0	0	4	1	-NIL-
2.	60 PED 2P3	Mini Project	CG	4	0	0	4	2	-NIL-
3.	60 PED 3P1	Project Work - Phase I	CG	16	0	0	16	08	Mini Project
4.	60 PED 4P1	Project Work - Phase II	CG	32	0	0	32	16	Project Work - Phase I

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COURSES OF STUDY

(For the candidates admitted from 2022-2023 onwards)

SEMESTER I

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
1		Induction Programme	-	-	-	-	-	0
THEORY								
2.	60 PED 101	Computer Applications in Design	PC	3	3	0	0	3
3.	60 PED 102	Concepts of Engineering Design	PC	3	3	0	0	3
4.	60 PED 103	Finite Element Methods in Mechanical Design	PC	3	3	0	0	3
5.	60 PED 104	Advanced Stress Analysis	PC	3	3	0	0	3
6.	60 PED 001	Research Methodology and IPR	PC	3	3	0	0	3
7.	60 PAC 001	English For Research Paper Writing	AC	1	1	0	0	0
PRACTICALS								
8.	60 PED 1P1	CAD Laboratory	PC	4	0	0	4	2
9.	60 PED 1P2	Computer Aided Analysis Laboratory I	PC	4	0	0	4	2
			Total	**24**	**16**	**0**	**8**	**19**

SEMESTER II

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PED 201	Advanced Vibrations and Acoustics	PC	3	3	0	0	3
2.	60 PED 202	Integrated Product Development	PC	3	3	0	0	3
3.	60 PED E1*	Programme Elective – I	PE	3	3	0	0	3
4.	60 PED E2*	Programme Elective – II	PE	3	3	0	0	3
5.	60 PED E3*	Programme Elective – III	PE	3	3	0	0	3
6.	60 PED E4*	Programme Elective – IV	PE	3	3	0	0	3
7.	60 PAC 002	Disaster Management	AC	1	1	0	0	0
PRACTICALS								
8.	60 PED 2P1	Computer Aided Analysis Laboratory II	PC	4	0	0	4	2
9.	60 PED 2P2	Technical Report Preparation and Presentation	CG	4	0	0	4	1
10.	60 PED 2P3	Mini Project	CG	4	0	0	4	2
			Total	**31**	**19**	**0**	**12**	**23**

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SEMESTER III

S.No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
THEORY								
1.	60 PED E5*	Programme Elective –V	PE	3	3	0	0	3
2.	60 PED E6*	Programme Elective –VI	PE	3	3	0	0	3
PRACTICALS								
3.	60 PED 3P1	Project Work - Phase I	CG	16	0	0	16	8
			Total	**22**	**6**	**0**	**16**	**14**

SEMESTER IV

S. No.	Course Code	Course Title	Category	Contact Periods	L	T	P	C
PRACTICALS								
1.	60 PED 4P1	Project Work - Phase II	CG	32	0	0	32	16
			Total	**32**	**0**	**0**	**32**	**16**

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 72

Note:
PC- Professional Core Courses; PE- Professional Elective Courses; CG-Career Guidance Courses; AC- Audit Courses.

L: Lecture;
T: Tutorial;
P: Practical;
C: Credit

1 Hour Lecture = 1 credit
2 Hours tutorial = 1 credit
2 Hours practical = 1 credit

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M.E. / M.Tech. Degree Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 onwards)

FIRSTSEMESTER

S. No.	Course Code	Name of the Course	Duration of Internal Exam	Weightage of Marks			Minimum Marks for Pass in End Semester Exam	
				Continuous Assessment *	End Semester Exam **	Max. Marks	End Semester Exam	Total
THEORY								
1	60 PED 101	Computer Applications in Design	2	40	60	100	45	100
2	60 PED 102	Concepts of Engineering Design	2	40	60	100	45	100
3	60 PED 103	Finite Element Methods in Mechanical Design	2	40	60	100	45	100
4	60 PED 104	Advanced Stress Analysis	2	40	60	100	45	100
5	60 PED 001	Research Methodology and IPR	2	40	60	100	45	100
6	60 PAC 001	English For Research Paper writing	2	100	-	100	-	-
PRACTICAL								
7	60 PED 1P1	CAD Laboratory	3	60	40	100	45	100
8	60 PED 1P2	Computer Aided Analysis Laboratory I	3	60	40	100	45	100

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department wills put a process in place to ensure that the actual test paper follow the declared pattern.

**End Semester Examination will be conducted for maximum marks of 100 and subsequently be reduced to 60 marks for the award of terminal examination marks.

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60 PED 101	Computer Applications in Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To learn the basics of computer and systems in CAD aspects.
- To get familiarized with the computer graphics application in design.
- To introduce and work with discretized geometry in design of mechanical components and representations of shapes.
- To create solid modeling using graphical knowledge.
- To learn about Finite Element modeling and analysis.

Prerequisite

CAD/CAM

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Conceptualize the principles of CAD systems, implementation and its connections to CAM and CAE systems	Remember & Understand
CO2	Recognize 2D, 3D transformations and projection transformations	Remember & Analyze
CO3	Get knowledge of various approaches of geometric modeling	Remember & Apply
CO4	Comprehend mathematical representation of 2D and 3D entities	Remember & Apply
CO5	Know basic fundamentals of FEM	Remember & Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	1
CO2	3	3	2	2	2	1
CO3	3	3	2	3	2	1
CO4	3	3	2	3	2	1
CO5	3	3	2	2	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember	10	10	20	20
Understand	20	20	30	30
Apply	30	30	50	50
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K. S. Rangasamy College of Technology–Autonomous R2022								
60 PED 101 -Computer Applications in Design								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100

Introduction to Computer Graphics Fundamentals Computer Graphics Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation, concatenated transformations; mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system; inverse transformations and mapping.	[9]
Curves and Surfaces Modeling Projections of geometric models, orthographic projections, Geometric Modeling, Curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations. Surface representation.	[9]
NURBS and Solid Modeling NURBS- Basics- curves, lines, arcs, circle and bi linear surface. Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSG), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing etc.	[9]
Finite Element Modeling and Analysis Finite Element Analysis, finite element modeling, mesh generation mesh requirements, semiautomatic methods, fully automatic methods, System Simulation, Need of simulation, areas of applications, design and engineering applications in visual realism (Hidden – Line – Surface – solid removal algorithms shading - coloring), Introduction to parametric and variational geometry based software's and their principles	[9]
Assembly of Parts and Product Data Exchange Assembly modeling - interferences of positions and orientation - tolerances analysis – mass property calculations - mechanism simulation. Graphics and computing standards– Open GL Data Exchange standards – IGES, STEP etc–Communication standards.	[9]

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	Total Hours:	**45**
Textbook(s):		
1.	William M Newman and Robert F Sproull., “Principles of Interactive Computer Graphics”, McGraw Hill Book Co. Singapore, 2010.	
2.	Ibrahim Zeid and Sivasubramanian, R., “CAD/CAM – Theory and Practice”, Tata McGraw Hill Education Private Ltd., New Delhi, 2010.	
Reference(s):		
1.	Donald Hearn and M Pauline Baker., “Computer Graphics”, Prentice Hall Inc, New Delhi, 2006.	
2.	David F. Rogers, James Alan Adams “Mathematical elements for computer graphics”, 2nd Edition, TataMcGraw-Hill edition, 2010.	
3.	Tirupathi R. Chandrupatla, “Introduction to Finite Elements in Engineering”, Fourth Edition, Pearson, 2012.	
4.	Bathe K.J., Cliffs, N.J. “Finite Element Procedures in Engineering Analysis”, PHI Learning, Eastern Economy Editions, 2009.	

Course Content and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS**	
1.1	Computer Graphics Introduction	1
1.2	Transformation of geometric models: translation, scaling	1
1.3	Reflection, rotation, homogeneous representation	1
1.4	concatenated transformations; mappings of geometric models	1
1.5	Translational mapping & rotational mapping	1
1.6	General mapping & changes of coordinate system	2
1.7	Inverse transformations and mapping.	2
2.0	**CURVES AND SURFACES MODELING**	
2.1	Projections of geometric models	2
2.2	Orthographic projections, Geometric Modeling,	2
2.3	Curve representation: Parametric representation of analytic curves, parametric	1
2.4	Representation of synthetic curves	2
2.5	Curve manipulations & Surface representation.	2

3.0	**NURBS AND SOLID MODELING**	
3.1	NURBS- Basics- curves, lines, arcs, circle and bi linear surface	2
3.2	Fundamentals of solid modeling, boundary representation (B-rep)	1
3.3	Constructive Solid Geometry (CSG), sweep representation	2
3.4	Analytic Solid Modeling (ASM)	1
3.5	Other representations; solid manipulations	1
3.6	Solid modeling based applications	1
3.7	Mass properties calculations, mechanical tolerancing etc.	1
4.0	**FINITE ELEMENT MODELING AND ANALYSIS**	
4.1	Finite Element Analysis, finite element modeling	2
4.2	Mesh generation mesh requirements	1
4.3	Semi-automatic methods, fully automatic methods, System	1
4.4	Simulation, Need of simulation, areas of applications	2
4.5	Design and engineering applications in visual realism(Hidden – Line – Surface – solid removal algorithms shading - coloring)	2
4.6	Introduction to parametric and variational geometry based software's and their principles	1
5.0	**ASSEMBLY OF PARTS AND PRODUCT DATA EXCHANGE**	
5.1	Assembly modeling	1
5.2	interferences of positions and orientation	2
5.3	Tolerances analysis – mass property calculations - mechanism simulation	2
5.4	Graphics and computing standards	1
5.5	Open GL Data Exchange standards	2
5.6	IGES, STEP etc–Communication standards.	1

Course Designer

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60 PED 102	Concepts of Engineering Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on design process and its requirements
- To learn mathematical modelling and geometric modelling techniques in design process
- To acquire knowledge on materials and the material selection for design process
- To learn various material processing techniques and their selection
- To know the legal, environmental and safety issues in design process

Pre-requisites

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Explain the various design process involved in engineering design.	Understand, Apply & Analyze
CO2	Describe the various models and tools used in engineering design.	Understand, Apply & Analyze
CO3	Discuss the methods of material selection and materials in design.	Understand, Apply &Analyze
CO4	Analyze the various materials manufacturing process in design concepts.	Understand & Apply
CO5	Explain the legal, safety and environmental issues related with manufacturing and design.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	2	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	3	2	2
CO5	3	3	3	2	3	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S.Rangasamy College of Technology – AutonomousR2022

60 PED 102 - Concepts of Engineering Design

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100

Design Process 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.	[9]
Tools in Engineering Design 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.	[9]
Material Selection and Materials in Design 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. .	[9]
Material Processing in Design Classification of manufacturing processes and their role in 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.	[9]
Legal, Environmental and Safety Issues in Design and Quality Engineering 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.	[9]
Total Hours:	**45**
Text Book(s):	

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Tiruchengode - 637 215.

1.	George E. Dieter., "Engineering Design – A Materials and Processing Approach", McGraw Hill,
2	Karl T. Ulrich and Steven D. Eppinger., "Product Design and Development", McGraw Hill, International Edition, 2011.
Reference(s):	
1.	Pahl G andBeitz W., "Engineering Design", 3rd Edition, Springer – Verlag, NY, 2007.
2.	Ray M.S., "Elements of Engineering Design", Prentice Hall Inc., 1985.
3.	Suh. N. P., "The Principles of Design", Oxford University Press, NY, 1990.
4.	Atif Aziz, "Concepts in Engineering Design", New Age International Private Limited, 2017

Course Content and Lecture Schedule

Topics		No. of hours
1.0	**Design Process**	
1.1	Introduction –Design Process and Need Identification	1
1.2	Design Requirements	1
1.3	Product Life Cycle	1
1.4	Morphology of Design Steps of Product Design	1
1.5	Conceptual Design, Embodiment Design&Detailed Design	2
1.6	Concurrent Engineering	1
1.7	CAD&CAM, Human Factors in Design	2
2.0	**Tools in Engineering Design**	
2.1	Introduction &Creativity and problem solving	1
2.2	Decision theory, Modeling – Role of Models in Engineering Design	2
2.3	Mathematical Modeling, Geometric Modeling, finite element modeling	2
2.4	Rapid Prototyping – Simulation finite difference method, Monte-Carlo Method	2
2.5	Optimization – Search Methods, Geometric Programming, Structural and Shape Optimization	2
3.0	**Material Selection and Materials in Design**	
3.1	The Classification and Properties of Engineering Materials	1
3.2	Material Standards and Specifications – Methods of Material Selection	1

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3.3	Ashby chart and Method of Weight Factors- Derivation of Material Indice	2
3.4	Use of Material Selection Chart-Pugh Selection Method	1
3.5	Selection with Computed Aided Databases	1
3.6	Design for Brittle Fracture	1
3.7	Design for Fatigue Failure	1
3.8	Design for Corrosion Resistance- Designing with Plastics	2
4.0	**Material Processing in Design**	
4.1	Classification of Manufacturing Processes and their Role in Design	1
4.2	Factors Determining the Process Selection- Use of Process Selection Chart and Computerized Database	2
4.3	Design for Manufacturing	1
4.4	Design for Forging and Sheet Metal Forming	2
4.5	Design for Casting-Design for Machining, Welding and Assembly.	2
4.6	Design for Residual Stresses and Heat Treatment	1
5.0	**Legal, Environmental and Safety Issues in Design and Quality Engineering**	
5.1	The Origin of Laws- Contracts - Liability – Tort Law	1
5.2	Product Liability – Design Aspects of Product Liability- Codes of Ethics	2
5.3	Solving Ethical Conflicts- Design for Environment	1
5.4	Life Cycle Assessment – Material Recycling and Remanufacture-Design for Safety	2
5.5	Potential Dangers and Guidelines for Design for Safety	2
5.6	Design for Reliability Failure Mode Effect Analysis-Robust Design	1

Course Designer

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60 PED 103	Finite Element Methods in Mechanical Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To explore the mathematical theory involved in FEM
- To apply the various steps involved in FEM for solving 1-D problems
- To know the procedure and to solve two dimensional problems
- To implement computer to solve problems involving higher order elements
- To learn and solve linear, static and dynamic problems in Structural Mechanics.

Pre-requisites

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Develop system level matrix equations from a given mathematical model of a problem following the Galerkin weighted residual method or principle of stationary potential.	Understand, Apply& Analyze
CO2	Formulate 1D bar, beam elements and apply them to solve 1-D structural mechanics problems.	Understand & Apply
CO3	Apply FEM for solving 2D structural mechanics problems with plane stress, plane strain and ax symmetric conditions	Understand &Apply
CO4	Implement Gauss-Legendre scheme of numerical integration to evaluate integrals for iso-parametric elements	Remember, Apply & Analyze
CO5	Obtain the fundamental frequency of natural vibration for bars and beams.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	1
CO4	3	3	3	3	2	1
CO5	3	3	3	3	3	2
3- Strong; 2-Medium; 2-Low						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination(Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	10	10	20	20
Apply (Ap)	20	20	30	30
Analyse (An)	20	20	30	30
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S.Rangasamy College of Technology – AutonomousR2022

60 PED 103 - Finite Element Methods In Mechanical Design

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	E	Total
I	3	0	0	45	3	40	6	100

Fundamentals of FEM Introduction, Classification of problems – Dimensionality, time dependence, Boundary value problems, Initial value problems, Linear/Non-linear, etc., - Differential equation as the starting point for FEM, Finite element formulation, variational, weighted residual -Formulation of B.V.P.	[9]
Finite element analysis of one dimensional problems Steps in finite element method, discretization, Types of elements used, Shape functions, Linear Elements, Local and Global coordinates, Nodal degrees of freedom –1 D problems from Structural Mechanics -Bar and Beam problems.- –Applications to Heat Transfer problems.	[9]
Finite element analysis of two dimensional problems 2-D problems from Structural Mechanics –Plane stress and plane strain problems, Axisymmetric problems – Axi-symmetric forces and geometry-Principle of virtual work .	[9]
Iso-parametric formulation Computer implementation, higher order elements, Iso-parametric formulation- Coordinate transformation and Gauss quadrature – one, two and three point integration.	[9]
Dynamic Analysis Eigen-value problems – Natural vibration of bars and beams, Methods to find Eigen values and Eigenvectors-Introduction to transient field problems.	[9]
TotalHours	**45**

Text Book(s):

1.	Chandrupatla and Belegundu "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, 4th Edition, 2015.
2	Reddy J N, "Finite Element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, 3rdEdition, 2006.

Reference(s):

1.	Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 5th Ed.2012.
2.	Cook R.D. "Concepts and Applications of Finite Element Analysis" Wiley, New York, 4th Ed. 2007.

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3.	Bathe K.J., Cliffs, N.J. “Finite Element Procedures in Engineering Analysis”, PHILearning, Eastern Economy Editions, 2009.
4.	Ross C T F., “Advanced Applied Finite Element Methods”, Horwood Publishing, 1998.

Course Content and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**FUNDAMENTALS OF FEM**	
1.1	Introduction, Classification of problems	1
1.2	Dimensionality, time dependence, Boundary value problems	1
1.3	Initial value problems, Linear/Non-linear, etc.	1
1.4	Differential equation as the starting point for FEM	2
1.5	Finite element formulation	1
1.6	Variational, weighted residual	1
1.7	Formulation of B.V.P	2
2.0	**FINITE ELEMENT ANALYSIS OF ONE DIMENSIONAL PROBLEMS**	
2.1	Steps in finite element method, discretization	1
2.2	Types of elements used, Shape functions, Linear Elements	2
2.3	Local and Global coordinates, Nodal degrees of freedom	2
2.4	1 D problems from Structural Mechanics -Bar and Beamproblems	2
2.5	Applications to Heat Transfer problems	2
3.0	**FINITE ELEMENT ANALYSIS OF TWO DIMENSIONAL PROBLEMS**	
3.1	2-D problems from Structural Mechanics	1
3.2	Plane stress and plane strain problems	2
3.3	Axisymmetric problems	2
3.4	Symmetric forces and geometry	2
3.5	Principle of virtual work	2

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4.0	**ISO-PARAMETRIC FORMULATION**	
4.1	Computer implementation	1
4.2	Higher order elements	2
4.3	Iso-parametric formulation	2
4.4	Coordinate transformation and Gauss quadrature	2
4.5	One, two and three point integration	2
5.0	**DYNAMIC ANALYSIS**	
5.1	Eigen-value problems	1
5.2	Natural vibration of bars and beams	2
5.3	Methods to find Eigen values	2
5.4	Methods to find Eigenvectors	2
5.5	Introduction to transient field problems	2

Course Designer

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60 PED 104	Advanced Stress Analysis	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To enable the students to provide fundamental theory of elasticity and energy methods for stress and strain analysis.
- To learn the theory of torsion and its analogies
- To acquire the concept of shear center in symmetrical and unsymmetrical bending
- To learn knowledge on pressurized cylinders and rotating disks
- To impart knowledge on method of computing contact stresses.

Pre-requisite

Strength of Materials

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Know the concept of elasticity, and the difference between stress and strain.	Understand, Apply & Analyze
CO2	Apply basic field equations to torsion, bending and two dimensional energy methods.	Understand, Apply & Analyze
CO3	Solve problems in unsymmetrical bending and shear center.	Understand, Apply & Analyze
CO4	Calculate the stresses and deformation of the pressurized cylinders and rotating disc.	Understand & Apply
CO5	Apply principles of continuum mechanics to design a structure or component to achieve desired performance under realistic constraints.	Understand & Apply

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	3	3	3	2	2	2
CO3	3	3	2	3	2	2
CO4	3	2	2	2	1	2
CO5	3	3	2	2	3	2
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		Model Exam (Marks)	End Sem Examination(Marks)
	1	2		
Remember (R)	5	5	15	15
Understand (U)	5	5	15	15
Apply (Ap)	30	30	40	40
Analyze (An)	20	20	30	30
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K. S. Rangasamy College of Technology–AutonomousR2022								
60 PED 104 - Advanced Stress Analysis								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100

Theory of Elasticity Analysis of stress, Analysis of stain, Elasticity problems in two dimension and three dimensions, Mohr's circle for three dimensional stresses. Stress tensor, Air's stress function in rectangular and polar coordinates. Energy method for analysis of stress, strain and deflection , three theorem's - theorem of virtual work, theorem of least work, Castiglione's theorem, Rayleigh Ritz method, Galekin's method.	[9]
Shear Centre and Unsymmetrical Bending Location of shear centre for various thin sections - shear flows. Stresses and Deflections in beams subjected to unsymmetrical loading-kern of a section.	[9]
Stresses in Flat Plates and Curved Members 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.	[9]
Theory of Torsion Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable diameter, thin walled members of open cross section in which some sections are prevented from warping, Torsion of noncircular shaft	[9]
S**tresses in Rotating Members and Contact Stresses** 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.	[9]
Total Hours	**45**
Text Book(s):	

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Mechanical Engineering (UG & PG)
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1.	Richard Budynas, R. G.,"Advance Strength and Applied Stress Analysis", 2nd Edition, WCB/ McGraw Hill 2017.
2.	Dally, J. W. and Riley W F., "Experimental Stress Analysis", 3rd Edition, McGraw Hill International,1991.
Reference(s):	
1.	Sadd, Martin H., "Elasticity: Theory, applications and Numeric", 3rd Edition, Academic Press 2014.
2.	Boresi, A.P. and Chong K P., "Elasticity in Engineering Mechanics", 2nd Edition, John Wiley & Sons, 1987.
3.	Stephen Timoshenko, Goodier J N., "Theory of Elasticity" 3rd edition, McGraw Hill publication, 2017..
4.	Stephen Timoshenko, "Advanced Strength of Materials", Vol. 1 and 2, 3rd Edition, CBS Publishers and Distributors Pvt. Ltd., 2002.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**THEORY OF ELASTICITY**	
1.1	Analysis of stress and stain	1
1.2	Elasticity problems in two dimension and three dimensions	1
1.3	Mohr's circle for three dimensional stresses	1
1.4	Stress tensor, Air's stress function in rectangular and polar coordinates	1
1.5	Energy method for analysis of stress, strain anddeflection	1
1.6	Three theorem's -theorem of virtual work, theorem ofleast work	2
1.7	Castiglione's theorem, Rayleigh Ritz method, Galekin's method	2
2.0	**SHEAR CENTRE AND UNSYMMETRICAL BENDING**	
2.1	Location of shear centre for various thin sections	2
2.2	shear flows in thin sections	2
2.3	Stresses and Deflections in beams subjected to unsymmetrical loading	3
2.4	kern of a section	2
3.0	**STRESSES IN FLAT PLATES AND CURVED MEMBERS**	
3.1	Circumference and radial stresses	1
3.2	Deflections - curved beam with restrained ends	1
3.3	Closed ring subjected to concentrated load and uniform load	1
3.4	Chain links and crane hooks	1
3.5	Solution of rectangular plates	1
3.6	Pure bending of plates	1
3.7	Deflection – uniformly distributed load	1

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3.8	Various end conditions	2
4.0	**THEORY OF TORSION**	
4.1	Torsion of prismatic bars of solid section and thin walled section	2
4.2	Analogies for torsion, membrane analogy	1
4.3	Fluid flow analogy and electrical analogy	1
4.4	Torsion of conical shaft, bar of variable diameter	2
4.5	Thin walled members of open cross section in which some sections are prevented from warping	2
4.6	Torsion of noncircular shaft	1
5.0	**STRESSES IN ROTATING MEMBERS AND CONTACT STRESSES**	
5.1	Radial and tangential stresses in solid disc	1
5.2	Radial and tangential stresses in ring of uniform thickness	2
5.3	Varying thicknessallowable speeds	2
5.4	Methods of computing contact stress-deflection of bodies in point	2
5.5	Linecontact applications	2

Course Designer

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60 PED 001	Research Methodology and IPR	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the principles research process.
- To develop knowledge in analytical skills for collection of research data.
- To understand the procedure in the preparation of reports.
- To accomplish basic idea about the process involved in intellectual property rights.
- To enlighten the process of patent filling.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	To understand the research process and design.	Remember, Understand & Apply
CO2	To gain the knowledge about sources and collection of research data	Remember, Understand & Analyze
CO3	To understand the procedure of data analysis and preparation of reports and checking plagiarism.	Remember, Understand & Analyze
CO4	To gain the knowledge on trade mark and functions of UNESCO in IPR.	Remember, Understand & Apply
CO5	To enlighten the benefits, E-filing and Examinations related to patents.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	2	2
CO2	3	3	2	2	2	2
CO3	3	3	2	2	2	2
CO4	3	3	2	2	2	2
CO5	3	3	2	2	2	2
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	30
Understand (U)	20	20	40	30
Apply (Ap)	30	30	40	30
Analyze (An)	0	0	0	10
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED 001- Research Methodology and IPR

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	3	40	60	100

Research Design Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys, selection of the Right Medium and Journal of publication, Translation of research.	[9]
Data Collection and Sources Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.	[9]
Data Analysis and Reporting Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation. Checks for plagiarism, Falsification, Fabrication and Misrepresentation.	[9]
Intellectual Property Rights 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	[9]
Patents 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.	[9]
Total Hours:	**45**

Text Book(s):

1.	David I. Bainbridge, "Intellectual Property", Longman, 9th Edition, 2012.
2	Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).

