

DEPARTMENT OF MECHANICAL ENGINEERING

**COURSE STRUCTURE & SYLLABUS FOR
R25 M.Tech (Machine Design) PROGRAM**

(Applicable for batches admitted from 2025-2026)



**UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

		III MINORS MP(3H)	EG-CSE(A) (4H)
22. Sri. V. Bade Naik		EG-CSE,AIML ICP(5H)	I-I EW-FT(3H)
		III-I OE SET(3H)	II-I MOS LAB(6H)
			III-I (RA) DMM-I(3H)
			I-I EW-CE(6H)
			EG-AIML(A) (4H)

III-I OPEN ELECTIVES-1 ; 1. Sustainable Energy Technologies (Dr.D.BrahmeswaraRao)

2.Nano Technology (Smt.K. VijayaLakshmi)

IV-I OPEN ELECTIVES 3 & 4: 1. FILM 2. Optimization Techniques

III-I HONORS: 1. ADVANCED CAD-(KVL) 2. PRODUCT DESIGN & DEVELOPMENT-(KRJ)

III M.TECH MD : Advanced Robotics-NMR BSC

I VI.TECH TE : 1. Advanced Heat Transfer - 2. Advanced Heat Transfer Lab – MBG

I M.TECH CAD/CAM : Mechanical Behaviour of Materials-MMS-KVL

ENGINEERING WORKSHOP:

CE-BBK(6H), VBN(6H)

ME-AGK(3H),MMS(3H),MKS(3H),KP(3H)

PE- KP(6H), VVP(6H)

CHE-TLK(6H),MBG(6H),

FT- VJP(3H),KKB(3H),KRJ(3H),VKM(3H)

III LABS: TE-CM LAB-KKB

MD- Computational Lab-KKB CAD/CAM: CAD/CAM Lab-VVP

ENGINEERING GRAPHICS:

ECE:VVS,VKM,DBR

CSE:VKM, BSC, KRJ

AIML:TLK,KKB, VBN

EEE:KDK,DBR, KVL

ICP:VBN,MBG



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JNTUK KAKINADA - 533 003, Andhra Pradesh, India
M. Tech (MACHINE DESIGN)

I -SEMESTER

S.No	Course Code	Course Title		L	T	P	C
1	MD101 (Core-1)	Mechanical Vibrations and Acoustics		4	0	0	4
2	MD102 (Core-2)	Advanced Mechanics of Solids		4	0	0	4
3	MD103 (Core-3)	AI&ML for Mechanical Engineering		4	0	0	4
4	Programme Elective – I MD 104	MD1041	Advanced Finite Element Methods	3	0	0	3
		MD 1042	Product Design& Development				
		MD 1043	Geometric Modeling				
		MD 1044	Numerical methods for Mechanical Engineering				
5	Programme Elective –II MD 105	MD 1051	Design for Manufacturing & Assembly	3	0	0	3
		MD 1052	Multi Body Dynamics				
		MD 1053	Vision Systems and Image Processing				
		MD 1054	Tribology				
6	MD106	Machine Dynamics Lab		0	0	4	2
7	MD107	Design Practice Lab		0	0	4	2
8	MD 108	Seminar I		0	0	2	1
		Total		18	0	10	23

II -SEMESTER

S.No	Course Code	Course Title		L	T	P	C
1	MD 201 (Core-1)	Advanced Mechanisms & Robotics		4	0	0	4
2	MD 202 (Core-2)	Advanced Machine Design		4	0	0	4
3	MD 203 (Core-3)	Conditioning Monitoring and Fault Diagnosis		4	0	0	4
4	Programme Elective – III MD 204	MD 2041	Theory of Elasticity and Plasticity	3	0	0	3
		MD 2042	Advanced Optimization Techniques				
		MD 2043	Computational Fluid Dynamics				
		MD 2044	Mechanics of Composite Materials				
5	Programme Elective – IV MD 205	MD 2051	Experimental stress analysis	3	0	0	3
		MD 2052	Fracture Mechanics				
		MD 2053	Mechatronics				
		MD 2054	Introduction to Quantum Technologies				
6	MD 206	Computational Lab		0	0	4	2
7	MD 207	Composite Fabrication and Characterization Lab		0	0	4	2
8	MD 208	Seminar II		0	0	2	1
		Total		18	0	10	23

Note: Students are informed to complete Summer Internship (duration 8-10 weeks) at the end of the II Semester.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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III- SEMESTER

S. No	Course Code	Course Title	L	T	P	C
1	MD 301	Research Methodology and IPR/ Swayam 12 Week MOOC Course RM&IPR	3	0	0	3
2	MD 302*	Summer Internship/Industrial Training	-	-	3	3
3	MD 303**	Comprehensive Viva	-	4	-	2
4	MD 304	Dissertation Part - A	-	-	20	10
TOTAL			3	4	23	18

**** TWO EVALUATIONS FOR SEMESTER BEFORE FIRST AND SECOND MID EXAMINATIONS**

IV –SEMESTER

S. No	Course Code	Course Title	L	T	P	C
1	MD 401	Dissertation Part - B	-	-	32	16
TOTAL			-	-	32	16


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M.Tech I SEMESTER

Dr. D. Linga raju

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MD101	MECHANICAL VIBRATIONS AND ACOUSTICS	CATEGORY Program Core 1	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Explain and idealize the properties of complex structures into lumped parameter models for the overall vibration characteristics in design systems which require dynamical properties like damping, free and forced vibrations response.	
CO2	Compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system	
CO3	Evaluating the vibration parameters of continuous/elastic body systems for natural frequencies and subsequent mode shapes	
CO4	Make a practical experience of basics of sound, noise and vibration; as well as their measurement and control strategies.	
CO5	Describe the vibration measurement by using transducers and vibration exciters and able to assess occupational and environmental noise problems.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3	3		
CO3				3		
CO4			2			
CO5			3	3		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	INTRODUCTION : Relevance and need for vibrational analysis – Basics of SHM - Mathematical modelling of vibrating systems - Discrete and continuous systems - single-degree freedom systems - free and forced vibrations, damped and undamped systems.
UNIT – 2	MULTI DEGREE FREEDOM SYSTEMS : Free and forced vibrations of multi-degree freedom systems in longitudinal, torsional and lateral modes - Matrix methods of solution- normal modes - Orthogonality Principle-Energy methods, Eigen values and Eigen vectors
UNIT – 3	CONTINUOUS SYSTEMS : Torsional vibrations - Longitudinal vibration of rods - transverse vibrations of beams - Governing equations of motion - Natural frequencies and normal modes - Energy methods, Introduction to nonlinear and random vibrations.

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UNIT – 4	BASICS OF ACOUSTICS : Speed of Sound, Wavelength, Frequency, and Wave Number, Acoustic Pressure and Particle Velocity, Acoustic Intensity and Acoustic Energy Density, Spherical Wave propagation, Directivity Factor and Directivity Index, Levels and the decibel, Addition and subtraction of Sound levels, Octave Bands, Weighted Sound pressure Levels.
UNIT – 5	NOISE MEASUREMENT AND CONTROL : Sound Level Meters, Intensity Level Meters, Octave Band Filters Acoustic Analyzers, Dosimeter, Measurement of Sound Power, Impact of noise on humans, Loudness, sound absorption and insulation and Noise control strategy.

TEXT BOOKS:

1. S.S.Rao, "Mechanical Vibrations ", 5th Edition, Prentice Hall, 2011.
2. M.L.Munjal and B. Venkatesham, "Noise and Vibration Control", Second Edition, World Scientific, 2024.

REFERENCES:

1. W.T. Thomson, M.D. Dahleh and C Padmanabhan, "Theory of Vibration with Applications", 5th Edition, Pearson Education, 2008.
2. L.Meirovitch, "Elements of vibration Analysis", 2nd Edition, McGraw-Hill, New York, 1985.
3. Beranek and Ver, "Noise and Vibration Control Engineering: Principles and Applications", John Wiley and Sons, 2006.
4. Randall F. Barron, "Industrial Noise Control and Acoustics", Marcel Dekker, Inc., 2003.

