PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637 018

(AUTONOMOUS)

ME–ENGINEERING DESIGN

REGULATIONS 2019

(For the candidates admitted during the academic year 2021 – 2022 onwards)

(CHOICE BASED CREDIT SYSTEM)

CURRICULUM

SEMESTER I

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PED19101	Advanced Stress Analysis	3	0	0	3
2	PC	PED19102	Advanced Vibrations and Acoustics	3	1	0	4
3	PC	PED19103	Concepts of Engineering Design	3	0	0	3
4	PC	PED19104	Computer Aided Design	3	0	0	3
5	PE	PED1915*	Programme Elective I	3	0	0	3
6	PE	PED1925*	Programme Elective II	3	0	0	3
7	AC	PEN19171	English For Research Paper Writing (Audit Course I)	2	0	0	0
Practical							
8	PC	PED19105	Computer Aided Design Laboratory	0	0	4	2
TOTAL				**20**	**1**	**4**	**21**

SEMESTER II

S.No.	Category	Course Code	Course Title	L	T	P	C
Theory							
1	PC	PED19201	Finite Element Method	3	0	0	3
2	PC	PEN19201	Research Methodology and IPR	3	0	0	3
3	PE	PED1935*	Programme Elective III	3	0	0	3
4	PE	PED1945*	Programme Elective IV	3	0	0	3
5	AC	PEN19271	Pedagogy Studies (Audit Course II)	2	0	0	0
Practical							
6	PC	PED19202	Simulation and Analysis Laboratory	0	0	4	2
7	EE	PED19203	Mini Project	0	0	4	2
TOTAL				**14**	**0**	**8**	**16**

LIST OF ELECTIVES

PROGRAMME ELECTIVE I

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	PED19151	Advanced Machine Design	3	0	0	3
2	PE	PED19152	Design for Manufacturing and Assembly	3	0	0	3
3	PE	PMA19153	Mathematical Methods in Engineering	3	0	0	3
4	PE	PED19153	Rapid Prototyping and Tooling	3	0	0	3

PROGRAMME ELECTIVE II

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	PED19251	Advanced Engineering Materials	3	0	0	3
2	PE	PED19252	Mechanics of Composite Materials	3	0	0	3
3	PE	PED19253	Analysis and Synthesis of Mechanisms	3	0	0	3
4	PE	PED19254	Mechatronics in Manufacturing	3	0	0	3

PROGRAMME ELECTIVE III

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	PED19351	Tribology in Design	3	0	0	3
2	PE	PED19352	Robotics	3	0	0	3
3	PE	PED19353	Fracture Mechanics	3	0	0	3
4	PE	PED19354	Reverse Engineering	3	0	0	3

PROGRAMME ELECTIVE IV

S.No.	Category	Course Code	Course Title	L	T	P	C
1	PE	PED19451	Multi-body Dynamics	3	0	0	3
2	PE	PED19452	Condition Based Monitoring	3	0	0	3
3	PE	PED19453	Optimization Techniques in Design	3	0	0	3
4	PE	PED19454	Design of Hydraulic and Pneumatic systems	3	0	0	3

PED19101 ADVANCED STRESS ANALYSIS 3 0 0 3

COURSEOBJECTIVES

To enable the students to

- gain knowledge in stress, strain and elasticity deformation in 2d and 3d
- understand the concepts of energy methods for analysis of stress, strain and deflection
- learn the theory of torsion of solid section and thin walled section
- understand the shear center in symmetrical and unsymmetrical bending in beams
- acquire the knowledge of stress in thick walled cylinder under various pressures

UNIT I THEORY OF ELASTICITY 9

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.

UNIT II ENERGY METHODS 9

Energy method for analysis of stress, strain and deflection The three theorem's -theorem of virtual Work - theorem of least work - Castiglione's theorem - Rayleigh Ritz method - Galion's method, Elastic behavior of anisotropic materials like fiber reinforced composites.

UNIT III THEORY OF TORSION 9

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

UNIT IV UNSYMMETRICAL BENDING AND SHEAR CENTRE 9

Concept of shear center in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section

UNIT V PRESSURIZED CYLINDERS AND ROTATING DISKS 9

Governing equations, stress in thick walled cylinder under internal and external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength, Plastic action in thick walled cylinders and rotating disc. Introduction to the contact stresses.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- apply the knowledge and solve elasticity problems
- analysis stress, strain and deflection using various energy methods
- demonstrate the knowledge by analyzing torsion in prismatic bars

- solve problems in unsymmetrical bending and shear center
- apply basics concepts and analysis stresses in pressurized cylinders and rotating discs.

REFERENCES

- Sadd, Martin H., Elasticity: Theory, applications and Numeric, Third edition, Amsterdam Academic Press, 2014.
- Budynas, R. G. Advance strength and Applied Stress Analysis, Second Edition, WCB/McGraw Hill,2011
- Theory of Elasticity – Timoshenko and Goodier, McGraw Hill Education (India) Private Limited,Third edition, 2010
- Dally, J. W. and W.F. Riley, Experimental Stress Analysis, McGraw Hill International, Fourth Edition, 2005
- Boresi, A.P. and K. P. Chong, Elasticity in Engineering Mechanics, Second Edition, John Wiley & Sons, 2000

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

PED19102 ADVANCED VIBRATIONS AND ACOUSTICS 3 1 0 4

COURSE OBJECTIVES

To enable the students to

- become familiar with transient vibrations, response of dof systems and impulse response function.
- understand multi degree of freedom systems, damped and forced vibrations and the derivation for equations of motion.
- develop knowledge on continuous systems, natural vibrations of beams, solutions by different methods, forced vibrations of simply supported beam, mode summation method and solutions by rayleigh-ritz method.
- require knowledge on different methods of vibration control, numerical and computer methods in vibration, dunkerley's method, eigen value calculations and holzers's method.
- know about basics of acoustics like plane waves, sound speed, db scale, various transmission phenomena, sound power models and its determination along with basics of psychoacoustics.

UNIT I SINGLE DEGREE FREEDOM SYSTEM 12

Transient Vibrations, Response of a single degree of freedom system to step and any arbitrary excitation, convolution (Duhamel's) integral, impulse response function

UNIT II MULTI DEGREE FREEDOM SYSTEM 12

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.

UNIT III CONTINUOUS SYSTEMS 12

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

UNIT IV VIBRATION CONTROL 12

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.

UNIT V ACOUSTICS 12

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. Basics of psychoacoustics.

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course, the students will be able to:

- predict response of a SDOF system, damped or undamped, subjected to simple arbitrary base or force excitations. They will be able to obtain Shock Response Spectrum of SDOF systems for such excitations and understand use of the SRS.
- write differential equations of motion for MDOF systems, and through the technique of decoupling and orthogonal properties of natural modes, should be able to obtain the Eigen-values and mode shapes of natural vibrations and response to harmonic and arbitrary excitations.
- obtain the Eigen-values and mode shapes of natural vibrations of beams and response to harmonic excitations using orthogonal properties of natural modes.
- obtain natural frequencies and mode shapes of MDOF and continuous systems using computational methods such as Rayleigh-Ritz method, Holzer method, Dunckerley's method, and Stodola's method.
- know various terminologies used in acoustics and acoustic wave transmission, derive plane and spherical wave equations, and obtain sound pressure level at a given distance from a simple sound source of known strength.