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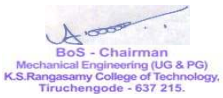

Reference(s):	
1.	Chawla H S., “Introduction to Intellectual Property Rights”, CBS PUB & DIST PVT Limited, INDIA, 2019.
2.	Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007
3.	David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007
4.	Arun K. Narasani, Kankanala K.C., Radhakrishnan V., “Indian Patent Law and Practice”, Oxford University Press, 2010.
5.	Richard Stim, “Patent, Copyright & Trademark - An Intellectual Property Desk Reference”, NOLO Publishers, 2020.
6.	The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Research Design**	
1.1	Overview of research process and design	1
1.2	Use of Secondary and exploratory data to answer the research question	2
1.3	Qualitative research	1
1.4	Observation studies	1
1.5	Experiments and Surveys	1
1.6	Selection of the Right Medium and Journal for publication	2
1.7	Translation of Research	1
2.0	**Data Collection and Sources**	
2.1	Measurements, Measurement Scales	2
2.2	Questionnaires and Instruments	2
2.3	Sampling and methods	2
2.4	Data - Preparing, Exploring, examining and displaying	3
3.0	**Data Analysis and Reporting**	
3.1	Overview of Multivariate analysis	1
3.2	Hypotheses testing and Measures of Association	2
3.3	Presenting Insights	1
3.4	Findings using written reports and oral presentation	2
3.5	Checks for Plagiarism	1
3.6	Falsification	1

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3.7	Fabrication, and Misrepresentation	1
4.0	**Intellectual Property Rights**	
4.1	Intellectual Property – The concept of IPR	1
4.2	Evolution and development of concept of IPR, IPR development process	2
4.3	Trade secrets, utility Models, IPR & Bio diversity	2
4.4	Role of WIPO and WTO in IPR establishments	1
4.5	Right of Property, Common rules of IPR practices	1
4.6	Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance	2
5.0	**Patents**	
5.1	Patents – objectives and benefits of patent, Concept, features of patent	2
5.2	Inventive step, Specification, Types of patent application	2
5.3	Process E-filling, Examination of patent	1
5.4	Grant of patent, Revocation	1
5.5	Equitable Assignments, Licences, Licensing of related patents	2
5.6	Patent agents, Registration of patent agents	1

Course Designers

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60 PED 1P1	CAD Laboratory	Category	L	T	P	Credit
		PC	0	0	4	2

Objectives

- To apply basic concepts to develop construction (drawing) techniques
- To manipulate drawings through editing and plotting techniques
- To learn geometric construction and produce template drawings
- To understand and demonstrate dimensioning concepts and techniques
- To learn the use of Blocks, Design Center, and Tool Palettes.

Pre-requisite

- NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Use the modern engineering tools necessary for engineering practice	Understand &Apply
CO2	Draw 2D part drawings, sectional views, and assembly drawings as per standards.	Understand &Apply
CO3	Create 3D Model on any CAD software	Understand &Apply
CO4	Convert 3D solid models into 2D drawings and prepare different views, sections, and dimensioning of part models.	Understand &Apply
CO5	Examine interference to ensure that parts will not interfere.	Understand, Apply & Create

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	3	3	2	3	2
CO2	1	3	3	2	3	2
CO3	1	3	3	2	3	2
CO4	1	3	3	2	3	2
CO5	1	3	3	2	3	2
3- Strong;2-Medium;1-Some						

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K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PED 1P1 - CAD Laboratory								
PED : M.E. Engineering Design								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	0	0	4	60	2	60	40	100

List of Experiments:

1. Part and Assembly of Flange Coupling
2. Part and Assembly of Universal Coupling
3. Part and Assembly of Bushed pin type flanged coupling
4. Part and Assembly of Knuckle Joint
5. Part and Assembly of Plummer Block
6. Part and Assembly of Connecting rod
7. Part and Assembly of Screw Jack
8. Part and Assembly of C-Clamp
9. Part and Assembly of Machine Vice
10. Part and Assembly of Foot-step bearing

Text book (s) :

1	Butt N.D., “Machine Drawing”, Charotar Publishing house Pvt. Ltd., 51st Edition, New

Course Designers

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BoS - Chairman
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Tiruchengode - 637 215.

60 PED 1P2	Computer Aided Analysis Laboratory I	Category	L	T	P	Credit
		PC	0	0	4	2

Objectives

- To develop the students to perform the structural analysis of 2D and 3D trusses
- To learn the students to perform structural analysis of beams
- To impart knowledge on torsion and bending analysis of bar and beam using CAE software.
- To develop the students to perform the stress analysis of plate, corner bracket
- To acquire skill to perform stress analysis of pressure vessel and cylinder using CAE software.

Pre-requisite

CAD Laboratory

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Perform the structural analysis of 2D and 3D trusses	Understand & Apply
CO2	Perform the structural analysis of beams	Understand & Apply
CO3	Perform the torsion and bending analysis of bar and beam	Understand & Apply
CO4	Perform the stress analysis of plate and corner bracket	Understand & Apply
CO5	Perform the stress analysis of cylindrical component	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	2
CO2	3	3	3	2	3	2
CO3	3	3	3	2	3	2
CO4	3	3	3	2	3	2
CO5	3	3	3	2	3	2
3- Strong; 2-Medium; 1-Some						

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K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PED 1P2- Computer Aided Analysis Laboratory I								
PED : M.E. Engineering Design								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	0	0	4	60	2	60	40	100

List of Experiments:

1. Structural analysis of four bar truss under structural and thermal loading.
2. Structural analysis of 3D space truss.
3. Stress and deflection analysis of simply supported beam with different support conditions
4. Analysis of continuous beam with overhang and multiple loading conditions.
5. Torsion analysis of a stepped cantilever bar.
6. Bending analysis of a simply supported I – beam.
7. Stress analysis of a rectangular plate with circular holes.
8. Stress analysis of corner bracket with plane stress condition.
9. Stress analysis of axi – symmetric components.
10. Stress analysis of a long cylindrical pressure vessel using plane strain element.

Text book (s) :

1	Chandrupatla and Belegundu “Introduction to Finite Elements in Engineering”, Prentice Hall of India Pvt. Ltd. New Delhi, 4th Ed., 2015.

Course Designer

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K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE - 637215
(An Autonomous Institution affiliated to Anna University)

M.E. / M.Tech. Degree Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 onwards)

SECOND SEMESTER

S. No.	Course Code	Name of the Course	Duration of Internal Exam	Weightage of Marks			Minimum Marks for Pass in End Semester Exam	
				Continuous Assessment *	End Semester Exam **	Max. Marks	End Semester Exam	Total
THEORY								
1	60 PED 201	Advanced Vibrations and Acoustics	2	40	60	100	45	100
2	60 PED 202	Integrated Product Development	2	40	60	100	45	100
3	60 PED E1*	Programme Elective – I	2	40	60	100	45	100
4	60 PED E2*	Programme Elective – II	2	40	60	100	45	100
5	60 PED E3*	Programme Elective – III	2	40	60	100	45	100
6	60 PED E4*	Programme Elective – IV	2	40	60	100	45	100
7	60 PAC 002	Disaster Management	2	100	-	100	-	-
PRACTICAL								
8	60 PED 2P1	Computer Aided Analysis Laboratory II	3	60	40	100	45	100
9	60 PED 2P2	Technical Report Preparation and Presentation	3	100	-	100	-	-
10	60 PED 2P3	Mini Project	3	100	-	100	-	-

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department will put a process in place to ensure that the actual test paper follow the declared pattern.

** End Semester Examination will be conducted for maximum marks of 100 and subsequently be reduced to 60 marks for the award of terminal examination marks.

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60 PED 201	Advanced Vibrations and Acoustics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on mechanical vibrations of single of freedom and continuous systems.
- To design systems to achieve the vibratory response, analyze and predict vibratory behavior of mechanical systems using multiple degrees of freedom.
- To interpret and solve acoustic engineering problems using analytical, modern computational and experimental methods.
- To understand the fundamentals of acoustics in engineering applications.
- To understand the principles in psychoacoustics used for Speech, mechanism of hearing, thresholds of the ear.

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations.	Understand, Apply & Analyze
CO2	Write differential equations of motion for MDOF systems, and through the technique of decoupling and orthogonal properties of natural modes.	Understand, Apply &Analyze
CO3	Obtain the Eigen-values and mode shapes of natural vibrations of beams and response to harmonic excitations using orthogonal properties of natural modes and to obtain natural frequencies and mode shapes.	Understand & Apply
CO4	Interpret and solve the acoustic engineering problems using analytical methods.	Understand & Apply
CO5	Apply principles of Psychoacoustics	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3		2	3	2	2
CO 2	3		3	3	2	2
CO 3	3		3	3	2	2
CO 4	3		2	3	2	2
CO 5	3		2	3	2	2
*3- Strong; 2-Medium; 1-*Some2						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		Model Exam (Marks)	End Sem Examination(Marks)
	1	2		
Remember (R)	10	10	30	30
Understand (U)	20	20	30	30
Apply (An)	30	30	30	30
Analyze	0	0	10	10
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S.Rangasamy College of Technology –Autonomous R2022

60 PED 201 - Advanced Vibrations and Acoustics

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
I	3	0	0	45	0	40	60	100

Fundamentals of Vibration Transient Vibrations, Response of a single degree of freedom damped and undamped system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function.	[9]
Multi Degree of Freedom Systems Multi degree of freedom systems, Free, damped and forced vibrations of two degree of freedom systems, Eigen values and Eigen vectors, normal modes and their properties, mode summation method, use of Lagrange's equations to derive the equations of motion.	[9]
Vibration of Continuous Systems Continuous Systems, Natural Vibrations of beams – Differential equation of motion, solution by the method of separation of variables, frequency parameter, natural frequencies and mode shapes, forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method Vibration Control, Methods of vibration control, principle of superposition, Numerical and computer methods in vibrations: Rayleigh, Rayleigh-Ritz and Dunkerley's methods, matrix iteration method for Eigen-value calculations, Holzer's method.	[9]
Fundamentals of Acoustics Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence, reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields, simple models of sound sources, sound power, determination of sound power and intensity levels at a point due to a simple source.	[9]
Psychoacoustics Speech, mechanism of hearing, thresholds of the ear – sound intensity and frequency, loudness, equal loudness levels, loudness, pitch and timbre, beats, masking by pure tones, masking by noise.	[9]

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	Total Hours	45
Text Book(s):		
1.	Rao, S.S., “Mechanical Vibrations”, Addison Wesley Longman, New York, 2012.	
2.	Lawrence E. Kinsler and Austin R.Frey, “Fundamentals of acoustics”,Wiley India Pvt. Ltd., New Delhi, 2009.	
Reference(s):		
1.	Thomson, W.T., “Theory of Vibration with Applications”, CBS Publishers and Distributors, New Delhi,2002.	
2.	Iyengar, R.N., “Elements of Mechanical Vibration”, I K International Pub. House Pvt. Ltd., New Delhi, 2007.	
3.	Graham S. Kelly and Shashidar K. Kudari., “Mechanical Vibrations“, Tata McGraw Hill Pub. Ltd., ND, 2007.	
4.	Michael Rettinger, “Acoustic Design and Noise Control”, Vol. I & II, Chemical Pub.Co., New York, 1977.	

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**FUNDAMENTALS OF VIBRATION**	
1.1	Transient Vibrations	1
1.2	Response of a single degree of freedom damped and undamped system to step excitation	2
1.3	Response of a single degree of freedom damped and undamped system to any arbitrary excitation	2
1.4	Convolution (Duhamel’s) integral	2
1.5	Impulse response function	2
2.0	**MULTI DEGREE OF FREEDOM SYSTEMS**	
2.1	Multi degree of freedom systems	1
2.2	Free, damped and forced vibrations of two degree of freedom systems,	2
2.3	Eigen values and eigen vectors, normal modes and their properties,	2
2.4	Mode summation method	2
2.5	Use of lagrange’s equations to derive the equations of motion	2
3.0	**VIBRATION OF CONTINUOUS SYSTEMS**	
3.1	Continuous Systems, Natural Vibrations of beams – Differential equation of motion,	1
3.2	Solution by the method of separation of variables, frequency parameter, natural frequencies and mode shapes	1
3.3	Forced vibration of simply supported beam subjected to concentrated harmonic force at a point, Mode summation method, discretized models of continuous systems and their solutions using Rayleigh – Ritz method,	2

3.4	Vibration Control, Methods of vibration control, principle of superposition, Numerical and computer methods in vibrations	2
3.5	Rayleigh, Rayleigh-Ritz and Dunkerley's methods	2
3.6	Matrix iteration method for Eigen-value calculations, Holzer's method	1
4.0	**FUNDAMENTALS OF ACOUSTICS**	
4.1	Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media,	2
4.2	Sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another, normal incidence,	2
4.3	Reflection at the surface of a solid, standing wave patterns, Symmetric Spherical waves, near and far fields,	2
4.4	Simple models of sound sources, sound power	2
4.5	Determination of sound power and intensity levels at a point due to a simple source	1
5.0	**PSYCHOACOUSTICS**	
5.1	Speech, mechanism of hearing, thresholds of the ear	2
5.2	Sound intensity and frequency, loudness, equal loudness levels	2
5.3	Loudness, pitch and timbre	2
5.4	Beats	1
5.5	Masking by pure tones, masking by noise	2

Course Designers

Dr. K. Santhanam - santhanam@ksrct.ac.in

60 PED 202	Integrated Product Development	Category	L	T	P	Credit
		PC	3	0	0	3

Objective

- To understand the principles of generic development process; product planning; customer need analysis for new product design and development.
- To enhance the understanding of setting product specifications and generate, select, screen, and test concepts for new product design and development.
- To apply the principles of product architecture and the importance of industrial design principles and DFM principles for new product development.
- To expose the different Prototyping techniques, Design of Experiment principles to develop a robust design and importance to patent a developed new product.
- Applying the concepts of economics principles; project management practices in development of new product.

Pre-requisite

NIL

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Apply the principles of generic development process; product planning; customer need analysis for new product design and development.	Remember, Understand & Apply
CO2	Identify product specifications and generate, select, screen, test concepts for new product design and development.	Remember & Apply
CO3	Apply the principles of product architecture, industrial design and design for manufacturing principles in new product development.	Remember & Apply
CO4	Apply the adopt Prototyping techniques and Design of Experiment principles to develop a robust design and document a new product for patent.	Remember, Understand & Apply
CO5	Apply the engineering concepts on product development economics.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	2	2
CO2	3	3	3	2	2	2
CO3	3	3	3	2	2	2
CO4	3	3	3	2	2	2
CO5	3	3	3	2	2	2
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	30
Understand (U)	20	20	40	30
Apply (Ap)	30	30	40	30
Analyze (An)	0	0	0	10
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S.Rangasamy College of Technology – Autonomous R2022

60 PED 202 - Integrated Product Development

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction to Product Design 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.	[9]
Product Specifications, Concept Generation, Selection and Testing Establish Target and Final product specifications – Activities of Concept Generation - Concept Screening and Scoring - Concept Testing Methodologies.	[9]
Product Architecture and Industrial Design 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.	[9]
Design for Manufacture, Prototyping and Robust Design 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.	[9]
Product Development Economics and Managing Projects Economic Analysis – Elements of Economic Analysis - Understanding and representing tasks- Baseline Project Planning - Accelerating the project - Project execution – Postmortem project evaluation.	[9]
Total Hours	**45**
Textbook(s):	

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

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**INTRODUCTION TO PRODUCT DESIGN**	
1.1	Characteristics of Successful Product development	1
1.2	Duration and Cost of Product Development	1
1.3	Challenges of Product Development	2
1.4	Product Development Processes and Organizations	2
1.5	Product Planning Process	2
1.6	Process of Identifying Customer Needs	1
2.0	**PRODUCT SPECIFICATIONS, CONCEPT GENERATION, SELECTION AND TESTING**	
2.1	Establish Target	1
2.2	Final product specifications	2
2.3	Activities of Concept Generation	2
2.4	Concept Screening and Scoring	2
2.5	Concept Testing Methodologies	2
3.0	**PRODUCT ARCHITECTURE AND INDUSTRIAL DESIGN**	
3.1	Product Architecture – Implications and establishing the architecture	1
3.2	Delayed Differentiation and Platform Planning	1
3.3	Related system level design issues	1
3.4	Need and impact of industrial design	2
3.5	Industrial design process	2
3.6	Management of the industrial design process	1

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3.7	Assessing the quality of industrial design	1
4.0	**DESIGN FOR MANFACTURE, PROTOTYPING AND ROBUST DESIGN**	
4.1	DFM Definition and Estimation of Manufacturing cost	2
4.2	Reducing the component costs, costs of supporting function and assembly costs	2
4.3	Impact of DFM decision on other factors, Prototype basics	2
4.4	Principles of prototyping, Prototyping technologies	2
4.5	Planning for prototypes, Robust design, Robust Design Process.	1
5.0	**PRODUCT DEVELOPMENT ECONOMICS AND MANAGING PROJECTS**	
5.1	Economic Analysis – Elements of Economic Analysis	2
5.2	Understanding and representing tasks	2
5.3	Baseline Project Planning - Accelerating the project	2
5.4	Project execution	1
5.5	Postmortem project evaluation	2

Course Designers

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60 PED E11	Advanced Machine Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on product development processes and organizations
- To study design concepts in order to enhance the design process
- To study behavior of engineering materials/components under fatigue and creep.
- To study statistical techniques and its applications in mechanical design
- To learn the Legal, Ethical Environmental and Safety Issues in Design and Quality Engineering

Pre-requisite

Design of Machine Element

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Realize that creativity, manufacturability, assembly, maintainability, emotions, reliability are also important aspects of design other than finding dimensions and stresses in the highly competitive, dynamic and customer centered market.	Understand, Apply & Analyse
CO2	Demonstrate the ability to identify needs of the customer and convert them into technical specifications of a product.	Understand, Apply & Analyse
CO3	Generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.	Understand, Apply & Analyse
CO4	Understand the principals used while designing for manufacture, assembly, emotions and maintenance.	Understand & Apply
CO5	Know various methods of rapid prototyping the products to test and modify the designs.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	1	2
CO2	3	2	3	2	1	2
CO3	3	3	2	2	1	2
CO4	3	2	3	2	1	2
CO5	3	3	3	2	1	2
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination(Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E11 - Advanced Machine Design

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction Development processes and organizations, Product Planning, The design process.	[9]
The Design Process Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing, human factors in design.	[9]
Material Processing and Design Design for manufacture, assembly, maintenance, casting, forging, sheet metal forming and welding.	[9]
Reliability Design for Reliability, failure mode effect analysis, strength based reliability, parallel and series systems, robust design.	[9]
Legal, Ethical Environmental and Safety Issues in Design and Quality Engineering Industrial design: Design for Emotion and experience, Introduction to retrofit and Eco design, Human behaviour in design, life cycle assessment, material recycling and remanufacture, Rapid Prototyping.	[9]
Total Hours:	**45**

TextBook(s):

1.	George E Dieter, "Engineering Design", McGraw Hill Company, New Delhi, 2016.
2	Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi. 2012.

Reference(s):

1.	Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.
2.	John J.C. "Design Methods", Wiley Inter science, 1970.
3.	Averill M. Law and David Kelton W., "Simulation, modelling and analysis", McGraw HillBook Co., 1991.
4.	Pahl, G andBeitz,W.,"Engineering Design–A Systematic Approach", Springer, 2nd Edition, 1996.

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Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**INTRODUCTION**	
1.1	Introduction to development processes and organizations	1
1.2	Development processes	2
1.3	Development organizations	2
1.4	Product Planning	2
1.5	Process Planning	2
2.0	**THE DESIGN PROCESS**	
2.1	Need Identification and problem definition	2
2.2	Product specification	1
2.3	Concept generation and selection	2
2.4	Evaluation, creativity methods	2
2.5	Concept testing, human factors in design	2
3.0	**MATERIAL PROCESSING AND DESIGN**	
3.1	Design for manufacture	2
3.2	Design for assembly	2
3.3	Maintenance	1
3.4	Casting, forging	2
3.5	Sheet metal forming and welding	2
4.0	**RELIABILITY**	
4.1	Design for Reliability	2
4.2	Failure mode effect analysis	2
4.3	Strength based reliability	1
4.4	Parallel and series systems	2
4.5	Robust design	2
5.0	**LEGAL, ETHICAL ENVIRONMENTAL AND SAFETY ISSUES IN DESIGN AND QUALITY ENGINEERING**	
5.1	Industrial design	2
5.2	Design for Emotion and experience	1
5.3	Introduction to retrofit and Ecodesign	1
5.4	Human behaviour in design	1
5.5	Life cycle assessment	1
5.6	Material recycling and remanufacture	1
5.7	Rapid Prototyping	2

Course Designers

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60 PED E12	Design for Manufacturing and Assembly	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To provide an overview of Design for Manufacturing and Assembly (DFMA) techniques
- To minimize product cost through design and process improvements.
- To introduce the concept and application for design for manufacturing and assembly to practicing designers and manufacturing engineers as well as design students
- To discuss various fundamentals of assembly and design recommendations for product development
- To learn how to reliability concepts to improve quality

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Recognize the product development cycle	Remember & Apply
CO2	Know the manufacturing issues that must be considered in the mechanical engineering design process	Remember& Analyze
CO3	Know the principles of assembly to minimize the assembly time	Remember, Understand & Apply
CO4	Know the effect of manufacturing process and assembly operations on the cost of product (not included by others)	Remember& Apply
CO5	Be familiar with tools and methods to facilitate development of manufacture mechanical designs	Remember& Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	1	1
CO2	3	2	2	2	2	1
CO3	3	2	3	2	1	1
CO4	3	3	3	3	2	1
CO5	3	2	2	2	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom'sCategory	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E12 - Design for Manufacturing and Assembly

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction Introduction Need Identification and Problem Definition, Concept Generation andEvaluation, Embodiment Design, Selection of Materials and Shapes.	[9]
Material Consideration Properties of Engineering Materials, Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II.	[9]
Design for Manufacture Selection of Manufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Selection of Materials and Processes, Case-Studies – III.	[9]
Design for Assembly Design for Assembly, Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering, Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies – IV	[9]
Design for Reliability Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality, Approach to Robust Design, Design for Optimization.	[9]
Total Hours:	**45**

Textbook(s):

1.	Courtney, T H., "Mechanical Behavior of Materials", 2nd Edition, Waveland Press, 2005.
2.	Dieter G E, "Engineering Design - A Materials and Processing Approach", 4th Edition, McGraw Hill, NY, 2008.
3.	Swift,K G and Booker, J D., "Process Selection: From Design to Manufacture", 2nd Edition, Elsevier – London, 2003.

Reference(s):

1.	Rao, S S. "Engineering Optimization: Theory and Practice", 4th Edition, John Wiley, NY, 2009.
2.	Boothroyd G, Dewhurst P and Knight W, "Product Design for Manufacture and Assembly, 3rd Edition,

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	JohnWiley, NY: Marcel Dekkar, 2010.
3.	Bralla J G, “Handbook of Product Design for Manufacture”, McGraw Hill, NY, 1998.
4.	Ashby M F and Johnson K, “Materials and Design - The Art and Science of Material Selection in Product Design”, 3rd Edition, Butterworth-Heinemann, 2014.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Introduction**	
1.1	Introduction Need Identification	2
1.2	Problem Definition	1
1.3	Concept Generation	2
1.4	Evaluation	1
1.5	Embodiment Design	1
1.6	Selection of Materials and Shapes	2
2.0	**Material Consideration**	
2.1	Properties of Engineering Materials	1
2.2	Selection of Materials – I,	1
2.3	Selection of Materials – II, Case Studies – I	2
2.4	Selection of Shapes	1
2.5	Co-selection of Materials and Shapes	2
2.6	Case Studies – II.	2
3.0	**Design for Manufacture**	
3.1	Selection of Manufacturing Processes,	1
3.2	Review of Manufacturing Processes, Design for Casting	2
3.3	Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes	2
3.4	Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing	2
3.5	Selection of Materials and Processes, Case-Studies – III.	2
4.0	**Design for Assembly**	
4.1	Design for Assembly, Review of Assembly Processes	2
4.2	Design for Welding – I	1
4.3	Design for Welding – II	1
4.4	Design for Brazing and Soldering, Design for Adhesive Bonding	2
4.5	Design for Joining of Polymers, Design for Heat Treatment,	2
4.6	Case-Studies – IV	1
5.0	**Design for Reliability**	
5.1	Design for Reliability	1
5.2	Failure Mode and Effect Analysis and Quality	2
5.3	Design for Quality	2
5.4	Approach to Robust Design	2
5.5	Design for Optimization	2

Course Designer

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60 PED E13	Mathematical Methods In Engineering	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To introduce the basic concepts of probability and explain about standard distributions.
- To familiarize the students with various methods in hypothesis testing
- To design and analyze the statistical experiments
- To solve initial value problems for ordinary differential equations numerically.
- To Solve numerically partial differential equations of parabolic, elliptic and hyperbolic types with appropriate boundary and initial conditions encountered in engineering design

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Comprehend the concept of probability and apply the concepts of standard distributions and central limit theorem.	Remember, Understand & Apply
CO2	Test the statistical hypothesis using t, F and χ^2 distributions.	Understand & Analyze
CO3	Analyze the design of experiments using different methods.	Understand & Apply
CO4	Compute the solution for initial value problem using single step and multi-step methods.	Understand & Apply
CO5	Find the solution of PDE using boundary condition.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	1
CO2	3	3	2	3	2	1
CO3	3	3	3	3	2	2
CO4	3	3	3	2	2	2
CO5	3	3	2	2	2	2
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	20	20
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	30	30
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E13 - Mathematical Methods In Engineering

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction to Probability Theory Probability theory and sampling distributions: basic probability theory – standard discrete and continuous distributions like Binomial, Poisson, Geometric distributions – Uniform, Exponential, Gamma and Normal distributions – central limit theorem and its significance.	[9]
Testing of Hypothesis Small sample tests based on t, F and Type equation here.distributions – Contingency table (Test for Independency)– Goodness of fit – large sample.	[9]
Design of Experiments (ANOVA) One way classification – Completely randomized design – Two way classification – Randomized block design – Latin square design – 2n factorial design.	[9]
Ordinary Differential Equations Single step methods: Taylor's series method – Euler's and modified Euler's methods – Fourth order Runge – Kutta method for solving first order equations – Multistep methods: Milne's and Adam's predictor and corrector methods.	[9]
Partial Differential Equations and Concepts in Solution to Boundary Value Problems Finite different solution of one dimensional heat equation by explicit method: Bender-Schmidt method – implicit method: Crank –Nicholson method – one dimensional wave equation – Laplace equation: Leibmann's iteration processes – Poisson equations.	[9]
Total Hours:	**45**

Text Book(s):

1. Gupta, S.C, and Kapur, J.N., "Fundamentals of Mathematical Statistics", Sultan Chand, 9th Edition, New Delhi, 1996.
2. Grewal B.S and Grewal J.S., "Numerical methods in Engineering and Science", 9th Edition, Khanna Publishers, New Delhi, 2007.

