DAYANANDA SAGAR UNIVERSITY

Shavige Malleshwara Hills, Kumaraswamy Layout,

Bengaluru - 560111, Karnataka.

SCHOOL OF ENGINEERING

SCHEME & SYLLABUS
FOR
MASTER OF TECHNOLOGY (M.Tech) – 2022

MECHANICAL ENGINEERING

SPECIALIZATION: DESIGN ENGINEERING

(With Effect from 2022-23)

SEMESTER I

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{CR}{AU}$	SCHEME OF TEACHING				
					L	T	P	S/P	C
1	204	22MDE5101	EXPERIMENTAL STRESS ANALYSIS	CR	03	01	-	-	04
2	204	22MDE5102	FINITE ELEMENT METHOD	CR	03	--	02	-	04
3	204	22MDE5103	SOLID MECHANICS	CR	03	--	02	-	04
4	204	22MDE5XXX	DEPARTMENT ELECTIVE-I	CR	03	-	-	-	03
5	204	22MDE5XXX	DEPARTMENT ELECTIVE-II	CR	03	-	-	-	03
6	204	22MDE5104	SPECIAL TOPICS	CR	-	02	-	-	02
GRAND TOTAL = 600					**15**	**03**	**04**	**-**	**20**

SEMESTER II

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{CR}{AU}$	SCHEME OF TEACHING				
					L	T	P	S/P	C
1	204	22MDE5201	ADVANCED MATERIALS AND MANUFACTURING TECHNOLOGY	CR	03	--	02	-	04
2	204	22MDE5202	MECHANICS OF COMPOSITE MATERIALS	CR	03	01	-	-	04
3	204	22MDE5203	ADVANCED MACHINE DESIGN	CR	03	--	02	-	04
4	204	22MDE5XXX	DEPARTMENT ELECTIVE-III	CR	03	-	-	-	03
5	204	22MDE5XXX	DEPARTMENT ELECTIVE-IV	CR	03	-	-	-	03
6	204	22MDE5204	MOOC Course	CR	-	02	-	-	02
GRAND TOTAL = 600					**15**	**03**	**04**	**-**	**20**

CR – CREDIT, AU – AUDIT, L – LECTURE, T – TUTORIAL, P – PRACTICAL, S/P – SEMINAR/PROJECT, C – NO. OF CREDITS,
CIA – CONTINUOUS INTERNAL ASSESSMENT

SEMESTER III

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{CR}{AU}$	SCHEME OF TEACHING				
					L	T	P	S/P	C
1	204	22MDE5XXX	DEPARTMENT ELECTIVE – V	CR	03	-	-	-	03
2	204	22MDE5XXX	OPEN ELECTIVE	CR	03	-	-	-	03
3	204	22MDE5301	DISSERTATION PHASE I	CR	-	-	12	-	06
GRAND TOTAL = 300					**06**	**-**	**12**	**-**	**12**

SEMESTER IV

SL	PROGRAM CODE	COURSE CODE	COURSE TITLE	$\frac{CR}{AU}$	SCHEME OF TEACHING				
					L	T	P	S/P	C
1	204	22MDE5XXX	DEPARTMENT ELECTIVE – VI	CR	03	-	-	-	03
2	204	22MDE5401	DISSERTATION PHASE II	CR	-	-	18	-	09
GRAND TOTAL = 400					**03**	**-**	**18**	**-**	**12**

CR – CREDIT, AU – AUDIT, L – LECTURE, T – TUTORIAL, P – PRACTICAL, S/P – SEMINAR/PROJECT, C – NO. OF CREDITS,
CIA – CONTINUOUS INTERNAL ASSESSMENT

DEPARTMENTAL ELECTIVES – I

SL	COURSE CODES	COURSE TITLE
1	22MDE5031	APPLIED MATHEMATICS
2	22MDE5032	DYNAMICS
3	22MDE5033	PRODUCT DEVELOPMENT
4	22MDE5034	DATA VISUALIZATION
5	22MDE5035	DIGITAL CONTROL SYSTEMS

DEPARTMENTAL ELECTIVES – II

SL	COURSE CODES	COURSE TITLE
1	22MDE5036	ROBOTICS
2	22MDE5037	SENSORS AND SIGNAL CONDITIONING
3	22MDE5038	DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS
4	22MDE5039	LEAN MANUFACTURING
5	22MDE5040	SMART MATERIALS AND STRUCTURES

DEPARTMENTAL ELECTIVES –III

SL	COURSE CODES	COURSE TITLE
1	22MDE5041	MECHATRONICS SYSTEM DESIGN
2	22MDE5042	MODELLING AND SIMULATION
3	22MDE5043	MECHANISM DESIGN
4	22MDE5044	INDUSTRIAL DESIGN AND ERGONOMICS
5	22MDE5045	ADDITIVE MANUFACTURING

DEPARTMENTAL ELECTIVES –IV

SL	COURSE CODES	COURSE TITLE
1	22MDE5046	RESEARCH METHODOLOGY
2	22MDE5047	EMBEDDED SYSTEMS
3	22MDE5048	FRACTURE MECHANICS
4	22MDE5049	MICRO ELECTRICAL MECHANICAL SYSTEMS (MEMS)
5	22MDE5050	TRIBOLOGY

DEPARTMENTAL ELECTIVES – V

SL	COURSE CODES	COURSE TITLE
1	22MDE5051	AUTOMOTIVE ELECTRONICS
2	22MDE5052	JIGS AND FIXTURES DESIGN
3	22MDE5053	OPTIMIZATION TECHNIQUES
4	22MDE5054	DESIGN OF EXPERIMENTS
5	22MDE5055	RELIABILITY AND FAILURE ANALYSIS

DEPARTMENTAL ELECTIVES – VI

1	22MDE5056	ROBUST DESIGN
2	22MDE5057	FINITE ELEMENT METHODS FOR STRUCTURAL MECHANICS APPLICATIONS
3	22MDE5058	DESIGN OF MATERIALS HANDLING SYSTEMS
4	22MDE5059	THEORY OF PLASTICITY
5	22MDE5060	NON LINEAR ANALYSIS

OPEN ELECTIVES

SL	COURSE CODE	COURSE TITLE	OFFERING DEPARTMENT
1	22MDE5061	DIGITAL MARKETING	COMPUTER SCIENCE & ENGINEERING
2	22MDE5062	PRODUCT LIFE CYCLE MANAGEMENT	MECHANICAL ENGINEERING
3	22MDE5063	PROJECT MANAGEMENT	ELECTRONICS & COMMUNICATION ENGINEERING

SEMESTER I

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5101**					
TITLE OF THE COURSE	**EXPERIMENTAL STRESS ANALYSIS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Introduce the various aspects of ESA as applied to engineering problems.
2. To solve engineering stress related problems using ESA technique.
3. To study the behavior of Photo elastic materials.
4. To introduce the various aspects Stress, strain and deformation calculations using fringes.
5. To learn fabrication and operational skills and applications for different loading conditions of photo elastic material.

COURSE OUTCOMES:

CO No.	**Outcomes** 5	**Bloom's Taxonomy Level**
CO1	Mount strain gages, take measurements and analyze the obtained data	L2
CO2	Design strain gage-based transducers for measuring specific loads.	L3
CO3	Describe the different methods of photo elasticity for strain measurement viz, stress freezing, and Moirés method.	L3
CO4	Undertakeexperimentalinvestigationstoverifypredictionsbyothermethods.	L3
CO5	Apply the principles and techniques of brittle coating analysis.	L5

CO6	Apply the principles and techniques of holographic interferometry.	L5

COURSE CONTENT:	
MODULE 1 Analysis of Experimental Data	**08 Hrs**
Introduction: Definition of terms, calibration, standards, dimensions and units, generalized measurement system, Basic concepts in dynamic measurements, system response, distortion, impedance matching, experiment planning. Analysis of different Experimental Data.	
MODULE 2 Data Acquisition and Processing	**10 Hrs**
Data Acquisition and Processing: General data acquisition system, signal conditioning revisited, data transmission, Analog-to-Digital and Digital-to- Analog conversion. Basic components (storage and display) of data acquisition systems. Computer program as a substitute for wired logic. Force, Different torque and Strain Measurement	
MODULE 3 Stress Analysis	**10 Hrs**
Stress Analysis: Two Dimensional Photo elasticity-nature of light,-wave theory of light, optical interference Polariscopes stress optic law effect of stressed model in plane and circular polariscopes, Isoclinics, Iso chromatics fringe order determination -Fringe multiplication techniques Calibration photo elastic model materials. Separation methods shear difference method, Analytical separation methods, Model to prototype scaling	
MODULE 4 Three Dimensional Photoelasticity	**10 Hrs**
Three-Dimensional Photo elasticity: Stress freezing method, General slice, Effective stresses, Stresses separation, Shear difference method, Oblique Incidence Method, secondary principal stresses, scattered light photoelasticity, Polariscope and stress data analyses.	
MODULE 5 Coating Methods and Mini Project	**10 Hrs**
Coating Methods: a) Photo elastic Coating Method-Birefringence coating techniques, Sensitivity Reinforcing and thickness effects -data reduction-Stress separation techniques, Photo elastic strain gauges. b) Brittle Coatings Method: Brittle coating technique Principles data analysis-coating materials, Coating techniques.	

Text Books:

1. Holman,"Experimental Methods for Engineers"7thEdition, Tata McGraw-Hill Companies, Inc,NewYork, 2007.
2. R.S.Sirohi,H.C.RadhaKrishna,"Mechanicalmeasurements"NewAgeInternationalPvt.Ltd., NewDel hi,2004
3. Experimental Stress Analysis Srinath, Lingaiah, Raghavan, Gargesa, Ramachandra and Pant, Tata McGraw-Hill, 1984.

4. Instrumentation, Measurement And Analysis Nakra Chaudhary, B C Nakra K K Chaudhry, Tata McGraw-Hill Companies, Inc, NewYork, Seventh Edition,2006.

Reference Books:

1. MeasurementSystemsApplicationandDesignDoeblinE.A.,4th(S.I.)Edition,McGrawHill,NewYork. 1989
2. Design and Analysis of Experiments- MontgomeryD.C., JohnWiley&Sons, 1997.
3. Experimental Stress Analysis-Dallyand Riley, McGrawHill, 1991.
4. Experimental Stress Analysis-Sadhu Singh, Khanna publisher, 1990.
5. Photo elasticity ValIant Vol II-M.M.Frocht,.JohnWileyandsons,1969.
6. Strain Gauge Primer-PerryandLissner, McGrawHill,1962.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5102**					
TITLE OF THE COURSE	**FINITE ELEMENT METHOD**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**60**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

- Introduce the various aspects of FEM as applied to engineering problems.
- Define the element properties such as shape function and stiffness matrix for the various elements
- Formulate element properties for 1D, 2D elements
- Use of FE tool in linear structural, heat transfer, and dynamics problems
- Analyze bars and trusses
- Analyze plane elasticity problems
- Formulate and solve dynamic problems

Laboratory Component

- Understand and formulate the problem based on given geometry and physics
- Know how to model, analyze mechanical systems using finite element analysis software
- To impart knowledge for creating 1D/2D/3D models using preprocessing of FE software
- To impart knowledge for creating 2D/3D models using CAD software and export to finite element software
- Learn the use of commercial software to solve complex problems

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Apply the weighted residual method and Rayleigh-Ritz method to approximatethe solutions of simple problems	L3
CO2	Develop finite element formulations for bar and beam elements using linear and quadratic shape functions and use them in simple heat transfer problems	L3
CO3	Formulate and use iso-parametric, axisymmetric, serendipity elements and use natural co-ordinate systems	L3
CO4	Demonstrate the applications to solid mechanics problems and dynamic considerations	L3
CO5	Model and analyze mechanical systems using ANSYS software	L5

COURSE CONTENT:	
MODULE 1	**06 Hrs**
Introduction to Finite Element Method - Introduction, Engineering Analysis, Convergence criteria, Vibrational formulations, weighted residual methods, Potential Energy 1D Bar Element, Admissible displacement function, Strain matrix, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain.	
MODULE 2	**06 Hrs**
One-Dimensional Elements- Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional, 1-D Bar Element, Assembly Procedure, Boundary and Constraint Conditions, 2-D Bar Element, 3-D Bar Element, Beam Element, Hermite shape functions, 1D Heat transfer, Truss element, Test Problems and Applications.	
MODULE 3	**08 Hrs**
Two-Dimensional Elements - Analysis of Plane Elasticity Problems, Three- Noded Triangular Element (TRIA 3), Four- Noded Quadrilateral Element (QUAD 4), Higher Order Elements Axisymmetric Solid Elements- Analysis of Bodies of Revolution. Axisymmetric Quadrilateral Ring Element- Geometric representation, Admissible displacement functions, Element stain matrix, element stress recovery, Element stiffness matrix, Consistent nodal force vector: Body force, initial strain. Surface traction, Element equations. Test Problems – Assessment of Accuracy, Practical Applications.	
MODULE 4	**08 Hrs**

Three-Dimensional Elements-Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Shape functions for Higher Order Elements	
MODULE 5	**08 Hrs**
Dynamic Considerations- Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	

Laboratory Component:

Experiment 1 (Revision)	1-D Elements, Bar, Truss & Beam Elements, Static & Dynamic Analysis	06 Hours
Experiment 2	Geometric Modeling of 2-D geometry using Ansys, Import 2-D geometryfrom other Modeling software 2-D Elements, Triangular & Quadrilateral, Liner and Higher-Order elements, Meshing Techniques; Manual & Automatic Meshing in Ansys,	06 Hours
Experiment 3	Geometric Modeling of 3-D geometry using Ansys, Import 3-D geometryfrom other Modeling software 3-D Elements, Tetrahedral & Hexahedral, Liner and Higher-Order elements, Meshing Techniques in 3-D; Manual & Automatic Meshing inAnsys, Import mesh from Hypermesh,	06 Hours
Experiment 4	Analysis of Structures 2-D & 3-D: Static Analysis. Modal Analysis. Harmonic Analysis. Spectrum Analysis. Buckling Analysis, Analysis of Composites.	06 Hours
		24 Hours

TEXT BOOKS:

1. Rao S. S., Finite Elements Method in Engineering, 4th Edition, Elsevier, 2006.
2. Chandrupatla T. R., Finite Elements in Engineering, 2nd Edition, PHI, 2007
3. Lakshminarayana H. V., Finite Elements Analysis, Procedures in Engineering, Universities Press, 2004.

REFERENCES :

1. Reddy J.N., An Introduction to the Finite Element Method, McGraw - Hill International Edition, New York, 1993.
2. Bathe K. J. Finite Elements Procedures, PHI,2002.
3. Cook R. D., et al. Concepts and Application of Finite Elements Analysis, Edition, Wiley & Sons, 2003

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5103**					
TITLE OF THE COURSE	**SOLID MECHANICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**60**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To able to assess the stress/deformations for a given case of loading
2. To apply the yield criteria to assess whether the material has undergone yielding
3. To understand asymmetrical bending and the influence of shear Centre
4. To analyze beams of different cross sections for bending
5. To analyze bars of various cross sections for torsion
6. To understand the procedure for axisymmetric and thermal stress analysis
7. Demonstrate the ability to use commercial software to solve simple and complex structural problems.