REFERENCES

1. Thomson W.T., "Theory of Vibrations with applications", Pearson Education 5th edition,2008.
2. R.S.Khurmi,J.K.Gupta, "Theory of Machines",S.Chand and Co, New delhi, 2005.
3. S.S. Rao, "Mechanical Vibrations", Pearson Education 5th edition., 2010.
4. Leonard Meirovitch, "Fundamentals of vibrations", McGraw Hill International Edition,2003
5. Lawrence E. Kinsler and Austin R.Frey, "Fundamentals of acoustics", Wiley Eastern Ltd.,2009

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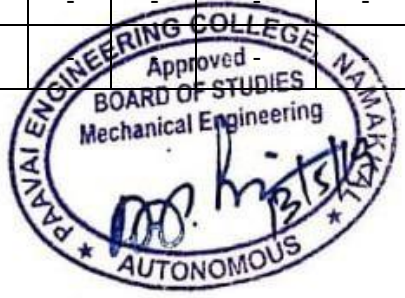
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3



PED19103 CONCEPTS OF ENGINEERING DESIGN 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart the fundamentals designing cost effective, preservation and productive.
- familiarize with the customer-oriented design and societal considerations.
- understand reinforces the knowledge being learned and shortens the overall learning of design methods.
- know the concepts of materials for the design process.
- acquire the knowledge in the design of reliability of failure mode effect analysis and probability concepts.

UNIT I DESIGN FUNDAMENTALS 9

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

UNIT II CUSTOMER ORIENTED DESIGN AND SOCIETAL CONSIDERATIONS 9

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

UNIT III DESIGN METHODS 9

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

UNIT IV MATERIAL SELECTION PROCESSING AND DESIGN 9

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

UNIT V PROBABILITY CONCEPTS IN DESIGN FOR RELIABILITY 9

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

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- understand the fundamentals of design process and designing codes and standards.
- familiarize the product design specifications, ergonomics and aesthetics.
- identify the suitable design methods for problem solving.
- understand the proper material selection processing
- apply the probability concepts in design foe reliability

REFERENCES

1. George E.Dieter and Linda C.Schmidt, Engineering Design,McGraw Hill, 5th International Editions, 2012.
2. Pahl, G, and Beitz. W, Engineering Design, Springer – Verlag, London, 2007.
3. Ray, M.S., ―Elements of Engg. Design, Prentice Hall Inc. 1985.
4. Suh, N.P., ―The principles of Design, Oxford University Press, NY.1990.
5. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development,McGraw Hill, 5th Edition 2011.

CO - PO Mapping

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COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO2	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO3	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO4	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO5	1	2	3	-	-	-	-	1	-	-	-	2	2	3

PED19104 COMPUTER AIDED DESIGN 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- acquire knowledge in cad software and hardware
- build an understanding of the fundamental concepts of computer networks
- focuses on the integration of CAD tools and role of the geometric model
- learn various geometric and orthographic curves and its surfaces
- introduce geometric modelling techniques, data structure design and algorithms for solid modelling

UNIT I INTRODUCTION TO CAD 7

CAD Hardware and Software, Types of systems and system considerations, input and output devices, hardware integration and networking, hardware trends, Software modules

UNIT II COMMUNICATION AND NETWORK CONCEPTS 9

Computer Communications, Principle of networking, classification networks, network wring, methods, transmission media and interfaces, network operating systems

UNIT III GEOMETRIC TRANSFORMATIONS 10

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.

UNIT IV CURVES AND SURFACES 10

Projections of geometric models, orthographic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves, curve manipulations. Surface representation

UNIT V MATHEMATICAL REPRESENTATION OF SOLIDS 9

Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSF), sweep representation, Analytic Solid Modeling (ASM), other representations; solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing, etc., GD & T - types of models, types of simulation approaches.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- have a conceptual understanding of the principles of cad systems, the implementation of these principles, and its connections to cam and cae systems.
- understand 2d, 3d transformations and projection transformations

- get knowledge of various approaches of geometric modeling
- understand mathematical representation of 2d and 3d entities
- understand basic fundamentals of fem

REFERENCES

1. IbrahbimZeid,R.Sivasubramaniam "CAD / CAM Theory and Practice".TataMcraw-Hill 2009
2. Jim Browne, "Computer Aided Engineering and Design"New Age International (P) Limited2007
3. P. Radhakrishnan / V. Raju / S. Subramanyam, "CAD / CAM / CIM".New Age International (P) Limited 2008
4. P.N. Rao, "CAD / CAM principles and applications", Tata Mcraw-Hill, 2006.
5. Rogers / Adams, "Mathematical Elements for Computer Graphics"TataMcraw-Hill, 2017

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO2	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO3	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO4	1	2	3	-	-	-	-	1	-	-	-	2	2	3
CO5	1	2	3	-	-	-	-	1	-	-	-	2	2	3

AUDIT COURSE I

PEN19171 ENGLISH FOR RESEARCH PAPER WRITING 2 0 0 0

COURSE OBJECTIVES

To enable the students to

- understand how to improve the writing skills and level of readability.
- learn about what to write in each section and to understand the skills needed to write a title.
- choose and focus on a topic of interest and to learn how to paraphrase, summarize, using correct attribution and following documentation guidelines.
- craft a research paper in their discipline.
- ensure the good quality of paper at first-time submission.

UNIT I PLANNING AND PREPARATION 6

Precision of Words, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness. Expressing independent thought with grace, clarity and force.

UNIT II STRUCTURE OF A PAPER 6

Details of all the parts - Clarifying Who Did What, Highlighting the Findings, Hedging and Criticizing, Skills to identify something we really need to know -some ways to find a topic - to venture out across the swamp of research without losing our bearings - Paraphrasing - Sections of a Paper, Abstract, Introduction. Introduction to Free writing.

UNIT III LITERATURE REVIEWS AND CITATIONS 6

Key skills required to - write a title, an abstract, write an introduction, write the review of the literature, conduct a literature review of all current research in their field. Review of the Literature, Methods, Results, Discussion and Conclusions - citing references correctly and avoiding plagiarism.

UNIT IV EDITING AND ORGANISING SKILLS 6

Skills required to - write the Methods, write the Discussion, write the Results, write Conclusions. - write about what we've learned truthfully so the reader really gets it in thought and expression, demonstrating a clear understanding and execution of the research.

UNIT V WRITING STANDARDS 6

Useful phrases, to ensure paper is as good as it could possibly be the first – time submission -first draft, second draft, final draft of research report, journal article, literature review, dissertation chapter, grant proposal, or other relevant document. Avoid -inadequate support of generalizations, slipshod or hurried style, poor attention to detail, straying from directions, mechanical errors, underwritten and/or marred by confused purpose, lack of organization, repetition of ideas, improper use of words, and frequent grammatical, spelling and punctuation errors.

TOTAL PERIODS 30

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- prepare and write a research paper in their discipline.
- be initially organized and well-versed as a researcher, reviewing in detail general versus specific and problem-solution structures.
- understand the basics of citations, avoiding plagiarism and literature reviews.
- culminate the actual crafting and revising of a research paper.
- use suitable vocabulary, grammar and punctuation to write flawless piece of writing

REFERENCES

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

CO-PO Mapping

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COs		**Programmes Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	-	-	2	-	2	2	1	2	-
CO2	-	-	-	-	2	3	2	3	1	3	1	-	2	-
CO3	-	-	-	3	-	2	-	2	2	2	2	2	2	2
CO4	-	-	-	-	-	2	2	2	1	3	1	1	3	1
CO5	-	-	-	2	-	-	-	3	3	-	3	1	3	2

PROGRAMME ELECTIVE I

PED19151 ADVANCED MACHINE DESIGN 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the design concepts in order to enhance the basic design.
- study the behavior of mechanical components under fatigue and creep.
- understand the statistical techniques and its application in machine design.
- enhance the design factors considering strength-based reliability.
- design the product in way such that the environmental effect of the product is minimized.

UNIT I INTRODUCTION 9

Development processes and organizations, Product Planning

UNIT II THE DESIGN PROCESS 9

Need Identification and problem definition, product specification, concept generation and selection, evaluation, creativity methods, Concept testing

UNIT III MATERIAL PROCESSING AND DESIGN 9

Design for manufacture, assembly, maintenance, casting, forging, Rapid prototyping.