Reference(s):

Rev. No.0/w.e.f. 01.08.22
Passed in BoS Meeting held on 20/07/22
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1.	Gupta, S.C, and Kapur, J.N., “Fundamentals of Mathematical Statistics”, Sultan Chand, 9th Edition, New Delhi, 1996.
2.	Kandasamy P., Thilakavathy K. and Gunavathy K., “Numerical Methods”, 3rd Edition, S.Chand and Co., New Delhi, 2003
3.	Dr. Ameeya Kumar Nayak, Dr.Sanjeev Kumar, “Numerical methods”, NPTEL online video courses.
4.	Probability and distributions – Nptel: nptel.ac.in/courses/105103140/2

Course Contents and Lecture Schedule

S.No.	Topic	No. of Hours
1.0	**Probability Theory**	
1.1	Probability theory	1
1.2	Binomial distribution	1
1.3	Poisson distribution	1
1.4	Geometric distribution	1
1.5	Uniform distribution	1
1.6	Exponential distribution	1
1.7	Gamma distribution	1
1.8	Normal distribution	1
1.9	Central limit theorem	1
2.0	**Testing of Hypothesis**	
2.1	Introduction to Small sample	1
2.2	t test	1
2.3	F test	1
2.4	Application of t test and F test	1
2.5	Contingency table x^2	1
2.6	Goodness of fit x^2	1
2.7	Application of Chi-Square test	1
2.8	Large sample	1
2.9	Problems (large sample)	1
3.0	**Design of Experiments (ANOVA)**	
3.1	One way classification	1
3.2	Completely randomized design	1
3.3	Two way classification	2
3.4	Randomized block design	1
3.5	Latin square design	2
3.6	2^n factorial design	1
3.7	Application of (ANOVA)	1
4.0	**Ordinary Differential Equations**	
4.1	Single step methods	1
4.2	Taylor’s series method	1

4.3	Euler's and modified Euler's methods	1
4.4	Fourth order Runge Kutta method	1
4.5	Multistep methods	1
4.6	Milne's predictor and corrector method	1
4.7	Adam's predictor and corrector method	1
4.8	Fourth order Runge Kutta method	1
4.9	Adam's predictor and corrector method	1
5.0	**Partial Differential Equations and Concepts in Solution to Boundary Value Problems**	
5.1	Finite different solution	1
5.2	one dimensional heat equation by explicit method	1
5.3	Bender-Schmidt method	1
5.4	Crank –Nicholson method	1
5.5	One dimensional wave equation	1
5.6	Laplace equation	1
5.7	Leibmann's iteration processes	1
5.8	Poisson equations	1
5.9	Poisson equations Problems	1

Course Designers

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60 PED E14	Fuels and Combustion	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To study the types of fuels and its properties analysis methods.
- To study the various solid and liquid fuels and its purification methods.
- To analyze the properties of gases fuels.
- To understand the combustion characteristics of solid, liquid and gaseous fuels.
- To understand the working principle coal burning equipment

Pre-requisite

Thermal Engineering

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Acquire knowledge about the types of fuels and its properties analysis methods.	Remember, Understand & Apply
CO2	Categorize the types of solid and liquid fuels from various sources.	Understand & Analyze
CO3	Estimate on gaseous fuel properties and Wobbe index.	Understand & Apply
CO4	Categorize the gaseous fuels based on composition, properties and combustion stoichiometry.	Understand & Apply
CO5	Categorize the types of coal burning equipments and burner combustion.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	1	1
CO2	3	3	2	3	1	1
CO3	3	3	2	3	1	1
CO4	3	3	2	2	1	1
CO5	3	3	2	2	1	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E14 - Fuels and Combustion

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Introduction Fuels-Types And Characteristics Of Fuels-Determination Of Properties Of Fuels-Fuels Analysis-Proximate and Ultimate analysis-Moisture Determination-Calorific Value- Gross & Net Calorific Values – Calorimetry- Dulong's Formula for Cv Estimation-Flue Gas Analysis –Orsat Apparatus- Fuel & Ash Storage & Handling.	[9]
Solid and Liquid Fuels Solid fuels Types – Coal Family – Properties – Calorific Values – ROM, DMMF, DAG AND Bone Dry Basis– Ranking – Bulk & Apparent Density – Storage – Washability –Coking & Caking Coals –Renewable Solid Fuels – Biomass – Wood Waste – Agro Fuels– Manufactured Solid Fuels. Liquid Fuels Types – Sources – Petroleum Fractions-Classification – Refining – Properties Of Liquid Fuels – Calorific Value, Specific Gravity, Flash & Fire Point, Octane Number, Cetane Number Etc., - Alcohols – Tar Sand Oil – Liquefaction Of Solid Fuels, flow test, smoke points, storage and handling	[9]
Gaseous Fuels Classification – Composition & Properties – Estimation Of Calorific Value – Gas Calorimeter and sensor techniques- Rich and LeanGas – Wobbe Index – Natural Gas – Dry & Wet Natural Gas Stripped NG – Foul & Sweet NG – LPG –CNG – Methane – Producer Gas Gasifiers Water Gas – Town Gas – Coal Gasification –Gasification Efficiency – Non – Thermal Route – Biogas – Digesters – Reactions – Viability – Economics.	[9]
Combustion Stoichiometry – Mass Basis & Volume Basis – Excess Air Calculation – Fuel and Flue Gas Compositions – Calculations – Rapid Methods – Combustion Processes – Stationary Flame Combustion Explosive Combustion. Mechanism Of Combustion – Ignition & Ignition Energy – Spontaneous Combustion- Flame Propagation – Solid, Liquid & Gaseous Fuels Combustion – Flame Temperature.	[9]

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Coal Preparation System Coal Burning Equipment's – Types – Pulverized Coal Firing – Fluidized Bed Firing – Fixed Bed and Recycled Bed– Cyclone Firing – Spreader Stokers – Vibrating Grate Stokers Sprinkler Stokers, Travelling Grate Stokers. Oil Burners – Vaporizing Burners –Air Aspiration Gas Burners – Burners Classification According To Flame Structures –Factors Affecting Burners & Combustion -Environmental Considerations: Air pollution – Effects on Environment, Human Health etc. Principal pollutants – Legislative Measures – Methods of Emission control.	[9]
Total Hours:	**45**

Text Book(s):	
1.	Samir S, "Fuels and Combustion", 3rdEdition, CRC Press, 2010.
2.	Maximilian L,Franz W and Avinash Kumar A, "Handbook of Combustion", Volume 4 (Solid fuels), Wiley-VCH, 2010.
Reference(s):	
1.	Bhatt B I, and Vora S M, "Stoichiometry", Tata McGraw-Hill Education, 2004.
2.	Gajendra Babu M K and Subramanian K A, "Alternative Transportation Fuels: Utilisation in Combustion Engines", CRC Press, 2013.
3.	Arora, S. C., and Domkundwar, S., "A course in Power Plant Engineering", 8th Edition, Dhanpatraii Publications Ltd., New Delhi, 2016.
4.	Rai,G.D. "Introduction to Power Plant Technology", 11th reprint, Khanna Publishers, 2013.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Introduction**	
1.1	Fuels-Types And Characteristics Of Fuels	1
1.2	Determination Of Properties Of Fuels, Fuels Analysis	1
1.3	Proximate and Ultimate analysis, Moisture Determination	2
1.4	Calorific Value, Gross & Net Calorific Values, Calorimetry	2
1.5	Dulong's Formula for Cv Estimation, Flue Gas Analysis	2
1.6	Orsat Apparatus, Fuel & Ash Storage & Handling	1
2.0	**Solid and Liquid Fuels**	
2.1	Solid fuels Types, Coal Family, Properties, Calorific Values	2
2.2	ROM, DMMF, DAG AND Bone Dry Basis, Ranking, Bulk & Apparent Density	1
2.3	Storage, Washability, Coking, Caking Coals, Renewable Solid Fuels, Biomass, Wood Waste, Agro Fuels	2
2.4	Manufactured Solid Fuels. Liquid Fuels Types, Sources, Petroleum Fractions, Classification	1
2.5	Refining, Properties Of Liquid Fuels, Calorific Value, Specific Gravity, Flash, Fire Point	1
2.6	Octane Number, Cetane Number, Alcohols, Tar Sand Oil, Liquefaction of Solid Fuels	1
2.7	Flow test, smoke points, storage and handling	1

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3.0	**Gaseous Fuels**	
3.1	Classification, Composition, Properties, Estimation of Calorific Value	2
3.2	Gas Calorimeter and sensor techniques, Rich and Lean Gas, Wobbe Index	2
3.3	Natural Gas, Dry & Wet Natural Gas Stripped NG, Foul & Sweet NG, LPG, CNG	1
3.4	Methane, Producer Gas Gasifiers Water Gas, Town Gas	2
3.5	Coal Gasification, Gasification Efficiency, Non, Thermal Route, Biogas	2
3.6	Digesters, Reactions, Viability, Economics	
4.0	**Combustion**	
4.1	Stoichiometry, Mass Basis & Volume Basis, Excess Air Calculation	2
4.2	Fuel and Flue Gas Compositions, Calculations, Rapid Methods, Combustion Processes	2
4.3	Stationary Flame Combustion Explosive Combustion. Mechanism of Combustion Ignition & Ignition Energy	2
4.4	Spontaneous Combustion, Flame Propagation	2
4.5	Solid, Liquid, Gaseous Fuels Combustion, Flame Temperature.	1
5.0	**Coal Preparation System**	
5.1	Coal Burning Equipment's – Types, Pulverized Coal Firing, Fluidized Bed Firing	2
5.2	Fixed Bed and Recycled Bed, Cyclone Firing, Spreader Stokers, Vibrating Grate Stokers Sprinkler Stokers, Travelling Grate Stokers	2
5.3	Oil Burners, Vaporizing Burners, Air Aspiration Gas Burners, Burners Classification According To Flame Structures	2
5.4	Factors Affecting Burners & Combustion, Environmental Considerations, Air pollution	1
5.5	Effects on Environment, Human Health, Principal pollutants	1
5.6	Legislative Measures, Methods of Emission control	1

Course Designers

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60 PED E15	Bearing Design and Rotor Dynamics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To know about different types of bearings available for machine design and their operating principles
- To design hydrodynamic and hydrostatic bearing for given specifications and analyze the bearings for their performance
- To know the selection and design of rolling bearings for specific application
- To understand the bearing behavior under dynamic loading conditions
- To learn the computation and measurements of vibration behavior bearing

Pre-requisite

-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Acquire knowledge on classification and selection of bearings.	Remember, Understand & Apply
CO2	Design and perform analysis of fluid film bearing and foil/air bearings.	Remember, Understand & Apply
CO3	Analyse the stresses induced in the rolling bearing and predict the fatigue life.	Remember, Understand & Apply
CO4	Describe the dynamics of hydrodynamic bearing with different loading.	Remember, Understand & Apply
CO5	Explain the rotor dynamics and vibration for different design configurations.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E15 - Bearing Design and Rotor Dynamics

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	

Classification and Selection of Bearings Selection criteria-Dry and Boundary Lubrication Bearings-Hydrodynamic and Hydrostatic bearings-Electro Magnetic bearings-Dry bearings-Rolling Element bearings- Bearings for Precision Applications-Foil Bearings-Special bearings- Selection of plain Bearing materials –Metallic and Non-metallic bearings.	[9]
Design of Fluid Film Bearings Design and performance analysis of Thrust and Journal bearings – Full, partial, fixed and pivoted journal bearings design procedure-Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations- Design based on Charts & Tables and Experimental curves-Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings- Stiffness consideration - flow regulators and pump design.	[9]
Selection and Design of Rolling Bearings Contact Stresses in Rolling bearings- Centrifugal stresses-Elasto hydrodynamic lubrication-Fatique life calculations- Bearing operating temperature- Lubrication- Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements-Materials for rolling bearings- Manufacturing methods- Ceramic bearings-Rolling bearing cages-bearing seals selection.	[9]
Dynamics of Hydrodynamic Bearings Hydrodynamic Lubrication equation for dynamic loadings-Squeeze film effects in journal bearings and thrust bearings -Rotating loads , alternating and impulse loads in journal bearings – Journal centre Trajectory- Analysis of short bearings under dynamic conditions- Finite difference solution for dynamic conditions.	[9]

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Rotor Dynamics Rotor vibration and Rotor critical speeds- support stiffness on critical speeds- Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients - Mechanics of Hydro dynamic Instability- Half frequency whirl and Resonance whip-Design configurations of stable journal bearings.	[9]
Total Hours:	**45**

Text Book(s):	
1.	Neale, M.J., “Tribology Hand Book”, Butterworth Heinemann, United Kingdom 2001.
2.	Cameron, A. “Basic Lubrication Theory”, Ellis Herward Ltd., UK, 1983.
Reference(s):	
1.	Halling, J., “Principles of Tribology”, Macmillian, 2010.
2.	Williams J.A. “Engineering Tribology”, Oxford University Press, 2005.
3.	Basu, S.K., Sengupta, S.N & Ahuja, B.B., “Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd, New Delhi, 2013.
4.	Stachowiak, G. W., and Batchelor, A.W., “Engineering Tribology”, Butterworth-Heinemann, UK, 2014.

Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Classification and Selection of Bearings**	
1.1	Selection criteria-Dry and Boundary Lubrication Bearings	2
1.2	Hydrodynamic and Hydrostatic bearings-Electro Magnetic bearings	2
1.3	Dry bearings Rolling Element bearings- Bearings for Precision Applications	2
1.4	Foil Bearings-Special bearings- Selection of plain Bearing materials	2
1.5	Metallic and Non-metallic bearings	1
2.0	**Design of Fluid Film Bearings**	
2.1	Design and performance analysis of Thrust and Journal bearings	1
2.2	Full, partial, fixed and pivoted journal bearings design procedure	1
2.3	Minimum film thickness – lubricant flow and delivery – power loss, Heat and temperature distribution calculations	2
2.4	Design based on Charts & Tables and Experimental curves	1
2.5	Design of Foil bearings-Air Bearings- Design of Hydrostatic bearings-Thrust and Journal bearings	2
2.6	Stiffness consideration - flow regulators and pump design	2

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3.0	**Selection and Design of Rolling Bearings**	
3.1	Contact Stresses in Rolling bearings- Centrifugal stresses	2
3.2	Elasto hydrodynamic lubrication-Fatigue life calculations- Bearing operating temperature- Lubrication	2
3.3	Selection of lubricants-Internal clearance – Shaft and housing fit- -Mounting arrangements	2
3.4	Materials for rolling bearings- Manufacturing methods	2
3.5	Ceramic bearings-Rolling bearing cages-bearing seals selection	1
4.0	**Dynamics of Hydrodynamic Bearings**	
4.1	Hydrodynamic Lubrication equation for dynamic loadings	2
4.2	Squeeze film effects in journal bearings and thrust bearings	1
4.3	Rotating loads, alternating and impulse loads in journal bearings	1
4.4	Journal centre Trajectory	2
4.5	Analysis of short bearings under dynamic conditions	2
4.6	Finite difference solution for dynamic conditions	1
5.0	**Rotor Dynamics**	
5.1	Rotor vibration and Rotor critical speeds- support stiffness on critical speeds	2
5.2	Stiffness and damping coefficients of journal bearings-computation and measurements of journal bearing coefficients	2
5.3	Mechanics of Hydro dynamic Instability	2
5.4	Half frequency whirl and Resonance whip	2
5.5	Design configurations of stable journal bearings	1

Course Designer

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60 PED E21	Advanced Engineering Materials	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart the basic concepts and difference between composite materials with conventional materials.
- To apply knowledge for finding failure envelopes and stress-strain plots of laminates.
- To analyse engineering materials such as polymers, metals, ceramics and composites
- To equip the students with the organizational, practical and computational skillsnecessary to carry out research in advanced materials engineering.
- To learn the economic consideration and recycling of materials.

Pre-requisite

Engineering Materials and Metallurgy

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate an understanding of properties of Carbon nanotubes, structure and properties materials including multifunctional polymer nano composites.	Understand, Remember & Apply
CO2	Comprehend existence of imperfections and their effects on mechanical properties of materials and cause of failure.	Understand, Remember & Apply
CO3	Recognize and predict various types of failures using concept of fracture mechanics, creep and effect of impact.	Understand, Remember & Apply
CO4	Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites.	Understand, Remember & Apply
CO5	Know the economic considerations in usage and recycling of materials in human use.	Understand, Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	2	1
CO4	3	2	3	2	2	1
CO5	3	2	3	2	2	1
3- Strong;2-Medium;1-Some						

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Tiruchengode - 637 215.

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	10	10	20	20
Apply (Ap)	40	40	40	40
Analyze (An)	20	20	20	20
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E21 - Advanced Engineering Materials

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Nanomaterials: Carbon nanotubes, structure and properties, chemistry of carbon nanotubes, graphite whiskers, cones and polyhedral crystals, nanocrystaline diamond, carbide derived carbon nanotubes in multifunctional polymer nano composites, Composites processing, micromechanics, shape memory alloys (SMAs), metallic foam, Plastics, polymeric materials (molecular viewpoint), microstructures in polymers, mechanical properties (macro view point) chemical and physical properties (macro view point), designing with plastics,, thermoplastic materials (commodity plastics), thermoplastic materials (engineering plastics), thermoset materials, elastomeric (rubber) materials, related processes, Environmental aspects of plastics.	[9]
Imperfections in Solids and Mechanical Properties of Metals, Dislocations and Strengthening Mechanisms Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multi-axial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation.	[9]
Fractures and Creep Behavior Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behavior. Stress and temperature effects.	[9]

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Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites.	[9]
Electrical, Thermal, Optical and Magnetic Properties and economic Considerations Electrical conduction - Semi conductivity - Super conductivity. Electrical conduction in ionic ceramics and in polymers - Dielectric behaviour – Ferro electricity - Piezoelectricity - Heat capacity - Thermal expansion - Thermal conductivity –Thermal stresses - Diamagnetism and Para magnetism – Ferromagnetism - Anti-ferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour - Domains and Hysteresis, Basic concepts. Optical properties of metals and non-metals. Application of optical phenomena. Economic, Environmental and Social Issues of material usage - Economic considerations - Environmental and societal considerations - Recycling issues.	[9]
Total Hours:	**45**

Text Book(s):

1.	William D. Callister, "Materials Science and Engineering", John Wiley & sons, 10th Edition, 2018
2.	Courtney, T H., "Mechanical Behavior of Materials", 2nd Edition, Waveland Press, 2005.

Reference(s):

1.	Smallman R E and Bishop R J, "Modern Physical Metallurgy and Material Engineering-Science, Process, Application", Elsevier, 6th Edition, 1999
2.	Budinski, "Engineering Materials: Properties and Selection", 9th Edition, Prentice Hall India Learning Private Limited, 2009.
3.	Ashutosh Tiwari, Arul Murugan N, Rajeev Ahuja, "Advanced Engineering Materials and Modeling", Wiley-Scrivener Publishers, 2016.
4.	Srinivasan R., "Engineering Materials and Metallurgy", McGraw Hill Education, 2009.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Nanomaterials**	
1.1	Carbon nanotubes, structure and properties, chemistry of carbon nanotubes, graphite whiskers, cones and polyhedral crystals	2
1.2	Nanocrystaline diamond, carbide derived carbon nanotubes in multifunctional polymer nano composites	1
1.3	Composites processing, micromechanics, shape memory alloys (SMAs), metallic foam, Plastics, polymeric materials (molecular viewpoint), microstructures in polymers	2
1.4	Mechanical properties (macro view point) chemical and physical properties (macro view point)	1
1.5	Designing with plastics, thermoplastic materials (commodity plastics), thermoplastic materials (engineering plastics)	2
1.6	Thermoset materials, elastomeric (rubber) materials, related processes, Environmental aspects of plastics	1
2.0	**Imperfections in Solids and Mechanical Properties of Metals, Dislocations and Strengthening Mechanisms**	

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2.1	Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations	2
2.2	Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multi-axial stress	2
2.3	Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms	3
2.4	Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation	2
3.0	**Fractures and Creep Behavior**	
3.1	Fracture, Ductile and brittle fracture, Fracture mechanics	1
3.2	Impact fracture, Ductile brittle transition and Fatigue	2
3.3	Crack initiation and propagation	2
3.4	Crack propagation rate and Creep	2
3.5	Generalized creep behavior, Stress and temperature effects	2
4.0	**Applications and Processing of Metals and Alloys, Polymers, Ceramics and composites**	
4.1	Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment	2
4.2	Precipitation hardening. Types and applications of ceramics	1
4.3	Fabrication and processing of ceramics	1
4.4	Mechanical behaviour of polymers	2
4.5	Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition	2
4.6	Polymer types. Polymer synthesis and processing, Particle reinforced composites	1
5.0	**Electrical, Thermal, Optical and Magnetic Properties and economic Considerations**	
5.1	Electrical conduction - Semi conductivity - Super conductivity	1
5.2	Electrical conduction in ionic ceramics and in polymers, Dielectric behaviour, Ferro electricity, Piezoelectricity, Heat capacity, Thermal expansion, Thermal conductivity	2
5.3	Thermal stresses, Diamagnetism and Para magnetism, Ferromagnetism, Anti - ferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour	2
5.4	Domains and Hysteresis, Basic concepts. Optical properties of metals and non-metals. Application of optical phenomena. Economic	2
5.5	Environmental and Social Issues of material usage, Economic considerations, Environmental and societal considerations, Recycling issues	2

Course Designer

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60 PED E22	Supply Chain Management	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- Explain the role of supply chain management in an organization.
- Identify the various aspects of supply chain management and the factors affecting them.
- Explain the relationship among various factors involved in planning, organising and controlling supply chain operations.
- Summarize the sourcing and inventory decisions involved in supply chain operations
- Explain the use of information technology in supply chain management

Pre-requisite

-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	To introduce the concepts and elements of supply chain management.	Remember, Understand & Apply
CO2	To understand supply chain network design aspects for various manufacturing and service sectors.	Remember, Understand & Apply
CO3	To understand the principle of demand and supply in supply chain	Remember, Understand & Apply
CO4	To gain knowledge on the sourcing and inventory decisions in supply chain.	Remember, Understand & Apply
CO5	To understand the concepts of supply chain information systems.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E22 – Supply Chain Management

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Introduction Supply Chain Management Introduction, Types of supply chains with and examples, Evolution of SCM concepts, Supply chain performance, Strategic Fit, Drivers of Supply Chain Performance – key decision areas – External Drivers of Change. Supply contracts – centralized vs. decentralized system	[9]
Supply Chain Network Design Need for distribution network design- Factors affecting, Design options for distribution network. Network design decisions - Framework, factors influencing, Models of facility location and capacity allocation. Role of Transportation in supply chain, modes of transportation Modal Selection, Classification of carriers, Carrier Selection, Transportation Execution and Control. Food Mile Concept., design options.	[9]
Demand and Supply in Supply Chain Forecasting in supply chain- Methods, Approach, Errors. Aggregate planning in supply chain- Problem, Strategies and Implementation. Predictable variability in supply chain, Managing supply and demand. Distribution strategies-direct shipment, traditional warehousing, cross docking, inventory pooling, transhipment, Choosing appropriate strategy, Milk Run Model.	[9]
Sourcing and Inventory Decisions in Supply Chain Purchasing Vs Procurement Vs Strategic Sourcing, Item procurement importance matrix, Strategic Sourcing Methodology, Managing sourcing and procurement process, Supplier selection and evaluation, Bullwhip effect and its management, Economies of scale in supply chain- Cycle inventory, Estimation, Quantity discounts, Multiechelon cycle inventory. Uncertainty in supply chain- Safety inventory, Determination of appropriate level, Impact on uncertainity.	[9]
Supply Chain and Information Systems Information in supply chain, Role of Information technology, IT framework in supply chain, Supplier and Customer relationship management. Role of e-business in supply chain, e-sourcing and e-procurement. Technology drivers in supply chain - Risk management.	[9]
Total Hours:	**45**
Text Book(s):	

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1.	Chopra S. and Meihdl P., “Supply Chain Management- Strategy, Planning and Operations”, Pearson Education Asia. 2007.
2.	Dougart L., Stock J. and Ellram L., “Logistic Management”, Irwin McGraw Hill International Edition" 1998.
Reference(s):	
1.	Kaminsky S., “Design and Managing the Supply chain”, McGraw Hill International Edition. 2000.
2.	Raghuram G, and N.Rangaraj, “Logistics and Supply Chain Management -cases and concepts”, McMilan India Pvt Ltd, New Delhi,. 2000.
3.	Sahay B.S. “Supply Chain Management: For Global Competitiveness”, 2nd Edition, Macmillan, India Ltd, 2011.