Laboratory Component

The student will be able to

1. To know how to model mechanical systems using finite element analysis software and analyse structural response.
2. To simplify structural problems and analyse using finite element software such as through plane stress/plane strain/ axisymmetric assumptions.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To identify & analyse plane stress / plane strain / axisymmetric problems	L1/L2/L3
CO2	To analyse the principal stresses principal strain and principal planes for generalised case of loading in an isotropic material	L3
CO3	To assess the plastic deformation using different yield criterions	L2
CO4	To identify the shear centre of a beam section	L2
CO5	To analyse the structure subjecting to bending or torsion	L4
CO6	Design and analyse structures using hand calculation or using FEA	L5

COURSE CONTENT:	
MODULE 1 - Analysis of Stress	**08 Hrs**
Introduction, The State of Stress at a point, Stress Components on an Arbitrary Plane, Principal Stresses, Stress Invariants, Mohr's Circles for the Three- Dimensional State of Stress, Mohr's Stress Plane, Planes of maximum shear, Octahedral Stresses, State of pure shear, Decomposition into hydrostatic and pure shear states, Cauchy's stress quadric, Lame's Ellipsoid, The plane state of stress, Differential equations of equilibrium, Equations of equilibriumfor Plane Stress State, Equations of equilibrium in cylindrical coordinates, axisymmetric stress state	
MODULE 2 - Analysis of Strain	**06 Hrs**
Introduction, Deformations, Change in length of a linear element, The state of strain at a point, Principal axes of strain and principal strains, Plane state of strain, Plane strain in polar coordinates, Compatibility conditions, Strain Deviator and its invariants	
MODULE 3 - Stress-strain relations	**08 Hrs**
Generalized statement of Hooke's law, Displacement Equations of Equilibrium, Theories of failure, Ideally Plastic Solid, Stress space and strain space – Deviatoric plane or π-plane, Yield Surfaces of Tresca and Von-Mises, Stress-strain relationship (Plastic flow), Prandtl-Reuss Equations	
MODULE 4 - Bending of Beams	**06 Hrs**
Straight beams and Asymmetrical Bending, Euler-Bernoulli Hypothesis, Shear centre or centre of flexure, shear stresses in a thin-walled open sections, shear centre of T or L sections, Bending of curved Beams	

MODULE 5 - Torsion, and Axisymmetric problems	**08 Hrs**
Torsion of general prismatic bars (Circular/Elliptical/Equilateral Triangular/Rectangular), Membrane Analogy, Torsion of thin walled tubes, Torsion of bars with thin rectangular sections, Centre of twist and flexural centre. Axisymmetric problems: Lame's problem, Stresses in composite tubes-shrink fit, Rotating discs of uniform thickness, Discs of variable thickness, Rotating shafts and cylinders	

Laboratory Component:

Experiment 1	Identification of principal stresses and principal planes using MATLAB	04 hours
Experiment 2	Evaluation of normal stresses in straight beams as a result of thermal loading through MATLAB/FEA.	04 hours
Experiment 3	Comparison of axisymmetric analysis with Full 3D modelling using FEA.	04 hours
Experiment 4	Analysis of beams when it is subject to symmetrical / asymmetrical bending using FEA	04 hours
Experiment 5	Analysis of Torsion of bars of various cross section using FEA	04 hours
Experiment 6	Analysis a typical connecting rod or a pressure vessel using FEA	04 Hours
		24 Hours

Text Books:

1. Srinath , L. S. Advanced Mechanics of Solids , Tata McGraw-Hill Education, Third Edition,2008.
2. Kazimi, S. M. A. Solid Mechanics, Tata McGraw-Hill Education, 2001
3. Allan F. Bower, Applied Mechanics of Solids, CRC Press, 2009

Reference Books:

1. Shames I.H and Pitarresi, J.M.P., Introduction to Solid Mechanics, PHI Publications, ThirdEdition, 1999.
2. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book, 1958.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5104**					
TITLE OF THE COURSE	**SPECIAL TOPICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**04**	**-**	**-**	**48**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To present the fundamental principles and practices of AI , ML, Data Analytics and IOT
2. To address the real-world mechanical engineering problems using AI , ML, Data Analytics and IOT
3. To develop a basic understanding of these technologies and apply them to solve mechanical domain problems including Automotive, Aerospace and other interdisciplinary areas.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's TaxonomyLevel**
CO1	Recognise the importance of AI & ML, Data sciences & IOT in MechanicalEngineering	L2
CO2	Comprehend the ideas of AI and problem-solving techniques	L2
CO3	Apply Machine Learning and Deep Learning algorithms	L3
CO4	Apply Data Analysis algoritms	L3
CO5	Apply IOT concepts to mechanical domain problems	L3

COURSE CONTENT:	
MODULE 1 Introduction to New Technologies	**08 Hrs**
Introduction to Artificial Intelligence, Machine Learning, Data Analytics & Internet of Things. Application of the Mechanical Domain areas such as Automobile, Aerospace & other inter-disciplinary areas.	
MODULE 2 Machine Learning	**10 Hrs**
Introduction to Supervised Learning(Regression and Classificatio), Un-Supervised Learning (Clustering and Assciation), Reinforcement learning and Machine learning Algorithms(Linear Regression, Logistic Regression, Decision Tress, Random Forest, SVM,KNN, K-Means Clustering, Q-Learning)	
MODULE 3 Deep Learning	**10 Hrs**
Introduction to Deep Learning and Artificial Neural Network, Deep Neural Network (DNN), Convolution Neural Network (CNN), Recurrent Neural Network (RNN)	
MODULE 4 Data Analytics	**10 Hrs**
Introduction to Data Warehousing, Extract, Transform & Load (ETL), SQL & NOSQL	
MODULE 5 Internet of Things	**10 Hrs**
Introduction to Computer Networks and ISO, OSI Layers and TCP and IP Protocols. Introduction to Internet of Things, Introduction to Sensors, Actuator, Transducers, Gateway, IOT Architecture, Introduction to Node MCU and Arduino. Application of IOT in Home Mechanical, Aerospace and Automobile Industries.	

Text Books:

1. Mayur Ramgir, Internet of Things- Architecture, Implementation, and Security [Print Replica]Kindle Edition, Pearson
2. Manohar Swamynathan (Author), Mastering Machine Learning with Python in Six Steps; A Practical Implementation Guide to Predictive Data Analytics Using Python 1st ed, Kindle Edition, press.
3. Jojo Moolayil, Learn Keras for Deep Neural Networks: A Fast-Track Approach to Modern Deep Learning with Python 1st ed. Edition, Kindle Edition

Reference Books:

1. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of ComputationalAgents, Cambridge University Press, 2010.
2. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press, 2009.
3. Richard E Neapolitan; Xia Jiang Artificial Intelligence: With an Introduction to MachineLearning, Chapman and Hall/CRC Press, 2018.
4. Sttuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, PearsonE ducation 2007.
5. Nagy Z. Artificial Intelligence and Machine Learning Fundamentals: Develop real worldapplications powered by the latest AI advances. Packt Publishing Ltd; 2018.

DEPARTMENT ELECTIVE-I

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5031**					
TITLE OF THE COURSE	**APPLIED MATHEMATICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**--**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. To learn the various numerical schemes for curve fitting, solving linear equations and partial differential equations.
2. To study the solution to extreme problems using vibrational principle.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Solve problems using numerical methods.	L2
CO2	Solve and use various curve fitting techniques	L3
CO3	Solve and use the fundamentals of most commonly occurring situations in the form of ODE's and PDE's for real life applications.	L3
CO4	Solve and use various Numerical linear algebra techniques.	L3

COURSE CONTENT:	
MODULE 1 - Calculus of Variation:	**08 Hrs**
Introduction, The First Variation, Euler-Lagrange equation, Isoperimetric problems.	

MODULE 2 - Curve Fitting:	**10 Hrs**
Linear regression, Polynomial regression, General Linear Least Squares, Newton's Divided Differences, Lagrange interpolating polynomials, Inverse interpolation, spline interpolation, and Multidimensional interpolation.	
MODULE 3 - Ordinary Differential Equations	**10 Hrs**
Ordinary Differential Equations: Formulations of ordinary differential equations involving Mechanical engineering problems. Solutions- Equations of first order and first degree. Equations of first order and second degree. Bernoulli equation. Euler equation. Simultaneous linear differential equations	
MODULE 4 - Numerical solution of PDE's	**10 Hrs**
Laplace Equation, Solution technique, Boundary conditions, the control-volume approach, Heat conduction equation, explicit methods, a simple implicit method, Crank Nicolson method, parabolic equations in two spatial domains, Case studies.	
MODULE 5 - Numerical Linear algebra:	**10 Hrs**
Partition method, Croute's Triangularisation method. Eigen values and Eigen vectors. Bounds on Eigen Values. Jacobi method for symmetric matrices. Gauss Elimination, LU decomposition, Special Matrices and Gauss Seidel, Case studies.	

TEXT BOOKS:

1. Chapra, S.C. and Canale, R.P. Numerical Methods for Engineers, Sixth Edition, McGraw Hill.

2. Bruce van Brunt, The Calculus of Variations, Springer.

REFERENCES :

1. Chapra, S.C. Applied Numerical Methods with MATLAB, Second Edition, Mc Graw-Hill.

2. Cheney W. and Kincaid, D. Numerical Mathematics and Computing, Sixth Edition, Brooks/cole

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5032**					
TITLE OF THE COURSE	**DYNAMICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Introduce the various aspects of dynamics as applied to engineering problems.
2. Formulate behavior/dynamics of machines under different loading conditions.
3. Use of Kinematic tools like CATIA/MATLAB/ANSYS/ABAQUS to understand the Kinematic and dynamic behavior of machines and solve vibration problems.
4. To study the Principles of Design in machines.
5. To introduce the various aspects Kinematics and dynamics of machines.
6. To learn mechanism for simple and complicated structures using FEA.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Study the basics of Kinematics and dynamics of machines	L1
CO2	Simulate the mechanism for simple and complicated structures using FEA and ADAMS	L3
CO3	Apply the tools of analytical dynamics with the main goal of developing mathematical models that describe the dynamics of systems of rigid bodies.	L3
CO4	Formulate equations of motion for complicated mechanical systems and solving these equations.	L3

CO5	Demonstrate multi body dynamics in mechanical engineering design	L3
CO6	Apply the Dynamics for conceptual design	L3

COURSE CONTENT:	
MODULE 1 Introduction to Dynamics of Machines	**06 Hrs**
Geometry of Motion: Introduction, analysis and synthesis, Mechanism terminology, planar, Spherical and spatial mechanisms, mobility, Grashoffs law, Equivalent mechanisms, unique mechanisms. Kinematic analysis of plane mechanisms: Auxiliary point method using rotated velocity vector, Hall - Ault auxiliary point method, Goodman's indirect method, Numerical examples.	
MODULE 2 Principles of Dynamics	**08 Hrs**
Generalized Principles of Dynamics: Fundamental laws of motion, Generalized coordinates, Configuration space, Constraints, Virtual work, principle of virtual work, Energy and momentum, Work and kinetic energy, Equilibrium and stability, Kinetic energy of a system, Angular momentum, Generalized momentum. Lagrange's Equation: Lagrange's equation from D'Alembert's principles, Examples, Hamiltons equations, Hamiltons principle, Lagrange's, equation from Hamiltons principle, Derivation of Hamilton's equations, Numerical examples.	
MODULE 3 Synthesis of Linkages	**07 Hrs**
Synthesis of Linkages: Type, number, and dimensional synthesis, Function generation, Path generation and Body guidance, Precision positions, Structural error, Chebychev spacing, Two position synthesis of slider crank mechanisms, Crank-rocker mechanisms with optimum transmission angle Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle. Numerical examples.	
MODULE 4 Dimensional Synthesis	**07 Hrs**
Analytical Methods of Dimensional Synthesis: Freudenstein's equation for four bar mechanism and slider crank mechanism, Examples, Bloch's method of synthesis, Analytical synthesis using complex algebra.	
MODULE 5 System Dynamics	**08 Hrs**
System Dynamics: Gyroscopic action in machines, Euler's equation of motion, Phase Plane representation, Phase plane Analysis, Response of Linear Systems to transient disturbances. Spatial Mechanisms: Introduction, Position analysis problem, Velocity and acceleration analysis, Eulerian angles. Numerical examples.	

Text Books:

1. K.J.Waldron & G.L.Kinzel , “Kinematics, Dynamics and Design of Machinery”, Wiley India,2007.
2. Greenwood, “Classical Dynamics”, Prentice Hall of India, 1988.

Reference Books:

1. J E Shigley, “Theory of Machines and Mechanism” -McGraw-Hill, 1995
2. A.G.Ambekar , “Mechanism and Machine Theory”, PHI, 2007. 3. Ghosh and Mallick , “Theoryof Mechanism and Mechanism”, East West press

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5033**					
TITLE OF THE COURSE	**PRODUCT DEVELOPMENT**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are to:

1. Identify the customer needs, formulate the specifications and carry out need analysis.
2. Generate, screen and test the concepts.
3. Model the prototypes and carry out economic analysis
4. Explain the steps involved in product development process
5. Apply various methods for stimulating innovation of a product
6. Synthesize design with analysis to develop new product
7. Implement product principles in different organizations
8. Identify the design factors and processes as per customer specifications.
9. Provide a fundamental understanding of common principles, various standards & protocols

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Develop models by applying the concepts of product design theory	L3
CO2	Solve problems independently and identification of customer needs for the product growth	L3
CO3	Understand the process of product planning and specifications	L1
CO4	Have a basic knowledge of concept generation, selection and testing	L1

CO5	Identify the significance of product architecture and development economics	L2
CO6	Apply embodiment principles in prototyping for small product business	L3
CO7	Understand the product development by making a product and evaluate the salient features	L3

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
Product development- Characteristics of successful product development, Design and development of products, challenges of product development. A generic development process, front-end process. Identifying Customer Needs- Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.	
MODULE 2 Product Planning & Specifications	**08 Hrs**
The product planning process- identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Product Specifications- What are specifications, when are specifications established, establishing target specifications, setting the final specifications.	
MODULE 3 Concept Generation, selection and testing	**08 Hrs**
Concept generation -clarify the problem, search externally & internally, explore systematically, reflect on the results and the process. Concept Selection- Overview of methodology, concept screening, and scoring. Concept Testing- purpose of concept test, choose a survey population & format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.	
MODULE 4 Product Architecture & Development Economics	**07 Hrs**
Product architecture- implications & establishing the architecture, variety and supply chain considerations, platform planning and related system level design issues. Product Development Economics- Elements of economic analysis, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.	
MODULE 5 Prototyping	**07 Hrs**
Prototyping basics, principles of prototyping, technologies, planning for prototypes.	

