Rashtreeya Sikshana Samithi Trust

R.V.College of Engineering

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Mechanical Engineering

Master of Technology (M. Tech.)

Machine Design

Scheme and Syllabus of Autonomous System w.e.f 2016

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Mechanical Engineering

Vision:

Quality education in Design, Materials, Thermal and Manufacturing with emphasis on research, sustainable technologies and entrepreneurship for societal symbiosis.

Mission:

- Imparting knowledge in basic and applied areas of Mechanical Engineering.
- Providing state-of-the-art laboratories and infrastructure for academics and research in the areas of design, materials, thermal engineering and manufacturing.
- Facilitating faculty development through continuous improvement programs.
- Promoting research, education and training in materials, design, manufacturing, Thermal Engineering and other multidisciplinary areas.
- Strengthening collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Imbibing social and ethical values in students, staff and faculty through personality development programs

Program Specific Criteria (PSC) as per ASME

Program Educational Objectives (PEO)

The Graduates of M. Tech. in Machine Design Program will be prepared for:

PEO1 Practicing design of engineering systems through the application of the fundamental knowledge and skills of Mechanical Engineering.

PEO2 Enhancing their skills through training, independent inquiry, and professional development.

PEO3 Working independently as well as collaboratively, while demonstrating the professional and ethical responsibilities of the engineering profession.

Program Outcomes (PO)

M. Tech. in Machine Design graduates will be able to:

PO1: Apply the knowledge of Mathematics and Engineering for machine design

PO2: Identify and analyze the engineering challenges / problems regarding human needs in daily life about machines and systems.

PO3: Design and develop engineering solutions for global progress, productivity and economic development.

PO4: Use of modern tools and techniques for modeling and analysis of complex engineering systems.

PO5: Understand the impact of Machine Design engineering on all aspects of environment and society and to demonstrate the knowledge and need for sustainable development.

PO6: Work as professionals in accordance with the norms of Machine Design engineering practices and commit to societal, ethical and professional responsibilities.

PO7: Apply professional, ethical, legal, security and social issues in the design systems.

PO8: Demonstrate design principles to work as team member and / or leader in multidisciplinary areas of engineering

PO9: Communicate effectively through written and oral modes.

PO10: Understand and apply project management techniques, tools and practices to plan manage and complete an Engineering Design project.

PO11: Engage in independent and lifelong learning by pursuing higher studies and training.

Program: M.Tech in Machine Design

Program Specific Criteria (PSC):

Program Specific Criteria (PSC) as per American Society of Mechanical Engineers

The curriculum is designed to enable the students to (a) apply principles of engineering design, analysis, selection of materials and manufacturing processes using modern tools and techniques to new products; (b) be proficient in costing, quality assessment and its life cycle management; (c) work in teams, communicate effectively, demonstrate concern for environment and sustainability of products and processes.

The faculty members of the program possess in-depth understanding and expertise in their areas of specialization with a commitment to periodically update their knowledge in respective domains.

Program Specific Outcomes (PSO)

M. Tech. in Machine Design graduates will be able to:

PSO 1: Design Mechanical systems using interrelationship among force, stress, vibration and failure analysis.

PSO 2: Develop advanced analysis tools for evaluating performance of mechanical systems to enhance the capability of the designer.

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Department of Mechanical Engineering

M. Tech. in Machine Design

FIRST SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self-Study S**	
1	16MEM11P	Project Management	IM	3	1	0	0	4
2	16MAT12C	Advanced Mathematics	MA	4	0	0	0	4
3	16MMD13	Advanced Finite Element Methods (Theory & Practice)	ME	4	0	1	0	5
4	16MMD14	Advanced Theory of Vibrations	ME	4	0	0	1	5
5	16MMD15X	Elective 1	ME	4	0	0	0	4
6	16HSS16	Professional Skill Development	HSS	0	0	2	0	2
Total				**19**	**1**	**3**	**1**	**24**