Content and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**INTRODUCTION SUPPLY CHAIN MANAGEMENT**	
1.1	Introduction	1
1.2	Types of supply chains with and examples	1
1.3	Evolution of SCM concepts	1
1.4	Supply chain performance, Strategic Fit	1
1.5	Drivers of Supply Chain Performance – key decision areas	2
1.6	Supply contracts	1
1.7	External Drivers of Change – centralized vs. decentralized system	2
2.0	**SUPPLY CHAIN NETWORK DESIGN**	
2.1	Need for distribution network design	1
2.2	Factors affecting - Design options for distribution network	1
2.3	Network design decisions - Framework, factors influencing	1
2.4	Models of facility location and capacity allocation	1
2.5	Role of Transportation in supply chain	1
2.6	Modes of transportation Modal Selection,	1
2.7	Classification of carriers, Carrier Selection	1
2.8	Transportation Execution and Control	1
2.9	Food Mile Concept - design options.	1
3.0	**DEMAND AND SUPPLY IN SUPPLY CHAIN**	
3.1	Forecasting in supply chain- Methods, Approach, Errors.	1
3.2	Aggregate planning in supply chain- Problem	1
3.3	Strategies and Implementation	1

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3.4	Predictable variability in supply chain	1
3.5	Managing supply and demand	1
3.6	Distribution strategies-direct shipment	1
3.7	traditional warehousing, cross docking, inventory pooling	2
3.8	Transhipment, choosing appropriate strategy, Milk Run Model	1
4.0	**SOURCING AND INVENTORY DECISIONS IN SUPPLY CHAIN**	
4.1	Purchasing Vs Procurement Vs Strategic Sourcing	1
4.2	Item procurement importance matrix, Strategic Sourcing Methodology	1
4.3	Managing sourcing and procurement process	1
4.4	Supplier selection and evaluation	1
4.5	Bullwhip effect and its management, Economies of scale in supply chain	1
4.6	Cycle inventory, Estimation, Quantity discounts	1
4.7	Multiechelon cycle inventory. Uncertainty in supply chain	1
4.8	Safety inventory	1
4.9	Determination of appropriate level, Impact on uncertainty	1
5.0	**SUPPLYCHAIN AND INFORMATION SYSTEMS**	
5.1	Information in supply chain	1
5.2	Role of Information technology	1
5.3	IT framework in supply chain	1
5.4	Supplier and Customer relationship management	2
5.5	Role of e-business in supply chain	1
5.6	E-sourcing and E-procurement	1
5.7	Technology drivers in supply chain - Risk management	2

Course Designer

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60 PED E23	Analysis and Synthesis of Mechanisms	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To develop a thorough understanding of the various mechanisms and its design and simulation with ability to effectively use the various mechanisms in real life problems.
- To impart knowledge on configuring and synthesizing mechanical systems
- To learn how to use kinematic geometry to design linkages
- To analyze the motion of planar and spherical four bar linkages
- To know the concepts of synthesizing coupler curve mechanism.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Develop analytical equations describing the relative position, velocity and acceleration of all moving links.	Understand, Remember & Apply
CO2	Select, configure, and synthesize mechanical components into complete systems.	Understand, Remember& Apply
CO3	Use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.	Understand, Remember & Analyze
CO4	Formulate and analyze the movement of planar and spherical four-bar linkages.	Understand, Remember & Apply
CO5	Apply modern computer-based techniques in the selection, analysis and synthesis of components and their integration into complete mechanical	Understand, Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	3	2
CO2	3	3	2	3	2	1
CO3	3	3	3	3	2	1
CO4	3	2	3	2	2	1
CO5	3	2	3	2	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E23 - Analysis and Synthesis of Mechanisms

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Introduction Basic Concepts; Definitions and assumptions; planar and spatial mechanisms; kinematic pairs; degree of freedom; equivalent mechanisms; Kinematic Analysis of Planar Mechanisms. Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms, velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods	[9]
Path Curvature Theory Curvature Theory: Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions, cubic of stationary curvature, Ball's point, Applications in dwell mechanisms.	[9]
Kinematic Analysis Kinematic Synthesis of planar mechanisms, accuracy (precision) points, Chebesychev spacing, types of errors, Graphical synthesis for function generation and rigid body guidance with two, three and four accuracy points using pole method, centre and circle point curves, Analytical synthesis of four-bar and slider-crank mechanisms.	[9]
Synthesis of Four Bar Mechanisms Freudenstein's equation, synthesis for four and five accuracy points, compatibility condition, synthesis of four-bar for prescribed angular velocities and accelerations using complex numbers,three accuracy point synthesis using complex numbers.	[9]
Synthesis of Coupler Curve Based Mechanisms Coupler Curves: Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry. Kinematic Analysis of Spatial Mechanisms, Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms.	[9]
Total Hours:	**45**

Text Book(s):

1.	Hartenberg, R S and Denavit J, "Kinematic Synthesis of Linkages", McGraw-Hill, NewYork, 1980.
2.	Hamilton H.Mabie,"Mechanisms and Dynamics of Machinery",John Wiley and sons NewYork, 1982

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Reference(s):	
1.	Tuttle S B,"Mechanisms for Engineering Design" John Wiley and sons New York, 1998
2.	Ghosh A and Mallik A K, “Theory of Machines and Mechanisms”, Affiliated East-WestPress, New Delhi, 1988.
3.	Erdman A G and Sandor G N, “Mechanism Design – Analysis and Synthesis”, (Vol. 1and 2), Prentice Hall India, 1988.
4.	ShigleyJ E and Uicker J J, “Theory of Machines and Mechanisms”, 2nd Edition,McGraw-Hill, 1995.
5.	Robert L.Nortan ,"Design of Machinery”,Tata McGraw Hill Edition,2001

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction**	
1.1	Basic Concepts; Definitions and assumptions; planar and spatial mechanisms	1
1.2	Kinematic pairs, degree of freedom	1
1.3	Equivalent mechanisms	1
1.4	Kinematic Analysis of Planar Mechanisms	1
1.5	Review of graphical and analytical methods of velocity and acceleration analysis of kinematically simple mechanisms	2
1.6	Velocity-acceleration, analysis of complex mechanisms by the normal acceleration and auxiliary-point methods	3
2.0	**Path curvature theory**	
2.1	Curvature Theory: Fixed and moving centrodes	2
2.2	Inflection circle, Euler-Savary equation	2
2.3	Bobillier constructions	1
2.4	Cubic of stationary curvature	1
2.5	Ball’s point, Applications in dwell mechanisms	3
3.0	**Kinematic analysis**	
3.1	Kinematic Synthesis of planar mechanisms	1
3.2	Accuracy (precision) points, Chebesychev spacing,types of errors	1
3.3	Graphical synthesis for function generation	1
3.4	Rigid body guidance with two,three and four accuracy points using pole method, centre and circle point curves	2
3.5	Analytical synthesis of four-bar mechanisms	2
3.6	Analytical synthesis of slider-crank mechanisms	2

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4.0	**Synthesis of four bar mechanisms**	
4.1	Freudenstein's equation	1
4.2	Synthesis for four and five accuracy points, compatibility condition	2
4.3	Synthesis of four-bar for prescribed angular velocities using complex numbers	2
4.4	Synthesis of four-bar for prescribed angular accelerations using complex numbers	2
4.5	Three accuracy point synthesis using complex numbers	2
5.0	**Synthesis of Coupler Curve Based Mechanisms**	
5.1	Coupler Curves: Equation of coupler curve	2
5.2	Robert-Chebychev theorem	1
5.3	Double points and symmetry	1
5.4	Kinematic Analysis of Spatial Mechanisms	2
5.5	Denavit-Hartenberg parameters	1
5.6	Matrix method of analysis of spatial mechanisms	2

Course Designers

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60 PED E24	Instrumentation for Thermal Engineering	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To provide knowledge on various measuring instruments for thermal engineering.
- To gain the knowledge on Microprocessor and data acquisition system.
- To understand the various steps involved in error analysis and uncertainty analysis.
- To provide knowledge on advance measurement techniques.
- To understand the working principles of various types of analysis techniques.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Acquire knowledge the static and experimental error on analysis on the measurement and reliability of instruments.	Remember & Apply
CO2	Describe the working principle of data logger used in data acquisition system and interfacing of hardware with software using microcomputer and intelligent	Remember & Apply
CO3	Categorize the types of instruments and sensors used for measurement of thermo physical properties.	Remember & Apply
CO4	Become skilled in telemetry in measurements and data analyst.	Remember & Apply
CO5	Become skilled in chromatography analysis.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	1
CO2	3	3	3	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	2	1
CO5	3	3	3	2	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E24 - Instrumentation for Thermal Engineering

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Measurement Characteristics Fundamental elements of measuring instrument, Instrument Classification, Characteristics of Instruments – Static and dynamic, experimental error analysis, Systematic and random errors, Statistical analysis, Uncertainty, Experimental planning and selection of measuring instruments, Reliability of instruments.	[9]
Advancement in Measurements Data logging and acquisition – use of sensors for error reduction, elements of microcomputer interfacing, intelligent instruments in use, pneumatic, hydraulic and electronic controllers.	[9]
Measurement of Physical Quantities Measurement of thermo-physical properties, instruments for measuring temperature, pressure and flow, use of sensors for physical variables.	[9]
Advance Measurement Techniques and Analysis Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer, Hot wire Anemometer, heat flux sensors, Telemetry in measurement, Orsat apparatus. Chemical thermal, magnetic and optical gas analysers, measurement of smoke, Dust and moisture, gas chromatography, spectrometry, measurement of pH, Review of basic measurement techniques.	[9]
Uncertainty in measurements Errors in instruments, Analysis of experimental data and determination of overall uncertainties in experimental investigation, uncertainties in measurement of measurable parameters like pressure, temperature, flow etc. under various conditions.	[9]
Total Hours:	**45**

Text Book(s):

1.	Kumar D.S, "Mechanical Measurements and Control" 4thEdition, Metro politan book company Pvt. Ltd, New Delhi, 2016.
2.	Thomas G. Beckwith and Roy D. Marangoni, "Mechanical Measurements ", 6thEdition, Pearson Education

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Tiruchengode - 637 215.

	India, Noida, 2007
Reference(s):	
1.	Jain R.K., “Engineering Metrology”, 21st Revised Edition, Khanna publishers, New Delhi, 2015.
2.	Nakra, B.C., Choudhry K.K., “Instrumentation, Measurements and Analysis”, Tata McGraw Hill, New Delhi, 2nd Edition, 2003.
3.	Gupta S.C., “Engineering Metrology”, 20thEdition, Dhanpat Rai Publications, New Delhi, 2007.
4.	Sawhney A.K., “A Course in Mechanical Measurements and Instrumentation” Dhanpat Rai Publications, 2004.
5.	Donald P. Eckman, "Industrial Instrumentation ", Wiley Eastern, 2004.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Measurement Characteristics**	
1.1	Fundamental elements of measuring instrument	1
1.2	Fundamental elements of measuring instrument, Instrument Classification, Characteristics of Instruments	2
1.3	Static and dynamic, experimental error analysis, Systematic and random errors	2
1.4	Statistical analysis, Uncertainty	1
1.5	Experimental planning and selection of measuring instruments	2
1.6	Reliability of instruments	1
2.0	**Advancement in Measurements**	
2.1	Data logging and acquisition	2
2.2	Use of sensors for error reduction, elements of microcomputer interfacing	2
2.3	Intelligent instruments in use	2
2.4	Pneumatic and hydraulic controllers	2
2.5	Electronic controllers	
3.0	**Measurement of Physical Quantities**	
3.1	Measurement of thermo-physical properties	2
3.2	Instruments for measuring temperature	2
3.3	Instruments for measuring Pressure	2
3.4	Instruments for measuring flow	2
3.5	Use of sensors for physical variables	1

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4.0	**Advance Measurement Techniques and Analysis**	
4.1	Shadowgraph, Schlieren, Interferometer, Laser Doppler Anemometer	1
4.2	Hot wire Anemometer, heat flux sensors, Telemetry in measurement	2
4.3	Orsat apparatus. Chemical thermal, magnetic and optical gas analysers	2
4.4	Measurement of smoke, Dust and moisture, gas chromatography	2
4.5	Spectrometry, measurement of PH	1
4.6	Review of basic measurement techniques	1
5.0	**Uncertainty in measurements**	
5.1	Errors in instruments, Analysis of experimental data	1
5.2	Determination of overall uncertainties in experimental investigation	2
5.3	Uncertainties in measurement of measurable parameters like pressure	2
5.4	Uncertainties in measurement of measurable parameters of temperature	2
5.5	Uncertainties in measurement of measurable parameters of flow	2

Course Designers

Mr. M.Moorthi - moorthi@ksrct.ac.in

BoS - Chairman
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Tiruchengode - 637 215.

60 PED E25	Advanced Internal Combustion Engines	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the principles of operation in IC engines and its components.
- To study the various stages of combustion in CI engines.
- To understand the concepts of engine simulation.
- To identify the alternative fuels in the existing IC engines.
- To study the latest technologies in engine management system.

Pre-requisite

Thermal Engineering

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Calculate optimum fuel air mixture and application of electronic injection system for complete combustion and stages of combustion in S.I engine.	Remember & Apply
CO2	Explain the different types of combustion chamber working principles in C.I engine and analysis the fuel spry and air motion in turbo charger and super charger.	Remember & Apply
CO3	Explain the simulation of various engine processes for S.I and C. engines using governing equations.	Remember & Apply
CO4	Apply the thermodynamic and fluid mechanic based models in engine simulation.	Remember & Apply
CO5	Describe the working principle of recent trends in I.C engine.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	1
CO2	3	2	2	2	2	1
CO3	3	3	2	2	2	1
CO4	3	3	3	2	3	1
CO5	3	2	3	2	3	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E25 - Advanced Internal Combustion Engines

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Fundamentals of I.C Engine Spark Ignition Engines, mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – factors affecting knock – Combustion chambers.	[9]
Combustion Techniques in C.I. Engine Compression ignition engines, Stages of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – spray structure, spray penetration and evaporation – air motion – Introduction to turbo charging and supercharging.	[9]
Concepts of Engine Simulation Combustion modeling, Basic concepts of engine simulation, governing equations, simulation of various engine processes for SI and CI Engines. Thermodynamic and fluid mechanic based models.	[9]
Alternative Fuels Alternative fuels, Alcohol, Hydrogen, Natural Gas Bio diesel, fuel cell. Other possible fuels and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications. Dual fuel operation. Pollutant – Sources – Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters, Selective Catalytic Reduction and Particulate Traps – Methods of measurement.	[9]
Recent Trends in I.C. Engine Recent trends, LHR engines, surface ignition concept and multi fuel engines, stratified charge and lean burn engines, performance and emission characteristics, merits and demerits -Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines –Plasma Ignition – Zero Emission Vehicles, Engines for special applications – Mining, Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car Engine systems, Flexible fuel systems. Surface ignition**.**	[9]
Total Hours:	**45**
Text Book(s):	

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1.	Ganesan V. “Internal Combustion Engines”, Tata McGraw-Hill, New Delhi, 4th Edition, 2017.
2.	John B Heywood, “Internal Combustion Engine Fundamentals”, 2nd Edition, McGraw Hill, 2018.
Reference(s):	
1.	Crouse W. H., Anglin D. L., “Automotive Mechanics”, McGraw Hill Education Private Limited, New Delhi, 10th edition, 2017.
2.	Ramalingam K K, “Internal Combustion Engine Fundamentals”, 3rd Edition, Scitech Publications, 2015.
3.	Heisler H., “Advanced Engine Technology”, SAE International Publications, USA, 1998.
4.	Kirpal Singh, “Automobile Engineering”, Vol. 1 & 2, Standard Publishers, New Delhi, 13th Edition, 2017.
5.	Srinivasan S., “Automotive Mechanics” McGraw Hill Education Private Limited, New Delhi, 2nd Edition, 2017.

Course Contents and Lecture Schedule

S. No.	Topics	No.of hours
1.0	**Fundamentals of I.C Engine**	
1.1	Spark Ignition Engines, mixture requirements	1
1.2	Fuel, Injection systems, Monopoint, Multipoint injection	2
1.3	Direct injection, Stages of combustion	2
1.4	Normal and abnormal combustion	1
1.5	Factors affecting knock	2
1.6	Combustion chambers.	1
2.0	**Combustion Techniques in C.I. Engine**	
2.1	Compression ignition engines, Stages of combustion in C.I. Engine	2
2.2	Direct and indirect injection systems, Combustion chambers	2
2.3	Fuel spray behaviour, spray structure	2
2.4	Spray penetration and evaporation, air motion	2
2.5	Introduction to turbo charging and supercharging.	1
3.0	**Concepts of Engine Simulation**	
3.1	Combustion modeling, Basic concepts of engine simulation	2
3.2	Governing equations	2
3.3	Simulation of various engine processes for SI and CI Engines	2

3.4	Thermodynamic based models	1
3.5	Fluid mechanic based models.	2
4.0	**Alternative Fuels**	
4.1	Alternative fuels, Alcohol, Hydrogen, Natural Gas Bio diesel, fuel cell	1
4.2	Other possible fuels and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels	2
4.3	Engine Modifications. Dual fuel operation. Pollutant – Sources	2
4.4	Formation of Carbon Monoxide, Unburnt hydrocarbon, Oxides of Nitrogen, Smoke and Particulate matter	2
4.5	Methods of controlling Emissions, Catalytic converters, Selective Catalytic Reduction	1
4.6	Particulate Traps, Methods of measurement	1
5.0	**Recent Trends in I.C. Engine**	
5.1	Recent trends, LHR engines, surface ignition concept and multi fuel engines	1
5.2	Stratified charge and lean burn engines, performance and emission characteristics, merits and demerits	2
5.3	Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines	2
5.4	Plasma Ignition, Zero Emission Vehicles, Engines for special applications	2
5.5	Mining, Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car	1
5.6	Engine systems, Flexible fuel systems. Surface ignition	1

Course Designers

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60 PED E31	Tribology in Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on theories of friction and wear
- To acquire the concept of surface interaction and measurement.
- To understand the properties of bearing material and lubricants.
- To understand the analytical behavior of hydrostatic and squeeze film lubrication
- To learn the different types of hydrodynamic bearings and design of bearings based on analytical /theoretical approach.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Apply theories of friction and wear to various practical situations by analysing the physics of the process.	Remember, Understand & Apply
CO2	Explain the various surface measurement techniques and effect of surface texture on tribological behavior of a surface.	Remember & Apply
CO3	Select materials and lubricants to suggest a tribological solution to particular situation.	Remember, Understand & Apply
CO4	Explain the hydrostatic and squeeze film lubrication.	Remember, Understand & Apply
CO5	Design a hydrodynamic bearing using various bearing charts.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	2	1
CO3	3	3	2	2	2	1
CO4	3	3	3	2	3	1
CO5	3	3	3	2	3	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	10	10	20	20
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E31 - Tribology in Design

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Friction and Wear Friction, theories of friction, Wear, types of wear, theories of wear, genesis of friction, instabilities and stick-slip motion.	[9]
Surface Interaction and Measurement Friction control, Surface texture and measurement, wear prevention, Surface treatments, surface modifications, surface coating.	[9]
Lubrication of Bearings Tribological properties of bearing materials and lubricants. Reynolds's equation and its limitations, idealized bearings, infinitely long plane pivoted and fixed show sliders, infinitely long and infinitely short (narrow) journal bearings, lightly loaded infinitely long journal bearing (Petroff's solution), Finite Bearings.	[9]
Hydrostatic and Squeeze Film Lubrication Hydrostatic, squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings.	[9]
Elasto Hydrodynamic Lubrication Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, Ertel-Grubin equation, Design of hydrodynamic journal bearings lubrication of spheres, gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings.	[9]
Total Hours:	**45**

Text Book(s):

1. Alastair, C. and Mc Ettles, C M., "Basic Lubrication Theory", Ellis Horwood, 1981.
2. Basu, S K., Sengupta, S N &Ahuja, B B., "Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd, New Delhi, 2005

Reference(s):

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1.	Stachowiak, G W. and Batchelor, A W., “Engineering Tribology”, Butterworth- Heinemann, UK, 2005
2.	Majumdar, B C., “Introduction to Tribology of Bearings”, S.Chand& Company Ltd.,New Delhi,2008.
3.	Stolarski, T A., “Tribology in Machine Design”, Butterworth-Heinemann, UK, 2000.
4.	Cameron, A., “Basic Lubrication Theory”, 3rd Edition, Ellis Hardwoods Ltd., UK., 1983.

Course Contents and Lecture Schedule

S. No.	Topics	No.of hours
1.0	**Friction and Wear**.	
1.1	Friction applications	1
1.2	Theories of friction	2
1.3	Wear phenomena	1
1.4	Types of wear and theories of wear	2
1.5	Genesis of friction.	1
1.6	Instabilities and stick-slip motion.	2
2.0	**Surface Interaction and Measurement**	
2.1	Friction control	2
2.2	Surface texture and measurement	2
2.3	Wear prevention, Surface treatments	3
2.4	Surface modifications, surface coating	2
3.0	**Lubrication of Bearings**	
3.1	Tribological properties of bearing materials and lubricants	1
3.2	Reynolds’s equation and its limitations	2
3.3	Idealized bearings, infinitely long plane pivoted and fixed show sliders	2
3.4	Infinitely long and infinitely short (narrow) journal bearings	2
3.5	Lightly loaded infinitely long journal bearing (Petroff’s solution), Finite Bearings	2
4.0	**Hydrostatic and Squeeze Film Lubrication**	
4.1	Hydrostatic application	2
4.2	Squeeze film Circular and rectangular flat plates	2

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4.3	Variable and alternating loads	2
4.4	Piston pin lubrications	1
4.5	Application to journal bearings	2
5.0	**Elasto Hydrodynamic Lubrication**	
5.1	Elasto-hydrodynamic lubrication	1
5.2	Pressure viscosity term in Reynolds's equation	2
5.3	Hertz' theory, Ertel-Grubin equation	2
5.4	Design of hydrodynamic journal bearings lubrication of spheres	2
5.5	Gear teeth and rolling element bearings, Air lubricated bearings, Tilting pad bearings.	2

Course Designer

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60 PED E32	Robotics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the basic concepts associated with the design and functioning and applications of Robots.
- To learn about design of grippers, drives and control system in robots
- To impart knowledge on robot kinematics and robot programming.
- To understand the machine vision system in a robot
- To learn about the modelling and simulation for the automation of manufacturing plant

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Apply knowledge of mathematics, sciences and engineering	Remember & Apply
CO2	Identify the electrical, electronic and mechanical components and use of them design or machine elements and transmission system.	Remember & Apply
CO3	Know about the basic kinematics of robot and the different types of sensors used.	Remember & Apply
CO4	Understand the characteristics of robot languages and concept of robot cell layout	Remember & Apply
CO5	Study the different industrial applications of robot	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	1
CO2	3	3	3	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	3	1
CO5	3	3	3	2	3	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PED E32 - Robotics								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.	[6]
Robot Grippers Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot	[6]
Drives and control systems Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control - Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.	[7]
Kinematics Transformation matrices and their arithmetic, link and joint description, Denavit – Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations	[9]
Machine Vision System Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming: Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Introduction to various types such as RAIL and VAL II etc., Features of type and development of languages for recent robot systems.	[9]
Modeling and Simulation for manufacturing Plant Automation Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence: Introduction to Artificial Intelligence, AI techniques, Need and application of AI. Other Topics in Robotics:- Socio-Economic aspect of robotisation, Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics	[8]
Total Hours:	**45**

Text Book(s):

1.	Groover, M P., “Industrial Robotics-Technology, Programming and Applications”, 2nd Edition, Tata McGraw Hill Education, New Delhi, 2012.
2.	John J. Craig, “Introduction to Robotics (Mechanics and Control), Addison-Wesley, 3rd Edition, 2008

Reference(s):

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1.	Richard D.K, Thomas A.C., and Michael, N., “Robotic Engineering: An Integrated Approach”, Prentice Hall India, 2nd edition, 2002
2.	Dorf, R C., “Handbook of Design, Manufacturing & Automation”, John Wiley and Sons.
3.	David, W P., “Industrial Automation”, John Wiley and Sons. 1989.
4.	AshitavaGhoshal, “Robotics-Fundamental Concepts and Analysis”, Oxford University Press, Sixth impression, 2010

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction**	
1.1	Three laws, DOF, Misunderstood devices	1
1.2	Elements of Robotic Systems	1
1.3	Automation - Concept, Need, Automation in Production System	1
1.4	Principles and Strategies of Automation	1
1.5	Basic Elements of an Automated System, Advanced Automation Functions	1
1.6	Levels of Automations, Introduction to automation productivity.	1
2.0	**Robot Grippers**	
2.1	Types of Grippers, Design aspect for gripper	1
2.2	Force analysis for various basic gripper system. Sensors for Robots	1
2.3	Characteristics of sensing devices, Selections of sensors	1
2.4	Classification and applications of sensors. Types of Sensors	1
2.5	Need for sensors and vision system in the working and control of a robot	2
3.0	**Drives and control systems**	
3.1	Types of Drives, Actuators and its selection while designing a robot system	1
3.2	Types of transmission systems, Control Systems	1
3.3	Types of Controllers, Introduction to closed loop control	1
3.4	Control Technologies in Automation:- Industrial Control Systems	1
3.5	Process Industries Verses Discrete-Manufacturing Industries, Continuous Verses Discrete Control	1
3.6	Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.	2

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4.0	**Kinematics**	
4.1	Transformation matrices and their arithmetic link and joint description	2
4.2	Denavit – Hartenberg parameters	1
4.3	frame assignment to links, direct kinematics, kinematics redundancy	1
4.4	kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods	2
4.5	Velocities and Static forces in manipulators:-Jacobians, singularities, static forces, Jacobian in force domain	2
4.6	Dynamics:- Introduction to Dynamics , Trajectory generations	1
5.0	**Machine Vision System**	
5.1	Vision System Devices, Image acquisition, Masking, Sampling and quantisation	1
5.2	Image Processing Techniques, Noise reduction methods, Edge detection	1
5.3	Segmentation. Robot Programming: Methods of robot programming	2
5.4	lead through programming, motion interpolation, branching capabilities	2
5.5	WAIT, SIGNAL and DELAY commands, subroutines	1
5.6	Programming Languages: Introduction to various types such as RAIL and VAL II	1
5.7	Features of type and development of languages for recent robot systems.	1
6.0	**Modeling and Simulation for manufacturing Plant Automation**	
6.1	Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant	2
6.2	Modern Tools- Artificial neural networks in manufacturing automation	1
6.3	AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation	1
6.4	Artificial Intelligence: Introduction to Artificial Intelligence, AI techniques, Need and application of AI	2
6.5	Other Topics in Robotics:- Socio-Economic aspect of robotisation, Economical aspects for robot design	1
6.6	Safety for robot and associated mass, New Trends & recent updates in robotics	1

Course Designer

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60 PED E33	Fracture Mechanics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on mechanics of cracked components of different modes by which these components fail under static load conditions.
- To acquire knowledge on mechanics of cracked components of different modes underfatigue load conditions
- To know the crack tip plasticity and their characteristics
- To learn the test methods for critical energy release rate, and stress intensity factor
- To understand the mechanism of fatigue failure

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Identity different modes of fracture failure and evaluate the crack resistance and their growth	Remember, Apply & Analyze
CO2	Identity different cracks with their stress intensity	Remember, Apply & Analyze
CO3	Manage singularity at crack tip using complex variable.	Remember, Apply & Analyze
CO4	Determine critical energy release rate, critical stress intensity factor and J-Integral	Remember, Apply & Analyze
CO5	Calculate the fatigue life of a component with or without crack in it.	Remember, Apply & Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	1
CO2	3	3	3	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	3	1
CO5	3	3	3	2	3	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination(Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	0	0	0	0
Apply (Ap)	30	30	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E33 - Fracture Mechanics

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Elements of solid Mechanics The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation - limit analysis – Airy's function – field equation for stress intensity factor	[9]
Stationary Crack Under static Loading Two dimensional elastic fields – Analytical solutions yielding near a crack front – Irwin's approximation - plastic zone size – Dugdaale model – determination of J integral and its relation to crack opening displacement.	[9]
Energy balance and Crack Growth Griffith analysis – stable and unstable crack growth –Dynamic energy balance – crack arrest mechanism –K1c test methods - R curves - determination of collapse load..	[9]
Fatigue Crack Growth Curve Empirical relation describing crack growth law – life calculations for a given load amplitude – effects of changing the load spectrum -- rain flow method– external factors affecting the K1c values.- leak before break analysis.	[9]
Applications of Fracture Mechanics Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods.	[9]
Total Hours:	**45**

Text Book(s):

1.	David Broek, "Elementary Engineering Fracture Mechanics", MartinusNijhoffPublisher, 3rd revised edition, 2013.
2.	KareHellan, "Introduction of Fracture Mechanics", McGraw-Hill Book Company, 2005.