Text Books:

1. Karl.T.Ulrich and Steven D Eppinger, Product Design and Development-Irwin/McGrawHill -2000.
2. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly - 2002

Reference Books:

1. Chitale, A. C. and Gupta, R. C., Product Design and Manufacturing, PH1, 3rd Edition, 2003.
2. Tim Jones and Butterworth Heinmann, New Product Development, Oxford, UCI,1997

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5034**					
TITLE OF THE COURSE	**DATA VISUALIZATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. Review of viewing transformations
2. Study the clipping algorithms
3. Representing curves, surfaces and solids
4. Study visual realism principles

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Learned to generate mathematical representation of surfaces and Visualizations appropriate to the specific task and data source	L3
CO2	Creating transformations and clipping of multiple versions of visualizations using mathematical techniques.	L3

COURSE CONTENT:	
MODULE 1 Viewing Transformations	**06 Hrs**
Representation of points, Transformations: Rotation, Reflection, Scaling, Combined Transformations, Translations and Homogeneous Coordinates, A geometric interpretation of homogeneous coordinates, Over all scaling, Points at infinity, Rotation about an arbitrary point, Reflection through an arbitrary line. Viewing transformation, Clipping - points, lines, Text, Polygon, Cohen, Sutherland line clipping, Sutherland, Hodgmen algorithm.	
MODULE 2 Types and Mathematical Representation of Curves	**08 Hrs**

Curve representation, Explicit, Implicit and parametric representation. Nonparametric and parametric representation of Lines, Circles, Ellipse, Parabola, Hyperbola, Conics. Parametric representation of synthetic curve, Hermite cubic splines, , Bezier curves: Blending function, Properties, generation, B-spline curves- Cox-de Boor recursive formula, Properties, Open uniform basis functions, Non-uniform basis functions, Periodic B-spline curve.	
MODULE 3 Types and Mathematical Representation of Surfaces	**08 Hrs**
Surface entities- Plane, Ruled, surface of revolution, Tabulated cylinder, Bezier surface, B-spline surface, Coons patch, Off set surface, Surface representation, Parametric representation of analytic surface- plane, Ruled surface, Surface of revolution, Tabulated cylinder, Parametric representation of synthetic surfaces, Hermite bicubic surface, Bezier surface, B-spline surface, Coons surface, Offset surface.	
MODULE 4 Types and Mathematical Representation of Solids	**07 Hrs**
Solid entities- block, Cylinder, cone, Sphere, wedge, Torus, Solid representation, Fundamentals of solid modeling, Set theory, Regularized set operations, Set membership classification, Half spaces, Basic elements, Building operations, Boundary representation, Basic elements, Building operations, Constructive solid geometry, Basic elements, Building operations, Sweep representation.	
MODULE 5 Visual Realism	**07 Hrs**
Visibility of object views, Visibility techniques: minimax test, Containment test, Surface test, Silhouttes, Homogeneity test, Sorting, Coherence, Hidden line priority algorithm, Hidden surface removal- Z-buffer algorithm, Warnock's algorithm, Hidden solid removal - ray tracing algorithm. Shading, Shading models, Diffuse reflection, specular reflection, Ambient light, Shading surfaces Constant shading, Gourmand shading, Phong shading, Shading enhancements, Shading Solids, Ray tracing for CSG, z- buffer algorithm for B-rep and CSG, octree encoded objects, Colouring- RGB, CMY, HSV, HSL colour models	

TEXT BOOKS:

1. Ibraham Zeid, CAD/CAM-Theory and Practice, McGraw Hill, 2006
2. Rogoer's Adams, Mathematical Elements for Computer Graphics, McGraw Hill,1990

REFERENCES :

1. Xiang Z, Plastock, R. A, Computer Graphics, Schaums Outlines, McGraw Hill. 2007.
2. Foley, Van- Damn, Finner and Hughes, Computer Graphics principles and practice, Addison Wesley,1990

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5035**					
TITLE OF THE COURSE	**DIGITAL CONTROL SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are

1. Ability to carry out the stability analysis and control systems.
2. Ability to learn processors for industrial applications.
3. To understand the state space approach
4. To understand PID controllers

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Solve problems using z-transform, inverse z- transform techniques.	L3
CO2	Know the advantage of state variable technique, controllability, observability for effective design of controller using digital technique	L3
CO3	Develop competency in controller design	L3
CO4	Analyse the time response of controllers	L4

COURSE CONTENT:	
MODULE 1 Sampling and holding	**06 Hrs**
Sample and hold device D/A, A/D conversion – Z transform – Inverse Z transform – Properties – Pulse transfer function and response between sampling intervals – Reconstruction.	
MODULE 2 State equations of discrete data systems	**08 Hrs**

State transition equations – Relationship between state equation and transfer functions - Characteristic equations – Eigen value – eigen vector –Diagonalization of Matrix – Jordan canonical form – Methods of computing state transition matrix –State diagram – Decomposition of discrete data transfer function	
MODULE 3 Controllability and observability of linier time invariant discrete data systems	**08 Hrs**
Relationships between controllability, observability and transfer function-Stability of linier discretecontrol system – Stability tests – Bilinear transformation method – Jury's stability test	
MODULE 4 Correlationbetween time response and root locations in S plane and Z plane	**07 Hrs**
Direct design in Z and W plane – State space design – Design via pole placement, digital PID controller design.	
MODULE 5 Selection of processors	**07 Hrs**
Mechanization of control algorithms – Merits and demerits – Applications of temperature control – Control of electric drives.	

Text Books:

1. Ogata, K. Discrete Time Control Systems, Pearson Education Asia, 2001
2. Gopal, M. Digital Control and State Variable Methods, Tata McGraw Hill,1999

Reference Books:

1. Kuo, B.C. Digital Control Systems, Oxford University Press, 1992
2. Gopal, M. Digital Control Engineering, Willey Eastern Ltd.1989
3. Laboratory manual, school of engineering, DSU

DEPARTMENTAL ELECTIVES – II

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5036**					
TITLE OF THE COURSE	**ROBOTICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To understand the basic engineering knowledge for the design of robots
2. To describe spatial descriptions and transformations
3. To explain manipulator kinematics and trajectory generation concepts
4. To discuss the robot programming for various applications
5. To teach students about basic robotics through lectures and simulations

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Apply the basic engineering knowledge for the design of robots	L3
CO2	Illustrate the spatial descriptions and transformations	L2
CO3	Apply the manipulator kinematics and trajectory generation concepts	L2
CO4	Demonstrate the programming principles for robot control.	L3
CO5	Demonstrate the process of building a robot using MatLab	L4
CO6	Demonstrate the path following and trajectory control modeling using Simulink	L3

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
A brief history of robotics, robot anatomy, work volume, links, joint and joint notation scheme, degrees of freedom, arm configuration, wrist configuration, end- effector, robot drive systems, control systems, precision of movement, robotic sensors, robot programming and work cell control, robot applications.	
MODULE 2 Coordinate Frames, Mapping and Transforms	**08 Hrs**
Coordinate Frames, Mapping: Mapping between rotated frames, mapping between translated frames, Mapping between rotated and translated frames, description of objects in space, transformation of vectors; rotation and translation of vectors, combined rotation and translation of vectors, composite transformation, fundamental rotation matrices, Euler angle representation.	
MODULE 3 Robot Kinematics and Dynamics	**08 Hrs**
Introduction, description of links and joints, kinematic modeling of the manipulator, Denavit-Hartenberg notation, kinematic relationship between adjacent links, 2- DOF planar manipulator arm, kinematic model of a cylindrical arm, articulated arm kinematic model, robot arm dynamics, manipulator dynamics-construction of manipulators, Lagrangian formulation and N-E formulation.	
MODULE 4 Path planning & Programming	**07 Hrs**
Introduction, general considerations in path description and generation, joint-space schemes, cartesian-space schemes, geometric problems with Cartesian paths, description of paths with a robot programming language, methods of robot programming, lead through programming methods, robot program as a path in space, motion interpolation, wait, signal, and delay commands, branching.	
MODULE 5 Robot Sensors and Machine Vision	**07 Hrs**
Transducers and sensors, sensors in robotics, tactile sensors; touch and force sensors, force sensing wrist, proximity and range sensors, uses of sensors in robotics, introduction to machine vision, sensing and digitizing, imaging devices, lighting techniques, analog to digital signal conversion, image storage, image processing and analysis	

Text Books:

1. John J. Craig, Introduction to Robotics, Third Edition, Pearson India Education Services Pvt.Ltd, 2015
2. Mikell P Groover, Mitchel Weiss, Industrial Robotics, Second Edition, McGraw Hill Education(India) Private Limited, 2012
3. Ashitava Ghosal, Robotics-Fundamental Concepts and Analysis, Oxford University Press, 2006.

Reference Books:

1. Fu, K, S., Gonzalez R. C., and Lee C.S.G., Robotics Control, Sensing, Vision and Intelligence,McGraw Hill, Thirteenth reprint 2015.
2. Schilling R. J., Fundamentals of Robotics, Analysis and Control, PHI, 2006.
3. Niku, S. B. Introduction to Robotics Analysis, Systems, Applications, Pearson Education, 2008.
4. R K Mittal, I J Nagrath, Robotics and Control, Tata McGraw-Hill Education, 2003

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5037**					
TITLE OF THE COURSE	**SENSORS AND SIGNAL CONDITIONING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To instill knowledge of advanced sensor systems.
2. To provide an application oriented approach in instrumentation.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain the characteristics of instrumentation system	L2
CO2	Identify the most suitable method of sensing and transduction for anapplication.	L2
CO3	Describe various types magnetic sensors and their applications	L1
CO4	Discuss analog and digital instrumentation aspects	L2
CO5	Design instrumentation and associated data acquisition system.	L3
CO6	Develop data acquisition system for any typical mechanical applications	L3

COURSE CONTENT:	
MODULE 1 Basic Concepts	**06 Hrs**
Basic Concepts of Measurements and characteristics of an Instrumentation System-System configuration, Problem analysis, Basic characteristics of measuring, Calibration, Generalized measurements, Zero order, First order, second order system, Dead time element.	

MODULE 2 Sensors and Transducers	**08 Hrs**
Electromechanical sensors, Resistance type, Potentiometer, Strain gauge, Resistance thermometer, RTD, Inductance type, Capacitance type, Piezo Electric type.	
MODULE 3 Magnetic sensors	**07 Hrs**
NMR, MRI, Fiber optic sensors, Opto electronic sensors, CCD, Digital transducers.	
MODULE 4 Analog and Digital Instrumentation	**07 Hrs**
Operational Amplifiers, Signal generation, Signal processing, Filtering and signal analysis.	
MODULE 5 Data Acquisition, Conversion, Transmission and Processing	**08 Hrs**
Signal Conditioning of the inputs – Single channel and Multichannel data acquisition, Data conversion, Multiplexers, Sample and hold circuits, Data transmission systems, Pulse code formats, Modulation techniques, Telemetry system.	

Text Books:

1. Nubert, H.K.P., Instruments Transducers, Clarendon Press, Oxford, 1963
2. Ernest O. Doebelin, Measurement System Application & Design McGraw Hill, New York,1983.

Reference Books:

1. Ramon Pallas-Areny, John G. Webster, Analog Signal Processing, A Wiley Interscince Publication, John Wielly & Sons, INC
2. Fernando E. Valdes-Perez Ramon Pallas-Areny, Microcontrollers, CRC Press, Taylor and Francis Group

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5038**					
TITLE OF THE COURSE	**DESIGN OF HYDRAULIC AND PNEUMATIC SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To understand fundamentals of Hydraulic and Pneumatic systems
2. To design simple Hydraulic and Pneumatic circuits.
3. To design circuits for low cost automation. Demonstrate ability to make use of commercial software to solve complex problems.
4. Demonstrate ability to make use of commercial software to solve complex problems.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Comprehend the principles, features and functions of hydraulic pumps andactuators.	L3
CO2	Understand the concepts of flow control valves and regulators.	L2
CO3	Realize the different types of hydraulic circuits and systems, and design the same.	L3
CO4	Know the principles, features and functions of pneumatic pumps and actuators.	L3
CO5	Recognize the working of different pneumatic circuits and systems, and design pneumatic circuits and systems.	L5
CO6	Design, develop and analyse different types of hydraulic and pneumatic circuits and real systems.	L3

COURSE CONTENT:	
MODULE 1 Hydraulic Systems and Actuators	**06 Hrs**
Basic principles- Hydraulic Principles. Hydraulic Power Generators- Selection and specification of pumps, pump characteristics. Hydraulic Actuators - Linear, Rotary - Selection Characteristics.	
MODULE 2 Control and Regulation Elements	**08 Hrs**
Hydraulic Valves: Pressure, Flow, Direction Controls- Proportional Control valve. Fluid power symbols.	
MODULE 3 Design of Hydraulic Circuits	**08 Hrs**
Reciprocating, Quick return, Sequencing, synchronizing and other industrial circuits like press circuits - hydraulic milling machine - grinding, planning, copying, forklift, earth mover circuits - design and selection of components - safety and emergency mandrels. Selection and sizing of components-calculation of frictional head loss-equivalent length for various components-actuator load calculation- pump sizing.	
MODULE 4 Pneumatic Systems and Actuators	**07 Hrs**
Pneumatic system fundamentals: FRL, actuators and valves. Logic Circuits - Position - Pressure Sensing, switching, electro-pneumatic.	
MODULE 5 Design of Pneumatic Circuits	**07 Hrs**
Design of Pneumatic circuits using - Karnaugh maps. Cascade-Step counter. Installation, Maintenance and Special Circuits- Pneumatic equipment - selection of components - design calculations -application - fault finding - hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation.	

Text Books:

1. Majumdar, S. R. Oil hydraulics and Pneumatics, Tata McGraw Hill, 2003.
2. Bolton, W. Pneumatic and hydraulic systems, Butterworth Heinemann, 1997.

Reference Books:

1. Anthony Esposite, Fluid Power with Applications, Pearson Education, 2000.
2. Andrew Parr, Hydraulics and Pneumatics, Jaico, 1999.
3. Laboratory Manual, School of Engineering, DSU.

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5039**					
TITLE OF THE COURSE	**LEAN MANUFACTURING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Introduce the various aspects of lean Manufacturing like just in time, Kanban systems,
2. Understanding the Benefits of lean manufacturing, Types of wastes, Reduction of wastes.
3. Understanding the system manufacturing, manufacturing strategy, design considerations for manufacture component and quality systems.
4. Identify the strategic issues like Training. Lean accounting, Activity based costing Product costing materials for effective manufacturing and make a future state for lean manufacturing.
5. Use of Opportunity to learn the fundamental principles of lean in manufacturing

COURSE OUTCOMES: 36

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Illuminate the Brief history of lean manufacturing, Just in time production,Toyota systems, Kanban systems	L2
CO2	Describe the lean manufacturing for Assessment tools, Implementing lean manufacturing and Science behind lean manufacturing.	L2
CO3	Evaluating the Lean accounting like Product costing, Volume adjusted costing and Focused factory concept.	L3
CO4	Explain the Group technology coding classification , Kaizen, 5S,TPM Automation , Yoko poko , Design Root cause analysis	L2

	,Failure models and effects	
CO5	Analysing the lean manufacturing by visiting implemented industry.	L5
CO6	Evaluating and conducting a mini project to solve realistic engineering problems on lean manufacturing.	L3

COURSE CONTENT:	
MODULE 1 General	**06 Hrs**
Brief history of lean manufacturing, Just in time production, Toyota systems, Kanban systems, Kanban rules, Benefits of lean manufacturing, Types of wastes, Reduction of wastes.	
MODULE 2 Lean manufacturing	**08 Hrs**
Principles - Basic tools - Techniques - Definition - Assessment tools- Implementing lean manufacturing – Science behind lean manufacturing – Capacity utilization - Variability – Delivery	
MODULE 3 Strategic issues:	**08 Hrs**
Actions - Issues - Focus - Leadership - Management of teams – Training. Lean accounting: Activity based costing - Product costing - Volume adjusted costing – Focused factory concept – Building strategic advantage through enterprise wide	
MODULE 4 Value stream and process mapping	**07 Hrs**
Overview - Where to use - Step by step approach –How to use – Reduce stream mapping – Present and future states - VSM symbols – Process mapping – Detailed instructions - limits – facilitation.	
MODULE 5 Cellular manufacturing:	**07 Hrs**
Work cell – Cell design - Facility planning – Plant layout – Balancing the work in work cells – Tact time – Defining - Benefits - Uses - Limitations –Facilities planning tools. Group technology coding classification - Productivity Improvement Aids - Kaizen – Kanban - 5S - TPM - Automation - Jidoka – Mistake proofing – Yoko poko Design Root cause analysis - Failure models and effects.	