WEB RESOURCES:

<http://www.nptel.ac.in/courses/112103111>

<http://www.nptel.ac.in/courses/112103112>


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MD102	ADVANCED MECHANICS OF SOLIDS	CATEGORY Program Core 2	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Able to calculate stress in the machine components and analyze the failure modes.	
CO2	Able to identify the failure modes of different structural members and applying various energy methods for statically determinant and indeterminate structures	
CO3	Able to calculate bending stresses in curved beams and beams subjected to non-symmetrical bending	
CO4	Able to calculate torsional stresses in circular and non-circular cross section members and multi walled thin-walled tubes	
CO5	Able to calculate and analyze contact stress when two bodies are in contact.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			1	1		
CO2			1	1		
CO3			1	1		
CO4			2	2		
CO5			1	1		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Theories of stress and strain, Definition of stress at a point, stress notation, principal stresses, other properties, differential equations of motion of a deformable body, deformation of a deformable body, strain theory, principal strains, strain of a volume element, small displacement theory. Stress –strain temperature relations, Elastic response of a solid, Hooke's Law, isotropic elasticity, Anisotropic elasticity, initiation of Yield, Yield criteria.
UNIT – 2	Failure criteria: Modes of failure, Failure criteria, Excessive deflections, Yield initiation, fracture, Progressive fracture, (High Cycle fatigue for number of cycles $N > 10^6$, buckling. Application of energy methods: Elastic deflections and statically indeterminate members and structures: Principle of stationary potential energy, Castiglione's theorem on deflections, Castiglione's theorem on deflections for linear load deflection relations,


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	deflections of statically determinate structures.
UNIT – 3	Unsymmetrical bending: Bending stresses in Beams subjected to unsymmetrical bending; Deflection of straight beams due to unsymmetrical bending. Curved beam theory: Winkler Bach formula for circumferential stress – Limitations – Correction factors –Radial stress in curved beams – closed ring subjected to concentrated and uniform loads-stresses in chain links.
UNIT – 4	Torsion : Linear elastic solution; Prandtl elastic membrane (Soap-Film) Analogy; Narrow rectangular, Circular, elliptical cross Sections, ;Hollow thin wall torsion members ,Multiply connected Cross Section.
UNIT – 5	Contact stresses: Introduction; problem of determining contact stresses; Assumptions on which a solution for contact stresses is based; Expressions for principal stresses; Method of computing contact stresses; Deflection of bodies in point contact; Stresses for two bodies in contact over narrow rectangular area (Line contact), Loads normal to area; Stresses for two bodies in line contact, Normal and Tangent to contact area.

TEXT BOOKS:

1. Advanced Mechanics of materials by Boresi & Sidebottom- Wiely International.
2. Theory of elasticity by Timoshenko S.P. and Goodier J.N. McGraw-Hill Publishers 3rd Edition
3. Advanced Mechanics of Solids, L.S Srinath

REFERENCE BOOKS:

1. Advanced strength of materials by Den Hortog J.P.
2. Theory of plates – Timoshenko.
3. Strength of materials & Theory of structures (Vol I & II) by B.C Punmia
4. Strength of materials by Sadhu singh


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MD 103	AI & ML for Mechanical Engineering	CATEGORY Program Core 3	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Explain the basic concepts of artificial intelligence	
CO2	Learn about the principles of supervised learning methods	
CO3	Gain knowledge in unsupervised learning method and Bayesian algorithms	
CO4	Get knowledge about neural networks and genetic algorithms.	
CO5	Understand the machine learning analytics and apply deep learning techniques to mechanical engineering applications.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Introduction: Definition of Artificial Intelligence, Evolution, Need, and applications in real world. Intelligent Agents, Agents and Environments; Good Behaviour - concept of rationality, the nature of environments, structure of agents. Introduction to Machine Learning (ML): Definition, Evolution, Need, applications of ML in industry and real-world, regression and classification problems, performance metrics, differences between supervised and unsupervised learning paradigms, bias, variance, overfitting and under fitting.
UNIT – 2	Unsupervised Learning: Clustering, K-means, Dimensionality Reduction, PCA and Kernel. Bayesian and Computational Learning: Bayes theorem, concept learning, maximum likelihood of normal, binomial, exponential, and Poisson distributions, minimum description length principle, Naïve Bayes Classifier, Instance-based Learning- K-Nearest neighbour learning.

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UNIT – 3	Neural Networks and Genetic Algorithms: Neural network representation, problems, perceptron, multilayer networks and backpropagation, steepest descent method, Convolutional neural networks and their applications, Local vs Global optima, Introduction to Genetic algorithms.
UNIT – 4	Deep Learning: Recurrent Neural Networks and their applications, LSTM, Deep generative models, Deep auto-encoders, Applications of Deep Networks. Machine Learning Algorithm Analytics: Evaluating Machine Learning algorithms, Model, Selection, Ensemble Methods - Boosting, Bagging, and Random Forests.
UNIT – 5	Overview of Applications to Mechanical Engineering: Introduction to Machine learning packages, preparation of dataset for machine learning (cleansing and featurizing) Design of 1D mechanical structures, Crack detection, fatigue life and creep estimation, Defect detection in casting and welding, Tool wear and Surface roughness prediction in CNC machining, Heat exchanger design optimization, fault classification.

TEXT BOOKS:

- 1) Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 2/e, Pearson Education, 2010.
- 2) Tom M. Mitchell, Machine Learning, McGraw Hill, 2013.
- 3) Ethem Alpaydin, Introduction to Machine Learning (Adaptive Computation and Machine Learning), The MIT Press, 2004.

REFERENCE BOOKS:

- 1) Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence, 3/e, McGraw Hill Education, 2008.
- 2) Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Learning, 2012.

ONLINE RESOURCES:

<https://www.tpointtech.com/artificial-intelligence-ai>
<https://www.geeksforgeeks.org/>


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MD 1041	ADVANCED FINITE ELEMENT METHODS	CATEGORY Program Elective 1	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Formulate and solve engineering problems using FEM and BEM.	
CO2	Apply FEM to structural, thermal, and fluid flow problems.	
CO3	Use boundary element formulation for linear problems with infinite domains.	
CO4	Implement numerical methods to solve FEM/BEM equations.	
CO5	Utilize commercial software for simulation and result interpretation.	

#Based on suggested Revised BTL.

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2			3	3		
CO3			3	3		
CO4			2	3		
CO5			3	3		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Finite Element Analysis of 1D Structural Members One Dimensional Problems: Formulation of Stiffness Matrix for a Bar Element by the Principle of Minimum Potential Energy, Properties of Stiffness Matrix, Characteristics of Shape Functions, Quadratic Shape Functions. Analysis of Trusses: Derivation of Stiffness Matrix for a Truss Element oriented Arbitrarily in to 2D plane, Calculation of Reaction Forces, Displacements, Stresses and Strains. Analysis of Beams: Derivation of Stiffness Matrix for Two Noded, Two Degrees of Freedom Per Node Beam Element, Load Vector, Deflection, Stresses, Shear Force and Bending Moment, Problems on Uniform and Stepped Beams for Different types of Loads Applied on Beams
UNIT – 2	2D and 3D Structural Element Analysis in FEA Finite Element Formulation of 2D Problems: Derivation of Element Stiffness Matrix for Two Dimensional CST Element, Derivation of Shape Functions for CST Element, Elasticity Equations, Constitutive Matrix Formulation, Formulation of Gradient Matrix,


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	Two Dimensional Iso parametric Elements and Numerical Integration, Problems. Finite Element Formulation of 3D Problems: Derivation of Element Stiffness Matrix for Tetrahedron Element, Properties of Shape Functions for 3D Tetrahedral Element, Stress-Strain Analysis for 3D Element, Strain - Displacement Relationship Formulation.
UNIT – 3	Thermal and Dynamic Analysis in FEA Steady State Heat Transfer Analysis: One Dimensional Finite Element Analysis of Fin and Composite Slabs. Two-Dimensional Steady State Heat Transfer Problems: Derivation of Thermal Stiffness Matrix for 2D Heat Transfer Problems-CST, Derivation of Thermal Force Vector for 2D Heat Transfer Problems. Dynamic Analysis: Formulation of Mass Matrices for Uniform Bar and Beam Elements using Lumped and Consistent Mass Methods Evaluation of Eigen Values and Eigen Vectors for a Stepped Bar and Beam Problems.
UNIT – 4	Plate Bending and Nonlinear FEA of Solids Plate Bending: Introduction, Plate Behavior, C^1 (Kirchhoff) Plate Elements, C^0 (Mindlin) Plate Elements, Mindlin Beam, More Devices for C^0 Plate Elements, Boundary Conditions, Analytical Problems. Nonlinear Finite Element of Solids: Material Nonlinearities, Objective Rates, Nonlinear Elasticity, Plasticity, Viscoplasticity, Viscoelasticity.
UNIT – 5	Boundary Element Method for Potential and Electrostatic Problems Boundary Element Method: Potential Problems: Introduction, Boundary Element Approach, Fundamental Solution, Numerical Implementation, Determination of C_i , Final Relation, Three Dimensional Analysis, Tackling Kernel Singularity. Boundary Element Formulation for Electrostatic Problems: Introduction, Basic Relation, Boundary Condition and Other Relations, Discretization and Matrix Formulation, Determination of Term $C(p)m$.

TEXT BOOKS:

1. The finite element methods in Engineering, S.S.Rao, Elsevier, 4th Edition, 2005.
2. Finite and Boundary Element Methods in Engineering, O.P.Gupta, Oxford and IBH Publishing Co. Pvt. Ltd., 1st Edition, 1991.