UNIT IV RELIABILITY 9

Design for Reliability, strength based reliability, parallel and series systems, robust design,

UNIT V LEGAL, ETHICAL, ENVIRONMENTAL AND SAFETY ISSUES IN DESIGN AND QUALITY ENGINEERING 9

Industrial design: Design for Emotion and experience, Introduction to retrofit and Ecodesign, Human behavior in design

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- students will 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.
- students will demonstrate the ability to identify needs of the customer and convert them into technical specifications of a product.
- students will be able to generate different ideas after identifying the need and determining the specifications and constraints of a product for a particular purpose.

- students will understand the principals used while designing for manufacture, assembly, emotions and maintenance.
- students will know various methods of rapid prototyping the products to test and modify the designs.

REFERENCES

1. George E Dieter, "Engineering Design", McGraw Hill Company, 00.
2. Prashant Kumar, "Product Design, Creativity, Concepts and Usability", Eastern Economy Edition, PHI New Delhi. 12
3. Woodson T.T., "Introduction to Engineering Design", McGraw Hill Book Company, 1966.
4. John J.C. "Design Methods", Wiley Inter science, 1970.
5. Averill M. Law and W. David Kelton "Simulation, modelling and analysis", McGraw Hill Book Company, 1991.

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CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

PED19152 DESIGN FOR MANUFACTURING AND ASSEMBLY 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart knowledge on embodiment design and selection of materials and shapes
- familiarize on the properties of Engineering Materials and respective case studies
- understand the designing of sheet metal, machining, powder metallurgy and polymer processing
- know the design of assembly, welding, brazing, soldering and joining of polymers
- acquire the required approach to robust design and design for optimization

UNIT I INTRODUCTION 9

Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes

UNIT II SELECTION OF MATERIALS 9

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

UNIT III DESIGN FOR MANUFACTURING 9

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, Co-selection of Materials and Processes, Case-Studies – III

UNIT IV DESIGN FOR ASSEMBLY 9

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

UNIT V DESIGN FOR RELIABILITY 9

Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality, Design for Reliability, Approach to Robust Design, Design for Optimization,

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- understand the product development cycle
- know the manufacturing issues that must be considered in the mechanical engineering design process
- know the principles of assembly to minimize the assembly time
- know the effect of manufacturing process and assembly operations on the cost of product (not included by others)

- be familiar with tools and methods to facilitate development of manufactural mechanical designs

REFERENCES

1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 03.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 00.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
4. T H Courtney, Mechanical Behavior of Materials, McGraw Hill, NY, 00.
5. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

PMA19153 MATHEMATICAL METHODS IN ENGINEERING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the basic concepts of Probability Theory and distributions
- learn different testing Statistical Hypothesis
- analyze the treatment involved in solving differential equations by means of Laplace transformation.
- study the significance of the distribution of heat, signals and frequency.
- acquire sound knowledge of techniques in solving Major Equations

UNIT I INTRODUCTION TO PROBABILITY THEORY 9

Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance.

UNIT II TESTING OF STATISTICAL HYPOTHESIS 9

Some sampling distributions like Chi square, t, F. Testing a statistical hypothesis, tests on single sample and two samples concerning means and variances. ANOVA: One – way, Two – way with/without interactions.

UNIT III LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9

Review of Definitions and properties (Statement only) of Laplace transform – Transform of some simple function, Transform of error function, Dirac Delta function, Unit Step functions – Convolution theorem – Inverse Laplace Transform: Complex inversion formula – Solutions to partial differential equations: Heat equation, Wave equation.

UNIT IV FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 9

Fourier transform: Definitions, properties – Transform of elementary functions, Dirac Delta function – Convolution theorem – Parseval‟s identity – Solutions to partial differential equations: Heat equation, Wave equation, Laplace and Poisson equations.

UNIT V MAJOR EQUATION TYPES ENCOUNTERED IN ENGINEERING AND PHYSICAL SCIENCES 9

Solution methods for wave equation, D'Alembert solution, potential equation, properties of harmonic functions, maximum principle, solution by variable separation method.

TOTAL PERIODS 45

COURSE OUTCOMES:

At the end of the course, the students will demonstrate their ability to:

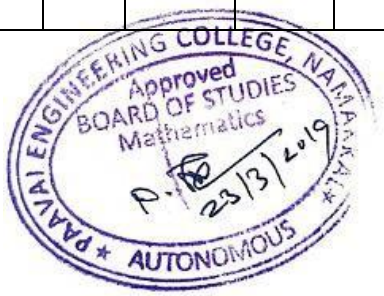
- apply statistical techniques to analyze multivariate functions.
- identify and solve engineering problems by applying the knowledge of ordinary and partial differential equations.
- solve the differential equations using Laplace Transform by applying its boundary conditions.
- gain knowledge in fourier transform techniques in distribution of heat and signal processing.
- Identify nature of a given wave equation and solve by applying D'Alembert solution and/or method of solution of method of separation of variables

REFERENCE BOOKS

1. Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall.
2. J. B. Doshi, Differential Equations for Scientists and Engineers, Narosa, New Delhi.
3. K. SankaraRao, "Introduction to Partial Differential Equations", Prentice Hall of India Pvt. Ltd., New Delhi, 1997.
4. Douglas C. Montgomery, Design and Analysis of Experiments (7^{th} Edition), Wiley Student Edition.
5. S. P. Gupta, Statistical Methods, S. Chand & Sons, 37^{th} revised edition.

CO-PO Mapping

COs	Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Week**													
	Programme Outcomes(POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO2	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO3	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO4	3	3	2	3	-	-	-	-	-	-	-	1	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	1	3	2



PED19153 RAPID PROTOTYPING AND TOOLING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- gain in depth knowledge about applications and benefits of Digital,Virtual and Rapid prototyping.
- make the students in understanding the concepts of various rapid prototyping systems and their materials and applications.
- develop knowledge on principles, products and advantages of various power based RP systems.
- impart knowledge of data processing, CAD modeling and reverse engineering concepts.
- know about the classifications of rapid tooling and applications towards various industries.

UNIT I INTRODUCTION 7

Need - Development of RP systems – RP process chain - Impact of Rapid Prototyping and Tooling on Product Development – Benefits- Applications – Digital prototyping - Virtual prototyping

UNIT II LIQUID BASED AND SOLID BASED RAPID PROTOTYPING SYSTEMS 10

Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, three dimensional printing: Working Principles, details of processes, products, materials, advantages, limitations and applications. Case studies

UNIT III POWDER BASED RAPID PROTOTYPING SYSTEMS 10

Selective Laser Sintering, Direct Metal Laser Sintering, Three Dimensional Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations – Case Studies.

UNIT IV REVERSE ENGINEERING AND CAD MODELING 10

Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements – geometric modeling techniques: Wire frame, surface and solid modeling – data formats – Data interfacing, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation.

UNIT V RAPID TOOLING 8

Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect – Fabrication processes, Applications. Case studies - automotive, aerospace and electronic industries

TOTAL PERIODS 45

COURSE OUTCOMES:

At the end of the course, the students will demonstrate their ability to:

- know the benefits of RP and tooling
- Prepare to learn about types of dimensional printing.
- distinguish various laser sintering methods.
- Solve the problems in CAD modeling and reverse engineering,
- Classify the rapid toolings.

REFERENCE BOOKS

1. Chua C.K., Leong K.F., and Lim C.S., Rapid prototyping: Principles and applications, second edition, World Scientific Publishers, 2003.
2. Peter D.Hilton,Hilton/Jacobs, Paul F.Jacobs, Rapid Tooling: Technologies and Industrial Applications, CRC press, 2000.
3. Andreas Gebhardt, Rapid prototyping, Hanser Gardener Publications, 2003.
4. Liou W.Liou, Frank W.Liou, Rapid Prototyping and Engineering applications : A tool box for prototype development, CRC Press, 2007.
5. Ali K. Kamrani, Emad Abouel Nasr, Rapid Prototyping: Theory and practice, Springer, 2006

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2

PROGRAMME ELECTIVE II

PED19251 ADVANCED ENGINEERING MATERIALS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the structure of various materials and its behaviors in the engineering field.
- learn imperfection, deformation, diffusion, dislocation and strengthening mechanisms.
- create phase diagram in iron carbon system to improve and enhance their research activities.
- acquire the knowledge of various failures of metals.
- familiarize the processing of metals like ceramics, polymers and composites.