Reference(s):

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Passed in BoS Meeting held on 20/07/22
Approved in Academic Council Meeting held on 23/07/2022

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1.	Preshant Kumar, “Elements of Fracture Mechanics”, Wheeler Publishing, 2013.
2.	TribikramKundu, “Fundamentals of Fracture Mechanics”, Ane Books Pvt. Ltd. New Delhi/ CRC Press, 1st Indian Reprint, 2013.
3.	Prasant Kumar, “Elements of Fracture Mechanics”, McGraw Hill Education, 2009.
4.	Meguid S A., “Engineering Fracture Mechanics”, Elsevier Applied Science, 1989.

Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Elements of solid Mechanics**	
1.1	The geometry of stress and strain	2
1.2	Plastic and elasto-plastic deformation	2
1.3	Limit analysis	1
1.4	Airy’s function	1
1.5	Field equation for stress intensity factor	2
2.0	**Stationary Crack Under static Loading**	
2.1	Two dimensional elastic fields	2
2.2	Analytical solutions yielding near a crack front	2
2.3	Irwin’s approximation	1
2.4	Plastic zone size	1
2.5	Dugdaale model	1
2.6	Determination of J integral and its relation to crack opening	2
3.0	**Energy balance and Crack Growth**	
3.1	Griffith analysis	2
3.2	Stable and unstable crack growth	2
3.3	Dynamic energy balance	2
3.4	Crack arrest mechanism	1
3.5	K1c test methods	1
3.6	Determination of collapse load.	1

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4.0	**Fatigue Crack Growth Curve**	
4.1	Empirical relation describing crack growth law	1
4.2	Life calculations for a given load amplitude	2
4.3	Effects of changing the load spectrum	2
4.4	Rain flow method	2
4.5	External factors affecting the K1c values	1
4.6	Leak before break analysis.	1
5.0	**Applications of Fracture Mechanics**	
5.1	Crack Initiation under large scale yielding	2
5.2	Thickness as a design parameter	2
5.3	Mixed mode fractures	2
5.4	Crack instability in thermal and residual stress field	2
5.5	Numerical methods.	1

Course Designer

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60 PED E34	Engine Pollution and Control	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To create an awareness on the various environmental pollution aspects and issues.
- To analyses the comprehensive insight into the pollution in engine and gas turbines.
- To impart knowledge on pollutant formation and control.
- To impart knowledge on various emission instruments and techniques.
- To understand the different types of driving cycles.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Acquire knowledge about the atmospheric pollution due to automobile and stationary engines and effect of global warming.	Remember, Apply & Analyze
CO2	List out the types of pollutant and formation, to design the engine reducing the low emissions and noise.	Remember, Apply& Analyze
CO3	List out the types of measuring instruments used to measure engine exhaust emissions.	Remember, Apply& Analyze
CO4	Categorize the different types of emission control techniques used in IC engines.	Remember, Apply & Analyze
CO5	Describe the driving cycle with standard test procedure and national and international emissions standards.	Remember, Apply& Analyze

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2	3	1
CO2	3	3	3	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	3	1
CO5	3	3	3	2	3	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom'sCategory	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	0	0	0	0
Apply (Ap)	30	30	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E34 - Engine Pollution and Control

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Pollution -Engines and Turbines Atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming– Greenhouse effect and effects of I.C. Engine pollution on environment.	[9]
Pollutant Formation Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke, Particulate emission. Effects of Engine Design -operating variables on Emission formation –Noise pollution.	[9]
Emission Measurement Non dispersive infrared gas analyser, gas chromatography, chemiluminescent analyser and flame ionization detector, smoke meters –Noise measurement and control.	[9]
Emission Control Engine Design modifications, fuel modification, evaporative emission control, EGR, air injection, thermal reactors, Water Injection, catalytic converters, application of microprocessor in emission control. Common rail injection system, Particulate traps, NOx converters, SCR systems. GDI and HCCI concepts.	[9]
Driving Cycles and Emission Standards Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.	[9]
Total Hours:	**45**

Text Book(s):

1.	Ganeshan V, "Internal Combustion Engines", Tata McGraw-Hill, 2015.
2.	Guy B.Martin, "Automotive Emission Control", Academic Press,2007

Reference(s):

1.	James D.Halderman and James Linder, "Automotive Fuel and Emission Control Systems", 2011.
2.	Crouse W. H., Anglin D. L., "Automotive Mechanics", McGraw Hill Education Private Limited, New Delhi, 10th edition, 2017.
3.	Springer and Patterson, "Engine Emission", Plenum Press, 1990.
4.	Paul Degobert – Automobiles and Pollution – SAE International ISBN-1-56091-563- 3, 1991.

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Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Pollution -Engines and Turbines**	
1.1	Atmospheric pollution from Automotive and Stationary engines and	3
1.2	Gas turbines, Global warming	2
1.3	Greenhouse effect	2
1.4	Effects of I.C. Engine pollution on environment	2
2.0	**Pollutant Formation**	
2.1	Formation of oxides of nitrogen, carbon monoxide, hydrocarbon	2
2.2	Aldehydes and Smoke, Particulate emission	2
2.3	Effects of Engine Design -operating variables on Emission formation	3
2.4	Noise pollution	2
3.0	**Emission Measurement**	
3.1	Non dispersive infrared gas analyser, gas chromatography	1
3.2	Chemiluminescent analyser	2
3.3	Flame ionization detector	2
3.4	Smoke meters	2
3.5	Noise measurement and control	2
4.0	**Emission Control**	
4.1	Engine Design modifications, fuel modification, evaporative emission control	2
4.2	EGR, air injection, thermal reactors, Water Injection, catalytic converters	1
4.3	Application of microprocessor in emission control	2
4.4	Common rail injection system, Particulate traps, nox converters	2
4.5	SCR systems. GDI and HCCI concepts	2
5.0	**Driving Cycles and Emission Standards**	
5.1	Transient dynamometer, Test cells	2
5.2	Driving cycles for emission measurement	2
5.3	Chassis dynamometer, CVS system	2
5.4	National and International emission standards	3

Course Designer

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60 PED E35	Computational Fluid Dynamics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To develop the governing differential equation with boundary conditions.
- To develop conduction heat transfer for 1D, 2D and 3D governing equations.
- To solve the pressure of viscous flow through vorticity method.
- To formulate explicit & implicit algorithms for solving the Euler equations and Navier-Stokes equations.
- To understand the different types of models in fluid dynamics.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Formulate the governing differential equation and apply it for solving boundary value problems.	Remember& Apply
CO2	Solve the one dimensional conduction problem using study state condition	Remember & Apply
CO3	Estimate the pressure of viscous flow through Vorticity method.	Remember & Apply
CO4	Solve the one dimensional and two dimensional conduction problem by using finite element method.	Remember & Apply
CO5	Describe the different types of models in fluid dynamics.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	1
CO2	3	2	2	2	2	1
CO3	3	3	3	2	2	1
CO4	3	3	3	2	3	1
CO5	3	2	3	2	3	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E35 - Computational Fluid Dynamics								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Governing Differential Equation and Finite Difference Method Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.	[9]
Conduction Heat Transfer Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one dimensional problem, Two-dimensional Transient Problems.	[9]
Incompressible Fluid Flow Governing Equations, Stream Function – Vorticity method, Determination of pressure for viscous flow, Simple Procedure of Patankar and spalding, Computation of Boundary layer flow, Finite difference approach.	[9]
Convection Heat Transfer and FEM Steady One-Dimensional and Two-Dimensional Convection – dimensional convection – Diffusion, Unsteady two-dimensional Introduction to finite element method – Solution of steady heat Incompressible flow– Simulation by FEM	[9]
Turbulence Models Algebraic Models – One equation model, K-Models, Standard and High and Low Reynolds number models, prediction of fluid flow and heat transfer using standard codes.	[9]
Total Hours:	**45**

Text Book(s):

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2013.
2. Ghoshdastidar, P.S., “Computational Fluid Dynamics and Heat Transfer” Cengage India Private Ltd., 1st Edition, 2017.

Reference(s):

1. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational Fluid Mechanic and Heat Transfer” Hemisphere Publishing Corporation, Newyork, USA, 2011.
2. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics -1: Fundamental and General Techniques”, Springer – Verlag, 2006.
3. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics -2: Specific Techniques for Different Flow Categories”, Springer – Verlag, 2006.
4. Chung, T.J. “Computational Fluid Dynamics”, Cambridge University, Press, 2002.

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Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Governing Differential Equation and Finite Difference Method**	
1.1	Classification, Initial and Boundary conditions	1
1.2	Initial and Boundary value problems	2
1.3	Finite difference method, Central	2
1.4	Forward, Backward difference	2
1.5	Uniform and non-uniform Grids	1
1.6	Numerical Errors, Grid Independence Test	1
2.0	**Conduction Heat Transfer**	
2.1	Steady one-dimensional conduction	2
2.2	Two and Three dimensional steady state problems	2
2.3	Transient one dimensional problem	3
2.4	Two-dimensional Transient Problems	2
3.0	**Incompressible Fluid Flow**	
3.1	Governing Equations, Stream Function	1
3.2	Vorticity method	2
3.3	Determination of pressure for viscous flow	2
3.4	Simple Procedure of Patankar and spalding	2
3.5	Computation of Boundary layer flow, Finite difference approach	2
4.0	**Convection Heat Transfer and FEM**	
4.1	Steady One-Dimensional and Two-Dimensional Convection	2
4.2	Dimensional convection – Diffusion	1
4.3	Unsteady two-dimensional Introduction to finite element method	2
4.4	Solution of steady heat Incompressible flow	2
4.5	Simulation by FEM	2
5.0	**Turbulence Models**	

5.1	Algebraic models	2
5.2	One equation model, K-Models	2
5.3	Standard and High and Low Reynolds number models	2
5.4	Prediction of fluid flow	3
5.5	Heat transfer using standard codes	

Course Designer

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60 PED E41	Multi-body Dynamics	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To present the basic theoretical knowledge of the Foundations of Multi-body Dynamics with applications to machine and structural dynamics.
- To build capability to carry out multi-body dynamic analysis of complex mechanisms
- To compute and assembly of mass matrix of planar system
- To acquire knowledge on kinematic analysis of rigid bodies and spatial system
- To know the procedure to compute the reaction forces

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.	Remember & Apply
CO2	Implement and analyze methods of formulating equations of motion for interconnected bodies.	Remember & Apply
CO3	Write programs to solve constrained differential equations for analyzing multi-body systems.	Remember & Apply
CO4	Simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.	Remember & Apply
CO5	Lead team projects in academic research or the industry that require modeling and simulation of multi-body systems.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	3	2	1
CO3	3	3	2	3	2	1
CO4	3	3	2	3	3	1
CO5	3	3	2	2	3	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

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60 PED E41 - Multi-body Dynamics

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction The method of constraints for planar kinematic analysis. Revolute, prismatic, gear and cam pairs are considered together with other 2 degrees-of-freedom types of constraints.	[4]
Basic Principles for Analysis of Multi-Body Systems The automatic assembly of the systems of equations for position, velocity and acceleration analysis. Iterative solution of systems of non-linear equations. Geometry of masses. The principle of virtual work and Lagrange's equations	[5]
Dynamics of Planar Systems Dynamics of planar systems. Systematic computation and assembly of mass matrix. Computation of planar generalized forces for external forces and for actuator-spring-damper element. Simple applications of inverse and forward dynamic analysis. Numerical integration of first-order initial value problems. The method of Baumgarte for the solution of mixed differential-algebraic equations of motion. The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.	[9]
Kinematics of Rigid Bodies in Space Reference frames for the location of a body in space. Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space. Velocity, acceleration and angular velocity. Relationship between the angular velocity vector and the time derivatives of Euler parameters.	[9]
Kinematic Analysis of Spatial Systems Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, and spherical). Equations of motion for systems with ball-and-socket	[9]
Computation of Forces Computation of spatial generalized forces for external forces and for actuator-spring-damper element. Computation of reaction forces from Lagrange's multi- pliers	[9]
Total Hours:	**45**

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Text Book(s):	
1.	Wittenburg, J., “Dynamics of Systems of Rigid Bodies”, Springer, 1977.
2.	Nikravesh, P.E., “Computer Aided Analysis of Mechanical Systems”, Prentice-Hall Inc, 1988.
Reference(s):	
1.	Donald T. Greenwood, “Principles of Dynamics”, 2nd Edition, Prentice Hall, 1987.
2.	Kane, T.R, Levinson, D.A., “Dynamics: Theory and Applications”, McGraw-Hill Book Co., 2005.
3.	Rampalli. R, Ferrarotti. G,Hoffmann. M,”Why Do Multi-body System Simulation”,NAFEMS Publications, January 2012
4.	E Roberson, R.E., Schwertassek, R., “Dynamics of Multibody Systems”, Springer-Verlag, Berlin, 1988.
5.	Huston, R.L., “Multibody Dynamics”, Butterworth-Heinemann, 1990.
6.	De Jalo n, J.C., Bayo, E., “Kinematic and Dynamic Simulation of Multibody Systems”, Springer-Verlag, 1994.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Introduction**	
1.1	The method of constraints for planar kinematic analysis	1
1.2	Revolute, prismatic, gear	1
1.3	Cam pairs are considered together with other 2 degrees	1
1.4	Freedom types of constraints	1
2.0	**Basic Principles for Analysis of Multi-Body Systems**	
2.1	The automatic assembly of the systems of equations for position	1
2.2	Velocity and acceleration analysis	1
2.3	Iterative solution of systems of non-linear equations	1
2.4	Geometry of masses	1
2.5	The principle of virtual work and Lagrange’s equations	1
3.0	**Dynamics of Planar Systems**	
3.1	Dynamics of planar systems. Systematic computation and assembly of mass matrix	1
3.2	Computation of planar generalized forces for external forces and for actuator-spring	2
3.3	Damper element. Simple applications of inverse and forward dynamic analysis	2
3.4	Numerical integration of first-order initial value problems. The method of Baumgarte for the solution of mixed differential-algebraic equations of motion	2
3.5	The use of coordinates partitioning, QR and SVD decomposition for the orthogonalization of constraints.	2
4.0	**Kinematics of Rigid Bodies in Space**	
4.1	Reference frames for the location of a body in space	2

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4.2	Euler angles and Euler parameters. The formula of Rodrigues. Screw motion in space.	1
4.3	Velocity, acceleration and angular velocity	2
4.4	Relationship between the angular velocity vector	2
4.5	Time derivatives of Euler parameters	2
5.0	**Kinematic Analysis of Spatial Systems**	
5.1	Basic kinematic constraints. Joint definition frames	2
5.2	The constraints required for the description in space of common kinematic pairs	2
5.3	revolute, prismatic, cylindrical, and spherical	2
5.4	Equations of motion for systems with ball-and-socket	3
6.0	**Computation of Forces**	
6.1	Computation of spatial generalized forces for external forces	2
6.2	Actuator	2
6.3	Spring	1
6.4	Damper element	2
6.5	Computation of reaction forces from Lagrange's multi- pliers	2

Course Designer

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60 PED E42	Condition Based Monitoring	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the vibration condition monitoring techniques
- To learn the steps in signal processing and analysis
- To know the interpretation and application of Fourier transform
- To understand the use, selection and procedure for vibration monitoring
- To learn the design principles & applications, dynamic balancing and alignment of machinery.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Know and be able to explain the aim and the basics of CM and be aware of some methods and procedures applied for general CM;	Remember& Apply
CO2	Appreciate and understand the basic idea behind vibration-based structural health, monitoring and vibration-based condition monitoring, know the general	Remember& Apply
CO3	Know the basics of Vibration of Linear Systems: time and frequency response, resonance;	Remember& Apply
CO4	Aware of some basic instrumentation used for machinery and structural vibration-based monitoring;	Remember& Apply
CO5	Aware of some basic faults in rotating machinery, their manifestation and methods for detection and recognition: low frequency, medium frequency and	Remember& Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	2	2	3	2	2
CO3	3	3	3	3	2	1
CO4	3	3	3	3	2	1
CO5	3	3	3	2	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

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60 PED E42 - Condition Based Monitoring

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Introduction The basic idea of health monitoring and condition monitoring of structures and machines. Virtual reality monitoring.	[9]
Basics of Signal Processing Study of periodic and random signals, probability distribution, statistical properties, auto and cross correlation and power spectral density functions of commonly found systems, spectral analysis.	[9]
Fourier Transform Basic idea of Fourier transforms, interpretation and application to real signals. Response of linear systems to stationary random signals: FRFs, resonant frequencies, modes of vibration.	[9]
Vibration Based Monitoring Introduction to vibration-based monitoring, Machinery condition monitoring by vibration analysis: Use and selection of measurements, analysis procedures and instruments.	[9]
Applications of Vibration Based Monitoring Typical applications of condition monitoring using vibration analysis to rotating machines, Some other health monitoring techniques, acoustic emission, oil debris and temperature analysis, Applications.	[9]
Total Hours:	**45**

Text Book(s):

1.	Hartog, J.O. Den., "Mechanical Vibrations", McGraw-Hill, New York, 1985.
2.	Rao, J.S., "Vibratory Condition Monitoring of Machines", CRC Press, London, 2000.

Reference(s):

1.	Iyengar, R.N., "Elements of Mechanical Vibration", I K International Pub. House Pvt. Ltd., New Delhi, 2007.
2.	Adams, M., "Rotating Machinery Analysis - From Analysis to Troubleshooting", New York, ISBN 0-8247-0258-1.
3.	Cornelius Scheffer Paresh Girdhar, "Practical Machinery Vibration Analysis and Predictive Maintenance", Newnes, 1st Edition, 04, Paperback ISBN: 9780750662758.
4.	"Hand Book of Condition Monitoring", Elsevier Science, Amsterdam, 1996.

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Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction**	
1.1	The basic idea of health monitoring	2
1.2	Condition monitoring of structures	3
1.3	Condition monitoring of machines	2
1.4	Virtual reality monitoring	2
2.0	**Basics of Signal Processing**	
2.1	Study of periodic and random signals	2
2.2	Study of probability distribution and statistical properties	2
2.3	Study of auto and cross correlation	1
2.4	power spectral density functions of commonly found systems	2
2.5	spectral analysis of commonly found systems	2
3.0	**Fourier Transform**	
3.1	Basic idea of Fourier transforms	1
3.2	interpretation and application to real signals	2
3.3	Response of linear systems to stationary random signals:	2
3.4	FRFs, resonant frequencies	2
3.5	modes of vibration	2
4.0	**Vibration Based Monitoring**	
4.1	Introduction to vibration	2
4.2	Vibration based monitoring	1
4.3	Machinery condition monitoring by vibration analysis	2
4.4	Use and selection of measurements	2
4.5	Analysis procedures and instruments	2
5.0	**Applications of Vibration Based Monitoring**	
5.1	Typical applications of condition monitoring	1
5.2	Vibration analysis to rotating machines using condition monitoring	2
5.3	Some other health monitoring techniques	2
5.4	Acoustic emission, oil debris	2
5.5	Temperature analysis and Applications	2

Course Designer

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60 PED E43	Optimization Techniques in Design	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To enable the students to learn various optimization techniques.
- To know the techniques of linear programming
- To learn the procedures to solve Non-linear programming problems
- To apply the optimization techniques to design engineering components.
- To acquire knowledge on Genetic Algorithms to solve engineering problems

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify optimization problems.	Remember, Understand & Apply
CO2	Apply linear programming techniques to solve engineering problems.	Remember, Understand & Apply
CO3	Solve Non-Linear Programming problems.	Remember, Understand & Apply
CO4	Design mechanical elements like beams, columns, gears, shafts using optimization techniques.	Remember, Understand & Apply
CO5	Discuss Genetic Algorithms and solve engineering optimization problems.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	1	2
CO2	3	3	2	2	1	2
CO3	3	3	2	2	2	1
CO4	3	3	2	2	2	1
CO5	3	3	2	2	2	2
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	20	20
Understand (U)	10	10	20	20
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E43 - Optimization Techniques in Design

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	

Introduction Introduction to optimization, classification of optimization problems, classical optimization techniques.	[9]
Linear Programming Simplex method and Duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's methods.	[9]
Non-Linear Programming One dimensional minimization, unconstrained and constrained minimization, direct and indirect methods.	[9]
Geometric Programming and Optimum Design Geometric programming, Optimum design of mechanical elements like beams, columns, gears, shafts.	[9]
Genetic Algorithms Introduction to Genetic Algorithms, Operators, applications to engineering optimization problems.	[9]
Total Hours:	**45**

Text Book(s):

1. Rao Singiresu, S., "Engineering Optimization: Theory and Practice", New Age International (P) Limited, Publishers New Delhi, 2010.
2. Deb Kalyanamoy., "Optimization for Engineering Design: Algorithms and Examples", Prentice Hall of India, Pvt. Ltd., New Delhi, 2009.

Reference(s):

1. Johnson Ray, C., "Optimum Design of Mechanical Elements", John Wiley & Sons, New York, 1990.
2. Goldberg, D.E., "Genetic Algorithms in Search, Optimization and Machine", Barnen, Addison-Wesley, New York, 2005.
3. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980.
4. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 4th Edition, 2012.
5. Duffin, R J., Peterson E L., and Zener, C., "Geometric Programming-Theory and Applications", Willey, New York, 2007.