Elective 1			
16MMD151	Advanced Solid Mechanics	16MMD152	Acoustics and Noise Control

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M. Tech. in Machine Design

SECOND SEMESTER								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self-Study S**	
1.	16MEM21R	Research Methodology	IM	3	1	0	0	4
2.	16MMD22	Theory of Mechanisms (Theory & Practice)	ME	4	0	1	0	5
3.	16MMD23X	Elective 2	ME	4	0	0	0	4
4.	16MMD24X	Elective 3	ME	4	0	0	0	4
5.	16MMD25X	Elective 4	ME	4	0	0	0	4
6.	16MMD26	Minor Project	ME	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**

Elective 2			
16MMD231	Tribology and Bearing Design	16MMD232/16MTE232	Design of Hydraulics and Pneumatics
Elective 3			
16MMD241	Theory of Plates and Shells	16MMD242/16MCM242	Industrial Robotics
Elective 4			
16MMD251	Selection of Materials and Processes	16MMD252	Computer Applications in Design

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M. Tech. in Machine Design

THIRD SEMESTER								
Sl. No.	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self-Study S**	
1	16MMD31	Advanced Machine Design (Theory & Practice)	ME	4	0	1	0	5
2	16MMD32X	Elective 5	ME	4	0	0	0	4
3	16MMD33X	Elective 6	ME	4	0	0	0	4
4	16MMD34X	Elective 7	ME	4	0	0	0	4
5	16MMD35	Internship/Industrial Training	ME	0	0	3	0	3
6	16MMD36	Technical Seminar	ME	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

Elective 5			
16MMD321	Fracture Mechanics	16MMD322	Computational Fluid Dynamics
Elective 6			
16MMD331	Mechatronics system design	16MMD332	Rotor Dynamics
Elective 7			
16MMD341	Design of Smart Structures	16MMD342	Design of Pressure Vessels

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FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Self-Study S**	
1	16MMD41	Major Project	ME	0	0	26	0	26
2	16MMD42	Seminar	ME	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

THIRD SEMESTER

ADVANCED MACHINE DESIGN
(Theory & Practice)

Course Code	**:**	**16MMD31**		**CIE Marks**	**:**	**100 + 50**
Hrs/Week	**:**	**L:T:P:S**	**4:0:2:0**	**SEE Marks**	**:**	**100 + 50**
Credits	**:**	**05**		**SEE Duration**	**:**	**3 + 3 Hrs.**

Course Objective:

Graduates will be able to

1. Fundamental understanding of linear elastic fracture mechanics (LEFM) and the conditions under which LEFM is valid;
2. Explain generalized (nonlinear) fracture mechanics;
3. Demonstrate various regimes of fatigue crack growth;
4. Experimental methods to assess the integrity and/or life of structural components.

Unit 1

12 hours

Introduction: 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. Fatigue of Materials: Introductory concepts, 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

Unit 2

12 hours

Stress-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behaviour, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. Strain-Life(ε-N)approach: Monotonic stress-strain behaviour ,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.

Unit 3

12 hours

LEFM Approach: 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 30 stress effects and Haigh diagrams, Notch strain analysis and the strain – life approach, Neuber's rule, Glinka's rule, and applications of fracture mechanics to crack growth at notches.

Unit 4

8 hours

Fatigue from Variable Amplitude Loading: 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.

Unit 5

8 hours

Surface Failure: 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.

Unit – 6 Lab component
Lab exercises 1. To determine the fatigue life (N_f) as functions of uniaxial tensile stress for an aluminium alloy. 2. To study the effect of fluctuating stress normally encountered in the cyclic loading of materials in service. 3. To determine the critical speed of shaft with various diameters. 4. To generate S-N curve by performing test on rotating-beam fatigue test 5. Perform fatigue analysis using ANSYS Workbench 6. Perform stress based approach for high cycle fatigue for constant amplitude, variable amplitude with proportional loading using ANSYS Workbench

Course Outcomes: After going through this course the student will be able to:

CO1: Identify and explain the types of fractures of engineered materials and their characteristic features

CO2: Develop detailed understanding of S-N curves, S-N approach & behaviour

CO3: Understand the differences in the classification of fracture mechanics (LEFM and EPFM) and how their corresponding parameters can be utilized to determine conditions under which engineering materials will be liable to fail catastrophically in service.