UNIT I STRUCTURE OF MATERIALS 9

Historical perspective of Materials Science - Properties of materials - Classification of materials. Advanced Materials, Future materials and modern materials, Atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and non-crystalline materials. Miller indices. Anisotropic elasticity. Elastic behavior of composites. Structure and properties of polymers. Structure and properties of ceramics.

UNIT II IMPERFECTIONS IN SOLIDS, DIFFUSION, DISLOCATIONS AND STRENGTHENING MECHANISMS 9

Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, re-crystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion.

UNIT III PHASE DIAGRAMS 9

Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron carbon system.

UNIT IV FAILURES OF MATERIALS 9

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.

UNIT V PROCESSING OF MATERIALS 9

Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behavior of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types.

Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites, Economic, Environmental and Social Issues of Material Usage. Recycling issues. Life cycle analysis and its use indesign.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites
- understand existence of imperfections and their effects on mechanical properties of materials and cause of failure
- demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure
- understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact
- know electrical, thermal, optical and magnetic properties of metals, ceramics, polymers and composites

REFERENCES

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons, 07
2. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 2010.

CO-PO Mapping

COs	Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Week**													
	Programme Outcomes(POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO2	3	3	3	-	-	-	-	-	-	-	-	3	3	2
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	2
CO4	3	2	3	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	2	-	-	-	-	-	-	-	-	2	3	2

PED19252 MECHANICS OF COMPOSITE MATERIALS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- learn the significance and future enhancements in composite materials.
- analyze the geometric and physical properties of typical composite materials.
- understand the concepts of mathematical relations and mechanical properties.
- get knowledge in failure theories and strength parameters.
- design and analyze the structure and various laminates of composite materials.

UNIT I INTRODUCTION 9

Characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus

UNIT II BASIC CONCEPTS AND CHARACTERISTICS 9

Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials

UNIT III ELASTIC BEHAVIOR OF UNIDIRECTIONAL LAMINA 9

Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters

UNIT IV STRENGTH OF UNIDIRECTIONAL LAMINA 9

Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macro mechanical failure theories, Applicability of various failure theories

UNIT V ELASTIC BEHAVIOR OF LAMINATE 9

Basic assumptions, 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. Design for structural composite materials.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- understand the basic concepts and difference between composite materials with conventional materials.
- understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
- apply knowledge for finding failure envelopes and stress-strainplots of laminates.
- develop a clear understanding to utilize subject knowledge using
- computer programs to solve problems at structural level.

REFERENCES

1. Isaac M. Daniels, Ori Ishai, "Engineering Mechaincs of Composite Materials", OxfordUniversity Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, "Analysis and Performance of fibercomposites", John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., "Composite Materials: Engineering and Science",CRC Press, Boca Raton, 03.
4. Madhujit Mukhopadhyay, "Mechanics of Composite Materials and Structures",University Press, 04.
5. Mazumdar S. K., "Composaite Manufacturing – Materials, Product and ProcessingEngineering", CRC Press, Boca Raton, 02.

CO – PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2

PED19253 ANALYSIS AND SYNTHESIS OF MECHANISMS 3 0 0 3

COURSE OBJECTIVES

To enable the students 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.
- understand analytical working mechanism of curvature theory.
- apply modern computer-based techniques in the selection, analysis, and synthesis of components and their integration into complete mechanical systems.
- study basic of simple and complex mechanism analysis movement of planar and spherical four-bar linkages.
- think creatively and understand couple curve analysis and to present logical solutions.

UNIT I INTRODUCTION 9

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

UNIT II PATH CURVATURE THEORY 9

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

UNIT III KINEMATIC ANALYSIS 9

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.

UNIT IV SYNTHESIS OF FOUR BAR MECHANISM 9

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.

UNIT V SYNTHESIS OF COUPLER CURVE BASED MECHNISM. 9

Coupler Curves : Equation of coupler curve, Robert-Chebychev theorem, double points and symmetry.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- develop analytical equations describing the relative position, velocity and acceleration of all moving links.
- select, configure, and synthesize mechanical components into complete systems.
- use kinematic geometry to formulate and solve constraint equations to design linkages for specified tasks.
- formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical and analytical methods.
- analyze and animate the movement of planar and spherical four-bar linkages.

REFERENCES

1. R.S. Hartenberg and J. Denavit, "Kinematic Synthesis of Linkages", McGraw-Hill, NewYork, 1980.
2. Robert L.Nortan ,"Design of Machinery',Tata McGraw Hill Edition
3. Hamilton H.Mabie,"Mechanisms and Dynamics of Machinery",John Wiley and sons NewYork
4. S.B.Tuttle,"Mechanisms for Engineering Design" John Wiley and sons New York
5. A. Ghosh and A.K. Mallik, "Theory of Machines and Mechanisms", Affiliated East-West Press, NewDelhi, 1988.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

PED19254 MECHATRONICS IN MANUFACTURING 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- study the concepts of mechatronics systems.
- acquire knowledge about the sensors and transducers.
- understand the working of the actuators.
- prepare the program and work on PLC.
- understand the working of CNC and micro controller.

UNIT I INTRODUCTION 9

Introduction to Mechatronics - Systems- Need for Mechatronics - Emerging area of Mechatronics - Classification of Mechatronics - Measurement Systems – Control Systems.

UNIT II SENSORS AND TRANSDUCERS 9

Introduction - Performance Terminology – Potentiometers - LVDT – Capacitance sensors - Strain gauges - Eddy current sensor - Hall Effect sensor – Temperature sensors - Light sensors - Selection of sensors - Signal processing.

UNIT III ACTUATORS 9

Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magneto strictive - Shape memory alloy - applications - selection of actuators.

UNIT IV PROGRAMMABLE LOGIC CONTROLLERS 9

Introduction - Basic structure - Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

UNIT V DESIGN AND MECHATRONICS CASE STUDIES 9

Designing - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine - Engine Management system - Automatic car park barrier - Data acquisition Case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- have exposure on mechatronics systems and overview of control systems & actuators.
- gain knowledge about the sensors and transducers and its applications.
- understood the working of various actuators and its applications.
- gain knowledge on various signal conditioning units in plc.
- understood the programming and working of cnc and micro controller.

REFERENCES

1. Bolton.W, “Mechatronics” , Pearson education, second edition, fifth Indian Reprint, 2003
2. Smaili.A and Mrad.F , "Mechatronics integrated technologies for intelligent machines", Oxford university press, 2008.
3. Devadas Shetty and Richard A.Kolk, “Mechatronics systems design”, PWS Publishing company,2007.
4. Godfrey C. Onwubolu, "Mechatronics Principles and Applications", Elsevier, 2006.
5. Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applicatlions”Tata McGraw- Hill Publishing company Limited, 2003.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
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CO1	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO2	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO3	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO4	2	-	1	-	2	-	-	-	-	-	-	-	2	2
CO5	2	-	1	-	2	-	-	-	-	-	-	-	2	2

PED19105 COMPUTER AIDED DESIGN LABORATORY 0 0 4 2

COURSE OBJECTIVES

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

CAD INTRODUCTION

- Sketcher
- Solid modeling & Surface Modeling - Extrude, Sweep, Trim.etc and Mesh of curves, freeform etc. Feature manipulation- Copy, Edit, Pattern, Suppress, History operationsetc.
- Assembly - Constraints, Exploded Views, Interference check.
- Drafting - Layouts, Standard & Sectional Views, Detailing & Plotting.
- Couplings –Flange, Universal, Oldham's, Muff, Gear couplings.
- Joints –Knuckle, Gib & cotter, strap, sleeve & cotter joints.
- Engine parts –Piston, connecting rod, cross-head (vertical and horizontal), stuffingbox, multi-plate clutch.
- Miscellaneous machine components –Screw jack, machine vice, tail stock, chuck, vane and gear pumps.
- Assembly using Parametric and feature based modeling packages.