REFERENCE BOOKS:

1. Finite Element Methods: Basic Concepts and Applications, Alavala Chennakesava R. PHI, 3rd Edition, 2012.
2. Introduction to Finite Elements in Engineering, Tirupathi R. Chandrupatla and Ashok D. Belegundu, Pearson Education, 4th Edition, 2011.
3. An Introduction to Finite Element Methods, J.N.Reddy, McGraw Hill Education, 3rd Edition, 2005.
4. The Finite Element Method in Engineering Science, O.C.Zienkowitz, McGrawHill, 1st Edition, 1971.
5. A First Course in Finite Elements, Jacob Fish and Ted Belytschko, Wiley, 1st Edition, 2007.
6. Fundamentals of Finite Element Analysis, David Hutton, McGraw Hill Education, 1st Edition, 2004.


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MD 1042	PRODUCT DESIGN AND DEVELOPMENT	CATEGORY Program Elective 1	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Apply creative thinking skills for idea generation	
CO2	Translate conceptual ideas into clear sketches	
CO3	Present ideas using IT application software and physical model	
CO4	Able to identify causes of failure through fault free analysis and perform failure analysis	
CO5	To carryout perform product testing under thermal, vibration, electrical and combined environments.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	<p>Product Design Process: Design Process Steps, Morphology of Design. Problem Solving and Decision Making: Problem-Solving Process, Creative Problem Solving, Invention, Brainstorming, Morphological Analysis, Behavioral Aspects of Decision Making, Decision Theory, Decision Matrix, Decision Trees.</p> <p>Modelling and Simulation: Triz, Role of Models in Engineering Design, Mathematical Modelling, Similitude and Scale Models, Computer Simulation, Geometric Modelling on Computer, Finite-Element Analysis.</p>
UNIT – 2	<p>Product management: The operation of product management: Customer focus of product management, product planning process, Wedge analysis, Opportunity search, Product life cycle Life cycle theory and practice.</p> <p>Product development: Managing new products, process, Sources of product innovation, The political dimension of product design, Managing the product launch and customer feedback.</p> <p>Product managers and manufacturing: The need for effective relationships, The</p>

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	impact of manufacturing processes on product decisions, Prototype planning, Productivity potentials, Management of product quality, Customer service levels.
UNIT – 3	Risk and Reliability: Risk and Society, Hazard Analysis, Fault Tree Analysis. Failure Analysis and Quality: Causes of Failures, Failure Modes, Failure Mode and Effect Analysis, FMEA Procedure, Classification of Severity, Computation of Criticality Index, Determination of Corrective Action, Sources of Information, Copyright and Copying. Patent Literature.
UNIT – 4	Product Testing; thermal, vibration, electrical, and combined environments, temperature testing, vibration testing, test effectiveness. Accelerated testing and data analysis, accelerated factors. Weibull probability plotting, testing with censored data.
UNIT – 5	Design For Maintainability: Maintenance Concepts and Procedures, Component Reliability, Maintainability and Availability, Fault Isolation in design and Self-Diagnostics. Product Design for Safety, Product Safety and User Safety Concepts, Examples of Safe Designs. Design Standardization and Cost Reduction: Standardization Methodology, Benefits of Product Standardization; International, National, Association and Company Level Standards; Parts Modularization

TEXT BOOKS:

1. Engineering Design, George E. Dieter, McGraw-Hill
2. Product Integrity and Reliability in Design, John W. Evans and Jillian Y. Evans, Springer Verlag

REFERENCES:

1. The Product Management Handbook, Richard S. Handscombe, McGraw-Hill
2. New Product Design, Ulrich Eppinger
3. Product Design, Kevin Otto.


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MD 1043	GEOMETRIC MODELING	CATEGORY Program Elective 1	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Develop parametric equations for simple geometric entities, formulate algebraic and geometric form of a cubic spline.	
CO2	Develop equations for Bezier curve.	
CO3	Develop equations for B-Spline curve	
CO4	Develop parametric representation of analytic and synthetic surfaces	
CO5	Understand and implement various schemes used for construction of solid models.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				1		
CO2			2	2		
CO3			3	2		
CO4			3	2		
CO5			3	3	3	

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Cubic Splines-1: Historical Developments, Definition, Explicit and implicit equations, parametric equations, Algebraic and geometric form of cubic spline, tangent vectors, parametric space of a curve, blending functions
UNIT – 2	Cubic Splines-2: , four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves. Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives.
UNIT – 3	B-Spline Curves: B-Spline basis, equations, knot vectors, properties, and derivatives, NURBS
UNIT – 4	Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature.

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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UNIT – 5	Solids: Tricubic solid, Algebraic and geometric form. Solid modeling concepts: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem.
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TEXT BOOKS:

1. CAD/CAM by Ibrahim Zeid, Tata McGraw Hill.
2. Elements of Computer Graphics by Roger & Adams Tata McGraw Hill.

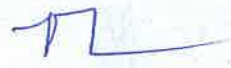
REFERENCES:

1. Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers
2. Computer Aided Design and Manufacturing, K.Lalit Narayan, K.MallikarjunaRao, MMM Sarcar, PHI Publishers


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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JNTUK KAKINADA - 533 003, Andhra Pradesh, India

MD 1044	NUMERICAL METHODS FOR MECHANICAL ENGINEERING	CATEGORY Program Elective 1	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Use numerical methods in engineering analysis and computing, Familiar with numerical solutions of linear and nonlinear equations.	
CO2	Aquaint with fitting data with a function (having error) by linear, multiple linear and polynomial regression and Familiar with the solution techniques of boundary value and characteristic value problems.	
CO3	Apply Fourier and Laplace transforms and perform transformations between time and frequency domains.	
CO4	Solve partial differential equations (one dimensional and two dimensional) (Elliptic, parabolic, hyperbolic) by finite difference method.	
CO5	Implement algorithms and programming for solving complicated problems using numerical methods.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, nonlinear regression - computer programs.
UNIT – 2	Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems.
UNIT – 3	Transformation Techniques: Continuous Fourier series, frequency and time domains, Laplace transform, Fourier integral and transform, discrete Fourier transform (DFT), Fast Fourier transform (FFT).

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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UNIT – 4	Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – Poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method.
UNIT – 5	Partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs

TEXTBOOKS:

1. Steven C.Chapra, Raymond P.Canale "Numerical Methods for Engineers" Tata Mc-Graw Hill
2. 2.Curtis F.Gerald, Partick.O.Wheatly,"Applied numerical analysis"Addison-Wesley,1989
3. 3.Douglas J.Faires,Riched Burden"Numerical methods", Brooks/Cole publishing
4. company,1998.Second edition.

REFERENCES:

1. Ward Cheney and David Kincaid "Numerical mathematics and computing" Brooks/Colepublishing company1999, Fourth edition.
2. Riley K.F,. M.P.Hobson and Bence S.J,"Mathematical methods for physics and engineering", Cambridge University press,1999.
3. Kreysis, Advanced Mathematics.


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD1051	DESIGN FOR MANUFACTURING AND ASSEMBLY	CATEGORY Program Elective 2	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Understand the basic concepts of DFMA and their applications. Apply design rules to manual assembly.	
CO2	Apply design rules for ease of machining and understand the design recommendations for machined parts	
CO3	Understand the selection, simulation and design rules of casting processes. Also to understand the design considerations for extruded sections and various forming processes.	
CO4	Understand the design considerations and effect of thermal stresses in welded joints. Understand the design factors for forging.	
CO5	Understand the design considerations for automatic assembly and to do quantitative analysis of assembly systems.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				2		
CO2				2	2	
CO3			1	2	2	
CO4			1	2	2	
CO5				1		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Introduction to DFM, DFMA: How Does DFMA Work? Reasons for Not Implementing DFMA, What Are the Advantages of Applying DFMA During Product Design?, Typical DFMA Case Studies, Overall Impact of DFMA on Industry, ISO Standards. Design for Manual Assembly: General Design Guidelines for Manual Assembly, Development of the Systematic DFA Methodology, Assembly Efficiency, Effect of Part Symmetry, Thickness, Weight on Handling Time, Effects of Combinations of Factors, Application of the DFA Methodology.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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UNIT – 2	Machining processes: Overview of various machining processes-general design rules for machining-dimensional tolerance and surface roughness-Design for machining – ease –redesigning of components for machining ease with suitable examples. General design recommendations for machined parts.
UNIT – 3	Metal casting: Appraisal of various casting processes, selection of casting process,- general design considerations for casting-casting tolerance-use of solidification, simulation in casting design-product design rules for sand casting. Extrusion & Sheet metal work: Design guide lines extruded sections-design principles for punching, blanking, bending, deep drawing-Keeler Goodman forging line diagram – component design for blanking.
UNIT – 4	Metal joining: Appraisal of various welding processes, factors in design of weldments – general design guidelines-pre and post treatment of welds-effects of thermal stresses in weld joints-design of brazed joints. Forging: Design factors for forging – closed die forging design – parting lines of dies – drop forging die design – general design recommendations.
UNIT – 5	Design for Assembly Automation: Fundamentals of automated assembly systems, System configurations, parts delivery system at workstations, various escapement and placement devices used in automated assembly systems, Quantitative analysis of Assembly systems, Multi station assembly systems, single station assembly lines.