CO4: Appreciate the theoretical basis of the experimental techniques utilized for surface failure analysis

References

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John wiley Newyork, Second edition. 2001. ISBN: 978-1-933489-67-4
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, Newyork 1992. ISBN: 988-3-955783-62-2
3. Robert L. Norton , "Machine Design", Pearson Education India, 2000, ISBN 0-06-008493-3
4. S.Suresh, "Fatigue of Materials", Cambridge University Press, -1998 5.Julie.A.Benantine , "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990 6.Fatigue and Fracture, ASM Hand Book, Vol 19,2002. ISBN: 924-3-865783-67-8

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Practical

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Practical

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	M	L	M	L	M	-	-	-	-	-
CO2	H	-	-	-	-	-	M	-	-	-	-
CO3	L	M	-	H	M	H	-	-	-	-	-
CO4	M	-	M	L	-	-	L	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	H
CO2	M	-
CO3	L	-
CO4	H	L

FRACTURE MECHANICS (Elective 5)						
Course Code	**:**	**16MMD321**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

Course Objective:

Graduates shall be able to

1.Understand the fracture behavior of materials.

2. Apply Linear & nonlinear fracture mechanics principles & their applications to structural design.

3. To perform damage tolerance analysis of structures.

4. Explain fracture phenomena in metals and non-metals.

Unit 1

8 hours

History and Overview, Why Structures Fail, Historical Perspective, Early Fracture Research, The Liberty Ships, Post-War Fracture Mechanics Research, The Fracture Mechanics Approach to Design, The Energy Criterion, The Stress-Intensity Approach, Time-Dependent Crack Growth and Damage Tolerance, Effect of Material Properties on Fracture, A Brief Review of Dimensional Analysis.

Unit 2

12 hours

Linear Elastic Fracture Mechanics, An Atomic View of Fracture, Stress Concentration Effect of Flaws, The Griffith Energy Balance, Comparison with the Critical Stress Criterion, Modified Griffith Equation, The Energy Release Rate, Instability and the R-Curve, Reasons for the R-Curve Shape, Load Control vs. Displacement Control, Structures with Finite Compliance, Stress Analysis of Cracks, The Stress Intensity Factor, Relationship between K and Global Behaviour, Effect of Finite Size , Principle of Superposition, Weight Functions.

Unit 3

12 hours

Relationship between K and G, Crack-Tip Plasticity, The Irwin Approach, The Strip-Yield Model , Comparison of Plastic Zone Corrections, Plastic Zone Shape, K -Controlled Fracture, Plane Strain Fracture: Fact vs. Fiction , Effect of Thickness on Apparent Fracture Toughness, Plastic Zone Effects, Implications for Cracks in Structures, Mixed-Mode Fracture, Mathematical Foundations of Linear Elastic Fracture Mechanics, Plane Elasticity, Cartesian Coordinates, Polar Coordinates, Crack Growth Instability Analysis, Crack-Tip Stress Analysis, Generalized In-Plane Loading, The Westergaard Stress Function, Elastic-Plastic Fracture Mechanics, Crack-Tip-Opening Displacement, The Contour Integral, J as a Path-Independent Line Integral , J as a Stress Intensity Parameter , The Large Strain Zone , Laboratory Measurement of J , Relationships Between J and CTOD, Crack-Growth Resistance Curves , Stable and Unstable Crack Growth, Computing J for a Growing Crack, J-Controlled Fracture.