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course, students will be able to model various mechanical componentsusing commercially available 3D software.

REFERENCES

1. Prof.Sham Tickoo " CAD / CAM " CADCIM Technologies Purdue University Northwest, USA, 2012.

CO-PO Mapping

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CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2

SEMESTER II

PED19201 FINITE ELEMENT METHOD 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart basic knowledge in Finite element method
- provide knowledge about shape functions and degrees of freedom
- give wide knowledge in 2D scalar variable problems
- understand the concepts of plane stress and plane strain
- analyze the natural vibration of bars and beams

UNIT I INTRODUCTION 9

Classification of problems – Dimensionality, Time dependence, Boundary Value problems, Initial value problems, Linear/Non-linear, etc.

UNIT II FINITE ELEMENT METHOD-BASIC PRINCIPLES 10

Differential equation as the starting point for FEM, steps in finite element method, discretization, types of elements used, Shape functions, Linear Elements, Local and Global coordinates, Coordinate transformation and Gauss-Legendre scheme of numerical integration, Nodal degrees of freedom

UNIT III 2D SCALAR VARIABLE PROBLEMS 9

Finite element formulation, variational, weighted residual and virtual work methods

UNIT IV 2D VECTOR VARIABLE AND AXISYMMETRIC PROBLEMS 10

1-D and 2-D problems from Structural Mechanics – Bar, Beam, Plane stress and plane strain problems, Axisymmetric problems – Axisymmetric forces and geometry

UNIT V ANALYSIS OF BEAMS 7

Eigen-value problems, Natural vibration of bars and beams, Methods to find eigen-valuesand eigen-vectors.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- classify the given problem on the basis of its dimensionality, time-dependence as Static or Dynamic, Linear or Non-linear.
- develop system level matrix equations, and to know the types of elements used, Gauss-Legendre scheme of numerical integration and degrees of freedom.
- understand the variational and weighted residual work methods
- know about the 1D and 2D problems from structural mechanics and plane stress, plane strain problems.
- identify the methods to find eigen-values and eigen-vectors problems

REFERENCES

1. R.Chandrupatla and Ashok.D.Belegundu "Introduction to Finite Elements in Engineering", Prentice Hall of India Pvt. Ltd. New Delhi, Ed.4, 2012
2. S.S.Bhavikati, "Finite Element Analysis" New Age International Publishers.2015
3. Rao.S.S, "The Finite Element method in Engineering" 3rd Edition, Butterworth Heinemann,2012
4. Reddy J N, "An Introduction to Finite element Method", Tata McGraw Hill publishing Co Ltd, New Delhi, 3rd Ed., 2011
5. Bhatti Asghar.M, "Fundamentals Finite Element Analysis and Applications" John Wiley & Sons,2013

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
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CO2	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	2	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	2	-	-	-	-	-	-	2	3	3

PEN19201 RESEARCH METHODOLOGY AND IPR 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- understand the formulation of research problem
- be familiar with data collection and literature survey process
- know the statistical concepts in experimentation
- acquire knowledge in writing research proposal
- understand about patent rights and its importance

UNIT I RESEARCH PROBLEM FORMULATION 9

Meaning of research, Objectives of Research, Types of research, Significance of Research, Research process, Selecting the problem, Necessity of defining the problem, Meaning of Research design, Need for research design, features of a good design, Different research designs.

UNIT II LITERATURE SURVEY 9

Quantitative and Qualitative data, Scaling, Scaling Techniques, Experiments and Surveys, Collection of primary and secondary data, Data preparation process. Research problems, Effective literature studies approaches, Survey for existing literature, Procedure for reviewing the literature, analysis and assessment.

UNIT III DESIGN OF EXPERIMENTS 9

Strategy of Experimentation - Typical applications of experimental design, Guidelines for designing experiments; Basic statistical concepts - Statistical concepts in experimentation, Regression approach to analysis of variance.

UNIT IV RESEARCH PROPOSAL AND WRITING 9

Contents of a research proposal, Writing a research report- Research writing in general, Referencing, Writing a bibliography, Presentation and assessment by a review committee, Plagiarism, Research ethics.

UNIT V INTELLECTUAL PROPERTY RIGHTS 9

Intellectual Property- Definition, WTO, Fundamentals of Patent, Copyright, The rights of the owner, Term of copyright, Register of trademark, Procedure for trade mark, Term of trademark; New Developments in IPR- Administration of patent system, IPR of Biological Systems, Computer Software.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, students will be able to

- identify research problems.
- collect and prepare suitable data for research.
- design experiments for different statistical concepts.
- write research proposals and reports.
- apply their research work for patent through IPR.

REFERENCES

1. C.R Kothari and Gaurav Garg, "Research Methodology Methods and Techniques", 4th Edition, New Age International Publishers, 2019.
2. Ranjit Kumar, "Research Methodology": A step by Step Guide for beginners, 2nd Edition, Pearson Education, 2010.
3. Douglas C. Montgomery, "Design and Analysis of Experiments", 9th edition, Wiley Publishers, 2017.
4. Neeraj Pandey and Khushdeep Dharni, "Intellectual Property rights", PHI Learning, 2014.
5. Dr.R.Radhakrishnan and Dr.S.Balasubramanian, "Intellectual Property Rights, text and cases", Excel Books, New Delhi.

CO-PO MAPPING :

Mapping of Course Outcomes with Programme Outcomes : **(1,2,3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak**														
COs	**Programme Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	-	-	-	-	1	-	-	1	3	3	3
CO2	3	3	1	-	-	-	-	2	-	3	1	3	3	3
CO3	3	2	3	2	-	-	-	2	-	-	1	3	3	3
CO4	3	3	2	-	-	-	-	1	-	3	1	3	3	3
CO5	3	3	3	2	-	-	-	3	-	1	2	3	3	3

PED19202 **SIMULATION AND ANALYSIS LABORATORY** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to gain practical knowledge and to get hands on experience in various analysis and simulation techniques by using mechanical software tools.

LIST OF EXPERIMENTS

Analysis of Mechanical Components – Use of FEA Packages like ANSYS/NASTRAN etc.,

Exercises shall include analysis of

1. Machine elements under Static loads
2. Thermal Analysis of mechanical systems
3. Modal Analysis
4. Stress Analysis of an Axis -Symmetric Component
5. Machine elements under Dynamic loads
6. Harmonic Response Analysis
7. Non-linear systems
8. Use of kinematics and dynamics simulation software like ADAMS, MATLAB.

Analysis of velocity and acceleration for mechanical linkages of different mechanisms.

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course, the students will be able to gain basis knowledge of analysis and simulation tools, and understand thermal analysis of various mechanical systems

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	2	-	-	-	-	-	-	2	2	2

PED19203 **MINI PROJECT** **0 0 4 2**

COURSE OBJECTIVES

To enable the students to

- give an opportunity to the student to achieve integrated mechanical design of a product through part design assembly preparation of manufacturing drawings.
- get real time exposure to design problems to solve them using design principles.
- understand properties of different materials and apply them according to functional and structural requirements.
- get hands-on training in fabrication method, modelling techniques and product architecture.
- work as a team to develop team spirit and communication, exchange creative ideas, improve self-learning and planning skills.

GUIDELINE FOR REVIEW AND EVALUATION

Each students works under a project supervisor. The product system /component(s) to be designed may be decided in consultation with the supervisor and if possible with an industry. A project report to be submitted by the student which will be reviewed and evaluated for internal assessment by a Committee constituted by the Head of the Department. At the end of the semester examination the project work is evaluated based on oral presentation and the project report jointly by external and internal examiners.