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Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Introduction**	
1.1	Introduction to optimization	1
1.2	Classification of optimization problems	1
1.3	Structural optimization problem statement	1
1.4	Classification based on the objective function	1
1.5	Classification based on constraints	1
1.6	Classification based on objective and constraints	1
1.7	Classification based on the nature of optimization	1
1.8	Classical optimization techniques	1
1.9	Discretization of the “function” variable	1
2.0	**Linear Programming**	
2.1	Simplex method	2
2.2	Duality in linear programming	2
2.3	Linear Programming Model	1
2.4	Sensitivity or post-optimality analysis	2
2.5	Karmarkar’s methods	2
3.0	**Non-Linear Programming**	
3.1	One dimensional minimization	2
3.2	Unconstrained and Constrained minimization	3
3.3	Direct and Indirect methods.	2
3.4	Non-Linear Programming Problems	1
3.5	Discretization of the “function” variable	1
4.0	**Geometric Programming and Optimum Design**	
4.1	Geometric programming	2
4.2	Optimum design of beams	2
4.3	Optimum design of columns	1
4.4	Optimum design of gears	2
4.5	Optimum design of shafts	2

5.0	**Genetic Algorithms**	
5.1	Introduction to Genetic Algorithms	2
5.2	Genetic Algorithms - Operators	2
5.3	Genetic Algorithms - Applications	2
5.4	Applications to engineering optimization problems	2
5.5	applications to engineering optimization problems	1

Course Designers

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60 PED E44	Alternative Fuels for IC Engines	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the availability, suitability and properties for various alternative fuels.
- To gain the knowledge on types of liquid alternative fuels used for S.I. Engines.
- To understand the knowledge on types of liquid alternative fuels used for C.I. Engines.
- To analyse the performance and emission characteristics of various gaseous alternative fuels used for S.I. Engines.
- To investigate the performance and emission characteristics of various gaseous alternative fuels used for C.I. Engines.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Gain the knowledge about the availability and suitability of alternative fuels for IC engines.	Remember & Apply
CO2	Categorize the liquids fuels for SI engines and types of emission levels.	Remember & Apply
CO3	Categorize the fuels for diesel engine and types of fuel additives for low emissions.	Remember & Apply
CO4	Categorize the types of gaseous of fuels used in SI and CI engine and safety precautions.	Remember & Apply
CO5	Analyse the engine performance and emissions levels operated in duel fuel mode.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	1
CO2	3	2	3	2	3	1
CO3	3	3	3	2	3	1
CO4	3	3	2	2	2	1
CO5	3	3	2	2	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

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60 PED E44 - Alternative Fuels for IC Engines

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels – Ethanol, Methanol, Diethyl ether, Dimethyl ether, Hydrogen, Liquefied Petroleum Gas, Natural Gas, Bio-gas and Bio-diesel.	[9]
Liquid Fuels for S.I. Engines Requirements, Utilisation techniques – Blends, Neat form, Reformed Fuels, Storage and Safety, Performance and Emission Characteristics.	[9]
Liquid Fuels for C.I. Engines Requirements, Utilisation techniques - Blends, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and Additives, Performance and emission characteristics.	[9]
Gaseous Fuels for S.I. Engines Hydrogen, Compressed Natural gas, Liquefied Petroleum gas, and Bio gas in SI engines – Safety Precautions – Engine performance and emissions.	[9]
Gaseous Fuels for C.I. Engines Hydrogen, Biogas, Liquefied Petroleum gas, Compressed Natural gas in CI engines. Dual fuelling, Performance and emission characteristics.	[9]
Total Hours:	**45**

Text Book(s):

1. GajendhraBabu, M K., Subramaniyan, K A., "Alternative Transportation Fuels, Utilisation in Combustion Engine", CRC press, Taylor and Francis Group, 2013.
2. Ramadhas, A. S., "Alternative Fuels for Transportation", CRC Press, 2012.

Reference(s):

1. Roger F. Haycock and John E. Hillier, "Automotive Lubricants Reference Book", 2nd Edition, SAE International Publications, 2004.
2. Gerhard Knothe, Jon Van Gerpen, Jargon Krahl, The Biodiesel Handbook, AOCS Press Champaign, Illinois 2005.

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3.	Richard L Bechtold P.E., Alternative Fuels Guide book, Society of Automotive Engineers, 1997 ISBN 0-76-80-0052-1.
4.	Ayhan Demirbas, 'Biodiesel A Realistic Fuel Alternative for Diesel Engines', Springer- Verlag London Limited 2008, ISBN-13: 9781846289941.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**Introduction**	
1.1	Availability, Suitability, Properties, Merits and Demerits of Potential Alternative Fuels	3
1.2	Ethanol, Methanol, Diethyl ether	2
1.3	Dimethyl ether, Hydrogen, Liquefied Petroleum Gas	2
1.4	Natural Gas, Bio-gas and Bio-diesel	2
2.0	**Liquid Fuels for S.I. Engines**	
2.1	Requirements, Utilisation techniques	2
2.2	Blends, Neat form, Reformed Fuels	2
2.3	Storage and Safety	2
2.4	Performance and Emission Characteristics	3
3.0	**Liquid Fuels for C.I. Engines**	
3.1	Requirements, Utilisation techniques	2
3.2	Blends, Neat fuels, Reformed fuels	2
3.3	Emulsions, Dual fuelling	1
3.4	Ignition accelerators and Additives	2
3.5	Performance and emission characteristics	2
4.0	**Gaseous Fuels for S.I. Engines**	
4.1	Hydrogen, Compressed Natural gas	2
4.2	Liquefied Petroleum gas	2
4.3	Bio gas in SI engines	1
4.4	Safety Precautions	2
4.5	Engine performance and emissions	2
5.0	**Gaseous Fuels for C.I. Engines**	
5.1	Hydrogen, Biogas, Liquefied Petroleum gas	2
5.2	Compressed Natural gas in CI engines	2
5.3	Dual fuelling	2
5.4	Performance characteristics	2
5.5	emission characteristics	1

Course Designers

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60 PED E45	Advanced Materials and Their Processing	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on the structure, properties of engineering materials
- To acquire concept of fracture mechanism and its associated theories
- To select the suitable materials for various applications
- To know the significance of modern metallic materials and their application.
- To identify polymeric material structure and its properties

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Gain the knowledge about the behaviour of materials and strengthening mechanisms.	Remember & Apply
CO2	Understand the fracture behaviour and failure analysis of metallic materials.	Remember & Apply
CO3	Analyse the properties and select the materials for intended application.	Remember & Apply
CO4	Acquire knowledge on modern metallic materials and smart materials.	Remember & Apply
CO5	Describe polymeric material structure, production, properties and application.	Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	20	20	40	40
Understand (U)	0	0	0	0
Apply (Ap)	40	40	60	60
Analyze (An)	0	0	0	0
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

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60 PED E45 - Advanced Materials and Their Processing								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Behaviour of Materials Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms, work hardening, solid solution hardening, grain boundary strengthening, poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature, strain and strain rate on plastic behaviors - Super plasticity - Deformation of non-crystalline material. Introduction to metastable and functional alloys Fundamental concepts of Bulk Metallic glasses.	[9]
Fracture Behaviour Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue - Fracture of non-metallic materials – Failure analysis, sources of failure, procedure of failure analysis.	[9]
Selection of Materials Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.	[9]
Modern Metallic Materials Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal. Advanced Functional Alloys, Soft and hard magnetic materials Superalloys: Alloy design, Microstructure and Properties.	[9]
Non Metallic Materials Polymeric materials - Formation of polymer structure - Production techniques of fibres, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Non-equilibrium Processes, Single Crystal Growth, Rapid Solidification, Inert Gas Condensation	[9]
Total Hours:	**45**

Text Book(s):

1.	Thomas H.Courtney, “Mechanical Behaviour of Materials ", McGraw-Hill, 2nd Edition, 2005.
2.	George E.Dieter, “Mechanical Metallurgy ", McGraw Hill, 1988.

Reference(s):

1.	Flinn, R.A. and Trojan, P.K., "Engineering Materials and their Applications ", 4thEdition, Jaico, 1999.
2.	Charles J.A., Crane, F.A.A and Furness, J.A.G., "Selection and use of Engineering Materials”, Butterworth- Heiremann, 1997.
3.	William D. Callister, “Materials Science and Engineering”, John Wiley & sons, 10th Edition, 2018
4.	Ashutosh Tiwari, Arul Murugan N, Rajeev Ahuja, “Advanced Engineering Materials and Modeling”, Wiley-Scrivener Publishers, 2016.
5.	“Failure Analysis and Prevention", Metals Hand Book, Vol.10, 10thEdition, 2002.

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Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Behaviour of Materials**	
1.1	Mechanism of plastic deformation, role of dislocations, yield stress, shear strength of perfect and real crystals - Strengthening mechanisms	2
1.2	Work hardening, solid solution hardening, grain boundary strengthening	1
1.3	Poly phase mixture, precipitation, particle, fiber and dispersion strengthening. Effect of temperature,	2
1.4	Strain and strain rate on plastic behaviors	1
1.5	Super plasticity - Deformation of non- crystalline material.	1
1.6	Introduction to metastable and functional alloys	1
1.7	Fundamental concepts of Bulk Metallic glasses.	1
2.0	**Fracture Behavior**	
2.1	Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms	2
2.2	Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue	2
2.3	Low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Effect of surface and metallurgical parameters on fatigue -	3
2.4	Fracture of non-metallic materials, Failure analysis, sources of failure, procedure of failure analysis	2
3.0	**Selection of Materials**	
3.1	Motivation for selection, cost basis and service	1
3.2	Requirements - Selection for mechanical properties strength, toughness, fatigue and creep	2
3.3	Selection for surface durability corrosion and wear resistance	2
3.4	Relationship between materials selection and processing - Case studies in materials	2
3.5	Selection with relevance to aero, auto, marine, machinery and nuclear applications.	2
4.0	**Modern Metallic Materials**	
4.1	Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel,	2
4.2	Maraging steel - Intermetallics, Ni and Ti aluminides	1
4.3	Smart materials, shape memory alloys	1
4.4	Metallic glass - Quasi crystal. Advanced Functional Alloys	2
4.5	Soft and hard magnetic materials Superalloys	2

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4.6	Alloy design, Microstructure and Properties	1
5.0	**Non-Metallic Materials**	
5.1	Polymeric materials - Formation of polymer structure	1
5.2	Production techniques of fibres, foams, adhesives and coatings	2
5.3	Structure, properties and applications of engineering polymers	2
5.4	Non-equilibrium Processes, Single Crystal Growth	2
5.5	Rapid solidification, inert gas condensation	2

Course Designer

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60 PAC 001	English For Research Paper Writing	Category	L	T	P	Credit
		PC	2	0	0	0

Objectives

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Understand that how to improve your writing skills and level of readability	Remember, Understand & Apply
CO2	Learn about what to write in each section	Remember, Understand & Apply
CO3	Understand the skills needed when writing a Title	Remember, Understand & Apply
CO4	Understand the skills needed when writing the Conclusion	Remember, Understand & Apply
CO5	Ensure the good quality of paper at very first-time submission	Remember, Understand & Apply

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Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PAC 001 - English for Research Paper Writing								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	2	0	0	30	0	40	60	100
Introduction to Research Paper Writing Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness								[6]
Presentation Skills Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction								[6]
Title Writing Skills 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								[6]
Result Writing Skills 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								[6]
Verification Skills Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first time submission								[6]

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	Total Hours:	**30**
Text Book(s):		
1.	Adrian Wall work, 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	
Reference(s):		
1.	Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006	
2.	Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.	
3.	Phill Williams, Advanced Writing skills for students of English, Rumian Publishers, 2018	
4.	Sudhir S. Pandhye, English Grammar and Writing Skills, Notion Press, 2017.	

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction to Research Paper Writing**	
1.1	Planning and Preparation, Word Order	2
1.2	Breaking up long sentences, Structuring Paragraphs and Sentences	1
1.3	Being Concise and Removing Redundancy	2
1.4	Avoiding Ambiguity and Vagueness	1
2.0	**Presentation Skills**	
2.1	Clarifying Who Did What, Highlighting Your Findings	2
2.2	Hedging and Criticizing	2
2.3	Paraphrasing and Plagiarism, Sections of a Paper	1
2.4	Abstracts, Introduction	1
3.0	**Title Writing Skills**	
3.1	Key skills are needed when writing a Title	1
3.2	Key skills are needed when writing an Abstract, key skills are needed when writing an Introduction	2
3.3	Skills needed when writing a Review of the Literature	2
3.4	Methods, results, discussion, conclusions, the final check	1
4.0	**Result Writing Skills**	
4.1	Skills are needed when writing the Methods	2
4.2	Skills needed when writing the Results	1
4.3	Skills are needed when writing the Discussion	1
4.4	Skills are needed when writing the Conclusions	2
5.0	**Verification Skills**	
5.1	Useful phrases	2
5.2	Checking Plagiarism	2
5.3	How to ensure paper is as good as it could possibly be the first time submission	2

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60 PAC 002	Disaster Management	Category	L	T	P	Credit
		PC	2	0	0	0

Objectives

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches Teach how to improve writing skills and level of readability

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Ability to summarize basics of disaster	Remember, Understand & Apply
CO2	Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.	Remember, Understand & Apply
CO3	Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.	Remember, Understand & Apply
CO4	Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.	Remember, Understand & Apply
CO5	Ability to develop the strengths and weaknesses of disaster management approaches	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

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60 PAC 002 – Disaster Management

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	2	0	0	30	0	40	60	100

Introduction Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	[6]
Repercussions of Disasters and Hazards 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.	[6]
Disaster Prone Areas In India 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	[6]
Disaster Preparedness and Management 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.	[6]
Risk Assessment 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.	[6]
Total Hours:	**30**
Text Book(s):	

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1.	Goel S. L., Disaster Administration and Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2.	NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
Reference(s):	
1.	Sahni, Pardeepet.al.," Disaster Mitigation Experiences and Reflections", Prentice Hall of India, 2001.
2.	Subramanian R,"Disaster Management", Vikas publishing Housing Pvt. Ltd., 2018.
3.	Chu-huaKuei, Christian N Madu, Handbook of Disaster Management Risk Reduction & Management: Climate change and Natural Disaster, world scientific, 2017.
4.	JankiAndharia, Disaster studies: Exploring Intersectional ties in Disaster Discourse, Springer, 2020.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction**	
1.1	Disaster: Definition, Factors and Significance	2
1.2	Difference between Hazard and Disaster	2
1.3	Natural and Manmade Disasters	2
1.4	Difference, Nature	2
1.5	Types and Magnitude	1
2.0	**Repercussions of Disasters and Hazards**	
2.1	Economic Damage, Loss of Human and Animal Life	2
2.2	Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones	2
2.3	Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches	2
2.4	Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents	1
2.5	Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts	2
3.0	**Disaster Prone Areas In India**	
3.1	Study of Seismic Zones	1
3.2	Areas Prone to Floods and Droughts	2
3.3	Landslides and Avalanches	2
3.4	Areas Prone to Cyclonic and Coastal Hazards with Special Reference To Tsunami	2
3.5	Post-Disaster Diseases and Epidemics	2

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4.0	**Disaster Preparedness and Management**	
4.1	Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard	2
4.2	Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches	2
4.3	Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches	2
4.4	Application of Remote Sensing, Data from Meteorological and other Agencies	2
4.5	Media Reports: Governmental and Community Preparedness	1
5.0	**Risk Assessment**	
5.1	Disaster Risk: Concept and Elements	2
5.2	Disaster Risk Reduction, Global and National Disaster Risk Situation	2
5.3	Techniques of Risk Assessment	2
5.4	Global Co-Operation in Risk Assessment and Warning	2
5.5	People's Participation in Risk Assessment. Strategies for Survival	1

Course Designer

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60 PAC 003	Constitution Of India	Category	L	T	P	Credit
		PC	2	0	0	0

Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.	Remember, Understand &Apply
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India	Remember, Understand &Apply
CO3	Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.	Remember, Understand &Apply
CO4	Discuss the passage of the Hindu Code Bill of 1956.	Remember, Understand &Apply
CO5	Discuss the role and functioning of election commission of India.	Remember, Understand &Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

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60 PAC 003 – Constitution of India

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	2	0	0	30	0	40	60	100

History of Making of The Indian Constitution History, Drafting Committee, (Composition & Working)	[3]
Philosophy of The Indian Constitution Preamble, Salient Features	[3]
Contours of Constitutional Rights and Duties 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.	[6]
Organs of Governance Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.	[6]
Local Administration District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.	[6]
Election Commission Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.	[6]
Total Hours:	**30**

Text Book(s):

1.	The Constitution of India, 1950 (Bare Act), Government Publication.

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2.	Busi S N, Ambedkar B R, “Framing of Indian Constitution”,1st Edition, 2015.
Reference(s):	
1.	Jain, M P, “Indian Constitution Law”, 7th Edition, Lexis Nexis,2014
2.	Basu, D D, “Introduction to the Constitution of India”, Lexis Nexis, 2015.
3.	Bhansali S R., “Textbook on The Constitution of India”, Universal Publishers, 2015
4.	Jain, M P., ”Outlines of Indian Legal and Constitutional History”, Lexis Nexis, 2014

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**History of Making of The Indian Constitution**	
1.1	History	1
1.2	Drafting Committee, (Composition & Working)	2
2.0	**Philosophy of The Indian Constitution**	
2.1	Preamble, Salient Features	3
3.0	**Contours of Constitutional Rights and Duties**	
3.1	Fundamental Rights, Right to Equality, Right to Freedom	1
3.2	Right against Exploitation, Right to Freedom of Religion	1
3.3	Cultural and Educational Rights	1
3.4	Right to Constitutional Remedies	1
3.5	Directive Principles of State Policy, Fundamental Duties	2
4.0	**Organs of Governance**	
4.1	Parliament, Composition, Qualifications and Disqualifications	2
4.2	Powers and Functions, Executive	1
4.3	President, Governor, Council of Ministers	1
4.4	Judiciary, Appointment and Transfer of Judges	1
4.5	Qualifications, Powers and Functions	1
5.0	**Local Administration**	
5.1	District’s Administration head: Role and Importance Municipalities	1
5.2	Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation	1
5.3	Panchayat raj: Introduction, PRI: ZilaPanchayat. Elected officials and their roles	1
5.4	CEO ZilaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments)	1
5.5	Village level: Role of Elected and Appointed officials, Importance of grass root democracy	2

Course Designer

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60 PED 2P1	Computer Aided Analysis Laboratory II	Category	L	T	P	Credit
		ES	0	0	4	2

Objectives

- To learn to perform the modeling and meshing of machine component
- To perform the analysis on helical spring deflection and modal analysis of beam
- To acquire knowledge to perform transient analysis using CAE software.
- To develop the students to perform the Design optimization of beam
- To impart knowledge on contact analysis and heat transfer analysis using CAE software.

Pre-requisite

Computer Aided Analysis Laboratory I

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Create the modeling of bearing block and connecting rod	Understand &Apply
CO2	Perform the axial deflection analysis of an open – coiled Helical spring	Understand &Apply
CO3	Perform the modal and transient analysis of cantilever beam	Understand &Apply
CO4	Perform the design optimization, drop test and contact analysis	Understand &Apply
CO5	Perform the steady state and transient heat transfer analysis.	Understand &Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	3	2
CO2	3	2	2	3	3	2
CO3	3	2	2	3	3	2
CO4	3	2	2	3	3	2
CO5	3	2	2	3	3	2
3- Strong; 2-Medium; 1-Some						

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60 PED 2P1- Computer Aided Analysis Laboratory II								
PED : M.E. Engineering Design								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	0	0	4	60	2	60	40	100

List of Experiments

1. Solid model creation.
2. Transient analysis of cantilever beam.
3. Modal Analysis of Cantilever beam for natural Frequency determination.
4. Modal analysis of stepped shaft.
5. Buckling failure.
6. Harmonic analysis of guitar.
7. Steady state heat transfer analysis on composite wall.
8. Transient heat transfer analysis of slab.
9. Thermal stress analysis of a 2D component.
10. Radiation exchange between surfaces.

Text book (s) :

1	Chandrupatla and Belegundu “Introduction to Finite Elements in Engineering”, Prentice Hall of India Pvt. Ltd. New Delhi, 4th Ed., 2015.
2	Reddy J N, “Finite Element Method”, Tata McGraw Hill publishing Co Ltd, New Delhi, 3rdEd., 2006.

Reference(s) :

1	Logan Deryl L., “A First Course in Finite Element Method”, Thomson Brook/Cole, 5th Ed.2012.
2	Cook R.D. “Concepts and Applications of Finite Element Analysis” Wiley, New York, 4th Ed. 2007.
3	Bathe K.J., Cliffs, N.J. “Finite Element Procedures in Engineering Analysis”, PHI Learning, Eastern Economy Editions, 2009.
4	Ross C T F., “Advanced Applied Finite Element Methods”, Horwood Publishing, 1998.

Course Designer

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60 PED 2P2	Technical Report Preparation and Presentation	Category	L	T	P	Credit
		PC	0	0	4	1

Objectives

- To provide exposure to the students to refer and read the research articles in referred journals and conference proceedings
- To learn to review the research articles and to find the research gap
- To improve the technical report writing and presentation skills of the students.
- To acquire strong communication skills to deliver their findings
- To provide exposure to use latest IT tools for presentation

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Collect the relevant literature such as national/international refereed journals selected topics of research.	Remember, Understand & Apply
CO2	Review the research articles of their interest	Remember, Understand & Apply
CO3	Write Technical reports to publish at national/international conference.	Remember, Understand & Apply
CO4	Develop strong communication skills to deliver their work in front of technically qualified audience.	Remember, Understand & Apply
CO5	Prepare and present report with latest IT tools	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	1	2	3	1
CO2	3	3	1	2	3	1
CO3	3	3	1	2	3	1
CO4	3	3	1	2	2	1
CO5	3	3	1	2	2	1
3- Strong;2-Medium;1-Some						

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K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PED 2P2 - Technical Report Preparation and Presentation								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	0	0	4	60	1	100	0	100

Methodology

- Each student is allotted to a faculty of the department by the HOD
- By mutual discussions, the faculty guide will assign a topic in the general / subject area to the student
- The students have to refer the Journals and Conference proceedings and collect the published literature
- The student is expected to collect at least 20 such Research Papers published in the last 5 years
- Using OHP/Power Point, the student has to make presentation for 15-20 minutes followed by 10 minutes discussion
- The student has make two presentations, one at the middle and the other near the end of the semester
- The student has to write a Technical Report for about 30-50 pages (Title page, One page Abstract, Review of Research paper under various subheadings, Concluding Remarks and List of References). The technical report has to be submitted to the HOD one week before the final presentation, after the approval of the faculty guide.

	Week	Activity
Execution	I	Allotment of Faculty Guide by the HoD
	II	Finalizing the topic with the approval of Faculty Guide
	III-IV	Collection of Technical papers
	V-VI	Mid semester presentation
	VII-VIII	Report writing
	IX	Report submission
	X-XI	Final presentation

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60 PED 2P3	Mini Project	Category	L	T	P	Credit
		PC	0	0	4	2

Objectives

- To impart the practical knowledge to the students
- To make them to carry out the technical procedures in their project work
- To provide an exposure to the students to refer, read and review the research articles
- To write technical papers relevant to their project work and placing this as their beginning stage for their final presentation.
- To acquire strong communication skills to present among the audience.

Pre-requisite

-NIL-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Get an opportunity to work in actual industrial environment if they opt for internship.	Remember, Understand & Apply
CO2	Solve a live problem using software/analytical/computational tools.	Remember, Understand & Apply
CO3	Collect the literature relevant to their chosen area of interest	Remember, Understand &Apply
CO4	Learn to write technical reports.	Remember, Understand & Apply
CO5	Develop skills to present and defend their work in front of technically qualified audience	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	1	2	3	1
CO2	3	2	1	2	3	1
CO3	3	2	1	2	3	1
CO4	3	2	1	3	2	1
CO5	3	2	1	3	2	1
3- Strong;2-Medium;1-Some						

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K.S. Rangasamy College of Technology – Autonomous R 2022								
60 PED 2P3 - Mini Project								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	0	0	4	60	2	100	0	100

Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

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K.S.RANGASAMY COLLEGE OF TECHNOLOGY, TIRUCHENGODE - 637215

(An Autonomous Institution affiliated to Anna University)

M.E. / M.Tech. Degree Programme

SCHEME OF EXAMINATIONS

(For the candidates admitted from 2022-2023 onwards)

THIRD SEMESTER

S. No.	Course Code	Name of the Course	Duration of Internal Exam	Weightage of Marks			Minimum Marks for Pass in End Semester Exam	
				Continuous Assessment *	End Semester Exam **	Max. Marks	End Semester Exam	Total
THEORY								
1	60 PED E5*	Programme Elective – V	2	40	60	100	45	100
2	60 PED E6*	Programme Elective – VI	2	40	60	100	45	100
PRACTICAL								
3	60 PED3P1	Project Work - Phase I	3	100	-	100	-	-

*CA evaluation pattern will differ from course to course and for different tests. This will have to be declared in advance to students. The department wills put a process in place to ensure that the actual test paper follow the declared pattern.

** End Semester Examination will be conducted for maximum marks of 100 and subsequently be reduced to60marksfortheawardofterminalexaminationmarks

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60 PED E51	Advanced Finite Element Method	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To formulate the advanced FE Plate and Shell elements
- To demonstrate use of FE formulation to solve dynamic problems
- To learn the concept of material and geometric Non-linearity
- To acquire knowledge and solve contact problems.
- To apply the h-refinement technique for convergence of results

Pre-requisite

Finite Element Analysis

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Formulate the Plate and Shell elements and solve the appropriate problems	Remember, Understand & Apply
CO2	Solve dynamic vibration problems using various numerical methods	Remember, Understand & Apply
CO3	Solve the non-linear problems in Metal Forming Process	Remember, Understand & Apply
CO4	Model and solve 2D frictionless contact problems	Remember, Understand & Apply
CO5	Estimate the errors in FE model and apply the adaptive refinement	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

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60 PED E51 - Advanced Finite Element Method

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	

Bending of Plates and Shells Review of Elasticity Equations – Bending of Plates and Shells – Finite Element Formulation of Plate and Shell Elements - Conforming and Non-Conforming Elements –C_0 and C_1 Continuity Elements – Application and Examples.	[9]
Dynamic Problems Direct Formulation – Free, Transient and Forced Response – Solution Procedures –Subspace Iterative Technique – Houbolt, Wilson, Newmark Methods – Examples.	[9]
Non-Linear Problems Introduction – Iterative Techniques – Material non-linearity – Elasto Plasticity – Plasticity– Visco Plasticity – Geometric Non linearity – large displacement Formulation –Application in Metal Forming Process.	[9]
Contact Problems Condition of impenetrability - Gap elements for modelling contact -Tangent stiffness matrix and force vectors for 2D frictionless contact problems.	[9]
Error Estimates and Adaptive Refinement Error norms and Convergence rates – h-refinement with adaptivity – Adaptive refinement.	[9]
Total Hours:	**45**

Text Book(s):

1. Bathe K.J., and Cliffs, N.J. "Finite Element Procedures in Engineering Analysis", PHI Learning, Eastern Economy Editions, 2009.
2. Reddy J N, "Finite Element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, 3rdEdition, 2006.