Unit 4

8 hours

Fatigue Crack Propagation, Similitude in Fatigue, Empirical Fatigue Crack Growth Equations, Crack Closure , A Closer Look at Crack-Wedging Mechanisms, Effects of Loading Variables on Closure, The Fatigue Threshold, The Closure Model for the Threshold, A Two-Criterion Model, Threshold Behaviour in Inert Environments , Variable Amplitude Loading and Retardation, Linear Damage Model for Variable Amplitude Fatigue, Reverse Plasticity at the

Crack Tip, The Effect of Overloads and Under loads , Models for Retardation and Variable Amplitude Fatigue, Growth of Short Cracks, Micro-mechanisms of Fatigue , Fatigue in Region II, Fatigue at High ΔK Values, Fatigue Crack Growth Experiments, Crack Growth Rate and Threshold Measurement, Closure Measurements, A Proposed Experimental Definition of ΔK_{eff}, Damage Tolerance Methodology.

Unit 5

8 hours

Computational Fracture Mechanics, Overview of Numerical Methods, The Finite Element Method, The Boundary Integral Equation Method, Traditional Methods in Computational Fracture Mechanics, Stress and Displacement Matching, Elemental Crack Advance, Contour Integration, Virtual Crack Extension: Stiffness Derivative Formulation, Virtual Crack Extension: Continuum Approach, The Energy Domain Integral, Theoretical Background, Generalization to Three Dimensions , Finite Element Implementation, Mesh Design, Linear Elastic Convergence Study , Analysis of Growing Cracks , Properties of Singularity Elements, Quadrilateral Element, Triangular Element.

Course Outcomes: After going through this course the student will be able to:
CO1: Illustrate material failure for any combination of applied stresses.
CO2: Estimate failure conditions of a structure
CO3: Determine the stress intensity factor for simple components of simple geometry
CO4: Predict the likelihood of failure of a structure containing a defect

References

1. FractureMechanics: Fundamentals and Applications, T. L. Anderson, Taylor and Francis Fourth Edition, 2005. ISBN: 977-3-735689-37-8
2. Elementary Engineering Fracture Mechanics, David Broek , Kluwer Academic Publishers, 4th revised edition. ISBN: 978-1-935159-47-9
3. Elements of Fracture Mechanics, Prashanth Kumar, Tata McGraw-Hill Education, 2009 ISBN: 077-1-732682-17-2
4. Fracture Mechanics by E.E. Gdoutos, Kluwer Academic Publishing, Boston, 1993. ISBN: 947-1-272683-32-9
5. Deformation and Fracture Mechanics of Engineering Materials by R.W. Hertzberg, Callister, Fourth Edition, John Wiley and Sons, Inc., 1996, ISBN: 078-3-736649-27-2

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	L	L	-	H	-	-	-	-	-	-
CO2	-	-	H	M	-	L	-	-	-	-	-
CO3	H	H	-	-	M	-	-	-	-	-	-
CO4	-	-	M	L	-	-	L	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	M
CO2	L	H
CO3	H	-
CO4	-	M

COMPUTATIONAL FLUID MECHANICS (Elective 5)						
Course Code	**:**	**16MMD322**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

The objectives of this course are

- To introduce the basics of computational fluid dynamics and its application to solve engineering problems.
- Introduction to basic governing equations of fluid flow and heat transfer.
- To train the students to apply these equations to real fluid flow situations.
- Introduction to numerical methods and popular discretization techniques to solve these equations.