Text Books:

1. Taiichi Ohno, (1988), The Toyota Production System (Beyond Large Scale production),
2. Portland, Oregon Productivity Press

Reference Books:

1. Kigoshi Suzaki, (1988), The New Manufacturing Challenge, Free Press, New York.
2. Shigeo Shing, (1989), Study of Toyota Production System, Portland, Oregon

SEMESTER	**I**					
YEAR	**I**					
COURSE CODE	**22MDE5040**					
TITLE OF THE COURSE	**SMART MATERIALS AND STRUCTURES**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Understand the concept of MEMS and Microsystems.
2. Understand the diverse technological and functional approaches and applications.
3. Provides an insight of micro sensors, actuators and micro fluidics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the physical properties of smart materials.	L2
CO2	Study the characteristics of the system using sensors and actuators.	L2
CO3	Analyse the responses of Static and Dynamic systems	L3
CO4	Design, analyse and fabricate smart structures for various applications.	L3
CO5	Determine the vibration characteristics of the systems using sensors Experimentally	L5
CO6	Detect damage using Electro-Mechanical Impedance (EMI) Technique	L3

COURSE CONTENT:	
MODULE 1 Overview of Smart Materials	**06 Hrs**
Overview of Smart Materials, Structures and Products Technologies. Smart Materials (Physical Properties) - piezoelectric materials, magneto strictive, electro strictive materials, magneto electric materials. Magneto rheological fluids, electro rheological fluids, shape memory materials, fiber-optic sensors.	
MODULE 2 Sensors and Actuators	**08 Hrs**
Smart Sensor, Actuator and Transducer Technologies - smart sensors- accelerometers, force sensors, load cells, torque sensors, pressure sensors, microphones, impact hammers, MEMS sensors, sensor arrays smart actuators: displacement actuators, force actuators, power actuators, vibration dampers, shakers, fluidic pumps, motors smart transducers, ultrasonic transducers, sonic transducers, air transducers.	
MODULE 3 Measurement and Control	**08 Hrs**
Measurement, Signal Processing, Drive and Control Techniques- quasi-static and dynamic measurement methods, signal-conditioning devices, constant voltage, constant current and pulse drive methods; calibration methods, structural dynamics and identification techniques, passive, semi-active and active control, feedback and feedforward control strategies.	
MODULE 4 Smart Structures	**07 Hrs**
Design, Analysis, Manufacturing and Applications of Engineering Smart Structures And Products - Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products.	
MODULE 5 Applications	**07 Hrs**
Emphasis on structures, automation and precision manufacturing equipment, automotive, consumer products, sporting products, computer and telecommunications products, medical and dental tools and equipment.	

Text Books:

1. Srinivasan, A. V., Smart Structures: Analysis and Design, Cambridge University Press,Cambridge; New York, 2001
2. Culshaw, B., Smart Structures and Materials, Artech House, Boston, 1996.

Reference Books:

1. Uchino, K., Piezoelectric Actuators and Ultrasonic Motors, Kluwer Academic Publishers, Boston, 1997.
2. Otsuka, K. and Wayman, C. M., Shape Memory Materials – CambridgeUniversity Press,Cambridge; New York, 1996.
3. Gandhi, M. V. and Thompson, B.S, Smart Materials and Structures, Chapman and Hall, London; New York, 1992

SEMESTER II

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5201**					
TITLE OF THE COURSE	**ADVANCED MATERIALS AND MANUFACTURING TECHNOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To study the behavior of various materials with different structure-property relationship
2. To introduce the various aspects Ceramics, composites, MMCS
3. To learn fabrication and operational skills and applications for Composite materials
4. To have overview of surface engineering and other treatments for materials environment.

Laboratory Component:

1. To understand the preparation of polymer composites through hand lay-up, vacuum bagging and resin transfer moulding process.
2. To comprehend the 3D printing of polymer/metal/ceramic samples.
3. To design new materials using ANSYS Material Designer.
4. To perform mould flow analysis
5. To work on open ended problems/projects related to advanced materials.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the properties of materials and its structure-property relationship	L2
CO2	Understand the principles underlying the functional and mechanical behavior of ceramic materials	L2

CO3	Develop competency in composite manufacturing techniques, and be able to select the appropriate technique for manufacture of various composite products.	L3
CO4	Analyse real life surface failure problems and determine the correct surface engineering solution.	L4
CO5	Create a Representative Volume Elements and compute the responses while exposing it to several macroscopic load cases.	L3
CO6	Prepare a new composite specimen using advanced materials.	L3

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
Introduction- Properties of Materials, Structure property relationship, Newer Materials – Ceramics and Composite materials, Ceramics – Fine ceramics, Types of ceramics, Structure of Ceramics, Properties of Ceramics, and Applications.	
MODULE 2 Composite Materials	**06 Hrs**
Composite Materials- Types – Metal matrix Composites (MMC), Ceramic Matrix Composites (CMC), Polymeric composites Structure, Properties and Applications of different composite materials.	
MODULE 3 Processing of Metal matrix Composites (MMC), Ceramic Matrix Composites (CMC)	**08 Hrs**
Processing of MMC & CMC, Vacuum infiltration, squeeze casting, pressure die casting, Rheo-casting, Compo-casting, Super plastic forming	
MODULE 4 Processing of Polymer matrix Composites (PMC)	**08 Hrs**
Processing of PMC-Hand Lay Up, Bag Molding Process, Autoclave molding, Compression molding, Pultrusion, Filament winding, Resin Transfer molding, Injection molding.	
MODULE 5 Surface Engineering	**08 Hrs**
Surface Engineering- Surface quality & integrity, concepts, Mechanical treatment, Thermal & Thermo-chemical treatment. Thermal Spraying Processes and Applications- Vapor depositions processes and applications, Ion-treatment, Laser Treatment.	

Laboratory Component:

Experiment 1	Preparation of polymer composites through hand lay-up, vacuum bagging and resin transfer moulding process.	06 Hours
Experiment 2	Preparation of polymer/metal/ceramic samples using 3D printing.	06 Hours
Experiment 3	Designing new materials for various applications using ANSYS Material Designer.	06 Hours
Experiment 4	Mould flow analysis using ANSYS	06 Hours
	Total	**24 Hours**

Text Books:

1. Paul Degarmo, E. Black, J.T. and Ronald A Kohser, Materials and Processing in Manufacturing, JohnWiley & Sons, 2011.
2. Minoru Taya, and Richard J. Arsenault, Metal Matrix Composites, Elsevier Science & Technology,1989
3. Mallick, P.K. Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Third Edition, CRC Press, 2007

Reference Books:

1. Schwartz, M.M. Composite Materials Handbook, Second Edition, McGraw Hill Higher Education,NewYork, 1995
2. Tadeusz Burakowski and Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC Press, 1998

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5202**					
TITLE OF THE COURSE	**MECHANICS OF COMPOSITE MATERIALS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the course are:

1. to tailor a composite to get desired characteristics (such as orthotropy/transverse isotropy/quasi- isotropy)in a composite
2. to estimate the lamina properties from the constituents through micromechanical relations
3. to evaluate the stresses/strains in a lamina for given case of loading
4. to assess whether the lamina has undergone failure for a given state of loading
5. to predict the properties of laminate based on the laminate configurations
6. to predict the failure of laminate based on failure analysis of lamina
7. to assess influence of temperature and humidity on the degradation of properties and failure of laminates

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	To identify the class of composite materials (isotropic/orthotropy/anisotropy)based on its structure/configuration	L1
CO2	To estimate the properties of lamina from constituents	L2
CO3	To assess the failure of lamina for given loading condition	L3
CO4	To assess the laminate properties for a given stacking sequence	L2

CO5	To analyse the failure of laminate for given case of loading	L4
CO6	To design a composite configuration for any given case of loading taking into account the process/environment induced stresses etc	L5

COURSE CONTENT:	
MODULE 1 Introduction and Micromechanics of a lamina	**08 Hrs**
Introduction to Composite Materials-Definition and Characteristics, Historical Development, Applications, Advantages and Limitations. Structural Performance of Conventional Materials, Geometric and Physical Definitions, Material Response under Load, types and Classifications of composite Materials, Lamina and Laminate , scales of Analysis, Basic lamina properties, Degree of Anisotropy. Micromechanical relationship for evaluation of lamina level properties from the constituents	
MODULE 2 Micro Mechanics of a lamina	**10 Hrs**
Elastic Behavior of Composite Lamina -Stress- Strain relations, Relations between Mathematical and Engineering Constants, Stress- Strain Relations for a Thin Lamina (2-D), Transformation of stress and stain (2-D, 3-D), Transformation of Elastic Parameters (2-D, 3-D), Transformation of stress and strain relations in terms of Engineering Constants (2 –D), Transformation relations for Engineering Constants (2 – D).	
MODULE 3 Failure theories of an orthotropic lamina	**10 Hrs**
Strength of Composite Lamina-Introduction, Failure Theories, Maximum Stress Theory, Maximum Strain Theory, and Energy based Interaction Theory, Interactive Tensor Polynomial Theory, Failure- Mode – Based Theories, Failure Criteria for Textile Composites, Computational Procedure for Determination of Lamina Strength, Evaluation and Application of lamina Failure Theories.	
4€	
MODULE 4 Macro Mechanics of laminates	**10 Hrs**
Laminate Terminologies, Definitions, Elastic behavior of Multidirectional Laminates-Basic Assumptions, Strain – Displacement Relations, Stress- Strain Relations of a Layer within a laminate, Force and Moment Resultants, General Load –Deformation Relations: Laminate Stiffness, Inversion Load –Deformation Relations: Laminate Compliances, symmetric Laminates, Balance Laminates, Orthotropic Laminates, quasi-isotropic Laminates, Laminate Engineering Properties. Computational Procedure for Determination of Engineering Elastic Properties . Failure and Strength prediction of multi-directional laminates	

MODULE 5 Hygrothermal effects on laminates	10 Hrs
Hygrothermal Effects -Introduction, Hygrothermal Effects on Mechanical Behavior, Coefficient of thermal and Moisture Expansion of a Unidirectional Lamina, Hygrothermal Strains in a Unidirectional lamina, Hygro thermo elastic Load - Deformation and Deformation – Load relations, Hygro thermal Load- Deformation relations, Co-efficient of thermal and Moisture Expansion - Multidirectional Laminates and Balanced/Symmetric laminates. Physical significance of Hygrothermal forces and Moments, Hygrothermal Isotropy and Stability. Coefficient of thermal Expansion of Unidirectional and Multidirectional carbon/ Epoxy Laminates, Hygro thermo elastic stress Analysis of Multidirectional laminates, Residual stresses.	

Text Books:

1. Srinath , L. S. Advanced Mechanics of Solids , Tata McGraw-Hill Education, Third Edition,2008.
2. Kazimi, S. M. A. Solid Mechanics, Tata McGraw-Hill Education, 2001
3. Allan F. Bower, Applied Mechanics of Solids, CRC Press, 2009

Reference Books:

1. Shames I.H and Pitarresi, J.M.P., Introduction to Solid Mechanics, PHI Publications, ThirdEdition, 1999.
2. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book, 1958.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5203**					
TITLE OF THE COURSE	**ADVANCED MACHINE DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**-**	**-**	**48**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To review the theory of failures, fatigue, creep, wear of surfaces
2. Understand fatigue crack growth, stress life, and LEFM approach
3. To identify and able to solve engineering design problems
4. To know the basics of surface failure, stress, and strength

Laboratory Component

1. To train commercial FE software to solve fatigue and fracture problems
2. To perform fatigue & fracture failure analysis of structures and components using finite elementanalysis software

COURSE OUTCOMES:

CO No.	**Outcomes** 4ε	**Bloom's Taxonomy Level**
CO1	Review the theory of failures, fatigue, creep, wear of surfaces	L2
CO2	Understand basic machine elements in machine design and understand their concepts in life estimation	L1
CO3	Explain LEFM concepts and S-N approach for notched members	L1
CO4	Understand the basics of surface failure, stress, and strength	L1
CO5	Demonstrate fatigue failure of mechanical components using ANSYS software	L3
CO6	Analyze fracture failure in different components using ANSYS software	L3

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods, and standard test specimens, Fatigue fracture surfaces, and macroscopic features, Fatigue mechanisms, and microscopic features.	
MODULE 2 Stress-Life (S-N) Approach	**08 Hrs**
S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation, and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. Strain-Life (ε-N) approach: Monotonic stress-strain behavior, Strain controlled test methods ,Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	
MODULE 3 LEFM Approach	**08 Hrs**
LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis, and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	
MODULE 4 Fatigue from Variable Amplitude Loading	**08 Hrs**
Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction, and sequence effects, Cycle counting methods, Life estimation using stress life approach.	
MODULE 5 Surface Failure	**06 Hrs**
Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.	

Course Content Lab Component:

Experiment 1	Fatigue analysis in ANSYS | fatigue failure | high cycle & low cycle fatigue life	06 Hours
Experiment 2	Fatigue Analysis of a plate with a hole using ANSYS Workbench	06 Hours
Experiment 3	Fatigue analysis of a formula SAE Hub	06 Hours
Experiment 4	fracture testing using Ansys workbench	06 Hours
	Total	**24 Hours**

Text Books:

1. Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, and Henry O. Fuchs, Metal Fatigue inEngineering, John Wiley, New York, Second edition. 2001.
2. Jack. A. Collins, Failure of Materials in Mechanical Design, John Wiley, New York 1992.

Reference Books:

1. S. Suresh, Fatigue of Materials, Second Edition, Cambridge University Press, Cambridge, U.K.1998
2. Julie. A. Benantine, Fundamentals of Metal Fatigue Analysis, Prentice-Hall, 1990
3. ASM Metals Hand Book, Fatigue and Fracture, Vol 19, 2002.