Reference(s):

1. Zienkiewicz, O.C., and Taylor, R.L., "Finite Element Method: Volume 2 Solid Mechanics", 5th Edition, Butterworth-Heinemann, Oxford, 2000.
2. Belytschko T and Liu W K., and Moran, B., "Nonlinear Finite Elements for Continua and Structures", 2nd Edition, John Wiley & Sons Ltd., England, 2014.
3. Robert D.Cook., David.S, Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis" 4thEdition, Wiley Publication, 2013.

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4.	Logan Deryl L., "A First Course in Finite Element Method", Thomson Brook/Cole, 5th Ed.2012.
5.	Ross C T F., "Advanced Applied Finite Element Methods", Horwood Publishing, 1998.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Bending of Plates and Shells**	
1.1	Review of Elasticity Equations	1
1.2	Bending of Plates and Shells	2
1.3	Finite Element Formulation of Plate and Shell Elements	2
1.4	Conforming and Non-Conforming Elements	2
1.5	C_0 and C_1 Continuity Elements	1
1.6	Application and Examples.	1
2.0	**Dynamic Problems**	
2.1	Direct Formulation	2
2.2	Free, Transient and Forced Response	2
2.3	Solution Procedures –Subspace Iterative Technique	2
2.4	Houbolt, Wilson	1
2.5	Newmark Methods	2
3.0	**Non-Linear Problems**	
3.1	Introduction – Iterative Techniques	1
3.2	Material non-linearity – Elasto Plasticity	2
3.3	Plasticity– Visco Plasticity – Geometric	2
3.4	Non linearity – large displacement Formulation	2
3.5	Application in Metal Forming Process	2
4.0	**Contact Problems**	
4.1	Condition of impenetrability	2
4.2	Gap elements for modelling contact	2
4.3	Tangent stiffness matrix	2
4.4	Force vectors for 2D frictionless contact problems.	3
5.0	**Error Estimates and Adaptive Refinement**	
5.1	Error norms and Convergence rates	3
5.2	h-refinement with adaptivity	3
5.3	Adaptive refinement.	3

Course Designer

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60 PED E52	Advanced Metallurgy	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To analyze the Structure of materials at different levels, basic concepts of crystalline materials.
- To explain the concept of phase, phase diagram and understand the basic terminologies associated with metallurgy.
- To learn the heat treatment processes and its effects on material properties
- To explain features, classification, applications of newer class materials like smart materials, piezoelectric materials, biomaterials, composite materials etc.
- To learn the methods of fabrication of composite materials

Pre-requisite

Engineering Materials and Metallurgy

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate understanding of various aspects of crystal and lattice structure and their imperfection.	Remember, Understand & Apply
CO2	Recognize and identify the phases in metallic materials and their effect on their properties.	Remember, Understand & Apply
CO3	Comprehend the process of heat treatment of different nonferrous alloys and tool steel and decide a heat treatment to acquire their desired properties.	Remember, Understand & Apply
CO4	Demonstrate acquisition of knowledge of composites, ceramics, orthodental and biomaterials.	Remember, Understand & Apply
CO5	Know the recent developments in the field and understand modern research material.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

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60 PED E52 – Advanced Metallurgy

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Physical State of Metals Aspects of Physical Metallurgy: Crystal structure, systems and Barvias lattices, Indexing of lattice planes (Miller's Indices), Indexing of lattice directions, Co-ordination Number (Ligency), Density calculations and imperfections in crystals.	[9]
Phases of Metals Study of Equilibrium diagrams for Fe-C systems, Cu - Bronze alloys i.e. Cu:Zn, Cu:Sn, Cu:Al etc., Developments in metallic materials like HSLA state, maraging steels, dual phased steels, creep resisting steels, materials for high and low temperature applications, Nimerics, Inconels, Haste Alloys etc., Al, Ni alloys, Ti, Mg alloys.	[9]
Heat Treatment Heat Treatment of Nonferrous alloys, Heat Treatment of Tool steels.	[9]
Modern Materials Orthodental materials, Bio material, Prosthetic materials, Nano materials, superconducting materials, sports materials.	[9]
Fabrication of Composites Composites, ceramics, cermets, shape memory alloys their manufacturing techniques, advantages and limitations. Surface coatings and their tribological aspects. PVD, CVD, IVD ion implantation method.	[9]
Total Hours:	**45**

Text Book(s):

1.	Khanna, O.P., "A Text Book of Material Science and Metallurgy", Dhanpat Rai and Sons, New Delhi, 2000.
2.	William F. Smith, "Principles of Material Science and Engineering", McGraw-Hill Book Co., New Delhi, 1995

Reference(s):

Rev. No.0/w.e.f. 01.08.22
Passed in BoS Meeting held on 20/07/22
Approved in Academic Council Meeting held on 23/07/2022

BoS - Chairman
Mechanical Engineering (UG & PG)
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1.	Gupta, R.B., “Material Science”, Satya Publications, 4th Edition, New Delhi, 1980.
2.	William D. Callister, Jr, “Material Science and Engineering an Introduction”, John Wiley and Sons Inc.1989.
3.	Brandes, E.A., and Brook, G.B., “Smithells Metals Reference Book”, Butterworth Heinemann.
4.	Lawrence H. Van Vlack, “Elements of Material Science and Engineering”, Addison Wesley Publishing Company.1989.
5.	Donald L. Wise, “Biomaterials and Bioengineering Handbook”, 1st edition, Marcel Dekker Inc.2000

Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Physical State of Metals**	
1.1	Aspects of Physical Metallurgy	2
1.2	Crystal structure	1
1.3	Systems and Barvias lattices	2
1.4	Indexing of lattice planes	1
1.5	Indexing of lattice directions	1
1.6	Co-ordination Number (Ligency)	1
1.7	Density calculations and imperfections in crystals	1
2.0	**Phases of Metals**	
2.1	Study of Equilibrium diagrams for Fe-C systems	2
2.2	Cu - Bronze alloys i.e. Cu:Zn, Cu:Sn, Cu:Al	1
2.3	Developments in metallic materials like HSLA state	1
2.4	Maraging steels, dual phased steels	1
2.5	Creep resisting steels	1
2.6	Materials for high and low temperature applications	1
2.7	Nimerics, Inconels, Haste Alloys	1
2.8	Al, Ni alloys, Ti, Mg alloys.	1
3.0	**Heat Treatment**	
3.1	Heat Treatment of Nonferrous alloys	5
3.2	Heat Treatment of Tool steels	4

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4.0	**Modern Materials**	
4.1	Orthodental materials	2
4.2	Bio material	1
4.3	Prosthetic materials	1
4.4	Nano materials	2
4.5	Superconducting materials	2
4.6	Sports materials	1
5.0	**Fabrication of Composites**	
5.1	Composites	1
5.2	Ceramics, cermets, shape memory alloys their manufacturing techniques	2
5.3	Advantages and limitations of ceramics, cermets, shape memory alloys	2
5.4	Surface coatings and their tribological aspects	2
5.5	PVD, CVD, IVD ion implantation method	2

Course Designer

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60 PED E53	Design of Material Handling Equipments	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on the need and application of different material handling techniques, equipment's used in common use and in industrial sector.
- To prepare the students to design the hoist
- To learn the mechanism of hoisting gears, design and its application
- To acquire knowledge on conveyors, types and application
- To know the design procedures of elevators for material transport.

Pre-requisite

-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Classify various types of material handling equipment and their applications.	Remember, Understand & Apply
CO2	Design the chain drive, rope drive systems and their attachments in material handling equipment.	Remember, Understand & Apply
CO3	Design various hoisting gear mechanisms and to select the motor ratings for power drive in the material handling equipment.	Remember, Understand & Apply
CO4	Design the belt, screw conveyor, pneumatic and vibratory conveyor for material transportation.	Remember, Understand & Apply
CO5	Design the bucket, cage elevators, escalators and fork lift truck.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E53 - Design of Material Handling Equipments

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Materials Handling Equipment Intraplant transporting facilities - types - Principle groups of material handling equipment – Types of material handling equipment – Choice of material handling equipment - General characteristics - applications.	[9]
Design of Hoist Welded and roller chains - Hemp and steel wire ropes - pulleys, pulley systems, sprockets and drums - Load handling attachments - Forged hooks and eye hooks - Crane grabs – Electric lifting magnets - Grabbing attachments – Ladles - Arresting gear and Brakes.	[9]
Hoisting Gear Drives of Hoisting gear - Hand and power drives – Traveling gear - Rail traveling mechanism - Cantilever and monorail cranes – Trackless travelling mechanisms - Slewing, jib and luffing gear - Selecting the motor ratings - Cogwheel drive.	[9]
Conveyors Types - Belt conveyor - Pneumatic conveyor - Screw conveyor - apron conveyor - Vibratory conveyor – Design and applications.	[9]
Elevators Bucket elevators - design - Loading and bucket arrangements - Cage elevators - Shaft way, guides, counter weights, hoisting machine, safety devices – Fork lift truck – Escalators	[9]
.	**45**

Text Book(s):

1.	Rudenko, N., "Materials handling equipment", Peace publications, Mascow, 2000.
2.	Spivakovsy, A.O and Dyachkov, V.K., "Conveying Machines", Volumes I and II, MIR Publishers, 1985.

Reference(s):

1.	Alexandrov, M., "Materials Handling Equipments", MIR Publishers, 1981.
2.	Ray Siddhartha., "Introduction to Material Handling", New age International, 2007.
3.	Arora, K.C and Vikas V. Shinde., "Aspects of Material handling", First edition, Laxmi publications,2007.

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4.	Fayed, M.E., and Thomas S.S., “Mechanical conveyors", Selection and operation”, 1st edition, CRC press, 1996.
5.	“Design Data Book”, Compiled by P.S.G. College of Technology, Kalaikathir Achchagam, Coimbatore, 2011.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Materials Handling Equipment**	
1.1	Intra plant transporting facilities	2
1.2	Intra plant Principle of material handling equipment	1
1.3	Groups of material handling equipment	2
1.4	Types of material handling equipment	1
1.5	Choice of material handling equipment	1
1.6	General characteristics of material handling equipment	1
1.7	Applications of material handling equipment	1
2.0	**Design of Hoist**	
2.1	Welded and roller and Hemp and steel wire ropes	2
2.2	Pulleys, pulley systems and sprockets and drums	2
2.3	Load handling attachments and Forged hooks and eye hooks	2
2.4	Crane grabs and Electric lifting magnets	1
2.5	Grabbing attachments and Ladles - Arresting gear and Brakes	2
3.0	**Hoisting Gear**	
3.1	Drives of Hoisting gear	1
3.2	Hand and power drives	1
3.3	Traveling gear - Rail traveling mechanism	2
3.4	Cantilever and monorail cranes	1
3.5	Trackless travelling mechanisms	1
3.6	Slewing, jib and luffing gear	1
3.7	Selecting the motor ratings - Cogwheel drive	2

4.0	**Conveyors**	
4.1	Types of Belt conveyor	2
4.2	Pneumatic conveyor	2
4.3	Screw and apron conveyor	2
4.4	Vibratory conveyor Design and applications	3
5.0	**Elevators**	
5.1	Bucket elevators design	1
5.2	Design of Loading and bucket arrangements	2
5.3	Design of Shaft way, guides, counter weights hoisting machine	2
5.4	Safety devices and Fork lift truck Design	2
5.5	Escalators and Cage elevators	2

Course Designer

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60 PED E54	Advances in Casting and Welding Processes	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on foundry layout and design characteristics.
- To study the metallurgical concepts and applications of casting process.
- To acquire knowledge on advancements in casting and CAD of casting
- To learn the welding metallurgy and heat treatment effects
- To understand the recent welding process and their application

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Demonstrate the principle and design considerations in casting.	Remember, Understand & Apply
CO2	Identify the phases in metallic materials, castability and their defects.	Remember, Understand & Apply
CO3	Comprehend the trends and layout in foundry.	Remember, Understand & Apply
CO4	Demonstrate the weldability of metals, heat treatment and their effects.	Remember, Understand & Apply
CO5	Describe the recent welding techniques and their application.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E54 - Advances in Casting and Welding Processes

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Casting Design Heat transfer between metal and mould –Design considerations in casting – Designing for directional solidification and minimum stresses - principles and design of gating and risering.	[9]
Casting Metallurgy Solidification of pure metal and alloys – shrinkage in cast metals – progressive and directional solidification –– Degasification of the melt-casting defects – Castability of steel , Cast Iron, Al alloys , Babbit alloy and Cu alloy.	[9]
Recent Trends in Casting and Foundry Layout Shell moulding, precision investment casting, CO_2 moulding, Centrifugal casting, Die casting, Continuous casting, Counter gravity low pressure casting, Squeeze casting and semisolid processes. Layout of mechanized foundry – sand reclamation – material handling in foundry pollution control in foundry – Computer aided design of casting.	[9]
Welding Metallurgy and Design Heat affected Zone and its characteristics – Weldability of steels, cast iron, stainless steel, aluminium, Mg , Cu ,Zirconium and titanium alloys – Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement – Lamellar tearing – Residual stress – Distortion and its control . Heat transfer and solidification - Analysis of stresses in welded structures – pre and post welding heat treatments – weld joint design – welding defects – Testing of weldment.	[9]
Recent Trends in Welding Friction welding, friction stir welding – explosive welding – diffusion bonding – high frequency induction welding – ultrasonic welding – electron beam welding – Laser beam welding –Plasma welding – Electro slag welding narrow gap, hybrid twin wire active TIG – Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes – Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace, nuclear, surface transport vehicles and under water welding.	[9]
Total Hours:	**45**
Text Book(s):	

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1.	Jain P.L., “Principles of Foundry Technology”, Tata McGraw-Hill Publishers, 2013.
2.	Carrry B., “Modern Welding Technology”, Prentice Hall Pvt Ltd.6th Edition, 2004
Reference(s):	
1.	“Casting - ASM Handbook”, Vol 15, 2011.
2.	“Welding Brazing & Soldering - ASM Handbook” Vol.6, 2003.
3.	Srinivasan N.K., “Welding Technology”, Khanna Tech Publishers, 2002.
4.	Heineloper & Rosenthal, “Principles of Metal Casting”, Tata McGraw Hill, 2005.
5.	Parmer R.S., “Welding Engineering and Technology”, Khanna Publishers, 2002.
6.	Cornu. J., “Advanced welding systems”, Volumes I, II and III, Jaico Publishers, 2011.

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Casting Design**	
1.1	Heat transfer between metal and mould	2
1.2	Design considerations in casting	2
1.3	Designing for directional solidification and minimum stresses	3
1.4	principles and design of gating and risering	2
2.0	**Casting Metallurgy**	
2.1	Solidification of pure metal and alloys	2
2.2	Shrinkage in cast metals – progressive and directional solidification	2
2.3	Degasification of the melt-casting defects	3
2.4	Castability of steel , Cast Iron, Al alloys, Babbit alloy and Cu alloy	2
3.0	**Recent Trends in Casting and Foundry Layout**	
3.1	Shell moulding, precision investment casting, CO_2 moulding	1
3.2	Centrifugal casting, Die casting, Continuous casting	2
3.3	Counter gravity low pressure casting, Squeeze casting and semisolid processes	2
3.4	Layout of mechanized foundry – sand reclamation	2
3.5	Material handling in foundry pollution control in foundry	1
3.6	Computer aided design of casting	1
4.0	**Welding Metallurgy and Design**	
4.1	Heat affected Zone and its characteristics	1

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4.2	Weldability of steels, cast iron, stainless steel, aluminium, Mg , Cu ,Zirconium and titanium alloys	2
4.3	Carbon Equivalent of Plain and alloy steels Hydrogen embrittlement	2
4.4	Lamellar tearing – Residual stress – Distortion and its control	1
4.5	Heat transfer and solidification - Analysis of stresses in welded structures	1
4.6	Pre and post welding heat treatments – weld joint design	1
4.7	Welding defects – Testing of weldment	1
5.0	**Recent Trends in Welding**	
5.1	Friction welding, friction stir welding – explosive welding – diffusion bonding	1
5.2	High frequency induction welding – ultrasonic welding – electron beam welding	1
5.3	Laser beam welding –Plasma welding – Electro slag welding narrow gap, hybrid twin wire active TIG	2
5.4	Tandem MIG- modern brazing and soldering techniques – induction, dip resistance, diffusion processes	2
5.5	Hot gas, wave and vapour phase soldering. Overview of automation of welding in aerospace	2
5.6	Nuclear, surface transport vehicles and under water welding.	1

Course Designer

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60 PED E55	Mechanics of Composite Materials	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To comprehend the mechanics of composite materials on macroscopic and microscopic level
- To know the elastic behaviour and stress-strain plots of composite lamina
- To apply knowledge for finding failure mechanism based on failure theories in a lamina
- To know the elastic behaviour and stress-strain plots of composite laminates
- To know the design methodology for structural composite materials.

Pre-requisite

Engineering Materials and Metallurgy

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Interpret the basic concepts and difference between composite materials with conventional materials.	Understand, Remember & Apply
CO2	Recognize role of constituent materials in defining the average properties and response of composite materials on macroscopic level.	Understand, Remember & Apply
CO3	Develop the macro-mechanical failure theories for unidirectional Lamina	Understand, Remember & Apply
CO4	Apply knowledge for finding failure envelopes and stress-strain plots of laminates.	Understand, Remember & Apply
CO5	Design the structural composite materials against laminate failure	Understand, Remember & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	1
CO2	3	2	3	3	3	1
CO3	3	2	3	3	2	1
CO4	3	2	3	2	2	1
CO5	3	2	3	2	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)	End Sem Examination (Marks)
	1	2		
Remember (R)	10	10	10	10
Understand (U)	10	10	10	10
Apply (Ap)	20	20	40	40
Analyze (An)	20	20	40	40
Evaluate (Ev)	0	0	0	0
Create (Cr)	0	0	0	0
Total	60	60	100	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E55 - Mechanics of Composite Materials

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
II	3	0	0	45	3	40	60	100

Introduction and Characteristics Classification of composite materials, Characteristics of composites, Overview of advantage and limitations of composite materials, Significance andobjectives of composite materials, Science and technology, current status and future prospectus. Introduction to Laminate composite materials.	[9]
Elastic Behavior of Unidirectional Lamina Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials, Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters.	[9]
Strength of Unidirectional Lamina Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro-mechanical Failure theories, Applicability of various failure theories.	[9]
Elastic Behavior of Laminate Basic assumptions, Classical Lamination theory, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates.	[9]
Stress and Failure Analysis of Laminates Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates, Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials. Design requirements and design failure criteria.	[9]
Total Hours:	**45**

Text Book(s):

1.	Kaw and Autar K, "Mechanics of Composite Materials", CRC Press, 2nd Edition, 2006.
2.	Robert M Jones, "Mechanics of Composite Materials ", CRC Press, 2nd Edition, 2015.

Reference(s):

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BoS - Chairman
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1.	Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.
2.	Isaac M. Daniels, Orilshai, “Engineering Mechanics of Composite Materials”, Oxford University Press, 2006.
3.	Bhagwan D. Agarwal, Lawrence J. Broutman, “Analysis and Performance of Fiber Composites”, John Wiley and Sons, Inc. 2017.
4.	Krishnan K. Chawla., “Composite materials: Science and Engineering”, Springer Publishers, 2010

Course Contents and Lecture Schedule

S.No.	Topics	No.of hours
1.0	**Introduction and Characteristics**	
1.1	Classification of composite materials, Characteristics of composites	2
1.2	Overview of advantage and limitations of composite materials	2
1.3	Significance and objectives of composite materials	2
1.4	Science and technology, current status and future prospectus	2
1.5	Introduction to Laminate composite	1
2.0	**Elastic Behavior of Unidirectional Lamina**	
2.1	Micromechanics, Basic lamina properties	2
2.2	Constituent materials and properties, Properties of typical composite materials	2
2.3	Stress-strain relations,	2
2.4	Relation between mathematical and engineering constants	2
2.5	Transformation of stress, strain and elastic parameters.	1
3.0	**Strength of Unidirectional Lamina**	
3.1	Micromechanics of failure; failure mechanisms	3
3.2	Macro-mechanical strength parameters	2
3.3	Macro-mechanical Failure theories	2
3.4	Applicability of various failure theories	2
4.0	**Elastic Behavior of Laminate**	
4.1	Basic assumptions, Classical Lamination theory	2
4.2	Strain-displacement relations	1
4.3	Stress-strain relation of layer within a laminate	1

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4.4	Force and moment resultant	2
4.5	General load–deformation relations	2
4.6	Analysis of different types of laminates	1
5.0	**Stress and Failure Analysis of Laminates**	
5.1	Types of failures	1
5.2	Stress analysis and safety factors for first ply failure of symmetric laminates	2
5.3	Micromechanics of progressive failure; Progressive and ultimate laminate failure	2
5.4	Design methodology for structural composite materials	2
5.5	Design requirements and design failure criteria	2

Course Designer

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60 PED E61	Rapid Prototyping and Tooling	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To describe product development, conceptual design and classify rapid prototyping systems.
- To learn the operating principles, capabilities and limitations of liquid and solid based systems.
- To learn the operating principles of powder based additive manufacturing system.
- To learn the concepts of reverse engineering.
- To select and use correct CAD formats in rapid tooling.

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Describe product development, conceptual design and classify rapid prototyping systems and its applications.	Understand, Apply & Analyse
CO2	Identify The process of photopolymers, photo polymerization, layering technology, laser and laser scanning.	Understand, Apply & Analyse
CO3	Applying of measurement and scaling technique for prototype manufacturing	Understand, Apply & Analyse
CO4	Identify the Rapid Prototyping Data Formats	Understand & Apply
CO5	Realize the application of Rapid prototyping and rapid tooling technologies for product development.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E61- Rapid Prototyping and Tooling

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	

Introduction to Rapid Prototyping Need for the time compression in product development, History of RPT systems, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Growth of RPT industry and classification of RPT systems.	[9]
Rapid Prototyping Methods Fused deposition Modeling (FDM): Principle, Process Parameters, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications. Stereo Lithographic Resin (SLR) systems: Process parameters, Process details, Data Preparation, Data files, and Machine details, Applications. Selective Laser Sintering (SLS): Types of machines, Principle of operation, Process parameters, Data preparation for SLS, applications. Laminated Object Manufacturing (LOM): Principle of Operation, LOM materials, Process details, Applications.	[9]
Concept Modelers 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.	[9]
Rapid Tooling Indirect Rapid Tooling- Silicone rubber tooling, Aluminum filled epoxy tooling, Spray metal tooling, etc., Direct rapid tooling- Direct Accurate clear epoxy solid injection molding (AIM), Quick cast Process, Copper polyamide, Rapid Tools, Direct metal laser sintering (DMLS), ProMetal, Sand Casting Tooling, Laminate tooling, Soft tooling v/s Hard tooling.	[9]

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Software for Rapid Tooling STL Files, Over view 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 orientation. Allied process – Vacuum Casting, Surface Digitizing, Surface Generation from point cloud, Surface modification, data transfer to solid models - Applications in Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry , Medical and Bioengineering field.	[9]
Total Hours:	**45**

Text Book(s):	
1.	Chua C.K., Leong K.F. and Lim C.S,"Rapid Prototyping: Principles and Applications", 3rd Edition, World Scientific, New Jersey, 2010.
2.	Pham D.T. and Dimov S.S., "Rapid Manufacturing", 1 st Edition, Springer-Verlag, London, 2011.
Reference(s):	
1.	Frank W. Liou, "Rapid Prototyping and Engineering Applications", CRC Press, 2008.
2.	Jacobs P.F., "Rapid Prototyping and Manufacturing: Fundamentals of Stereolithography", McGraw-Hill, New York, 2010
3.	Wohlers Terry, "Wohlers Report 2014", Wohlers Associates, 2014.
4.	Frank W. Liou, "Rapid Prototyping and Engineering Applications", CRC Press, 2008

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**INTRODUCTION TO RAPID PROTOTYPING**	
1.1	Introduction	1
1.2	Need for the time compression in product development	1
1.3	History of RPT systems	1
1.4	Fundamentals of Rapid Prototyping	1
1.5	Advantages and Limitations of Rapid Prototyping	1
1.6	,Growth of RPT industry	2
1.7	Classification of RPT systems	2
2.0	**RAPID PROTOTYPING METHODS**	
2.1	Fused deposition Modeling (FDM): Principle, Process Parameters	1
2.2	Path generation, Applications	1
2.3	Solid Ground Curing: Principle of operation	1
2.4	Machine details, Applications	1
2.5	Stereo Lithographic Resin (SLR) systems: Process parameters, Process details,	1
2.6	Data Preparation, Data files, and Machine details, Applications	1
2.7	Selective Laser Sintering (SLS): Types of machines, Principle of operation,	1
2.8	Process parameters, Data preparation for SLS, applications	1
2.9	Laminated Object Manufacturing (LOM): Principle of Operation, LOM materials, Process	1

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	details, Applications	
3.0	**CONCEPT MODELERS**	
3.1	Concept modelers – Principle	1
3.2	Thermo jet printer	1
3.3	Sander‘s model market	1
3.4	3-D Printer	1
3.5	Genisys Xs Printer	1
3.6	JP system	1
3.7	Object Quadra System	1
3.8	Laser Engineered Net Shaping	2
4.0	**RAPID TOOLING**	
4.1	Indirect Rapid Tooling- Silicone rubber tooling	1
4.2	Aluminum filled epoxy tooling, Spray metal tooling	1
4.3	Direct rapid tooling- Direct Accurate clear epoxy solid injection molding	1
4.4	Quick cast Process	1
4.5	Copper polyamide	1
4.6	Direct metal laser sintering (DMLS)	1
4.7	ProMetal tooling	1
4.8	Sand Casting Tooling,Laminate tooling	1
4.9	Soft tooling v/s Hard tooling	1
5.0	**SOFTWARE FOR RAPID TOOLING**	
5.1	STL Files, Over view of Solid view	1
5.2	Magics, mimics	1
5.3	Rapid Manufacturing- Process optimization	1
5.4	Factors influencing accuracy, Data preparation Errors, Part building Errors, Errors in finishing, Influence of part orientation	2
5.5	Allied process – Vacuum Casting, Surface Digitizing, Surface Generation from point cloud	1
5.6	Surface modification, data transfer to solid models	1
5.7	Applications in Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, Medical and Bioengineering field.	2

Course Designers

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60 PED E62	Design of Hydraulic and Pneumatic Systems	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on the science, use and application of hydraulics system as fluid power in Industry.
- To acquire the concept of control and regulation elements in hydraulic system
- To learn the procedure to design hydraulic circuits for different application
- To study the fundamentals of pneumatic system and circuits
- To understand the procedure for installation, maintenance and design of special circuits

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Select and apply the use of rotary and linear actuators.	Remember, Understand & Apply
CO2	Choose the different types of control and regulation elements.	Remember, Understand & Apply
CO3	Design the various industrial circuits in hydraulic systems.	Remember, Understand & Apply
CO4	Design the various pneumatic system and circuits.	Remember, Understand & Apply
CO5	Diagnose the faults and implement the maintenance measures.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

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Syllabus

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60 PED E62- Design of Hydraulic and Pneumatic Systems								
PED : M.E. Engineering Design								
Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Oil Hydraulic Systems and Hydraulic Actuators Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics. Hydrostatic drives, types, selection.	[9]
Control and Regulation Elements Pressure - Direction and Flow control valves - Relief valves, non-return and safety valves – actuation systems. Proportional Electro hydraulic servo valves	[9]
Hydraulic Circuits 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	[9]
Pneumatic Systems and Circuits Pneumatic fundamentals - control elements, pneumatic sensors - logic circuits – switches – fluidic logic circuits - Sequential circuits -Cascade methods - step counter method - - Karnaugh - Veitch map.	[9]
Installation, Maintenance and Special Circuits Pneumatic equipments- selection of components - design calculations – application -fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.	[9]
Total Hours:	**45**

Text Book(s):	
1.	Antony Espossito, “Fluid Power with Applications”, Pearson Education, 2011.
2.	Srinivasan, R., “Hydraulic and Pneumatic Controls”, Tata McGraw Hill, 2009.
Reference(s):	
1.	Dudley A. Pease and John J. Pippenger., “Basic fluid power”, Prentice Hall, 1987.
2.	Andrew Parr, “Hydraulic and Pneumatics” (HB), Jaico Publishing House, 1999.
3.	Bolton. W., “Pneumatic and Hydraulic Systems “, Butterworth –Heinemann, 1997.
4.	Majumdar S.R., “Pneumatic Systems, Principles and Maintenance” Tata Mc Graw Hill, 2010.