TOTAL PERIODS 60

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- use of design principles and develop conceptual and engineering design of any components
- ability to integrate the parts design with assembly and ability to prepare manufacturing drawings
- select appropriate material to suit the functional requirement of the component.
- use modelling and analysis software effectively to design components and assemble them.
- design a system with a view to fulfill social, economic , environmental, legal and safety aspects in the course of development of the product.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO2	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO3	3	-	2	-	-	-	-	-	3	3	3	2	2	2
CO4	3	-	2	-	-	-	-	-	3	3	3	2	2	2

AUDIT COURSE II

PEN19271 PEDAGOGY STUDIES 2 0 0 0

COURSE OBJECTIVES

To enable the students to

- understand the aims, objectives and educational philosophies of Education
- acquire the knowledge of Instructional objectives of teaching and teaching skills
- apply the knowledge of methods and strategies of teaching in real classroom situation
- utilize the instructional aids and tools for effective classroom teaching
- acquaint with the knowledge of professional development of teachers

UNIT I EDUCATION AND ITS PHILOSOPHY 6

Education- Definition, Aims, Objectives, Scope, Educational philosophy of Swami Vivekananda, Mahatma Gandhi, Rabindranath Tagore, Sri Aurobindo and J.Krishnamoorthy, Montessori, Jean-Jacques Rousseau, Friedrich Froebel and John Dewey.

Current trends and issues in Education-Educational reforms and National policy on Education-1968 and 1986-its objectives and features..

UNIT II INSTRUCTIONAL OBJECTIVES AND DESIGN 8

Instructional Objectives: Taxonomy of Educational objectives- Writing of general and specificobjectives.

Instructional design: Planning and designing the lesson.

Writing of lesson plan : meaning, its need and importance, format of lesson plan. Types of lesson plan

Skills of teaching : various ways of introducing lessons, explaining skills, problem solving skills, illustrative skills, scaffolding skills, integrating ICT skills, questioning skills, Reinforcement skills,skill of probing questions, skill of stimulus variation and computation skills.

UNIT III INSTRUCTIONAL METHODS AND STRATEGIES 6

Instruction strategies – Lecture, demonstration, laboratory, Inductive method, Deductive method, Inquiry method, seminar, panel discussion, symposium, problem solving, project based learning (PBL),Learning by doing, workshop, role- play(socio-drama), Recent trends: Constructivist learning - Problem-based learning - Brain-based learning – Collaborative learning - Flipped learning - Blended learning - e-Learning trends - Video conferencing.

UNIT IV INSTRUCTIONAL MEDIA 6

Key concepts in the selection and use of media in education, Developing learning resource material using different media, Instructional aids – types, uses, selection, preparation, utilization. Dale cone of Experience, Teacher's role in procuring and managing instructional Aids – Projected and non-projected aids, multimedia, video-teleconferencing etc..,

UNIT V TEACHER PREPARATION 4

Teacher – roles & responsibilities, functions, characteristics, competencies, qualities, Preparation of professional teacher, Organizing professional aspects of teacher preparation programs, Professional development of teachers-In-service training, Refresher programmes, workshop and higher studies.

TOTAL PERIODS 30

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- explain the educational philosophies of education
- write instructional and specific objectives in lesson plan
- utilize the teaching skills and methods effectively
- use instructional media efficiently
- update themselves in the area of professional development

REFERENCES

1. T V Somashekar, G Viswanathappa and Anice James (2014), Methods of Teaching Mathematics, Hyderabad, Neelkamal publications Pvt Ltd
2. National Policy on Education 1968 and 1986-National Policy on Education 1986-Programme of Action 1992.
3. Batra, P. (2010). Social science learning in schools: Perspectives and challenges. New Delhi: Sage publications India.
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5. Encyclopedia of Modern Methods of Teaching and Learning (Vol. 1-5).
6. Karthikeyan, C. (2004). A Text book on instructional technology, RBSA
7. Siddiqui, MujibulHasan (2005). Techniques of classroom teaching A.P.H
8. Dhamija, N. (1993). Multimedia approaches in teaching social studies. New Delhi: Harman Publishing House
9. Jeffrey Bennett (2014). On Teaching Science: Principles and Strategies That Every Educator Should Know. Big Kid Science: Boulder,CO
10. Kulbir Singh. (2010). Teaching of mathematics. New Delhi: Sterling Publishers.
11. Bawa, M.S. &Nagpal, B.M. (2010). Developing teaching competencies. New Delhi: Viva Book House
12. Sharma, R.A. (2008). Technological foundation of education. Meerut: Lall Books Depot.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs		**Programmes Outcomes (POs)**												
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	-	-	2	-	2	2	1	2	-
CO2	-	-	-	-	2	3	2	3	1	3	1	-	2	-
CO3	-	-	-	3	-	2	-	2	2	2	2	2	2	2
CO4	-	-	-	-	-	2	2	2	1	3	1	1	3	1
CO5	-	-	-	2	-	-	-	3	3	-	3	1	3	2

PROGRAMME ELECTIVE III

PED19351 TRIBOLOGY IN DESIGN 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- impart the knowledge in friction and surface measurement
- basics of theories of wear and wear prevention
- understand the bearing material properties which influence the tribological characteristics of surfaces and lubricants
- students are able to design of bearings and types
- understand the analytical behavior of different types bearings and design of bearings based on analytical / theoretical approach

UNIT I FRICTION AND SURFACE MEASUREMENT 9

Friction, theories of friction, Friction control, Surface texture and measurement, genesis of friction, instabilities and stick-slip motion.

UNIT II WEAR 9

Wear, types of wear, theories of wear, wear prevention.

UNIT III BEARING MATERIALS AND LUBRICANTS 9

Tribological properties of bearing materials and lubricants.

UNIT IV BEARINGS 9

Lubrication, 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, Design of hydrodynamic journal bearings.

UNIT V THEORY OF HYDROSTATIC AND HYDRODYNAMIC LUBRICATION 9

Hydrostatic, squeeze film Circular and rectangular flat plates, variable and alternating loads, piston pin lubrications, application to journal bearings. Elasto-hydrodynamic lubrication – pressure viscosity term in Reynolds's equation, Hertz' theory, lubrication of spheres, gear teeth, Air lubricated bearings.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- the students will be able to understand theories of friction and surface measurement
- they will understand the theories of wear and prevention of wear
- they will be able to select materials and lubricants to suggest a tribological solution to a particular situation.

- the students will be able to design a bearing using various bearing charts.
- the students will be able to understand the hydrostatic and dynamic lubrication.

REFERENCES

1. Majumdar, B.C, "Introduction to Tribology of Bearings", S.Chand, 2ndEdition, 2008
2. John Williams, "Engineering Tribology", Cambridge University Press, 2006
3. S.K.Basu, S.N.Sengupta&B.B.Ahuja ,"Fundamentals of Tribology", Prentice–Hall of India Pvt Ltd New Delhi.,2005
4. Sushil Kumar Srivastava, "Tribology in Industries", S.Chand& Company Ltd, New Delhi.2001
5. G.W.Stachowiak& A.W .Batchelor , Engineering Tribology, Butterworth - Heinemann, UK, 2005

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	3	3	-	-	-	-	-	-	3	2	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	3	2	2
CO4	3	3	3	3	3	-	-	-	-	-	-	3	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	3	2	2

PED19352 **ROBOTICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the basic concepts of robot and its automation
- gain the depth knowledge of gripper and sensors
- familiarize the working principle of robot through various mechanical pneumatic drives and control systems
- understand the concepts of journal bearing , finite bearing
- study the various programming languages and the operating commands of robot

UNIT I INTRODUCTION **9**

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.

UNIT II ROBOT GRIPPERS **9**

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.

UNIT III DRIVES AND CONTROL SYSTEMS **9**

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 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.