TEXT BOOKS:

1. Design for manufacture, John cobert, Adisson Wesley. 1995
2. Design for Manufacture by Boothroyd,
3. Design for manufacture, James Bralla

REFERENCE:

- ASM Hand book Vol.20

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD1052	MULTI BODY DYNAMICS	CATEGORY Program Elective 2	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1		
CO2		
CO3		
CO4		
CO5		

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Review of kinematics and dynamics of point mass and rigid body - types of constraints - constraints for revolute joints, translational joints, composite joints
UNIT – 2	Formulation of planar multi-body systems, kinematics and dynamics in point coordinates, body coordinates, and joint coordinates
UNIT – 3	Numerical methods for solution - analysis of planar multi-body systems, kinematic analysis in various formulations.
UNIT – 4	Inverse dynamic analysis, forward dynamic analysis, constraint stabilization - case studies, McPherson strut suspension, Double A-arm suspension, planar robot manipulator
UNIT – 5	Spatial multi-body systems-formulation- joints: - revolute, prismatic, cylindrical, spherical, universal-case studies.

TEXT BOOKS:


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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1. Planar Multibody Dynamics Formulation, Programming and Applications by Parviz E. Nikravesh, CRC Press
2. Dynamics of Multibody Systems by Ahmed A. Shabana, Cambridge University Press.

REFERNCES:

1. Planar Multibody Dynamics Formulation, Programming and Applications– Parviz E. Nikravesh, CRC Press
2. Computer-Aided Analysis of Mechanical Systems – Parviz E. Nikravesh, Prentice Hall, 1988
3. Dynamics of Multibody Systems– A. A. Shabana, Cambridge University Press, 1998

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD1053	VISION SYSTEMS AND IMAGE PROCESSING	CATEGORY Program Elective 2	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1		
CO2		
CO3		
CO4		
CO5		

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Machine vision: Vision sensors - Comparison with other types of sensors - Image acquisition and recognition - Recognition of 3D objects - Lighting techniques - Machine vision applications.
UNIT – 2	Image representation: Application of image processing - Image sampling, Digitization and quantization - Image transforms.
UNIT – 3	Spatial domain techniques: Convolution, Correlation. Frequency domain operations - Fast Fourier transforms, FFT, DFT, Investigation of spectra. Hough transform
UNIT – 4	Image enhancement: Filtering, Restoration, Histogram equalisation, Segmentation, Region growing.
UNIT – 5	Image compression: Edge detection - Thresholding - Spatial smoothing - Boundary and Region representation - Shape features - Scene matching and detection - Image classification.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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TEXT BOOKS:

1. Digital Image Processing by Gonzalez, R.C. and Woods, R.E., Addison Wesley Publications.
2. Robot Vision by Prof. Alan Pugh (Editor), IFS Ltd., U.K.
3. Digital Image Processing by A.Rosenfeld and A. Kak, Academic Press.

REFERENCES:

1. The Psychology of Computer Vision by P. Winstan, McGraw-Hill.
2. Algorithms for Graphics and Image Processing by T. Pavidis, Springer Verlag.

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD1054	Tribology	CATEGORY Program Elective 2	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	To must be able to understand friction and wear mechanism and the effects of lubrication. To must be able to describe lubrication systems and their selection criteria.	
CO2	To must be able to select rolling element bearing based on their static and dynamic load carrying capacity and must be able to understand condition monitoring procedures of the bearing.	
CO3	To must be able to design hydrostatic thrust and journal bearings for different applications.	
CO4	To must be able to understand to evaluate load carrying capacity and life of hydrodynamic thrust and journal bearing.	
CO5	To describe different type of seals and select suitable seals for given application and illustrate the failures of different types of bearing.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3			
CO2			3	2	2	
CO3			3	3	3	
CO4			2	2		
CO5			3	1		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Introduction: History of Tribology, Nature of surfaces and contact-Surface topography-friction and wear mechanisms, wear maps, effect of lubricants-methods of fluid film formation. Lubrication: Choice of lubricants,EHL(Elasto Hydrodynamic Lubrication), types of oil, Grease and solid lubricants- additives- lubrication systems and their selection.
UNIT – 2	Selection of rolling element bearings: Nominal life, static and dynamic capacity-Equivalent load, probabilities of survival- cubic mean load- bearing mounting details, pre loading of bearings, conditioning monitoring using shock pulse method.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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UNIT – 3	Hydrostatic Bearings: Thrust bearings – pad coefficients- restriction- optimum film thickness - journal bearings – design procedure –Aerostatic bearings; Thrust bearings and Journal bearings – design procedure.
UNIT – 4	Hydrodynamic bearings: Fundamentals of fluid formation – Reynold’s equation; Hydrodynamic journal bearings – Sommerfield number- performance parameters – optimum bearing with maximum load capacity – Friction – Heat generated and Heat dissipated. Hydrodynamic thrust bearings; Raimondi and Boyd solution for hydrodynamic thrust bearings- fixed tilting pads, single and multiple pad bearings- optimum condition with largest minimum film thickness.
UNIT – 5	Seals: Different type-mechanical seals, lip seals, packed glands, soft piston seals, Mechanical piston rod packing, labyrinth seals and throttling bushes, oil flinger rings and drain grooves – selection of mechanical seals. Failure of Tribological components: Failure analysis of plain bearings, rolling bearings, gears and seals, wear analysis using soap and Ferrography. Dry rubbing Bearings: porous metal bearings and oscillatory journal bearings – qualitative approach only.

TEXT BOOKS:

1. Rowe WW& O’ Dionoghue,”Hydrostatic and Hybrid bearing design “ Butterworths&Co.Publishers Ltd,1983.
2. Collacott R.A,” Mechanical Fault diagnosis and condition monitoring”, Chapman and Hall, London 1977.
3. Bernard J.Hamrock, “ Fundamentals of fluid film lubricant”, McGraw-Hill Co.,1994.

REFERENCES:

1. Neale MJ, (Editor) “ Tribology hand Book”NeumannButterworths, 1975.
2. Connor and Boyd JJO (Editors) “ Standard hand book of lubrication engineers “ ASLE,McGraw Hill Book & Co.,1968
3. Shigley J, E Charles,” Mechanical Engineering Design“, McGraw Hill Co., 1989

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD106	Machine Dynamics Lab	CATEGORY Lab	L-T-P 0-0-4	CREDITS 2
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COURSE OUTCOMES: At the end of the course, students will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Practically observe the phenomenon of damping on structures under various vibration excitations.	
CO2	Perform free and forced vibration analysis of discrete and continuous systems using measurement instruments	
CO3	Practice the experimental modal analysis on different beams and plates with variable boundary condition.	
CO4	Practice the measurement of sound pressure and directivity	
CO5	Learn the measurement methodologies of acoustic material characterization	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

Course Objectives: The course aims to

1. Calculate natural frequency, mode shapes and balancing (static and dynamic) of mechanical systems.
2. Understand the dynamic system response with and without damping.
3. Get exposed to sound characteristics and its measurements.

LIST OF EXPERIMENTS:

1. Determination of damped natural frequency of the vibrating system with different viscous oils.
2. Determination of steady state amplitude of a vibratory system with base excitation.
3. Determination of natural frequency and mode shape of multi degree freedom system.
4. Field balancing of the thin rotors using vibration pickups using MFS.
5. Determination of the magnitude of gyroscopic couple, angular velocity of precession and representation of vectors.
6. Experimental modal analysis of Beams.
7. Experimental modal analysis of plates.
8. Source directivity measurement.


Dr. D. Linga Raju


Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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9. Sound power and intensity measurement.
10. Sound absorption measurement by impedance tube.
11. Sound transmission loss measurement by impedance tube.
12. Outdoor Noise Measurements and hemispherical divergence.

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD108	Design Practice Lab	CATEGORY Lab	L-T-P 0-0-4	CREDITS 2
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Carry out structural, harmonic, thermal, and fracture analysis using FEA software for real time engineering applications.	
CO2	Simulate and analyze complex systems including contact, buckling, modal, and transient behavior using FEA tools.	
CO3	Perform thermal and coupled field analysis with different boundary conditions and interpret results for engineering decisions.	
CO4	Apply FEA techniques for optimization and sub-structuring of mechanical components.	
CO5	Demonstrate proficiency in using FEA software for solving multi-disciplinary engineering problems in structural and thermal domains.	