Course Contents and Lecture Schedule

S. No.	Topics	No. of hours
1.0	**OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS**	
1.1	Hydraulic Power Generators	1
1.2	Selection and specification of pumps	1
1.3	Pump characteristics	1

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1.4	Linear Actuators – selection and specification	1
1.5	Linear Actuators- characteristics.	1
1.6	Rotary Actuators- selection and specification	1
1.7	Rotary Actuators- characteristics.	1
1.8	Hydrostatic drives- types and selection	2
2.0	**CONTROL AND REGULATION ELEMENTS**	
2.1	Pressure control valves	2
2.2	Direction control valves	2
2.3	Flow control valves	1
2.4	Relief valves	1
2.5	Non-return valves	1
2.6	Actuation System	1
2.7	Proportional Electro hydraulic servo valves.	1
3.0	**HYDRAULIC CIRCUITS**	
3.1	Reciprocation and quick return circuits	1
3.2	Sequencing & Synchronizing circuits	1
3.3	Accumulator circuits	1
3.4	Industrial circuits- press circuits	1
3.5	Hydraulic milling machine	1
3.6	Grinding, planning, copying	1
3.7	Forklift and earth mover circuits	1
3.8	Design and selection of components	1
3.9	Safety and emergency mandrels	1
4.0	**PNEUMATIC SYSTEMS AND CIRCUITS**	
4.1	Pneumatic fundamentals	1
4.2	Control elements and pneumatic sensors	1
4.3	Logic circuits and switches	1
4.4	Fluidic logic circuits	1
4.5	Sequential circuits	1

4.6	Cascade methods	1
4.7	K-V Mapping methods	1
4.8	Step counter method	1
4.9	Classic methods	1
5.0	**INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS**	
5.1	Pneumatic equipments	1
5.2	Selection of components	1
5.3	Design calculations and application	2
5.4	Fault finding - hydro pneumatic circuits	1
5.5	Use of microprocessors for sequencing	1
5.6	PLC	1
5.7	Low cost automation	1
5.8	Robotic circuits	1

Course Designers

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60 PED E63	Applied Elasticity and Plasticity	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To understand the concept of stress, strain analysis and its applications.
- To learn constitutive equations to solve two dimensional problems
- To impart knowledge on computation of membrane and contact stresses
- To acquire the concept of plasticity under microscopic and macroscopic descriptions
- To analyse the effect of plastic strain in hydrostatic and deviatoric components

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Express the various stresses and strains.	Remember, Understand & Apply
CO2	Resolve the problems related with constitutive equations.	Remember, Understand & Apply
CO3	Discuss the membrane stresses and method of computing contact stresses.	Remember, Understand & Apply
CO4	Describe the microscopic and macroscopic plastic flow and stress strain curves.	Remember, Understand & Apply
CO5	Explain the various effects on the plastic strain analysis.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	2	3	1
CO2	3	3	2	2	3	1
CO3	3	3	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

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60 PED E63- Applied Elasticity and Plasticity

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Analysis of Stress and Strain Stress at a point, stress tensor, stress transformations, principal stresses, octahedral stress, equations of equilibrium, strain tensor, principal strains, strain-displacement relations, compatibility conditions, measurement of surface strains using strain gauges.	[9]
Constitutive Equations General theory, generalized Hooke's law, equations of elasticity, formulation of the general elasticity problem, boundary conditions, two dimensional problems in rectangular and polar co-ordinates, Airy's stress function.	[9]
Membrane and Contact Stresses Membrane stresses in axisymmetric shells, meridonial stress and circumferential stress, Introduction, geometry of contact surfaces, notation and meaning of terms, expressions for principal stresses and method of computing contact stresses.	[9]
Plasticity Plastic flow and its microscopic and macroscopic descriptions, stress-strain curves of real materials, definition of yield criterion, concept of a yield surface in principal stress space, yield criteria, Tresca, Von Mises.	[9]
Plastic Strain Analysis Prandtl-Reuss and Levy-Mises equations, deformation in plane stress-yielding of thin sheet in biaxial and uniaxial tension. Plane strain deformation-stress tensor, hydrostatic and deviatoric components, plastic potential, plastic instability, effect of strain rates and temperature effects on flow stress. Introduction to slip line theory.	[9]
Total Hours:	**45**

Text Book(s):

1.	Timoshenko, S. P., and Goodier, J. N., "Theory of Elasticity", McGraw Hill International Editions, 3rd Edition, 1970.
2.	Chakrabarthy, J., "Theory of Plasticity", McGraw Hill Co, 1987.

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Reference(s):	
1.	Durelli, A. J., Phillips, E. A and Tsao, C. H, “Introduction to the Theoretical and Experimental Analysis of Stress and Strain”, McGraw Hill, New York, 1958.
2.	Sadhu Singh. "Theory of Elasticity", Khanna Publishers, New Delhi 1988.
3.	Dieter G. E., “Mechanical Metallurgy”, McGraw Hill, 1988.
4.	Johnson, W. and Mellor, P. B., “Engineering Plasticity”, Van Nostrant Reinhold, 1983.
5.	Boresi, A. P, Schmidt, R. J and Sidebottom, O. M., “Advanced Mechanics of Materials”, John Wiley and Sons, Inc., 5th Edition, 1993.

Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Analysis of Stress and Strain**	
1.1	Stress at a point, stress tensor,	2
1.2	Stress transformations, principal stresses,	1
1.3	Equations of equilibrium, strain tensor,	2
1.4	Principal strains, strain-displacement relations	1
1.5	Compatibility conditions,	1
1.6	Measurement of surface strains using strain gauges.	2
2.0	**Constitutive Equations**	
2.1	General theory, generalized Hooke’s law, equations of elasticity,	2
2.2	Formulation of the general elasticity problem, boundary conditions	3
2.3	Two dimensional problems in rectangular	2
2.4	Polar co-ordinates, Airy’s stress function.	2
3.0	**Membrane and Contact Stresses**	
3.1	Membrane stresses in axisymmetric shells	1
3.2	Meridonial stress and circumferential stress,	2
3.3	Introduction, geometry of contact surfaces	2
3.4	Notation and meaning of terms, expressions for principal stresses	2
3.5	Method of computing contact stresses.	2
4.0	**Plasticity**	

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4.1	Plastic flow and its microscopic	2
4.2	Macroscopic descriptions, stress-strain curves of real materials	2
4.3	Definition of yield criterion	1
4.4	Concept of a yield surface in principal stress space	2
4.5	Yield criteria, Tresca, Von Mises.	2
5.0	**Plastic Strain Analysis**	
5.1	Prandtl-Reuss and Levy-Mises equations,	1
5.2	Deformation in plane stress-yielding of thin sheet in biaxial and uniaxial tension	2
5.3	Plane strain deformation-stress tensor, hydrostatic and deviatoric components,	2
5.4	Plastic potential, plastic instability, effect of strain rates	2
5.5	Temperature effects on flow stress. Introduction to slip line theory.	2

Course Designer

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60 PED E64	Theory of Plates and Shells	Category	L	T	P	Credit
		PC	3	0	0	3

Objectives

- To impart knowledge on the behavior of plates and shell elements
- To learn classical theory and computation of principal stress and strain
- To understand the formulation of governing equations for buckling of plates
- To frame the governing equation for vibration of rectangular plates
- To analyze thin elastic shells of revolution under axisymmetric loads shells

Pre-requisite

-Nil-

Course Outcomes

On the successful completion of the course, students will be able to

CO1	Recognize the concept of energy principles and variation methods of elasticity.	Remember, Understand & Apply
CO2	Compute the principal stresses and strains by using classical theory.	Remember, Understand & Apply
CO3	Perform buckling analysis of rectangular plates under compressive forces using Navier and Levy's solution.	Remember, Understand & Apply
CO4	Describe the concepts of vibration in plates	Remember, Understand & Apply
CO5	Evaluate the elastic properties of shells and axisymmetric loads shells with double curvature.	Remember, Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	3	1
CO2	3	2	2	2	3	1
CO3	3	2	2	2	3	1
CO4	3	3	2	3	2	1
CO5	3	3	2	3	2	1
3- Strong;2-Medium;1-Some						

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Assessment Pattern

Bloom's Category	Continuous Assessment Tests (Marks)		Model Exam (Marks)
	1	2	
Remember (R)	10	10	20
Understand (U)	20	20	30
Apply (Ap)	30	30	50
Analyze (An)	0	0	0
Evaluate (Ev)	0	0	0
Create (Cr)	0	0	0
Total	60	60	100

Syllabus

K.S. Rangasamy College of Technology – Autonomous R 2022

60 PED E64 - Theory of Plates and Shells

PED : M.E. Engineering Design

Semester	Hours/Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

General Introduction Review of equations of elasticity- kinematics, compatibility equations, stress measures – equations of motions- constitutive relations- transformation of stresses, strains and stiffness – energy principles and variational methods in elasticity- virtual work-external and internal virtual work variational operator –functionals- Euler Lagrange equations- energy principles- Hamilton's principle- principle of minimum total potential– applications	[9]
Classical Theory of Plates Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains- equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions – bending of rectangular plates with various boundary conditions and loading- symmetrical and asymmetrical bending of circular plates-limitations of classical theory- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)	[9]
Buckling Analysis of Rectangular Plates Buckling of simply supported plates under compressive forces- governing equations- the Navier solution- biaxial compression of a plate- uniaxial compression of a plate- buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions- general formulation- finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination).	[9]
Vibration of Plates Governing equations for natural flexural vibrations of rectangular plates - natural vibrations of plates simply supported on all edges - vibration of plates with two parallel sides simply supported - Levy's solution - vibration of plates with different boundary conditions – Rayleigh - Ritz method - Natural vibration of plates with general boundary conditions - transient analysis of rectangular plates - finite element analysis (elementary treatment only; discussion of various elements used and their capabilities- not for examination).	[9]

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Analysis of Thin Elastic Shells of Revolution Classification of shell surfaces - geometric properties of shells of revolution - general strain displacement relations for shells of revolution - stress resultants - equations of motion of thin shells analytical solution for thin cylindrical shells - membrane theory - flexure under axisymmetric loads shells with double curvature- geometric considerations - equations of equilibrium - bending of spherical shells - vibration of cylindrical shells - finite element analysis (elementary treatment only; discussion of various elements used and their capabilities- not for examination).	[9]
Total Hours:	**45**

Text Book(s):	
1.	Baskar, K and Varadan, T. K., "Plates- Theories and Applications", Ane Books Pvt. Ltd., New Delhi, 2013.
2.	Timoshenko, S., "Theory of Plates and Shells", McGraw Hill, 1990.
Reference(s):	
1.	Timoshenko, S and Krieger, S.W., "Theory of Plates and Shells", McGraw Hill Book Company, New York, 1990.
2.	Reddy, J.N., "Theory and Analysis of Elastic Plates and Shells", C.R.C.Press, NY, USA, 2nd Edition, 2006.
3.	Szilard, R., "Theories and Applications of Plate Analysis: Classical Numerical and Engineering Methods", Wiley, 2004.
4.	Chandrashekhara, K., "Theory of Plates", University Press, Hyderabad, 2001.

Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**General Introduction**	
1.1	Review of equations of elasticity- kinematics, compatibility equations, stress measures	2
1.2	Equations of motions- constitutive relations- transformation of stresses, strains and stiffness	1
1.3	Energy principles and variational methods in elasticity	2
1.4	Virtual work-external and internal virtual work variational operator	1
1.5	Functionals- Euler Lagrange equations- energy principles- Hamilton's principle	1
1.6	Principle of minimum total potential– applications	2
2.0	**Classical Theory of Plates**	
2.1	Plates as structural elements- stress and moment resultants- assumptions made in the classical theory- displacement fields and strains	2
2.2	Equations of equilibrium in Cartesian coordinates and in polar coordinates- boundary conditions	2
2.3	Bending of rectangular plates with various boundary conditions and loading	2
2.4	Symmetrical and asymmetrical bending of circular plates-limitations of classical theory	1

2.5	Finite element analysis(elementary treatment only; discussion of various elements used and their capabilities- not for examination)	2
3.0	**Buckling Analysis of Rectangular Plates**	
3.1	Buckling of simply supported plates under compressive forces- governing equations	1
3.2	The Navier solution- biaxial compression of a plate- uniaxial compression of a plate	2
3.3	Buckling of plates simply supported on two opposite edges- Levy's solution- buckling of plates with various boundary conditions	2
3.4	General formulation- finite element analysis	2
3.5	Discussion of various elements used and their capabilities- not for examination	2
4.0	**Vibration of Plates**	
4.1	Governing equations for natural flexural vibrations of rectangular plates	2
4.2	Natural vibrations of plates simply supported on all edges - vibration of plates with two parallel sides simply supported	2
4.3	Levy's solution - vibration of plates with different boundary conditions – Rayleigh - Ritz method	1
4.4	Natural vibration of plates with general boundary conditions - transient analysis of rectangular plates	2
4.5	Finite element analysis (elementary treatment only; discussion of various elements used and their capabilities- not for examination).	2
5.0	**Analysis of Thin Elastic Shells of Revolution**	
5.1	Classification of shell surfaces - geometric properties of shells of revolution	1
5.2	General strain displacement relations for shells of revolution - stress resultants	1
5.3	Equations of motion of thin shells analytical solution for thin cylindrical shells	2
5.4	Membrane theory - flexure under axisymmetric loads shells with double curvature- geometric considerations	2
5.5	Equations of equilibrium - bending of spherical shells - vibration of cylindrical shells	1
5.6	Finite element analysis (elementary treatment only; discussion of various elements used and their capabilities- not for examination)	2

Course Designer

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60 PED E65	Materials Testing and Characterization Techniques	Category	L	T	P	Credit
		ES	3	0	0	3

Objectives:

- To be knowledgeable in microstructure evaluation, crystal structure analysis
- To know the basic principle of electron microscopy
- To study the chemical, thermal analysis
- To learn about the static and dynamic mechanical testing methods.

Prerequisite:

Strength of Materials, Engineering Materials and Metallurgy

Course Outcomes:

On the successful completion of the course, students will be able to

CO1	Have knowledge about in microstructure evaluation, crystal structure analysis	Understand & Apply
CO2	Acquire knowledge in electron microscopy	Understand & Apply
CO3	Be knowledgeable in chemical and thermal analysis	Understand & Apply
CO4	Acquire knowledge in static mechanical testing methods.	Understand & Apply
CO5	Acquire knowledge in dynamic mechanical testing methods.	Understand & Apply

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	2
CO2	2	3	3	2	2	2
CO3	3	3	2	3	2	2
CO4	2	1	2	2	1	2
CO5	3	3	2	2	3	2
3- Strong; 2-Medium; 1-Low						

Assessment Pattern

Bloom's Category	Continuous Assessment Tests(Marks)		End Semester Examination(Marks)
	1	2	
Remember	10	10	30
Understand	40	40	50
Apply	10	10	20
Analyse	0	0	0
Evaluate	0	0	0
Create	0	0	0
Total	60	60	100

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Syllabus

K.S.Rangasamy College of Technology – Autonomous R2022								
60 PED E65 - Materials Testing and Characterization Techniques								
PED : M.E. Engineering Design								
Semester	Hours / Week			Total hrs	Credit	Maximum Marks		
	L	T	P		C	CA	ES	Total
III	3	0	0	45	3	40	60	100

Micro and Crystal Structure Analysis Principles of Optical Microscopy – specimen Preparation Techniques – Polishing and Etching – Polarization techniques – Quantitative Metallography - Estimation of grain size – ASTM grain size numbers – Microstructure of Engineering Materials – Elements of Crystallography – X-ray diffraction – Bragg's law – Techniques of X-ray Crystallography – Debye – Scherer Camera – Geiger Diffractometer – Analysis of diffraction patterns – Inter planer spacing – Identification of crystal structure, elements of electron diffraction.	[9]
Electron Microscopy Interaction of Electron beam with materials – Transmission electron microscopy – Specimen preparation – imaging techniques – BF & DF – SAD – Electron probe microanalysis – Scanning Electron Microscopy – Construction and Working of SEM – various imaging techniques – Applications – Atomic force microscopy - Construction and Working of AFM – Applications	[9]
Chemical and Thermal Analysis Basic principles, Practice amd applications of X-Ray spectrometry, Wave dispersive X-Ray spectrometry, Auger spectroscopy, Secondary Ion mass spectroscopy, Fourier transform Infra red Spectroscopy (FTIR) - Proton induced X-ray emission spectroscopy, Differential thermal analysis, differential thermal analysis, Differential scanning Calorimetry (DSC) and Thermo Gravity metric Analysis (TGA).	[9]
Mechanical Testing – Static Tests Hardness – Brinell, Vickers Rockwell and micro hardness test – Tensile test – Stress – Strain plot – proof stress- Torsion test – Ductility measurement – Impact test – Charpy & Izod – DWTT – Fracture toughness test, codes and standards for testing metallic and composite materials.	[9]
Mechanical Testing – Dynamic Tests Fatigue – Low and High cycle fatigues – Rotating beam & plate bending HCF tests – S_N curve – LCF tests – Crack growth studies – Creep test – LM parameters – AE test – modal analysis – Applications of dynamic test.	[9]
Total Hours:	**45**

1	Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001
2	Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.
Reference(s):	
1.	Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray- Micro Analysis, (2nd Edition), Plenum Publishing Corp., 2000
2.	Davis J.R., Tensile testing, 2nd Edition, ASM International, 2004.
3.	Morita S., Wiesendanger R., and Meyer E., "Non-contact Atomic Force Microscopy" Springer, 2002.
4.	ASM hand book – Materials characterization, Vol-10, 2004.

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Course Contents and Lecture Schedule

S.No.	Topics	No. of hours
1.0	**Micro and Crystal Structure Analysis**	
1.1	Principles of Optical Microscopy, specimen Preparation Techniques, Polishing and Etching	2
1.2	Polarization techniques , Quantitative Metallography	1
1.3	Estimation of grain size, ASTM grain size numbers, Microstructure of Engineering Materials	2
1.4	Elements of Crystallography, X-ray diffraction , Bragg's law , Techniques of X-ray Crystallography	1
1.5	Debye, Scherer Camera , Geiger Diffractometer	1
1.6	Analysis of diffraction patterns, Inter planer spacing	1
1.7	Identification of crystal structure, elements of electron diffraction.	1
2.0	**Electron Microscopy**	
2.1	Interaction of Electron beam with materials – Transmission electron microscopy – Specimen preparation	2
2.2	Imaging techniques – BF & DF – SAD – Electron probe microanalysis	2
2.3	Scanning Electron Microscopy – Construction and Working of SEM	3
2.4	Various imaging techniques – Applications – Atomic force microscopy - Construction and Working of AFM – Applications	2
3.0	**Chemical and Thermal Analysis**	
3.1	Basic principles, Practice amd applications of X-Ray spectrometry	1
3.2	Wave dispersive X-Ray spectrometry, Auger spectroscopy, Secondary Ion mass spectroscopy	2
3.3	Fourier transform Infra red Spectroscopy (FTIR) - Proton induced X-ray emission spectroscopy	2
3.4	Differential thermal analysis, differential thermal analysis	2
3.5	Differential scanning Calorimetry (DSC) and Thermo Gravity metric Analysis (TGA).	2
4.0	**Mechanical Testing – Static Tests**	
4.1	Hardness – Brinell, Vickers Rockwell and micro hardness test – Tensile test	2
4.2	Stress – Strain plot – proof stress- Torsion test	1
4.3	Ductility measurement	1
4.4	Impact test – Charpy & Izod	2

4.5	DWTT – Fracture toughness test	2
4.6	Codes and standards for testing metallic and composite materials.	1
5.0	**Mechanical Testing – Dynamic Tests**	
5.1	Fatigue – Low and High cycle fatigues	1
5.2	Rotating beam & plate bending HCF tests	2
5.3	S_N curve – LCF tests – Crack growth studies	2
5.4	Creep test – LM parameters – AE test	2
5.5	Modal analysis – Applications of dynamic test.	2

Course Designer

Dr.V.P.Arthanarieswaran – arthanarieswaran@ksrct.ac.in

<table>
<tr><th colspan="9">K.S.Rangasamy College of Technology – Autonomous R 2022</th></tr>
<tr><th colspan="9">60 PED 3P1 – Project Work - Phase I</th></tr>
<tr><th colspan="9">PED : M.E. Engineering Design</th></tr>
<tr><td rowspan="2">Semester</td><td colspan="3">Hours / Week</td><td rowspan="2">Total hrs</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>III</td><td>0</td><td>0</td><td>16</td><td>60</td><td>8</td><td>100</td><td>-</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="8">• To impart the practical knowledge to the students
• To make them to carry out the technical procedures in their project work
• To provide an exposure to the students to refer, read and review the research articles
• To learn different computational/experimental techniques
• To perform experiments/tests and to learn how to work in research environment</td></tr>
<tr><td>Course Outcomes</td><td colspan="8">At the end of the course, the students will be able to

1. Survey the relevant literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
2. Use different experimental techniques/different software/ computational/analytical tools.
3. Design and develop an experimental set up/ equipment/test rig.
4. Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them.
5. Work in a research environment or in an industrial environment.</td></tr>
<tr><td colspan="9">The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E/M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.</td></tr>
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<table>
<tr><th colspan="8">K.S.Rangasamy College of Technology – Autonomous R2022</th></tr>
<tr><th colspan="8">60 PED 4P1 – Project Work - Phase II</th></tr>
<tr><th colspan="8">PED : M.E. Engineering Design</th></tr>
<tr><td rowspan="2">Semester</td><td colspan="3">Hours / Week</td><td rowspan="2">Total hrs</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>CA</td><td>ES</td><td>Total</td></tr>
<tr><td>IV</td><td>0</td><td>0</td><td>32</td><td>60</td><td>16</td><td>40</td><td>60</td><td>100</td></tr>
<tr><td>Objective(s)</td><td colspan="7">• To enable and strengthen the students to carry out the project on their own and to implement their innovative ideas
• To forefront the risk issues and to retrieve the hazards by adopting suitable assessment methodologies and staring it to global
• To make them to carry out the technical procedures in their project work
• To learn different computational/experimental techniques
• To perform experiments/tests and to learn how to work in research environment</td></tr>
<tr><td>Course Outcomes</td><td colspan="7">At the end of the course, the students will be able to

1. Develop attitude of lifelong learning and will develop interpersonal skills to deal with people working in diversified field will.
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them.
4. Write technical reports and research papers to publish at national and international level.
5. Develop strong communication skills to defend their work in front of technically qualified audience.</td></tr>
<tr><td colspan="8">It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. . The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.</td></tr>
</table>

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