UNIT IV KINEMATICS **9**

Lubrication, 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, Design of hydrodynamic journal bearings

UNIT V MACHINE VISION SYSTEM **9**

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 oftype and development of languages for recent robot systems. Artificial neural networks in manufacturing automation, Introduction to Artificial Intelligence techniques, socio- economic and safety aspect of robotisation and updates in robotics.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- understand basic terminologies and concepts associated with robotics and automation
- gain the knowledge of types of grippers and sensors
- demonstrate comprehensive of various robot subsystems\
- understand the kinematics and dynamics to explain the exact working pattern of robots
- aware of the robot languages associated recent updates of robots and its programming languages

REFERENCES

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02.April 1989
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons. September 1994
3. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04 ,2008
4. Mikell P. Grooveret. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
5. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, Editon 02.March 1999

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	2	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	2	-	-	-	-	-	-	2	2	2
CO5	3	-	-	-	2	-	-	-	-	-	-	2	2	2

PED19353 **FRACTURE MECHANICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- introduce the basic concept of fracture mechanics and failure analysis
- know about the theoretical background of crack growth
- identify the stress /strain fracture characterizing parameters like stress intensity factor
- import knowledge on deformation fields near a crack tip
- learn the methods of estimating fracture toughness testing

UNIT I INTRODUCTION **9**

Modes of fracture failure, Brittle and ductile fracture, fatigue failure, environment assisted cracking.

UNIT II CRACK GROWTH **9**

Energy release rate: crack resistance, stable and unstable crack growth.

UNIT III STRESS ANALYSIS OF CRACKS **9**

Stress intensity factor: Stress and displacement fields, edge cracks, embedded cracks.

UNIT IV CRACK TIP PLASTICITY **9**

Crack tip plasticity: Shape and size of plastic zone, effective crack length, effect of plate thickness, J-Integral. Crack tip opening displacement.

UNIT V FRACTURE TOUGHNESS TESTING **9**

Test methods for determining critical energy release rate, critical stress intensity factor, J-Integral.

TOTAL PERIODS **45**

COURSE OUTCOMES

upon the completion of the course, the students will be able to

- students will be able to use any one of the four parameters for finding out damage tolerance: stress intensity factor, energy release rate, j integral, crack tip opening displacement.
- students will be able to manage singularity at crack tip using complex variable.
- students will understand important role played by plastic zone at the crack tip.
- students will learn modern fatigue and will able to calculate the fatigue life of a component with or without crack in it.
- students will learn modern sophisticated experimental techniques to determine fracture toughness and stress intensity factor.

REFERENCES

1. Brook D, “Elementary engineering fracture mechanics”
2. Liebowitz H., “Fracture” Volume I to VII.
3. A Nadai, W. S. Hemp, “Theory of flow and fracture of solids”, McGraw Hill Book Company, 1950.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO2	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO3	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2	2	2
CO5	2	2	2	2	3	-	-	-	-	-	-	3	2	2

PED19354 REVERSE ENGINEERING 3 0 0 3

COURSEOBJECTIVES

To enable the students to

- introduce the basic concepts, tools, data management and integration process of re-engineering
- know different types of Reverse Engineering tools.
- study the reverse engineering concepts and their implementations.
- understand the strategies, software components and evaluation models of data management.
- learn about the reuse tools, coordinate measurement and feature capturing for integration of reverse engineering.

UNIT I INTRODUCTION 5

Scope and tasks of RE - Domain analysis- process of duplicating.

UNIT II TOOLS FOR RE 8

Functionality- dimensional- developing technical data - digitizing techniques -construction of surface model - solid-part material- characteristics evaluation -software and application- prototyping – verification.

UNIT III CONCEPTS 12

History of Reverse Engineering – Preserving and preparation for the four stage process – Evaluation and Verification- Technical Data Generation, Data Verification, Project Implementation.

UNIT IV DATA MANAGEMENT 10

Data reverse engineering – Three data Reverse engineering strategies – Definition –organization data issues - Software application – Finding reusable software components – Recycling real-time embedded software – Design experiments to evaluate a Reverse Engineering tool – Rule based detection for reverse Engineering user interfaces.

Reverse Engineering of assembly programs: A model based approach and its logical basics.

UNIT V INTEGRATION 10

Cognitive approach to program understated – Integrating formal and structured methods in reverse engineering. Integrating reverse engineering, reuse and specification tool environments to reverse engineering –coordinate measurement –feature capturing – surface and solid members.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- explain the scope and tasks of re-engineering
- employ Re-digitisation tools and software for analysis
- evaluate the process of RE, data generation ,verification and project implementation.

- find suitable reusable software components.
- recognize different integrating methods of RE.

REFERENCES

1. Design Recovery for Maintenance and Reuse, T J Biggerstaff, IEEE Corp. July1991
2. White paper on RE, S. Rugaban, Technical Report, Georgia Instt. of Technology,1994
3. Reverse Engineering, Katheryn, A. Ingle, McGraw-Hill, 1994
4. Data Reverse Engineering, Aiken, Peter, McGraw-Hill, 1996
5. Reverse Engineering, Linda Wills, Kluiver Academic Publishers, 1996

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO3	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	2	-	1	-	-	-	-	2	3	2
CO5	3	-	-	-	2	-	1	-	-	-	-	2	3	2

PROGRAMME ELECTIVE IV

PED19451 **MULTI-BODY DYNAMICS** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn the basic kinematic analysis, constraints, gear and cam pairs.
- get in-depth knowledge in assembly analysis and solutions.
- analyze the dynamic properties under different methods,
- understand and simulate the parameters of a body in space
- know the concepts of kinematic constraints and pairs.

UNIT I INTRODUCTION **9**

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.

UNIT II BASIC PRINCIPLES FOR ANALYSIS OF MULYI-BODY SYSTEMS **9**

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

UNIT III DYNAMICS OF PLANAR SYSTEMS **9**

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.

UNIT IV KINEMATICS OF RIGID BODIES IN SPACE **9**

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

UNIT V KINEMATIC ANALYSIS OF SPATIAL SYSTEMS **9**

Basic kinematic constraints. Joint definition frames. The constraints required for the description in space of common kinematic pairs (revolute, prismatic, cylindrical, spherical). Equations of motion of constrained spatial systems. Introduction to computation of forces.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- derive equations of motion for interconnected bodies in multi-body systems with three dimensional motion.
- implement and analyze methods of formulating equations of motion for interconnected bodies.
- write programs to solve constrained differential equations for analyzing multi-body systems.
- simulate and analyze all types of static and dynamic behaviors of the multi-body systems including the kineto-static analysis.
- lead team projects in academic research or the industry that require modeling and simulation of multi-body systems.

REFERENCES

1. O.A.Bauchau; Flexible multi body dynamics. Springer science 2010
2. Kane, T.R, Levinson, D.A., Dynamics: Theory and Applications, McGraw-Hill Book Co.,1985.
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CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	3	-	-	-	-	-	-	-	-	2	3	3
CO2	3	2	3	-	-	-	-	-	-	-	-	2	3	3
CO3	3	3	3	-	-	-	-	-	-	-	-	2	3	3
CO4	3	3	3	-	-	-	-	-	-	-	-	2	3	3
CO5	3	3	3	-	-	-	-	-	-	-	-	2	3	3

PED19452 **CONDITION BASED MONITORING** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- understand the main concepts of condition monitoring techniques.
- analyze the concepts of signal processing and techniques.
- impart knowledge on vibration monitoring
- gain an understanding of how to manage mechanical fault diagnosis
- become familiar with condition monitoring of bearings and gear.

UNIT I INTRODUCTION TO CONDITION MONITORING 9

Basic concept, techniques -visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, crack monitoring, thickness monitoring, noise and sound monitoring, responsibilities of maintenance department, maintenance strategies, principles of maintenance, concepts of maintainability, availability and reliability.

UNIT II BASIC SIGNAL PROCESSING TECHNIQUES 9

Probability distribution and density, Fourier analysis, Hilbert Transform, Cestrum analysis, Digital filtering, Deterministic / random signal separation, Time-frequency analysis. Introduction to Wavelets, Continuous Wavelet Transform (CWT), Discrete Wavelet Transform (DWT), Wavelet Packet Transform (WPT), Types and application of wavelets.