Course Objectives: The course aims to

1. To provide practical exposure to structural, modal, thermal, and dynamic analyses using commercial FEA software.
2. To familiarize students with modeling techniques for static, dynamic, linear, and nonlinear problems.
3. To introduce fracture, buckling, contact, and optimization analyses relevant to mechanical and aerospace applications.
4. To enable hands-on experience in interpreting simulation results for real-world engineering problems.
5. To cultivate proficiency in using simulation tools for coupled-field analysis and advanced problem-solving strategies.

LIST OF EXPERIMENTS:

1. Analysis of Framed structures using FEA software.
2. Perform Fracture analysis for simple problem using FEA software.
3. Analysis of laminated composite structures using FEA software.
4. Perform a simple modal analysis for a cantilever beam using FEA software.
5. Perform Harmonic analysis for a given cantilever beam using FEA.
6. Perform a simple transient analysis for different beams.
7. Non-Linear Analysis: Find the geometric non-linearity behavior for a cantilever beam subjected to a large moment.
8. Buckling analysis: Solve simple buckling problems using Eigen value and nonlinear methods
9. Stress analysis of a rectangular plate with a circular hole.
10. Thermal Analysis of 1D and 2D problem with conduction and convection boundary Conditions. (Minimum 4 exercises)
11. Design optimization of unknown parameters for a given beam.


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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12. Use of contact elements to simulate two given beams when they are in contact with each other.
13. Flow Over a Flat Plate: Solve a classical flat plate 2-D air flow problem
14. Using Coupled Structural/Thermal Analysis: solve a simple structural/ thermal problems
15. Sub-structuring: Solve a simple problems using Sub-structuring method in ANSYS.
16. Melting Using Element Death: Using element death procedure model melting of a material.

Note: Conduct any 12 out of 16 exercises from the list

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD108	Seminar - 1	CATEGORY	L-T-P 0-0-2	CREDITS 1
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Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JNTUK KAKINADA - 533 003, Andhra Pradesh, India

M.Tech II SEMESTER

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JNTUK KAKINADA - 533 003, Andhra Pradesh, India

MD201	ADVANCED MECHANISMS AND ROBOTICS	CATEGORY Program Core 1	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Develop the mobility criteria and use the criteria to find the degree of freedom of various mechanisms.	
CO2	Develop the Eulery savary equations using Hartmanns construction to determine the centre of curvature	
CO3	To locate the relative roto centre using the function generation approach for 2-positions and 3-positions scenarios.	
CO4	Design the Freudenstein's equation to find the lengths of the links in a four bar mechanism	
CO5	To study the kinematics of different manipulators in daily life applications	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	1		
CO2			3	3		
CO3			3	3		
CO4			3	3		
CO5			3	3		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Advanced Kinematics of plane motion: The Inflection circle; Euler – Savary Equation; Analytical and graphical determination of d; Bobillier's Construction; Collineation axis ; Hartmann's Construction. Polode curvature; Hall's Equation; Polode curvature in the four bar mechanism; coupler motion; relative motion of the output and input links; Determination of the output angular acceleration and its Rate of change.
UNIT – 2	Synthesis-Graphical Methods: The Four bar linkage; Guiding a body through Two distinct positions; Guiding a body through Three distinct positions; The Rotocenter triangle ; Guiding a body through Four distinct positions; Burmester's curve. Functiongeneration and Path generation: Overlay's method, Roberts's theorem.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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UNIT – 3	Synthesis - Analytical Methods: Function Generation: Freudenstien's equation, Precision point approximation, Precision – derivative approximation; Path Generation: Synthesis of Four-bar Mechanisms for specified instantaneous condition; Method of components; Synthesis of Four-bar Mechanisms for prescribed extreme values of the angular velocity of driven link; Method of components.
UNIT – 4	Manipulator Kinematics: D-H transformation matrix; Direct and Inverse kinematic analysis of Serial manipulators: Articulated, spherical & industrial robot manipulators- PUMA, SCARA, STANFORD ARM, MICROBOT
UNIT – 5	Differential motions and Velocities: Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

TEXT BOOKS:

1. Jeremy Hirschhorn, Kinematics and Dynamics of plane mechanisms, McGraw-Hill, 1962.
2. L.Sciavicco and B.Siciliano, Modelling and control of Robot manipulators, Second edition, Springer -Verlag, London, 2000.
3. Amitabh Ghosh and Ashok Kumar Mallik, Theory of Mechanisms and Machines. E.W.P.Publishers.

REFERENCES:

1. Allen S.Hall Jr., Kinematics and Linkage Design, PHI, 1964.
2. J.E Shigley and J.J . Uicker Jr., Theory of Machines and Mechanisms, McGraw-Hill, 1995.
3. Joseph Duffy, Analysis of mechanisms and Robot manipulators, Edward Arnold, 1980


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD202	ADVANCED MACHINE DESIGN	CATEGORY Program Core 2	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	An ability to carry out and analyze various design models and product design.	
CO2	Able to identify the failure modes and various fatigue mechanisms of different machine components and life estimation.	
CO3	Ability to design the machine components against cyclic loads and their estimation	
CO4	Ability to design the machine components against surface fatigue failures.	
CO5	Ability to design the machine components against human ergonomic factors.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2	1		
CO2			2	1		
CO3			1	1		
CO4			1	1		
CO5			1	1		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Design philosophy: Design process, Problem formation, Introduction to product design, Various design models-Shigley model, Asimov model and Norton model, Need analysis, Strength considerations -standardization. Creativity and Creative techniques, Material selection in machine design, design for safety and Reliability, concept of product design.
UNIT – 2	Failure theories: Static failure theories, Distortion energy theory, Maximum shear stress theory, Coulomb-Mohr's theory, Modified Mohr's theory, Fracture mechanics theory., Fatigue mechanisms, Fatigue failure models, Design for fatigue strength and life, creep: Types of stress variation, design for fluctuating stresses, design for limited cycles, multiple stress cycles.
UNIT – 3	Fatigue failures: cumulative fatigue damage, thermal fatigue and shock, harmful and beneficial residual stresses, Yielding and transformation.
UNIT – 4	Surface failures: Surface geometry, mating surfaces, oil film and their effects,

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	design values and procedures, adhesive wear, abrasive wear, corrosion wear, surface fatigue, different contacts, dynamic contact stresses, surface fatigue failures, surface fatigue strength.
UNIT – 5	Human engineering considerations, Ergonomics, Modern approaches in design, Ethics in engineering design, Ethical issues considered during engineering design process. Creep and damping, creep phenomenon, creep curve, creep parameters, time temperature parameters and life estimate, energy dissipation in materials.

TEXT BOOKS:

1. Machine Design An Integrated Approach by Robert L. Norton, Prentice-Hall New Jersey, USA.
2. Mechanical Engineering Design by J.E. Shigley and L.D. Mitchell published by McGrawHill International Book Company, New Delhi.
3. Mechanical Behaviour of Materials- Norman E. Dowling, Stephen L. Kampe, Milo V. Kral Pearson publishers, 5th edition.

REFERENCES:

1. Fundamentals of machine elements by Hamrock, Schmid and Jacobian, 2nd edition, McGraw- Hill International edition.
2. Product design and development by Karl T. Ulrich and Steven D. Eppinger. 3rd edition, Tata McGraw Hill.
3. Product Design and Manufacturing by A.K. Chitale and R.C. Gupta, Prentice Hall
4. Engineering Design / George E Dieter / McGraw Hill /2008
5. Fundamentals of machine elements/ Hamrock, Schmid and Jacobian/ 2nd edition /McGrawHill International edition.


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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MD203	CONDITION MONITORING AND FAULT DIAGNOSIS / IDENTIFICATION	CATEGORY Program Core 3	L-T-P 4-0-0	CREDITS 4
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Analyze the signals from rotating and reciprocating machines	
CO2	Apply condition monitoring methods for fault diagnosis in machines	
CO3	Analyze the vibration signals from rotating and reciprocating machines	
CO4	Illustrate the faults in rotating and reciprocating machines	
CO5	Apply fault detection techniques for fault diagnosis in rotating and reciprocating machines	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	SIGNAL ANALYSIS OF CONTINUOUS STATIONARY SIGNALS: Introduction, Basic concepts, Signal types, Time domain Signal analysis, Data Acquisition, Filtering, Fourier Series, FFT, Modulation and Sidebands.
UNIT – 2	SIGNAL ANALYSIS OF CONTINUOUS NON-STATIONARY SIGNALS: Instrumentation, Data Recording, Order Analysis, Orbits, Envelope, Cepstrum, Short Term Fourier Analysis (STFT), Introduction to wavelets, Choice of window type, Choice of window length, Choice of incremental step, Practical details of signal processing.
UNIT – 3	CONDITION MONITORING METHODS: Vibration Analysis, oil Analysis, wear debris analysis, thermography, performance analysis, noise monitoring, temperature monitoring, wear behaviour monitoring, Signals generated by rotating and reciprocating shafts.
UNIT – 4	VIBRATION CONDITION MONITORING IN REAL SYSTEMS: Diagnostic tools. Condition monitoring of two stage compressor. Cement mill foundation. I.D. fan. Sugar centrifugal. Cooling tower fan. Air separator. Preheater fan, Field balancing of rotors. ISO standards on vibrations, active, passive hybrid methods of

Dr. D. Linga raj

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	condition monitoring.
UNIT – 5	FAULT DIAGNOSIS: Signal based fault classification, signals generated by rotating and reciprocating machines, low shaft orders and subharmonics, vibrations from gears, rolling element bearings and electrical machines. Introduction to machine learning for signal interpretation, Pattern recognition and clustering methods, Feature extraction and dimensionality reduction, Health Index and Remaining Useful Life (RUL) estimation.