DEPARTMENTAL ELECTIVES –III

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5041**					
TITLE OF THE COURSE	**MECHATRONICS SYSTEM DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To educate the student regarding integration of mechanical, electronic,
2. Electrical and computer systems in the design of CNC machine tools, Robots etc.
3. To provide students with an understanding of the Mechatronic Design Process, actuators, Sensors, transducers, Signal Conditioning, MEMS and Microsystems
4. To provide a hands-on experience to model a mechatronic system using mechanical and electronic components & to control them.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course makes the student to appreciate multi-disciplinary51 natureof modern engineering systems.	L3
CO2	After undergoing this course, the student is in a position to understand how mechatronics systems can be designed anddeveloped.	L2
CO3	Students will learn to use different electronics components and how to control them for different applications.	L3
CO4	Students will learn how to acquire data from a real time system and how to use that for betterment of the system.	L3
CO5	Students will have a hands-on experience on how to integrate electronics in existing mechanical systems	L5

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
Definition and Introduction to Mechatronic Systems. Modelling & Simulation of Physical systems Overview of Mechatronic Products and their functioning, measurement systems. Control Systems, simple Controllers. Study of Sensors and Transducers: Pneumatic and Hydraulic Systems, Mechanical Actuation System, Electrical Actual Systems, Real time interfacing and Hardware components for Mechatronics.	
MODULE 2 Electrical Actuation Systems	**08 Hrs**
Electrical systems, Mechanical switches, Solid state switches, solenoids, DC & AC motors, Stepper motors. System Models- Mathematical models - mechanical system building blocks, electrical system building blocks, thermal system building blocks, electromechanical systems, hydro-mechanical systems, pneumatic systems.	
MODULE 3 Signal Conditioning-	**07 Hrs**
Signal conditioning, the operational amplifier, Protection, Filtering, Wheatstone Bridge, Digital signals, Multiplexers, Data Acquisition, and Introduction to digital system processing, pulse-modulation.	
MODULE 4 MEMS and Microsystems	**08 Hrs**
Introduction, Working Principle, Materials for MEMS and Microsystems, Micro System fabrication process, Overview of Micro Manufacturing, Micro system Design, and Micro system Packaging. Data Presentation Systems-Basic System Models, System Models, Dynamic Responses of System	
MODULE 5	**07 Hrs**
Advanced Applications in Mechatronics Fault Finding, Design, Arrangements and Practical Case Studies, Design for manufacturing, Automated Manufacturing – Artificial intelligence in Mechatronics – Fuzzy Logic Applications in Mechatronics – Micro sensors in Mechatronics.	

Text Books:

1. Bolton, W. Mechatronics - Addison Wesley Longman Publication, 1999
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture- Tata McGraw-Hill Education,2002

Reference Books:

1. Kamm, L. J., Understanding Electro-Mechanical Engineering an Introduction to Mechatronics -IEEE Press, 1st Edition, 1996.
2. Shetty and Kolk, Mechatronics System Design- Cengage Learning, 2009.
3. Mahalik, Mechatronics- Tata McGraw-Hill Education, 2003.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5042**					
TITLE OF THE COURSE	**MODELLING AND SIMULATION**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. Gain hands training and experience on Simulation software.
2. Developing skill to apply simulation software for goal driven system models.
3. Acquire working knowledge in statistical techniques, modelling approach and systems simulation.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Develop performance models for real world systems and will be able to solvethose models through simulation and statistical techniques.	L3
CO2	Understand the behavior of modelling system and create model for simulationstudies.	L2
CO3	Develop skills to apply simulation software to construct and execute goal- driven system models.	L3
CO4	Interpret the model and apply the results to resolve critical issues in a real world environment.	L3
CO5	Demonstrate the software tools like MATLAB/PYTHON/ANSYS in solving real time problems and day to day problems.	L5
CO6	Simulate the models for the purpose of optimum control by using software.	L3

COURSE CONTENT:	
MODULE 1 Introduction to Simulation	**07 Hrs**
Simulation, Advantages, Disadvantages, Areas of application, System environment, components of a system, Model of a system, types of models, steps in a simulation study. Simulation studies related to Queuing systems, Inventory System etc.	
MODULE 2 General Principles	**06 Hrs**
Concepts in discrete - event simulation, event scheduling/ Time advance algorithm, simulation using event scheduling. Random Numbers theory	
MODULE 3 Random Variate Generation	**08 Hrs**
Inverse Transform Technique- Probability density functions, convolution methods- Erlang distribution, Acceptance Rejection Technique Optimization Via Simulation: Meaning, difficulty, Robust Heuristics, Random Search.	
MODULE 4 Data Input Modelling	**08 Hrs**
Data collection, Identification and distribution with data, parameter estimation, Goodness of fit tests, Selection of input models without data, Multivariate and time series analysis. Verification and Validation	
MODULE 5 Output Analysis	**07 Hrs**
Types of Simulations with Respect to Output Analysis, Stochastic Nature of output data, Measures of Performance and their estimation, Output analysis of terminating simulation, Output analysis of steady state simulations. Software: Selection of Simulation Software, Simulation packages, Trend in Simulation Software.	

Text Books:

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol, Discrete Event system Simulation,Pearson Education, Asia, 4th Edition, 2007, ISBN: 81-203-2832-9.
2. Geoffrey Gordon, System Simulation, Prentice Hall publication, 2nd Edition, 1978, ISBN: 81-203-0140-4.
3. Averill Law & David M. Kelton, Simulation, Modelling and Analysis, TMH 3rd Edition, 2003.
4. Banks, J., J.S. Carson, B.L. Nelson, and D.M. Nicol, Discrete-Event System Simulation, FourthEdition, Prentice-Hall, 2005.

Reference Books:

1. Gordon, G., System Simulation, PHI, 2006.
2. Averill M Law, W David Kelton, Simulation Modelling & Analysis, McGraw Hill InternationalEditions – Industrial Engineering series, 4th Edition, ISBN: 0-07-100803-9.
3. NarsinghDeo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition,2004, ISBN : 0-87692-028-8
4. Deo, System Simulation with Digital computer, PHI, 1978.
5. Francis Neelamkovil, Computer Simulation and Modelling, John Wiley and Sons, 1987.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5043**					
TITLE OF THE COURSE	**MECHANISM DESIGN**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Study the kinematic analysis and synthesis of mechanisms using graphical and analytical method.
2. Understand the various quantitative and qualitative approaches for different mechanisms.
3. Able to formulate, identify and solve mechanism problems.
4. To get familiarized with the advanced mechanisms which are necessary to design for specific application.

COURSE OUTCOMES:

CO No.	**Outcomes** 5€	**Bloom's Taxonomy Level**
CO1	Understand various mechanisms along with Grubler's equation & Grashof'scondition.	L3
CO2	Perform kinematic analysis of various mechanisms.	L4
CO3	Execute mechanism synthesis for specified positions of various mechanism using graphical method	L3
CO4	Perform mechanism synthesis for specified positions of various mechanism using analytical method	L3
CO5	Execute the plane motion analysis of different mechanism	L4
CO6	Demonstrate proficiency in the use of mechanism simulation software for kinematic analysis.	L3

COURSE CONTENT:	
MODULE 1 Kinematic Analysis of Mechanism	**06 Hrs**
Terminology, planar, Spherical and spatial mechanisms, mobility, Grashoff's law, Equivalent mechanisms, Unique mechanisms, Kinematic analysis of plane mechanisms using various method Position Analysis - Vector loop Equations for 4 bar, Slider Crank, Six bar linkages, velocity and acceleration analysis	
MODULE 2 Kinematic Mechanism synthesis - Graphical Method	**08 Hrs**
Type, Number and Dimensional Synthesis, Function Generation, Path Generation and Motion Generation, Graphical Methods Two Position, Three Position and Four Position Synthesis of 4-bar Mechanism, Slider Crank Mechanism. Guiding a body through two, three and four distinct positions.	
MODULE 3 Kinematic Mechanism synthesis - Analytical Method	**08 Hrs**
Analytical Methods - Blotch's Synthesis, Freudestien's Method, Coupler curve Synthesis, Cognate linkages - The Roberts – Chebychev theorem.	
MODULE 4 Advanced Kinematics of plane motion-I	**07 Hrs**
Introduction to plane motion. The Inflection circle, Euler – Savary Equation, Analytical and graphical determination of Bobillier's Construction, Collineation axis, Hartmann's Construction, Inflection circle for the relative motion of two moving planes, Application of the Inflection circle to kinematic analysis.	
MODULE 5 Advanced Kinematics of plane motion-II	**07 Hrs**
Motion Generation: Poles and relative poles, Location of poles and relative poles, polode, Curvature, Inflection circle	

Text Books:

1. Waldron, K.J. &Kinzel, G.L., Kinematics, Dynamics and Design of Machinery, Wiley, 2007.
2. Sandor, G. N and Erdman, A.G. Applied Mechanism Design, PHI, 1988.
3. Robert L Norton, Design of Machinery: An introduction to the Synthesis and Analysis ofMechanisms and Machines. Mcgraw-Hill, 3rd edition, 2003
4. Asok Kumar Mallik, Amitabha Ghosh, Gunter Dittrich, Kinematic Analysis and Synthesis ofMechanisms, CRC Press, 1st edition, 1994.

Reference Books:

1. Hall, A.S., Kinematics and Linkage Design, PHI.
2. Ambekar, A.G., Mechanism and Machine Theory, PHI, 2007.
3. David H. Myszka, Machines and Mechanisms, Pearson Education, 2005.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5044**					
TITLE OF THE COURSE	**INDUSTRIAL DESIGN AND ERGONOMICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. Identify and quantify ergonomics problems and prioritize the outcomes
2. To complete value added systems and controls
3. Integrating ergonomics and anthropometric information into industrial design projects
4. Apply practical design methodology and process to design project and objects

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Students will be able to analyze and calculate the level of risk in a job causingstress, fatigue and musculoskeletal disorders and design appropriate work systems	L3
CO2	Develop design strategies, form detail concepts and communicate design proposals	L4
CO3	Work as per Occupational Safety and Health Administration (OSHA) guidelines	L1
CO4	Understand the significance of different physical factors like shape, size, color, form etc.	L2
CO5	Respond to the socio-economic and cultural contexts of industrial design and the ethical duties.	L5

COURSE CONTENT:

MODULE 1 An approach to industrial design	**06 Hrs**
Elements of design structure for industrial design in engineering application in modern manufacturing systems. General approach to the man - machine relationship- workstation design-working position.	
MODULE 2 Shapes & Size Considerations	**08 Hrs**
Shapes and sizes of various controls and displays-multiple, displays and control situations - design of major controls in automobiles, machine tools etc., and design of furniture -redesign of instruments	
MODULE 3 Ergonomics and product design	**08 Hrs**
Ergonomics in automated systems- expert systems for ergonomic design. Anthropometric data and its applications in ergonomic, design-limitations of anthropometric data- use of computerized databases. Case study.	
MODULE 4 Visual Effects of Line and Form	**07 Hrs**
The mechanics of seeing- psychology of seeing general influences of line and form. Aesthetic Concepts. Concept of unity- concept of order with variety -concept of purpose style and environment-Aesthetic expressions. Style- components of style- house style, observation style in capital goods, case study	
MODULE 5 Color and light	**07 Hrs**
Colour and objects- color and the eye - colour consistency- colour terms- reactions to colour and colour continuation -colour on engineering equipment. Industrial Design in Practice - specifying design equipment- rating the importance of industrial design -industrial design in the design process.	

Text Books:

1. Mayall W.H., Industrial Design for Engineers - London Hiffee books Ltd. -1988.
2. Brain Shakel (Edited) - Applied Ergonomics HandBook, Butterworth Scientific. London, 1988.

Reference Books:

1. Bridger, R. C., Introduction to Ergonomics, McGraw Hill Publications, 1995.
2. Sanders & McCormick, Human Factor Engineering, McGraw Hill Publications, 6th edition, 2002.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5045**					
TITLE OF THE COURSE	**ADDITIVE MANUFACTURING**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are to:

1. Understand importance of additive manufacturing in advance manufacturing process.
2. Explore the potential of additive manufacturing in different industrial sectors
3. Apply 3D printing technology for additive manufacturing
4. Acquire knowledge, techniques and skills to select relevant additive manufacturing process
5. Familiarize with various materials that are used in additive manufacturing
6. Know the principles, methods, possibilities and limitations of additive manufacturing process

COURSE OUTCOMES:

CO No.	**Outcomes** 6(	**Bloom's Taxonomy Level**
CO1	Define the various process & materials used in Additive Manufacturing	**01**
CO2	Identify, analyse and solve problems related to Additive Manufacturingprocesses.	**02**
CO3	Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing	**03**
CO4	Analyse and select suitable process to carry out improvement in Additive Manufacturing	**04**
CO5	Apply knowledge of Rapid tooling in additive manufacturing for various applications	**03**

CO6	Design and fabricate working models for the conceptual applications.	**06**

COURSE CONTENT:	
MODULE 1 Introduction	**06 Hrs**
Overview, history, Basic principle, advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification, Materials used and challenges in Additive Manufacturing, Tooling, Applications	
MODULE 2 Additive Manufacturing Processes	**08 Hrs**
Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM), Micro- and nano-additive	
MODULE 3 Pre-Processing in Additive Manufacturing	**08 Hrs**
Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, Transformations, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials, pre heating of powders.	
MODULE 4 Post-Processing in Additive Manufacturing	**07 Hrs**
Post-processing equipment's, support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques	
MODULE 5 Rapid Tooling	**07 Hrs**
Introduction to Rapid tooling, classification, Direct and Indirect rapid tooling methods, Applications of additive manufacturing in rapid prototyping & rapid manufacturing, repairing and coating. Process optimization factors influencing accuracy, data preparation errors, Part building errors, Error in finishing &influence of build orientation.	

Text Books:

1. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles andApplications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
2. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototypingto direct digital manufacturing Springer, 2010.
3. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Reference Books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box forprototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials,Engineering Materials and Processes, Springer International Publishing AG 2018

DEPARTMENT ELECTIVES IV

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5046**					
TITLE OF THE COURSE	**RESEARCH METHODOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To understand the different aspects of social and managerial research.
2. To understand the approach and methods of managerial research.
3. To develop a thorough understanding of the fundamental theoretical ideas and research.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	This course makes the students to develop understanding on various kinds of research, objectives of doing research, research process, research designs andsampling.	L3
CO2	The Students will be able to have basic knowledge on qualitative research techniques	L2
CO3	The students will be able to have adequate knowledge on measurement & scaling techniques as well as the quantitative data analysis	L3
CO4	The students will be able to have basic awareness of data analysis-and hypothesis testing procedures	L3
CO5	The students will be able to have knowledge on Report writing, format of reports	L5
CO6	The students will be able to have basic knowledge on Research design and role of literature , importance of research and it's role.	L3

COURSE CONTENT:	
MODULE 1 Meaning of research	**06 Hrs**
Nature and scope of research, the research process and types of research, Definition of research problem-methods of problem formulation. Role of literature review in formulation of research problem, Research design, Uses and applications, Types of research designs, Exploratory, descriptive, experimental research designs.	
MODULE 2 Survey and sample study	**08 Hrs**
Sampling theories- random sampling and non-random sampling, Different methods of random and non-random sampling-sample size decisions, factors influencing sample size decision, Optimum sample size, Pilot survey.	
MODULE 3 Methods and techniques of data collection	**08 Hrs**
Observation and survey methods, Tools of data collection, Questionnaire and interview schedule, Questionnaire preparation, attitude measurement, Scaling techniques, Different types of scales, Validity and reliability of scale, Scale values.	
MODULE 4 Field work and data processing	**07 Hrs**
Classification and tabulation, Data summarization, analysis and interpretation of data, Univariate analysis, bivariate analysis, correlation and regression analysis, testing of hypothesis, Parametric and non-parametric tests, multivariate analysis, Factor analysis, discriminate analysis, conjoint analysis, clusters Analysis.	
MODULE 5 Report writing	**07 Hrs**
Types of reports, Substance of report, format of reports, Executive summary, Content of the report, Bibliography, References, Presentation of reports.	