UNIT III VIBRATION MONITORING 9

Introduction, vibration data collection, techniques, instruments, transducers, selection, measurement location, time domain analysis, frequency domain analysis, time-frequency domain analysis. Rotating and reciprocating machines Vibration signals from rotating and reciprocating machines –signal classification, signals generated by rotating machines, signals generated by reciprocating machines.

UNIT IV MECHANICAL FAULT DIAGNOSIS 9

Wear monitoring and lubricant analysis -sources of contamination, techniques, Spectrometric Oil Analysis Procedure (SOAP) and ferrography. Nondestructive testing techniques Measurement of surface and subsurface flaws –liquid penetrant inspection, eddy current inspection, radiographic inspection, ultrasonic inspection

UNIT V CONDITION MONITORING OF ROLLING ELEMENT BEARINGS& GEAR 9

Introduction, construction, types of faults, rolling element bearing diagnostics and gear diagnostics. Tool wear monitoring-Introduction of tool wear techniques and case studies.

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- know the different condition monitoring techniques and its advantages in industries.
- be aware of implement the basic signal processing techniques
- understand the role of vibration monitoring, its methodology and its use in condition monitoring of rotating and reciprocating machines.
- be able to apply the significance of mechanical fault diagnosis and non-destructive testing techniques in monitoring and maintenance.
- study condition monitoring of rolling element bearing, gears and tool condition monitoring techniques in machining.

REFERENCES

1. M.Adams, Rotating machinery analysis - from analysis to troubleshooting, Marcel Dekker, NewYork, 01, ISBN 0-8247-0258-1.
2. Cornelius SchefferPareshGirdhar, Practical Machinery Vibration Analysis and Predictive Maintenance, Newnes, 1st Edition, 04, Paperback ISBN: 9780750662758
3. Robert Bond Randall –Vibration-Based Condition Monitoring –Industrial, Aerospace and Automotive applications, John Wiley & Sons Ltd., 2011
4. Dr. K.Balaveera Reddy, ISTE Summer School on Machinery Diagnostics and Preventive Maintenance,
5. John Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books, 1993.

CO-PO Mapping

COs	Mapping of Course outcomes with Programme outcomes **(1/2/3 indicates strength of correlation)3-Strong, 2-Medium, 1-Week**													
	Programme Outcomes(POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	-	-	-	-	-	-	-	-	-	-	2	2	2

PED19453 **OPTIMIZATION TECHNIQUES IN DESIGN** **3 0 0 3**

COURSE OBJECTIVES

To enable the students to

- learn how to solve a problems using optimization technique.
- know the basic concepts of linear programming
- get acquire knowledge in non-linear programming techniques
- get interested in engineering design a view of optimization as a tool for design
- able to understand the concepts of genetic algorithms for optimization.

UNIT I INTRODUCTION AND CLASSICAL OPTOMOZATION TECHNIQUE 9

Introduction to optimization, classification of optimization problems, classical, optimization techniques

UNIT II LINEAR PROGRAMMING 9

Introduction to Linear programming, simplex method, simplex algorithm and Duality in linear programming, sensitivity or post-optimality analysis, Karmarkar's methods.

UNIT III NON-LINEAR PROGRAMMING 9

One dimensional minimization, unconstrained and constrained minimization, characteristics and classification of constrained minimization, direct and indirect methods

UNIT IV GEOMETRIC PROGRAMMING 9

Geometric programming, Optimum design of mechanical elements like beams, columns, gears, shafts, etc.

UNIT V GENETIC ALGORITHMS 9

Introduction to Genetic Algorithms, Operators, applications to engineering optimization problems

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- know the principles of optimization.
- have knowledge of algorithms for design optimization
- formulate an optimization problem.
- find the optimum solution of their problems using optimization techniques.
- investigate, study, develop, organize and promote innovative solutions for various applications.

REFERENCES

1. S. S. Stricker, "Optimising performance of energy systems" Battelle Press, New York,1985.
2. R.C. Johnson, "Optimum Design of Mechanical Elements", Willey, New York, 1980.
3. J. S. Arora, "Introduction to Optimum Design", McGraw Hill, New York, 1989.
4. Kalyanmoy Deb, "Optimization for Engineering Design", Prentice Hall of India, New Delhi, 05
5. L.C.W. Dixon, "Non-Linear Optimisation - Theory and Algorithms", Birkhauser,Boston, 1980.

CO-PO Mapping

Mapping of Course Outcomes with Programme Outcomes (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak														
COs	**Programme Outcomes(POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO2	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO3	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO4	3	3	3	2	2	-	-	-	1	-	-	2	3	3
CO5	3	3	3	2	2	-	-	-	1	-	-	2	3	3

PED19454 DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS 3 0 0 3

COURSE OBJECTIVES

To enable the students to

- familiarize the students with various hydraulic systems and hydraulic actuators.
- understand the control elements and actuation systems.
- learn to design Hydraulic circuits effectively.
- acquire knowledge to design the pneumatic systems and circuits.
- know about pneumatic equipments, design calculation and use of microprocessors

UNIT I OIL HYDRAULIC SYSTEMS AND HYDRAULIC ACTUATORS 9

Hydraulic Power Generators – Selection and specification of pumps, pump characteristics. Linear and Rotary Actuators – selection, specification and characteristics

UNIT II CONTROL AND REGULATION ELEMENTS 9

Pressure - direction and flow control valves - relief valves, non-return and safety valves - actuation systems.

UNIT III HYDRAULIC CIRCUITS 9

Reciprocation, quick return, sequencing, synchronizing circuits - accumulator circuits - industrial circuits – press circuits - hydraulic milling machine - grinding, planning, copying, - forklift, earth mover circuits- design and selection of components – safety and emergency mandrels

UNIT IV PNEUMATIC SYSTEMS AND CIRCUITS 9

Pneumatic fundamentals - control elements, position and pressure sensing – logic circuits - switching circuits - fringe conditions modules and these integration -sequential circuits - cascade methods - mapping methods – step counter method -compound circuit design - combination circuit design.

UNIT V INSTALLATION, MAINTENANCE AND SPECIAL CIRCUITS 9

Pneumatic equipments- selection of components - design calculations – application -fault finding – hydro pneumatic circuits - use of microprocessors for sequencing -PLC, Low cost automation - Robotic circuits

TOTAL PERIODS 45

COURSE OUTCOMES

Upon the completion of the course, the students will be able to

- demonstrate knowledge on hydraulic power generator, pumps and various actuators.
- identify proper control and regulation elements.
- design appropriate hydraulic circuits for various Engineering applications.
- describe design procedure for pneumatic circuits.
- select suitable components for designing hydro pneumatic circuits.

REFERENCES

1. Antony Espossito, "Fluid Power with Applications", Prentice Hall, 2013.
2. Dudleyt, A. Pease and John J. Pippenger, "Basic fluid power", Prentice Hall,1987.
3. Andrew Parr, "Hydraulic and Pneumatics" (HB), Jaico Publishing House, 2011.
4. Bolton. W., "Pneumatic and Hydraulic Systems ", Butterworth –Heinemann, 1997
5. K.Shanmuga Sundaram, "Hydraulic and Pneumatic Controls: Understanding made Easy" S.Chand & Co Book publishers, New Delhi, 2006 (Reprint 2009).

CO - PO Mapping

Mapping of Course Outcomes with Programme Outcomes:

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

COs	Programme Outcomes(POs)													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	-	-	-	-	-	1	-	-	-	-	2	3	2
CO2	3	-	-	-	1	-	1	-	-	-	-	2	3	2
CO3	3	-	2	-	-	-	1	-	-	-	-	2	3	2
CO4	3	-	-	-	1	-	1	-	-	-	-	2	3	2
CO5	3	-	2	-	-	-	1	-	-	-	-	2	3	2