TEXT BOOK:

1. Condition Monitoring of Mechanical Systems / Colcote.
2. Amiya Ranjan Mohanty, Machinery Condition Monitoring: Principles and Practices, 1st Edition, CRC press, 2014

REFERENCES:

1. John S. Mitchell, Introduction to Machinery Analysis and Monitoring, 1st Edition, Penn Well Books, 1993
2. R. C. Mishra, K. Pathak, Maintenance Engineering and Management, 1st Edition, Prentice Hall of India Pvt. Ltd., 2002.
3. Robert Bond Randall, Vibration-Based Condition Monitoring: Industrial, Aerospace and Automotive applications, 1st Edition, John Wiley & Sons Ltd., 2011


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD2041	THEORY OF ELASTICITY AND PLASTICITY	CATEGORY Program Elective 3	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Derive equations of equilibrium for 2D problems and write boundary conditions and compatibility equations.	
CO2	Solve 2D elasticity problems in rectangular and polar co-ordinate systems using various methods.	
CO3	Determine Principal stresses and strains for three dimensional problems. Write differential equations of equilibrium for three dimensional problems.	
CO4	Apply theory of elasticity to solve problems on torsion of non-circular shafts.	
CO5	Understand plastic behavior from stress-strain curves for materials and describe different strain-hardening models.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2				3	3	
CO3			2	3		
CO4			2	3	3	
CO5			2	3		

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	INTRODUCTION: Elasticity –Notation for forces and stresses-Components of stresses –components of strain –Hooke's law. PLANE STRESS AND PLANE STRAIN ANALYSIS: Plane stress-plane strain-Differential equations of equilibrium- Boundary conditions- Compatibility equations-stress function-Boundary conditions.
UNIT – 2	TWO DIMENSIONAL PROBLEMS IN RECTANGULAR COORDINATES: Solution by polynomials-Saint Venant's principle-Determination of displacements-bending of simple beams-application of Fourier series for two dimensional problems - gravity loading. TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES : General Equation in polar co-ordinates - stress distribution symmetrical about an axis –Pure bending of curved bars- strain components in polar coordinates-Displacements for symmetrical stress distributions-simple symmetric and asymmetric problems-

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	General solution of two dimensional problem in polar coordinates-Application of the general solution of two dimensional problem in polar coordinates-Application of the general solution in polar coordinates.
UNIT – 3	ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS: Principle stress - ellipsoid and stress-director surface-Determination of principle stresses-Maximum shear stresses-Homogeneous deformation-principle axis of strain rotation. GENERAL THEOREMS: Balance laws - Differential equations of equilibrium-conditions of compatibility - Determination of displacement-Equations of equilibrium in terms of displacements-principle of superposition-Uniqueness of solution –the Reciprocal theorem.
UNIT – 4	TORSION OF PRISMATIC BARS: General solution of problems by displacement (St. Venant's warping function) & force (Prandtl's stress function) approaches - Membrane analogy - Torsion of circular and non-circular (elliptic and rectangular) sections - Torsion of thin rectangular section and hollow thin walled section - Single and multi-celled sections.
UNIT – 5	THEORY OF PLASTICITY: Stress-strain curve - Theories of strength and failure –Yield Criteria - Yield Surface – Plastic Flow – Plastic Work – Plastic Potential – Strain hardening

TEXT BOOK:

1. Timoshenko, S., Theory of Elasticity and Plasticity, MC Graw Hill Book company.
2. Sadhu Singh, Theory of Elasticity and Plasticity, Khanna Publishers.

REFERENCES:

1. Papov, Advanced Strength of materials, MC Graw Hill Book Company.
2. Chen, W.F. and Han, D.J, Plasticity for structural Engineers, Springer-Verlag, New York.
3. Lubliner, J., Plasticity Theory, Mac Millan Publishing Co., New York.
4. Y.C.Fung., Foundations of Solid Mechanics, Prentice Hall India

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD2042	ADVANCED OPTIMIZATION TECHNIQUES	CATEGORY Program Elective 3	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1		
CO2		
CO3		
CO4		
CO5		

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Classical optimization techniques: Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions.
UNIT – 2	Numerical methods for optimization: Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, types of penalty methods for handling constraints.
UNIT – 3	Genetic algorithm (GA) : Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA, Multi-Objective GA: Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems
UNIT – 4	Genetic Programming (GP): Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation,

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	solving differential equations using GP.
UNIT – 5	Non-Traditional optimization techniques: Goal programming, simulated annealing, Neural Networks based optimization

TEXT BOOKS:

1. Optimal design – Jasbir Arora, McGraw Hill (International) Publishers
2. Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers
3. Engineering Optimization – S.S.Rao, New Age Publishers

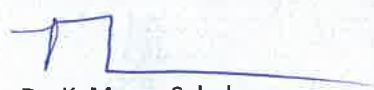
REFERENCES:

1. Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers
2. Genetic Programming- Koza
3. Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers


Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD2043	COMPUTATIONAL FLUID DYNAMICS	CATEGORY Program Elective 3	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Understand classification of PDEs and differential solutions and methods for elliptical, parabolic and hyperbolic equations.	
CO2	Understand basic principles and governing equations of CFD	
CO3	Apply finite difference method for incompressible viscous flow problems and compressible flow problems.	
CO4	Understand finite volume formulations for two dimensional and three dimensional problems	
CO5	Apply finite element methods for steady state and transient fluid flow problems	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1				3		
CO2				3		
CO3			2		3	
CO4				3		
CO5			2		3	

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions. Derivation of finite difference equations. Solution methods: Solution methods of elliptical equations – finite difference formulations, interactive solution methods, direct method with Gaussian elimination.
UNIT – 2	Parabolic equations -explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm. Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.
UNIT – 3	Formulations of incompressible viscous flows: Formulations of incompressible viscous flows by finite difference methods, pressure correction methods, vortex methods.

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	Formulations of compressible flows: potential equation, Euler equations-Central schemes, Navier-stokes system of equations, boundary conditions, example problems.
UNIT – 4	Finite volume method: Finite volume method via finite difference method, formulations for two and three-dimensional problems.
UNIT – 5	FINITE ELEMENT METHODS: Introduction to Finite Element Methods, Finite Element Interpolation Functions, Linear Problems-Steady-State Problems – Standard Galerkin Methods, Transient Problems – Generalized Galerkin Methods, Example Problems.

TEXT BOOK:

1. Computational fluid dynamics, T. J.Chung, Cambridge University press, 2002.

REFERENCE:

1. Text book of fluid dynamics, Frank Chorlton, CBS Publishers & distributors, 1985.
2. Patankar, S. V., 2017, Numerical Heat Transfer and Fluid Flow, Special Indian ed., CRC Press.
3. Muralidhar K., and Sundararajan T. (Editors), 2017, Computational Fluid Flow and Heat Transfer, 2nd ed. tenth reprint, Narosa.
4. Anderson Jr., J. D., 2017, Computational Fluid Dynamics: The Basics with Applications, Indian ed., McGraw Hill Education.
5. Donea, J., and Huerta, A., 2003, Finite Element Methods for Flow Problems, John Wiley & Sons, Ltd.
6. Zienkiewicz, O. C, Nithiarasu, P., and Taylor, R. L, 2013, The Finite Element Method for Fluid Dynamics, 7th ed., Butterworth-Heinemann Ltd.