Text Books:

1. Poulin V Young, Scientific social Surveys and Research, Prentice Hall of India, New Delhi,1984.
2. Kothari C.R, Research Methodology- Methods and Techniques, Vishwa Prakashan, New Delhi, 2001.

Reference Books:

1. Gibaldi, Joseph, MLA Handbook for Writers of Research Papers, Affiliated East West Press Pvt. Ltd., New Delhi 2000.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5047**					
TITLE OF THE COURSE	**EMBEDDED SYSTEMS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. To introduce the technologies behind embedded computing systems.
2. To introduce and discuss various software components involved in embedded system design and development.
3. To expose students to the recent trends in embedded system design.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the role of individual components involved in a typical embedded system	L2
CO2	Understand the electronic and mechanical components used in automobile systems	L2
CO3	Analyse the characteristics of different computing elements and select the mostappropriate one for an embedded system	L3
CO4	Develop simple tasks to run on an RTOS	L4

COURSE CONTENT:	
MODULE 1 Fundamentals of Embedded Systems	**06 Hrs**
Complex systems and microprocessors- Embedded system design process .Specifications- architecture design of embedded system- design of hardware and software components- structural and behavioral description.	

MODULE 2 Hardware Software Co-Design and Program Modelling	**08 Hrs**
Fundamental Issues, Computational Models- Data Flow Graph, Control Data Flow Graph, State Machine, Sequential Model, Concurrent Model, Object oriented model, UML	
MODULE 3 Embedded Product Design	**08 Hrs**
Design and Development of Embedded Product – Firmware Design and Development – Design Approaches, Firmware Development Languages.	
MODULE 4 Embedded Hardware and Firmware	**07 Hrs**
Integration and Testing of Embedded Hardware and Firmware- Integration of Hardware and Firmware. Embedded System Development Environment – IDEs, Cross Compilers, Disassemblers, Decompilers, Simulators, Emulators and Debuggers.	
MODULE 5 RTOS based Design and Neyworks	**07 Hrs**
RTOS based Design – Basic operating system services. Interrupt handling in RTOS environment. Design Principles. Task scheduling models. How to Choose an RTOS. Case Study – MicroC/OS-II.Networks – Distributed Embedded Architectures, Networks for embedded systems, Network based design, Internet enabled systems. Embedded Product Development Life Cycle – Description – Objectives -Phases – Approaches1. Recent Trends in Embedded Computing.	

Text Books:

1. J Staunstrup and Wayne Wolf, Hardware / Software Co-Design: Principles and Practice, PrenticeHall.
2. Jean J. Labrose, Micro C/OS II: The Real Time Kernel, 2e, CRC Press, 2002.

Reference Books:

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, Third Edition, McGraw HillEducation (India), 2014.
2. Shibu K.V., Introduction to Embedded Systems, McGraw Hill Education (India), 2009.
3. Steave Heath, Embedded System Design, Second Edition, Elsevier.
4. Wayne Wolf , Computers as Components-Principles of Embedded Computer System Design, MorganKaufmann publishers, Third edition, 2012.

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5048**					
TITLE OF THE COURSE	**FRACTURE MECHANICS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. The course will give much knowledge on fracture mechanics principles, fatigue failure and non-destructive testing and their applications.
2. Test methods and other techniques for fracture study will be discussed
3. The syllabus is designed for students interested in basic building knowledge on mechanics and learns more on engineering materials against crack induced fracture, diagnosis of cause and mechanisms of failure.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Able to possess the analytical tools needed to solve the idealized problem	L2
CO2	Be able to use these solutions and make appropriate design against failure analysis	L2
CO3	Perform investigation at the crack tip and approximate shape and size of the plastic zone	L3
CO4	Analyse the mixed-mode kinds of fracture	L3
CO5	Determine the fracture strength using experimental technique	L3

COURSE CONTENT:	
MODULE 1 Background	**06 Hrs**
Kinds of failure, Modes of fracture failure, Damage tolerance. Energy Release rate- Introduction, Griffith's Dilemma, Surface energy, Definition , Mathematical formulation ,Energy release rate of DCB specimen, Crack resistance, Stable and unstable crack growth, R- Curve for brittle Cracks, Critical energy release rate.	

MODULE 2 Mixed mode fracture criteria	**08 Hrs**
Crack path selection. Interface cracks in layered structures. Anisotropic fracture, linear and nonlinear fracture mechanics, J-Integral Stress Intensity factor- Introduction, Stress and Displacement fields in isotropic elastic materials, Stress Intensity factor –Background for mathematical Analysis, Westergaard approach, Problems	
MODULE 3 SIF of More Complex Cases	**08 Hrs**
Other applications of Westergaard, Approach, Application of the Finite dimensions, Cracks in a plate of finite dimensions. Edge cracks, embedded cracks, Critical stress intensity factor, Bending and Twisting of Cracked plates.	
MODULE 4 An elastic Deformation at the Crack tip	**07 Hrs**
Further Investigation at the Crack Tip, Approximate Shape and size of the plastic zone, Effective crack length, Effect of plate thickness, Crack tip opening displacement, problems.	
MODULE 5 Test Methods	**07 Hrs**
Introduction, -Test Techniques, Test Methods to determine and Determination of Critical CTOD. Fatigue failure- Low cycle and high cycle fatigue, Phase in fatigue life, Safe life and Fail-safe design philosophies, Principles of failure analysis.	

TEXT BOOKS:

1. Ralph I. Stephens, Ali Fatemi, Robert R. Stephens, Henry O. Fuchs, Metal Fatigue in engineering, John Wiley New York, Second edition. 2001.
2. Jack. A. Collins, Failure of Materials in Mechanical Design, John Wiley, New York 1992.
3. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw-Hill Education, 2009

REFERENCES :

1. Suresh, S., Fatigue of Materials, Cambridge University press, Cambridge, U.K.1991.
2. Fracture Mechanics, Fundamental and applications, Anderson T L, CRC Press, 2004.
3. Fatigue and Fracture, ASM Hand Book, Vol 19, 2002.

SEMESTER	**II**

YEAR	**I**					
COURSE CODE	**22MDE5049**					
TITLE OF THE COURSE	**MICRO ELECTRICAL MECHANICAL SYSTEMS (MEMS)**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. To learn dynamics and modelling of micro-systems
2. Understanding design and analysis of micro and Nano system applications
3. Develop experience on microsystems for sensors and actuators applications
4. To learn and characterize technology for MEMS
5. Gain knowledge and have knowledge on state-of-the-art MEMS techniques for Microsystems
6. Have an ability to identify, formulate and solve problems in the field of micro electrical systems.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Classify the MEMS devices based on its application.	L2
CO2	Demonstrate the working principles of various mechanical sensors and actuators	L2
CO3	Apply the concept of microfluidics in various applications	L3
CO4	Design the various mechanical sensors and actuators	L4
CO5	Identify the suitable fabrication method for a MEMS device	L3
CO6	Choose the appropriate characterization techniques to characterize the MEMS systems.	L3

COURSE CONTENT:

MODULE 1 Introduction	**06 Hrs**
Micro Electro-Mechanical Systems, Ultra Precision Engineering, Microsensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS : MOEMS; Magnetic MEMS; RF MEMS; Micro-fluidic Systems; Bio and Chemo – Devices; MEMS Packages and Design Considerations; Micro Instrumentation.	
MODULE 2 Mechanical Sensors and Actuators	**08 Hrs**
Principles of Sensing and Actuation; Beam and Cantilever; Micro plates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shear mode Piezo actuator; Gripping Piezo actuator; Inchworm Technology.	
MODULE 3 Thermal and Fluidic Micro Sensors and Actuators	**08 Hrs**
Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, and micro motors-Micro actuator systems: Ink-Jet printer heads, Micro-mirror TV Projector.	
MODULE 4 MEMS- Design and Analysis	**07 Hrs**
Basic concepts of design of MEMS devices and processes, Design for fabrication, Other design considerations, Analysis of MEMS devices, FEM and Multiphysics analysis, Modelling and simulation.	
MODULE 5 MEMS- Characterization	**07 Hrs**
Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunnelling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI)	
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Text Books:

1. Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning PrivateLimited, 2009.
2. Stephen D. Senturia, Microsystem Design, Springer, 2001
3. Marc Madou, Fundamentals of Microfabrication, Taylor & Francis Group, 2002
4. Gregory Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

Reference Books:

1. Bao, M.H., Micromechanical Transducers- Pressure sensors, accelerometers, and gyroscopes,Handbook, Elsevier, 2000.
2. Nadim Maluf, An Introduction to Micro electromechanical Systems Engineering, Artech HousePublishers, 2000.
3. Stephen D. Senturia, Microsystems Design, Kluwer Academic Publishers, New York, November 2000

SEMESTER	**II**					
YEAR	**I**					
COURSE CODE	**22MDE5050**					
TITLE OF THE COURSE	**TRIBOLOGY**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are:

1. Understand the steps involved in fundamentals of tribology
2. Able to know how to use the technology to gather and analyze data for bearings applications
3. Identify different types of bearings and lubrication and examine the applications and troubleshoot problems
4. Provide a broad based and discipline mechanism learning concept for tribology

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain basic and fundamental skills for tribological analyses	L3
CO2	Demonstrate the importance of tribology and extending product life of bearings.	L3
CO3	Methodologies of design and troubleshooting tribological and EHL systems	L4
CO4	Use experimental set-up for prediction of tribological behaviour	L3
CO5	Apply mathematical tool such as MATLAB for bearing design	L3

COURSE CONTENT:	
MODULE 1 Introduction to Tribology	**06 Hrs**
Introduction, Friction, Wear, Wear Characterization, Regimes of lubrication, Classification of contacts, lubrication theories, Effect of pressure and temperature on viscosity. Newton's Law of viscous forces, Flow through stationary parallel plates. Hagen's poiseuille's theory, viscometers. Numerical problems, Concept of lightly loaded bearings, Petroff's equation, Numerical problems.	
MODULE 2 Hydrostatic Bearings	**08 Hrs**
Hydrostatic thrust bearings, hydrostatic circular pad, annular pad, rectangular pad bearings, types of flow restrictors, expression for discharge, load carrying capacity and condition for minimum power loss, numerical problems, and hydrostatic journal bearings.	
MODULE 3 Journal Bearings	**08 Hrs**
Introduction to idealized full journal bearings. Load carrying capacity of idealized full journal bearings, Sommerfeld number and its significance, short and partial bearings, Comparison between lightly loaded and heavily loaded bearings, effects of end leakage on performance, Numerical problems.	
MODULE 4 Porous Bearings	**07 Hrs**
Introduction to porous and gas lubricated bearings. Governing differential equation for gas lubricated bearings, Equations for porous bearings and working principal, Fretting phenomenon and its stages. Antifriction bearings- Advantages, selection, nominal life, static and dynamic load bearing capacity, probability of survival, equivalent load, cubic mean load, bearing mountings.	
MODULE 5 Hydrodynamic Lubrications	**07 Hrs**
Pressure development mechanism. Converging and diverging films and pressure induced flow. Reynolds's 2D equation with assumptions. Introduction to idealized slide bearing with fixed shoe and Pivoted shoes. Expression for load carrying capacity. Location of center of pressure, effect of end leakage on 46 performance, Numerical problems, EHL Contacts- Introduction to Elasto – hydrodynamic lubricated bearings. Introduction to 'EHL' constant. Grubin type solution.	

Text Books:

1. Mujamdar. B.C., Introduction to Tribology of Bearing, Wheeler Publishing, New Delhi 2001
2. Radzimovsky, Lubrication of Bearings - Theoretical principles and design The Oxford pressCompany, 2000.

Reference Books:

1. Dudley D.Fulier., Theory and practice of Lubrication for Engineers, New York Company.1998
2. Moore., Principles and applications of Tribology, Pergamon press, 1975.
3. Pinkus 'O' Stemitch., Theory of Hydrodynamic Lubrication.
4. Stachowiak, G. W, Batchelor, A W., Engineering Tribology, Elsevier publication 1993.
5. Butterworth., Hydrostatic and hybrid bearings, 1983.

SEMESTER III

DEPARTMENTAL ELECTIVES – V

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5051**					
TITLE OF THE COURSE	**AUTOMOTIVE ELECTRONICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today's automotive industry.
2. Differentiate electronic and mechanical components used in automobile systems
3. Apply concept of integration of system components
4. Analyse and measure signal conversion parameters
5. Obtain an overview of automotive diagnostics

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the automotive components, subsystems, design cycles, communication protocols and safety systems	L2
CO2	Understand the electronic and mechanical components used in automobile systems	L3
CO3	Analyse and measure signal conversion parameters	L3
CO4	Apply concept of integration of system components	L3

COURSE CONTENT:	
MODULE 1 Automotive fundamentals overview	**06Hrs**
Four stroke cycle, engine control, ignition system, spark plug, spark pulse generation, ignition timing, drive train, transmission, brakes, steering system, starting system. Actuators – fuel metering actuators, fuel injector, ignition actuator,Exhaust After – Treatment System –AIR, catalytic converter, exhaust gas recirculation n (EGR), Evaporative emission systems	
MODULE 2 Air/ fuel system	**07Hrs**
Air/ fuel system – fuel handling, air intake system, air/ fuel management Sensors: Oxygen (02/EGO) sensors, throttle position sensor (TPS), engine crankshaft angular position (CKP)sensor, magnetic reluctance position sensor, engine speed sensor, ignition timing sensor, hall effect position sensor, shield field sensor, optical crankshaft position sensor, manifold absolute pressure(MAP) sensor-strain gauge and capacitor capsule, Engine coolant temperature(ECT) sensor, intake air temperature (AIT) sensor, knock sensor, airflow rate sensor, throttle angle sensor.	
MODULE 3 Electronic Engine Control	**08Hrs**
Electronic Engine Control – engine parameters, variables, engine performance terms, electronic fuel control system, electronic ignition control, idle speed control, EGR control. Vehicle motion control – cruise control, chassis, power brakes, antilock brake system (ABS), electronic steering control, power steering, traction control, electronically controlled suspension.	
MODULE 4 Communication	**07Hrs**
Communication-serial data, communication systems, protection, body and chassis electrical systems, remote keyless entry, GPS Automotive Instrumentation– sampling, measurement & signal conversion of various parameters. Radar warning system, low tire pressure warning system, radio navigation, advance driver information system	
MODULE 5 Automotive diagnostics	**08Hrs**
Integrated body- climate control systems, electronic HVAC system, Safety systems- SIR, interior safety, lighting, entertainment systems, Automotive diagnostics – Timing light, engine analyzer, on-board diagnostic off- board diagnostics, expert systems.	