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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JNTUK KAKINADA - 533 003, Andhra Pradesh, India

MD2044	MECHANICS OF COMPOSITE MATERIALS	CATEGORY Program Elective 3	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Describe what are composite materials and their differences with respect to conventional materials such as metals.	
CO2	Understands mechanical behavior various materials under different choices made for using certain types of composites in certain applications.	
CO3	Analyze the micromechanical properties of fiber reinforced composites i.e. Identify, describe and evaluate the properties of fiber reinforcements, polymer matrix materials	
CO4	Derive the mathematical expressions for the various stiffness parameters which govern the design and analysis of the composites.	
CO5	Apply constitutive equations of composite materials to predict the macro mechanical behavior composite laminates. Also appreciate the practical applications of structural composites.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT - 1	UNIT I COMPOSITE MATERIALS: History and evolution of basic concept of composite, Definition and Classification of Composites, Roles of constituents in composite, Interface and interphase, Matrix Resins: Thermoplastics and thermosetting matrix resins and advanced matrix-polyethylene(UHMWPE). Composite Reinforcements: Particle, short fiber, continuous fibers, Natural fibres: cellulose, jute, coir etc, Manmade fibers: boron, carbon, ceramic, glass and aramids, advanced reinforcement-polybenzthiazoles.
UNIT - 2	MECHANICS OF GENERIC MATERIALS: Mechanical behavior various material systems, Hookes law for general anisotropic materials, Stress-Strain

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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	relations for various kinds of materials behavior, Derivation of the engineering constants of constitutive matrices using mechanics of materials approach for orthotropic material. Fundamental terms to understand composite structural members, Coordinates systems for analysis of composite structures.
UNIT – 3	MICRO-MECHANICS OF COMPOSITES: Lamina, Calculation of fiber, matrix and void weight and volume fractions, Micromechanical analysis of composite lamina-Evaluation of four effective elastic moduli-Analytical rule of mixtures, Empirical models-Halpin-sai model, Chamis Model, Introduction to advanced micromechanical models (Numerical).
UNIT – 4	MECHANICS OF COMPOSITE LAMINATE: Derivation for the strength of unidirectional lamina, Lamina stiffness matrix $[Q]$, Designation and configuration of composite laminate-Laminate code, Transformation matrices, On-axis stiffness and off-axis stiffness, Laminate stiffness matrix $[Q^*]$, Classical lamination theory (CLT)-Assumptions, $[A][B][D]$ matrices, Effect of lamination schemes on $[A][B][D]$ matrices
UNIT – 5	ANALYSIS OF COMPOSITES: Analysis of inter-laminar stresses and strains with various lamination schemes, Coefficients of thermal and moisture expansions, Effect of hydrothermal environment on stresses and strains, First order shear deformation theory (FSDT), Introduction to analysis of sandwiched composite structures. Applications-Industrial, aerospace, automobile, sports, medical and house hold etc.

TEXT BOOKS:

1. Isaac M. Daniel, Ori Ishai, Mechanics of Composite Materials, 2006 by Oxford University Press; 2nd edition.
2. Autar K. Kaw, Mechanics of Composite Materials, 2006 by Taylor & Francis Group, LLC, 2nd edition.
3. Robert M. Jones, Mechanics of composite materials. 1998, McGraw-Hill, New York. 2nd edition.

REFERENCE:

1. Michael W. Hyer, 1998 by McGraw-Hill, New York. International Edition
2. Mechanics of Laminated Composite Plates and Shells, Theory and Analysis, Second Edition McGraw-Hill, New York. 2nd edition
3. Bhagwan D. Agarwal, Lawrence J. Broutman, Analysis and Performance of Fiber Composites, 2012 by John Wiley, 3rd Edition


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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JNTUK KAKINADA - 533 003, Andhra Pradesh, India

MD2051	EXPERIMENTAL STRESS ANALYSIS	CATEGORY Program Elective 4	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Understand the working principles of strain gauges and perform model analysis using theorems like Buckingham Pi and Muller-Breslau's.	
CO2	Explain the fundamentals and applications of photoelasticity in 2D and 3D stress analysis.	
CO3	Utilize various optical and mechanical tools for experimental stress measurement and validation.	
CO4	Apply non-destructive testing techniques like ultrasonic testing, X-ray, gamma-ray, rebound hammer, and Moiré fringe methods for material evaluation.	
CO5	Design experimental setups using model analysis, strain measurement, and advanced optical techniques to evaluate stress distribution in mechanical structures.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Strain Measurement Techniques Strain Gauges, Mechanical and Optical Strain Gauges, Description and Operation, Electrical Resistance, Inductance and Capacitance Gauges, Detailed Treatment on Resistance Gauges, Measurement of Static and Dynamic Strains, Strain Rosettes, Effect of Transverse Strains, Use of Strain Recorders and Load Cells.
UNIT – 2	Model Analysis and Structural Similitude Model Analysis, Structural Similitude, Use of Models, Structural and Dimensional Analysis, Buckingham Pi Theorem, Muller-Breslau's Principle for Indirect Model Analysis, Use of Begg's and Eney's Deformers, Moment Indicators, Design of Models for Direct and Indirect Analysis.
UNIT – 3	Photoelasticity and Optical Methods Two-Dimensional Photo elasticity, Stress Optic Law, Introduction to Polariscope,


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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	Plane and Circular Polariscopes, Compensators and Model Materials, Material and Model Fringe Value, Calibration of Photo elastic Materials, Isochromatic and Isoclinic Fringes, Time Edge Effects.
UNIT – 4	3D Photo elasticity and Advanced Optical Analysis Three-Dimensional Photo elasticity, Introduction, Stress Freezing Techniques, Stress Separation Techniques, Scattered Light Photo elasticity, Reflection Polariscopes.
UNIT – 5	Specialized and Non-Destructive Testing Miscellaneous Methods, Brittle Coating Method, Birefringence Techniques, Moiré Fringe Method, Non-Destructive Testing, Ultrasonic Pulse Velocity Technique, Rebound Hammer Method, X-Ray Method, Gamma-Ray Method.

TEXT BOOKS:

1. Experimental Stress Analysis, J.W. Dally and W.F. Riley, McGraw-Hill, 2nd Edition, 1991.
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers / Dhanpat Rai Publications, Revised Edition, 2009.

REFERENCES:

1. Experimental Stress Analysis, Sadhu Singh, Dhanpat Rai Publications, Revised Edition, 2009.
2. Handbook of Experimental Stress Analysis, Max Hetenyi, John Wiley and Sons, New York, 1st Edition, 1950.
3. Photoelasticity, M.M. Frocht, Vol. I and II, John Wiley and Sons, New York, 1st Edition, 1941 (Vol. I) and 1948 (Vol. II).
4. C. Rama Rao, Experimental Stress Analysis, University Press, 1st Edition, 2013.
5. N. Ramesh Babu, Experimental Stress Analysis: Principles and Practice, Anuradha Publications, 1st Edition, 2008.
6. R.K. Rajput, Strength of Materials (For NDT and Stress Analysis Reference), S. Chand and Company, Revised Edition, 2015.


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD2052	FRACTURE MECHANICS	CATEGORY Program Elective 4	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1		
CO2		
CO3		
CO4		
CO5		

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Introduction: Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter-granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature.
UNIT – 2	Griffiths Analysis: Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves. Linear Elastic Fracture Mechanics, (LEFM). Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness.
UNIT – 3	Elastic-Plastic Fracture Mechanics; (EPFM). The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use.
UNIT – 4	Fatigue: Definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micromechanisms of fatigue damage, fatigue

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. P. V. S. Ganesh Kumar

Dr. J. Suresh Kumar



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	limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction
UNIT – 5	Creep deformation: The evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples.

TEXT BOOKS:

1. T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995)
2. B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed 1993.

REFERENCES:

1. J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973)
2. J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials.
3. H.L. Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984).
4. S. Suresh, Fatigue of Materials, Cambridge University Press, (1998)
5. L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press, (2003).
6. Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education; 1st edition (1 July 2017)


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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MD2053	MECHATRONICS	CATEGORY Program Elective 4	L-T-P 3-0-0	CREDITS 3
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Pre-requisite:

COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1		
CO2		
CO3		
CO4		
CO5		

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

(Please fill the above with Levels of Correlation, viz., L, M, H)

UNIT	CONTENTS
UNIT – 1	Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.
UNIT – 2	Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.
UNIT – 3	Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems.
UNIT – 4	Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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UNIT – 5	System and interfacing and data acquisition, DAQS , SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends.
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TEXT BOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

REFERENCES:

- 1 Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
- 2 Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
- 3 Mechatronics System Design / Devdas shetty/Richard/Thomson.
- 4 Mechatronics/M.D.Singh/J.G.Joshi/PHI.


Dr. D. Linga Raju


Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD2054	INTRODUCTION TO QUANTUM TECHNOLOGIES	CATEGORY Program Elective 4	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Explain core principles of quantum mechanics and their technological implications.	
CO2	Analyze quantum phenomena like superposition and entanglement.	
CO3	Apply mathematical tools to model and solve quantum systems.	
CO4	Demonstrate understanding of quantum algorithms and quantum circuits.	
CO5	Evaluate potential applications and challenges in quantum communication and sensing.	

UNIT	CONTENTS
UNIT – 1	Fundamentals of Quantum Mechanics: Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrodinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.
UNIT – 2	Quantum Information Theory: Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)
UNIT – 3	Quantum Computing: Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, Introduction to quantum programming: Qiskit(overview)
UNIT – 4	Quantum Communication: Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)
UNIT – 5	Quantum Technologies and Applications: Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots;


Dr. D. Linga Raju


Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era.