Text Books:

1. Automobile Electrical and Electronic Systems" Tom Denton, Routledge, 5 edition,2017.
2. Understanding automotive electronics, William b. Ribbens,SAMS/Elsevier publishing 6thedition,2002

Reference Books:

1. Automotive electrics automotive electronics systems and components,Robert Bosch Gmbh, john wiley& sons ltd., 5th sedition, 2007

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5052**					
TITLE OF THE COURSE	**JIGS AND FIXTURES DESIGN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**--**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. Understanding the difference between jigs & fixtures design
2. To understand the construction design of various types of jigs and fixtures
3. To prepare and design of mounting of fixtures on the machine tool and learn more about indexing.
4. Learning the sequence of operations involved in jigs and fixtures.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	More idea on machined components for dimensional stability & functionality	L2
CO2	Design and develop productive and cost effective jigs and fixtures for machines	L3

COURSE CONTENT:	
MODULE 1 Introduction	**12Hrs**
Definition of Jigs and Fixtures, Difference between jigs and fixtures, Advantages, Steps for design. Location Degree of freedom, 3-2-1 principles, Choice of location, redundant location, Diamond pin calculation, Locating methods, Surface location, Rest blocks, pins, V-blocks, Equalizers, Profile locators.	

MODULE 2 Clamping	**12Hrs**
Basic principles, cutting forces, Rigid clamping, wedge clamping, Cam clamping, quick action clamps, Toggle clamps, simultaneously acting clamps, Guiding Elements- Jig bushes, Standards, Setting gauges.	
MODULE 3 Indexing Jigs and Fixtures	**12Hrs**
Indexing methods, Linear, Rotary, Indexing jigs, Indexing fixtures. Assembly and Welding Fixture – Principles	
MODULE 4 Design of Jigs and Fixture Bodies	**10Hrs**
Design of Jigs and Fixture Bodies other Elements types of Jigs and Fixtures -Plate jigs, Box jigs, Indexing jigs, Milling fixtures, and Indexing-milling fixtures, turning fixtures, Grinding fixtures, Universal jigs and fixtures, welding fixtures, Broaching fixtures, and Assembly Fixtures.	
MODULE 5 Preparation and Presentation of typical designs	**10Hrs**
Drill Jig, Drilling and Reaming Jigs, Milling Fixtures, Turning Fixtures, Indexing Jigs, Indexing Milling, Fixtures	

TEXT BOOKS :

1 Joshi, P .H. Jigs & Fixtures, Tata McGraw Hill Pub. Co. Ltd., 11th print, New Delhi, 1999.

2. Boyes E. William- Michigan, Jigs & Fixtures & Gauges, SME 1st Ed. 1986.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5053**					
TITLE OF THE COURSE	**OPTIMIZATION TECHNIQUES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**--**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

The objectives of the Course are:

1. Concentrating on solving complex optimization problems that arise in engineering applications.
2. Direct search methods like Univariate method, Hook and Jeeves' methods.
3. Using the tools like Genetic Algorithms, Simulated Annealing, and Tabu search methods for optimization.
4. Applying the mathematical results, search methods and numerical techniques for optimization using the one dimensional minimization methods.
5. Apply optimization knowledge for minimal cost and minimal weight.

COURSE OUTCOMES:

CO No.	**Outcomes** 8(	**Bloom's Taxonomy Level**
CO1	Explainthe Engineering application of optimization, Statement of optimizationproblem, Classification of optimization problems	L2
CO2	Evaluating theUnimodal function, unrestricted search, Exhaustive search, Dichotomous search	L3
CO3	Evaluating the Direct search methods- Univariate method, Hook and Jeeves' method, Powell's method, Simplex method.	L3
CO4	Explain the Desirable and undesirable effects – functional requirement material and geometrical parameters.	L2
CO5	Analysing the Optimization Techniques by visiting implemented industry.	L5
CO6	Evaluating and conducting a mini project to solve realistic engineering	L3

	problems on Optimization Techniques	

COURSE CONTENT:	
MODULE 1 Engineering application of optimization	**12Hrs**
Statement of optimization problem, Classification of optimization problems, single variable optimization, Multivariable optimization with no constraints. Multivariable optimization with equality constraints and inequality constraints, Kuhn - Tucker conditions.	
MODULE 2 One - dimensional minimization methods	**12Hrs**
Unimodal function, unrestricted search, Exhaustrive search, Dichotomous search, Fibonacci method, Golden section method. Quadratic, Cubic interpolation methods.	
MODULE 3 Direct search methods	**12Hrs**
Univariate method, Hook and Jeeves' method, Powell's method, Simplex method. Descent Methods- Steepest descent, Conjugate gradient, Quasi - Newton, Davidon - Fletcher - Powell method.	
MODULE 4 Genetic Algorithms	**10Hrs**
Genetic Algorithms - Simulated Annealing - Tabu search methods.	
MODULE 5 Desirable and undesirable effects	**10Hrs**
Functional requirement – material and geometrical parameters – Design of simple axial, transverse loaded members for minimum cost and minimum weight.	

Text Books:

1. Rao, S. S., Optimization - Theory and Application, Wiley Eastern, 1979.
2. Deb, K., Optimization for Engineering Design -Algorithms and Examples, Prentice-Hall India,1995

Reference Books:

1. Arora, J. S., Introduction to Optimum Design, Mc Graw-Hill, 1989.
2. Reklaitis, G. V., Ravindran, A. and Ragsdell, K. M., Engineering Optimization-Methods andApplications, Wiley, 1983.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5054**					
TITLE OF THE COURSE	**DESIGN OF EXPERIMENTS**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. Introduction of logic, application, and interpretation of various analysis of variance models
2. With up-to-date knowledge on factorial and Taguchi design tools for simulation, analysis, design and control
3. To learn more about response surface design

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understanding the design approach covered in class and their application to fundamental research	L2
CO2	Ability to work independently on design of experiments	L3

COURSE CONTENT:	
MODULE 1 Design of experiments	**06 Hrs**
Introduction, factor constraints, Interaction terms, Number of runs, enter data, analyze the data, level of factors, Custom designs-Introductions, examples, Screening design creation- Statistical Software introduction, demo using simple case studies.	
MODULE 2 Response surface design	**08 Hrs**

Introduction, creation, Central Composite Design, Box Behnken design, Contour profile of response surface plot, Design table, analyze the data, using Statistical software simple case study examples- Evolutionary operation, Experiment with random factor-Simple case studies.	
MODULE 3 Factorial Design	**08 Hrs**
Basic definition, principles and advantages- Creating, Blocking, responses and factors, Simple case studies,2- level fractional factorial design, Mixture design- Introduction, optimal mixture design, Simplex centroid design- examples, 2k Factorial design, linear Regression analysis error prediction, Full factorial design-Simple Case studies.	
MODULE 4 Taguchi design approach	**07 Hrs**
Orthogonal array, S/N Ratio, Smaller is better, nominal is better and Larger is better, with simple case studies, analyze the data-Factor effect diagram, Levels	
MODULE 5 Analysis of Variance	**07 Hrs**
Sum of square - Experimentation with single factor- Determining sample size-Model adequacy checking-Regression approach least square method-Non parametric method- Simple problems.	

TEXT BOOKS:

1. Douglas C Montgomery, Design and analysis of experiments, John Wiley& Sons, ltd., 5th edition, 2005.
2. Cox. C.R., The Theory of Design of Experiments, Chapman and Hall, 2000.

REFERENCES :

1. JMP. Design of Experiments, SAS Institute Inc., Cary, NC, USA, 2005.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5055**					
TITLE OF THE COURSE	**RELIABILITY AND FAILURE ANALYSIS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. To understand the course and is planned for those interested in reliability and failure analysis of experiments.
2. To allows and increase efficiency of experimentation, and reveal the essential reliability nature of a process.
3. In particular, risk analysis and techniques are learnt more.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understand the basics of fracture mechanics.	L2
CO2	Study the failure caused by corrosion.	L2
CO3	Analyse failures by interface reaction and diffusion process.	L3
CO4	Determine statistical analysis techniques	L3
CO5	Detect how failure are modeled	L3

COURSE CONTENT:	
MODULE 1 - Introduction	**06Hrs**
Need and scope of failure analysis and prevention Quality and Reliability, Industry practices of FA and reliability engineering, Common failure types.	

MODULE 2 - Mechanical Fracture, Reaction and Diffusion Induced	**07Hrs**
Time Varying Reliability Analysis, NDT for failure analysis, Destructive testing, Fracture mechanics, Fatigue, Delamination.Electromigration, Thermomigration.	
MODULE 3 - Corrosion Induced Failure	**08Hrs**
General wear, Galvanic corrosion, Stress Corrosion Cracking. Industrial engineering tools for failure analysis: Fishbone diagram.	
MODULE 4 - Statistical Analysis of Failure	**08Hrs**
Basics of statistics, Normal, Weibull and log-normal distribution, Statistical modeling of failure. Industrial engineering tools for failure analysis: Reliability	
MODULE 5 - Examples of failure analysis	**07Hrs**
Electromigration in IC devices, fatigue analysis of solder joints for IC package, Case of twin-tower.	

TEXT BOOKS :

1. Modarres, Reliability and Risk analysis, Mara Dekker Inc., 1993
2. New Juran, J.M and Gryna, F.M, Quality Planning and Analysis **-** Tata Mc Graw Hill publishing Company Ltd. 1982, Delhi, India.

REFERENCES :

1. Halpern, Seigmund, The Assurances Sciences, Prentice Hall International, New Jersey, U.S.A. 1978
2. Blanchard, Bejamin S. Logistics Engineering and Management, Prentice Hall International, New Jersey, U.S.A. 1986.

Open Elective

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5061**					
TITLE OF THECOURSE	**DIGITAL MARKETING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. To learn how to do marketing online- Boost website traffic, generate potential leads & increase sales revenue with better brand awareness using internet platforms like Social Media, Email Marketing, Mobile Marketing, Ecommerce Marketing and Affiliate Marketing.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	After completion of the program the students will be able to plan, conceptualize and implement Digital Marketing strategy for client requirements.	L2

COURSE CONTENT:	
MODULE 1 - Digital Marketing Overview	**08Hrs**
Introduction, Key terms and concepts, what is marketing? What is digital marketing? Why Digital Marketing wins over traditional Marketing, Understanding marketing strategy, the building blocks of marketing, Understanding Digital Marketing Process: Increasing Visibility, Visitors engagement	
MODULE 2 - Search Engine Optimization and Search Markets	**07Hrs**

Stakeholders in Search, Customer Insights, O n &off-page Optimization, Meta Tags, Layout, Content Updates, Inbound Links & Link Building, Goal Configuration & Funnels, Intelligence Reporting, Conversions, Bounce Rate, Traffic Sources, Scheduling etc.	
MODULE 3 - Social Media	**07Hrs**
What is Social Media Marketing? Overview of Facebook, Twitter, LinkedIn, Blogging, YouTube and Flickr building brand awareness using social media, social Media Management, Insights and Analytics, Best Practice Examples and case Studies.	
MODULE 4 - Website Analytics	**06Hrs**
Goal Configuration & Funnels, Intelligence Reporting, Conversions, Bounce Rate, Traffic Sources, Scheduling etc	
MODULE 5 - Email and Mobile Marketing	**08Hrs**
User Behaviour, Segmentation, Key Metrics, Best Practice Case Studies, Split Testing, Campaign Process Optimisation, SMS Strategy, Mobile Advertising, Mobile Optimized Websites, 7 Step Process for Mobile Apps, Proximity Marketing, Strategic Steps, Review &Testing.	

TEXT BOOKS:

1. Digital Marketing, Vandana Ahuja, Oxford University Press
2. The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Campaigns, Ian Dodson, Wiley 2016

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5062**					
TITLEOF THE COURSE	**PRODUCT LIFE CYCLE MANAGEMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. To understand various aspects of Product Life Cycle Management.
2. To understand Digital Manufacturing.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should be able to use methods, tools and technique taught in the Product Life Cycle Management.	L2

COURSE CONTENT:	
MODULE 1 - Introduction to Product Life Cycle Management (PLM)	**08Hrs**
Definition, PLM Lifecycle model, Threads of PLM, Need for PLM, Opportunities and benefits of PLM, Views, Components and Phases of PLM, PLM feasibility study, PLM visioning. PLM Concepts, Processes and Workflow -Characteristics of PLM, Environment driving PLM,PLM Elements, Drivers of PLM, Conceptualization, Design, Development, Validation, Production, Support of PLM.	
MODULE 2 - Product Data Management (PDM) Process and Workflow	**07Hrs**
PDM systems and importance, reason for implementing a PDM system, financial justification of PDM implementation. Versioning, check-in and checkout, views, Metadata, Lifecycle, and workflow. Applied problems and solution on PDM processes and workflow.	
MODULE 3 - Tools of Communication for collaborative work	**08Hrs**
Creation of 3DXML and CAD drawing using CAD software. Creation of an animation for assembly instructions on 3D via composer, creation of an acrobat 3D document. Applied problems and solutions on tools of communication for collaborative work. Collaborative Product Development-Digital mock-up and prototype development, design for environment, virtual testing and validation, marketing collateral	
MODULE 4 - Developing a PLM strategy and conducting a PLM assessment	**07Hrs**
Strategy, Impact of strategy, implementing a PLM strategy, PLM initiatives to support corporate objectives. Infrastructure assessment, assessment of current systems and applications.	

MODULE 5 - Digital Manufacturing – PLM	06Hrs
Digital manufacturing, benefits manufacturing, manufacturing the first-one, Ramp up, virtual learning curve, manufacturing the rest, production planning.	

TEXT BOOKS:

1. Product Lifecycle Management: Grieves, Michael, McGraw-Hill Edition 200
2. Product Data Management: Burden,Rodger, Resource Pub,2003

REFERENCES :

1. Fabio Guidice, Guido La Rosa, Product Design for the environment-A lifecycle approach, Taylor and Francis
2. Hartman, Product Lifecycle Management with SAP,2006
3. Robert J Thomas, NDP: Managing and forecasting for strategic processes

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5063**					
TITLE OF THE COURSE	**PROJECT MANAGEMENT**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSEOBJECTIVES:

1. To understand various aspects of project management
2. To understand role of project manager

COURSEOUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Students should be able to use project management methods, tools and technique	L2

COURSE CONTENT:	
MODULE 1 - THE PROJECT MANAGEMENT FRAMEWORK –INTRODUCTION	**08Hrs**
What is a Project? What is project Management? Relationship among Project management, Program management and Portfolio Management, Project Management and Operations Management, Role of a Project Manager.	
MODULE 2 – THE PROJECT MANAGEMENT FRAMEWORK-PROJECT LIFE CYCLE AND ORGANISATION	**06Hrs**
The project Life Cycle Overview, Project vs. Operational work, Stakeholders, Organizational Influences on Project Management.	
MODULE 3 - THE STANDARD FOR PROJECT MANAGEMENT OF A PROJECT	**08Hrs**

Project Management Process for a Project: Common Project Management Process Interactions, Project Management Process Groups, Initiating Process Group, Planning Process Group, Executing Process Group, Monitoring and Controlling Process Group, and Closing Process Group.	
MODULE 4 - THE PROJECT MANAGEMENT KNOWLEDGE AREAS: PART I	**07Hrs**
Project Integration management, Project scope management, Project time management, Project cost management, Project quality management	
MODULE 5 - THE PROJECT MANAGEMENT KNOWLEDGE AREAS: PART II	**07Hrs**
Project Human Resource Management, Project Communications Management, Project Risk Management, Project Procurement Management.	

TEXT BOOKS:

1. A Guide to the Project Management Body of Knowledge (PMBOK® Guide)— Fifth Edition (ENGLISH)

REFERENCES :

1. http://www.pmi.org/

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**22MDE5301**					
TITLE OF THE COURSE	**DISSERTATION PHASE I**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**12**	**144**	**6**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

1. To develop the work practice in students to apply theoretical and practical tools/techniques
2. To improve the professional competency
3. To improve research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
4. To solve real life problems related to industry and current research.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Solving of real time problems not necessarily new line of enquiry, but shows that student has mastered research and synthesizing skills in producing a contribution to knowledge.	L3
CO2	Builds competency and research aptitude.	L3

COURSE CONTENT:
The thesis shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.

SEMESTER IV

DEPARTMENTAL ELECTIVES –VI

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**22MDE5056**					
TITLE OF THE COURSE	**ROBUST DESIGN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. Optimize designs with multiple outputs and variability.
2. Learn design costs and develop branching arrays.
3. Modeling output variation and ranking the contribution to the output variation
4. Estimating the process capability for design variability and inputs.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Understanding typical quality engineering applications.	L2
CO2	Plan, design, and conduct experimental investigations effectively for design purpose.	L3
CO3	Developing tolerance level and sensitivity for design applications.	L3

COURSE CONTENT:	
MODULE 1 Introduction	**08Hrs**

Elements of cost, Noise factors causes of variation, Quadratic loss function and variation of quadratic loss functions. Steps in robust design - parameter design and tolerance design, Experimental Design: Classical experiments- factorial experiments, terminology, factors. Levels, Interactions, Treatment combination, randomization, 2-level experimental design for two factors and three factors. 3-level experiment deigns for two factors and three factors, factor effects, factor interactions, Fractional factorial design, Saturated design, Central composite designs, Illustration through numerical examples.
MODULE 2 **06Hrs**
Measures of variability, Concept of confidence level, Statistical distributions - normal, log normal and Weibull distributions. Hipothesis testing, Probability plots, choice of sample size illustration through numerical examples.
MODULE 3 **07Hrs**
Measures of variability, Ranking method, column effect method and ploting method, Analysis of variance (ANOVA), in factorial experiments - YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data, illustration through numerical examples.
MODULE 4 **08Hrs**
Types orthogonal arrays, Selection of standard orthogonal arrays, Linear graphs and interaction assignment, dummy level technique, Compound factor method, modification of linear graphs, Column merging method, Branching design, Strategies for constructing orthogonal arrays. Taguchi's inner and outer arrays.
MODULE 5 **07Hrs**
Evaluation of sensitivity to noise, Signal to noise ratios for static problems, Smaller – the – better types, Nominal – the – better – type, larger – the- better – type. Signal to noise ratios for dynamic problems, Illustrations through numerical examples. Parameter and tolerance design concepts, Parameter design strategy, Tolerance deign strategy, Illustrations through numerical examples.

TEXT BOOKS :	
1.	Douglas Montgomery, Design and analysis of experiments, Willey India Pvt. Ltd., V Ed., 2007.
2.	Phillip J. Ross, Techniques for Quality Engineering, 2nd edition. McGraw Hill Int. Ed., 1996.
REFERENCES :	
1.	Thomas B. Barker, Quality by Experimental Design, Marcel Dekker Inc ASQC Quality Press, 1985
2.	Jeff Wu, C.F., and Michael Hamada, Experiments planning, analysis and parameter design optimization, John Willey Ed., 2002.
3.	Condra, W.L. and Marcel Dekker, Reliability improvement by Experiments, Marcel Dekker Inc ASQC Quality Press, 1985

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**22MDE5057**					
TITLE OF THE COURSE	**FINITE ELEMENT METHODS FOR STRUCTURAL MECHANICS APPLICATIONS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. Understand the fundamental ideas of the FEM
2. Prepare a suitable FE model for structural mechanical analysis problems.
3. Understanding of the significance, calculation, interpretation and convergence criteria for structural mechanics.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Have acquired knowledge of finite element analysis linear and nonlinear analysis of structural application problems.	L2
CO2	To evaluate and interpret FEA analysis results for structural design and evaluation purposes.	L3

COURSE CONTENT:	
MODULE 1 - Beam Elements	**06Hrs**
Analysis of Beams and Frames, 1-D Beam Element, 2-D Beam Element, 3-D Beam Element, Shear Flexible Beam Elements, Test Problems, practical Applications and computational Problems.	
MODULE 2 - Finite Elements for Plates, Plate Theories	**07Hrs**

Classical plate theory, shear deformation theory, improved shear deformation theory. Kirchoff Plate Elements, Mindlin Plate Elements, Test Problems, Practical Applications and Computational Problems.	
MODULE 3	**08Hrs**
Finite Elements or Shells, Flat Shell Elements: Facet Approximation, Curved Shell Elements Isoparametric Shell Elements: Eight- node quadrilateral shell element. Axisymmetric Shell Elements, Practical Applications in Stress analysis of industrial fan impeller, Vibration analysis of a cylinder cantilever shell, Buckling analysis of a blade stiffened panel, Nonlinear behavior of a curved panel , Computational Problems.	
MODULE 4 - Finite Element Analysis Programs	**07Hrs**
FEA Program, Organization, Capabilities-Material Models Element library, procedures library, Data processing. FEA Program- A Catalogue, MSc.Nastran, NISA, MARC.LS-DYNA, ANSYS.	
MODULE 5- Advanced Applications	**08Hrs**
Nonlinear Finite Element Analysis, Analysis of laminated Composite Structures. Computational Fracture Mechanics, Structural Optimization, Computational Heat Transfer, Computational Fluid Dynamics, Electromagnetic and Coupled- Field analyses, Simulation of Manufacturing Processes.	

TEXT BOOKS :

1. Lakshminarayana, H. V. Finite Element Analysis Procedures in Engineering, Universities Press private Limited, Hyderabad, 2012.

REFERENCES :

1. Tirupathi R. Chandrupatla, Ashok D. Belegundu, Introduction to Finite Elements in Engineering, PHI Learning, 2008.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**22MDE5058**					
TITLE OF THE COURSE	**DESIGN OF MATERIALS HANDLING SYSTEMS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. To expose the students with latest material handling system used in industry.
2. To reduce manufacturing cycle time, delays, damage and improve working conditions of the systems
3. Developing tools for robot handling systems.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Basics of material handling system.	L2
CO2	Various material handling equipment used in industry.	L3
CO3	AGV's AS/RS system, conveyor systems.	L2
CO4	Application of Robotics in material handling	L3

COURSE CONTENT:	
MODULE 1 - Material Handling	**06Hrs**
Functions, Types, analysis, Importance & Scope, Principles, - Part feeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, in process handling – bulk handling equipment & methods.	
MODULE 2	**07Hrs**

Industrial trucks, lifting device, monorails, manipulators, conveyors, storage systems, elevators, racks, bins, pallets, cranes –Automation of material handling – mechanization of part handling.	
MODULE 3 - Types of AGV's	**07Hrs**
Guidance techniques – Painted line, wire guided, vision guided method – Applications – Vehicle guidance & routing – Traffic control & safety – system management – Quantitative analysis of AGV system.	
MODULE 4 - Conveyor systems	**08Hrs**
Types, Quantitative relationship & analysis – Automated storage system, performance – AS/RS system – Basic components, types, controls, features, applications, Quantitative analysis – carousel storage system – applications.	
MODULE 5- General considerations in robot material handling	**08Hrs**
Material transfer application – pick & place operations – machine loading & unloading – characteristics of robot application – Robot cell design – processing, operations – Spot welding, Spray painting, Plastic moulding, forging.	

TEXT BOOKS :

1. Mikell P. Groover, Automated Production system & computer integrated manufacturing –– Prentice Hall of India – 1987.
2. Govindan .K.R, Plant Layout & Material Handling – Anuradha agency – 2001.

REFERENCES :

1. Allegeri, Theodove . H, Material Handling Principle &Practice - C.B.S. Publisher, 1987.
2. Material Handling Equipment for the Manufacturing Industry - AICTE, 1995.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**22MDE5059**					
TITLE OF THE COURSE	**THEORY OF PLASTICITY**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. Introduction of plasticity and elasto plastic analysis of systems.
2. System Formulation and solving them

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Student shall be able to demonstrate knowledge and understanding on concepts of stress, strain, bending, torsion, vibrations, beams and frames.	L2
CO2	Knowledge of strain problems in practical applications with steady and non-steady case.	L3
CO3	Know the difference between plasticity and elasticity.	

COURSE CONTENT:	
MODULE 1 - Stresses and Strains	**06Hrs**
Introduction, The Stress–Strain Behaviour, Analysis of Stress, Mohr's Representation of Stress, Analysis of Strain Rate, Concepts of Stress Rate.	
MODULE 2 - Foundations of Plasticity	**08Hrs**

The Criterion of Yielding, Strain -Hardening Postulates, The Rule of Plastic Flow, Particular Stress–Strain Relations, The Total Strain Theory, Theorems of Limit Analysis, Uniqueness Theorems, Extremum Principles, Plastic Analysis of Beams and Frames: Introduction, Limit Analysis of Beams, Limit Analysis of Plane Frames, Displacements in Plane Frames, Variable Repeated Loading, Minimum Weight Design, Influence of Axial Forces, Limit Analysis of Space Frames.
MODULE 3 - Elastoplastic Bending and Torsion **08Hrs**
Plane Strain Compression and Bending, Cylindrical Bars Under Torsion and Tension, Thin-Walled Tubes Under Combined Loading, Pure Bending of Prismatic Beams Under Transverse Loads, Torsion of Prismatic Bars, Torsion of Bars of Variable Diameter, Combined Bending and Twisting of Bars. Advanced Elastoplastic Problems: Expansion of a Thick Spherical Shell, Expansion of a Thick Walled Tube, Thermal Stresses in a Thick-Walled Tube, Thermal Stresses in a Thick Spherical Shell, Pure Bending of a Curved Bar, Rotating Discs and Cylinders, Infinite Plate with a Circular Hole, Yielding Around a Cylindrical Cavity.
MODULE 4 - Steady Problems in Plane Strain **07Hrs**
Symmetrical Extrusion Through Square Dies, Unsymmetrical and Multihole Extrusion, Sheet Drawing Through Tapered Dies, Extrusion Through Tapered Dies, Extrusion Through Curved Dies, Ideal Die Profiles in Drawing and Extrusion, Limit Analysis of Plane Strain Extrusion, Cold Rolling of Strips, Analysis of Hot Rolling, Mechanics of Machining.
MODULE 5- Non steady Problems in Plane Strain **07Hrs**
Indentation by a Flat Punch, Indentation by a Rigid Wedge, Compression of a Wedge by a Flat Die, Cylindrical Depression in a Large Block, Compression Between Smooth Platens, Compression Between Rough Platens, Yielding of Notched Bars in Tension, Bending of Single-Notched Bars, Bending of Double-Notched Bars, Bending of Beams and Curved Bars, Large Bending of Wide Sheets.

TEXT BOOKS :

1. Chakrabarty, J Theory of Plasticity, 3rd ed., 2006, Elsevier.
2. Jacob Lubliner, Plasticity Theory, Revised Edition, 2008.
3. Owen, D. R. J. and Hinton, E. Finite Elements in Plasticity- Theory & Practice, Pineridge Press.

REFERENCES :

1. Hill R, Mathematical theory of plasticity, Oxford, 1998
2. Han W B. Daya Reddy, Plasticity-Mathematical Theory and Numerical Methods, Springer.
3. Maugin, G. A. The Thermo-Mechanics of Plasticity and Fracture, Cambridge University Press.

SEMESTER	**IV**

YEAR	**II**					
COURSE CODE	**22MDE5060**					
TITLE OF THE COURSE	**NON LINEAR ANALYSIS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**36**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

1. To introduce linear and nonlinear vibration analysis of systems.
2. Formulation of continuous system problems and solving them.

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Student shall be able to demonstrate knowledge and understanding on concepts of degrees of freedom, vibration control, linear and non-linear vibrations.	L2
CO2	Application of non-linear analysis problems in practical applications.	L3

COURSE CONTENT:	
MODULE 1 - Review of one degree of freedom free and forced vibrations	**12Hrs**
Introduction, Transient Vibration of single Degree-of freedom systems- Impulse excitation, Arbitrary excitation, Laplace transform formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation.	
MODULE 2 - Vibration Control	**12Hrs**
Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, and Vibration dampers. Modal analysis & Condition Monitoring,	

Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.	
MODULE 3 - Non Linear Vibrations	**12Hrs**
Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.	
MODULE 4 - Random Vibrations	**10Hrs**
Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.	
MODULE 5 - Continuous Systems	**10Hrs**
Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.	

TEXT BOOKS :

1. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, Theory of Vibration with Application, 5th Edition Pearson Education, 2008.
2. Rao, S. S., Mechanical Vibrations, 4th Edition, Pearson Education, 2004.

REFERENCES :

1. Graham Kelly, S., Mechanical Vibrations, Schaum's Outlines, Tata McGraw Hill, 2007.
2. Sujatha, C, Vibraitons and Acoustics - Measurements and signal analysis, Tata McGraw Hill, 2009.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**22MDE5401**					
TITLE OF THE COURSE	**DISSERTATION PHASE II**					
SCHEME OF INSTRUCTION	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**-**	**-**	**18**	**216**	**12**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The dissertation demonstrates the student's mastery of relevant resources and methods.

1. An ordered, critical exposition of knowledge gained through student's own effort.
2. Demonstrates sound under-standing of research process.
3. Demonstrates knowledge of appropriate methodology.
4. Demonstrates ability to present study in a disciplined way in scholarly conventions of the discipline.
5. Ability to make critical use of published work.

COURSE OUTCOMES:

CO No.	**Outcomes** 1(	**Bloom's Taxonomy Level**
CO1	Improves the professional competency and research.	L3
CO2	Develops the work to apply theoretical and practica tools/techniques.	L3
CO3	Solve problems related to industry and current research.	L3
CO4	Possible publication in journal or conferences.	L3

COURSE CONTENT:
THE REPORT GENERALLY CONTAINS: 1. Cover

2. Title page
3. Certificate(s)
4. Acknowledgements
5. Abstract
6. Contents page
7. List of figures or Tables
8. Introduction
9. Literature survey
10. Methodology
11. Results and Discussion
12. Conclusion and scope of future work.
13. Reference list / Bibliography
14. Appendices.

Avoiding plagiarism

1. Plagiarism is taking the words, theories, or ideas of another person and passing them off as your own.
2. Plagiarism can be copying inadvertently/advertently a passage from a book or journal or pasting something from the internet into report without referencing the original source.
3. Plagiarism can also result from wrong referencing.

Avoiding plagiarism

The guide/supervisor shall certify that the report is checked for plagiarism and is within 25% of the content.

The thesis shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed. It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic. Student should submit the thesis covering the content discussed above and highlighting the features of work to be carried out in the thesis. Student should follow standard practice of thesis writing. At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva–voce.