TEXT BOOKS:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredine Zettili


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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MD 206	COMPUTATIONAL LAB	CATEGORY Lab	L-T-P 0-0-4	CREDITS 2
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Develop codes in MATLAB and PYTHON.	
CO2	Develop programmes to solve system of linear equations.	
CO3	Understand various curve fitting methods.	
CO4	Write various codes to solve differential and partial differential equations.	
CO5	Understand and implement Fourier transformations.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		3	2	2	3	
CO2				2	3	
CO3			2	2	3	
CO4			2	2	3	
CO5			2	2	3	

(Please fill the above with Levels of Correlation, viz., L, M, H)

Part: 1 Numerical Methods

1. Generate a MATLAB / Python code for solving a system of linear equation (Gauss Elimination Method, LU Decomposition (Factorization), Jacobi Iteration)
2. Generate a MATLAB / Python code for Euler's method, Runge – Kutta method to solve differential equations
3. Generate a MATLAB / Python code for Matrices and Eigen values
 - i. Eigen values and Eigen vectors
 - ii. Jacobi method
4. Generate a MATLAB / Python code to solve Partial Differential equations
 - i. Elliptical PDE
 - ii. Parabolic PDE
 - iii. The Crank – Nicholson method
 - iv. Two dimensional parabolic PDE

Part: 2 Finite Element Methods

1. Generate a MATLAB / Python code to solve 1D Bar problem
2. Generate a MATLAB / Python code to solve Plane Truss problem
3. Generate a MATLAB / Python code to solve Beam problem


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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4. Generate a MATLAB / Python code to solve 2D Plate problem (Plane Stress/Strain).
5. Generate a MATLAB / Python code to solve Free Vibration Problem.


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Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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MD 2103	COMPOSITE FABRICATION AND CHARACTERIZATION LAB	CATEGORY Lab	L-T-P 0-0-4	CREDITS 2
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COURSE OUTCOMES: At the end of the course, students will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Understands the purpose and the ways to develop new composite materials upon proper combination of known materials.	
CO2	Is able to b)predict a wide range of mechanical and other properties of materials as a function of parameters such as volume fraction, orientation & regularity arrangement and particle aspect ratio.	
CO3	Is capable of comparing/evaluating the relative merits of using alternatives (corresponding to various simple and composite materials) for important engineering and other applications.	
CO4	Perform research to identify new dimensional scope and application of composite materials.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

COURSE OBJECTIVES:

1. Inculcate a culture of research among faculty and students alike
2. Fabricate a variety of composites using different matrix, reinforcement and filler materials through hand layup technique or other methods
3. Characterize the mechanical and tribological behaviour of a variety of composites
4. Investigate the significance of reinforcement on the mechanical and tribological characteristics of composites
5. Conduct fractographic studies to understand the mechanism of failure under different loading conditions and mechanism of wear for different types of wear mode
6. Recommend optimal conditions for the desired performance level and explore commercial application

LIST OF EXPERIMENTS:

PART-A: Fabrication and Specimen Preparation Experiments

The Crafting, Creation and Construction of objects, parts, items of a product using proposed materials and systematic procedure.

1. Fabrication of PMC by


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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- a) Hand Layup Open Moulding
- b) Vacuum Bag Moulding
2. Fabrication of MMC by
 - a) Muffle Furness and Stir Casting Process
3. Fabrication of CMC by
 - a) Milling, Blending and Sintering Techniques
4. Test Specimen Preparation for Characterization as per ASTM Standards

PART-B: Characterization Experiments

The process of measuring and determining physical, chemical, mechanical and microstructural properties of materials using a variety of analytical methods, techniques and tools under various operational conditions and environments.

1. Characterization of PMC test specimens on Tensile Tester, Fatigue Tester, TMA and FFT
2. Characterization of MMC test specimens on Tensile Tester, Fatigue Tester, Pin on Disc and FFT
3. Characterization of CMC test specimens on Tensile Tester, Fatigue Tester, Pin on Disc and FFT

TOOLS/EQUIPMENTS AND APPARATUS:

The essential tools/equipments required for students to conduct experimentation includes

1. Test Specimen Preparation Kit
2. Micro Tensile/Impact/Hardness Testers
3. Dry Wear Test Rig (Pin Disc Apparatus/)
4. Fatigue Testing
5. Thermo Mechanical Analyzer
6. FFT Analyzer and ME-Scope Simulation
7. Furness and Stir Casting Apparatus
8. Millers and Sintering Equipments


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD208	SEMINAR - 2	CATEGORY	L-T-P 0-0-2	CREDITS 1
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Dr. D. Linga raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JNTUK KAKINADA - 533 003, Andhra Pradesh, India

M.TECH III SEMESTER

Dr. D. Linga Raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr. M. Venkatesham

Dr. K. Ramji

Dr. V. Suresh Babu

Dr. PVS Ganesh Kumar

Dr. J. Suresh Kumar



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MD 301	RESEARCH METHODOLOGY AND IPR	CATEGORY Lab	L-T-P 3-0-0	CREDITS 3
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COURSE OUTCOMES: At the end of the course, students will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Explain the meaning of engineering research and apply to develop an appropriate framework for research studies.	K2& K3
CO2	Identify the procedure of Literature Review, Technical Reading, etc. and apply to develop a research design during their project work.	K2 & K3
CO3	Explain and apply the fundamentals of patent laws and drafting procedure in their research works.	K2& K3
CO4	Demonstrate the copyright laws, subject matters of copyrights, designs etc. to apply in patent filing.	K2 & K3
CO5	Identify the new developments in IPR and employ the applications of computer software in writing/filing patents in future.	K2 & K3

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1						
CO2						
CO3						
CO4						
CO5						

UNIT	CONTENTS
UNIT – I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations
UNIT – II	Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.
UNIT–III	Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.
UNIT – IV	Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.
UNIT – V	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

Dr. D. Linga raj

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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TEXTBOOKS:

1. C.R. Kothari , 2nd Edition, "Research Methodology: Methods and Techniques".
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners"

REFERENCE BOOKS:

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



Dr. D. Linga Raju



Dr. V. V. Subba Rao



Dr. N. Mohan Rao



Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD 2103	SUMMER INTERNSHIP/ INDUSTRIAL TRAINING	CATEGORY INTERNSHIP	L-T-P 0-0-3	CREDITS 3
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Note: Students are informed to complete Summer Internship duration 8-10 weeks at the end of the II Semester.


Dr. D. Linga Raju

Dr. V. V. Subba Rao


Dr. N. Mohan Rao


Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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JNTUK KAKINADA - 533 003, Andhra Pradesh, India

MD 303	COMPREHENSIVE VIVA	CATEGORY	L-T-P 0-4-0	CREDITS 2
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Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD 304	DESSERTATION PART -A	CATEGORY PROJECT	L-T-P 0-0-20	CREDITS 10
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COURSE OUTCOMES: At the end of the course, student will be able to

CO's	Outcomes	Knowledge Level (K)#
CO1	Identify a topic in advanced areas of machine design.	
CO2	Review literature to identify gaps and define objectives and scope of the work.	
CO3	Employ the ideas from literature and develop research methodology.	
CO4	Develop a model experimental setup and/or computational techniques necessary to meet the objectives.	

#Based on suggested Revised BTL

Mapping of course outcomes with program outcomes

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	1		3
CO2	3	2	3	1		3
CO3	3	3	3	3	3	3
CO4	3	3	3	3	3	3

Description:

Students are expected to choose real world contemporary problem and apply the engineering principles learned, to solve the problem through building prototypes or simulations or writing codes or establishing processes/synthesis/correlations etc. The department constituted panel will decide the suitability and worthiness of the project.

Dissertation Evaluation:

- The dissertation shall be submitted as per the schedule given in the academic calendar.
- The dissertation supervisor will periodically review the progress of the student and finally give his/her assessment of the work done by the student.
- The dissertation part –A will be evaluated for 100, marks with the following weightages.

Sub-component	Weightage
a)Periodic evaluation by guide	40 marks
b)Mid-term review	20 marks
C)End sem viva –voce examination	40 marks

Dr. D. Linga raj

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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Evaluation criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the panel and will be informed to the students.

Criteria	Description	Weightage
I	Selection of Topic	
II	Literature Survey	
III	Defining the Objectives and Solution Methodology	
IV	Performance of the Task	


Dr. D. Linga raju

Dr. V. V. Subba Rao


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Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



UNIVERSITY COLLEGE OF ENGINEERING KAKINADA
JNTUK KAKINADA - 533 003, Andhra Pradesh, India

M.TECH IV SEMESTER

Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar



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MD 401	DESSERTATION PART -B	CATEGORY PROJECT	L-T-P 0-0-32	CREDITS 16
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Dr. D. Linga raju

Dr. V. V. Subba Rao

Dr. N. Mohan Rao

Dr. K. Meera Saheb

Dr.M.Venkatesham

Dr.K.Ramji

Dr.V.Suresh Babu

Dr.PVS Ganesh Kumar

Dr.J.Suresh Kumar