Unit – I	**06 Hrs**
Introduction to CFD:the need for computer simulations of fluid flows; Brief history of CFD; A few examples of contribution of CFD to engineering design **Governing equations of fluid flows:** Navier-Stokes equations, Equations of inviscid compressible and incompressible flows; Concepts of convection and diffusion.	
Unit – II	**07 Hrs**
Analysis of the governing equations of fluid flows: Navier-Stokes to Burgers equation, Convection-diffusion equation, Linear convection equation, Diffusion equation, Unsteady and steady state heat conduction equations. **Mathematical classification of Partial Differential Equations (PDEs):**Elliptic, Parabolic and Hyperbolic equations; Physical significance of the equation; Method of Characteristics; diffusion, Burgers and linear convection equations.	
Unit – III	**07 Hrs**
Finite difference method: Introduction to Finite Difference Method (FDM) and its application to unsteady heat conduction and steady heat conduction equations; Explicit and implicit methods; FDM for linear convection equation and upwind differencing method; FDM in two dimensions. **Properties of numerical methods:** Consistency, Stability, Convergence, Order of accuracy, Modified equations, Artificial viscosity or Numerical diffusion, Numerical dispersion.	
Unit – IV	**07 Hrs**
Finite volume method: Introduction to Finite Volume Method (FVM) and its application to unsteady and steady heat conduction equations, Linear convection equation; Central discretization and upwind discretization in FVM; 2-D Finite volume method on Cartesian, quadrilateral and triangular grids; Basics of grid generation.	

Unit – V	07 Hrs
Numerical methods for incompressible flows: Basic problem of the pressure updating; stream function and vorticity formulation, Pressure correction methods, SIMPLE algorithm, Artificial compressibility formulation. **Solution of algebraic equations:** Gauss-Seidel iteration method, Tri-diagonal matrix (Thomas) algorithm, Alternating Direction Implicit (ADI) method.	
Course outcomes: After the course the students will be able to: Understand the basics involved in the developments of CFD (L1 & L2). Formulate and solve processes (L3). Interpret the results and to obtain the solution to governing equations to fluid flow and heat flow processes (L4 & L5). Ability to develop CFD models for "real world" engineering problems (L6).	

Reference Books

1	John D Anderson; **Computational Fluid Dynamics:** The Basics with Applications; McGraw –Hill, 6th Edition; 1995; ISBN: 0070016852;
2	J.Tu,G.Yeoh,C.Liu ;**Computational Fluid Dynamics:** a Practical Approach; Elsevier , 2nd Edition ;2013 ;ISBN-13: 9780750685634
3	Joel H Ferziger and Peric ; **Computational Methods for Fluid Dynamics;** Springer 2nd edition, 1999, ISBN :3540653732
4	SV Patankar; **Numerical Fluid flow and Heat Transfer;** Hemisphere Publishing Corporation; 1980; **ISBN:** 0891165223
5	H.Versteeg, W.Malalsekra; **An Introduction to Compuational Fluid Dynamics**, Finite Volume Method: 2nd Edition ,Dorling Kindersley Pvt Ltd Copyright 2008 with Pearson Education Ltd UK. ISBN : 978-81-317-2048-6
6	J. C. Tannehill, D. A. Anderson and R. H. Pletcher, **Computational Fluid Mechanics and Heat Transfered,** 2,Taylor & Francis, UK, 2001.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	MEPO1	MEPO2	MEPO3	MEPO4	MEPO5	MEPO6
CO1	L		L	L	H	M
CO2	M		M		H	M
CO3	M		M		M	M
CO4	H		H		H	M

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	**PSO2**
CO1	-	M
CO2	L	-
CO3	H	-
CO4	-	M

MECHATRONICS SYSTEMS (Elective 6)						
Course Code	**:**	**16MMD331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Substantiate the need for interdisciplinary study in technology education.
2. Understand the evolution and development of Mechatronics as a discipline.
3. Compare various types of transducers used in industrial automation, machine control systems, instrumentation and equipments.
4. Understand the applications of microprocessors in various systems and to know the functions of each element.

Unit – I	**07 Hrs**

Introduction: Definition, Multidisciplinary Scenario, Evolution of Mechatronics, Design of Mechatronics system, Objectives, advantages and disadvantages of Mechatronics.

Transducers and Sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, proximity switches and Hall effect sensors.

Unit – II	**10 Hrs**

Microprocessors and Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers, Microprocessor architecture, Terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data, Registers, Program Counter, Flags, Fetch cycle; write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Unit – III	**12 Hrs**

PLC: Introduction to PLC's, basic structure, Principle of operation, Programming and concept of ladder diagram, Concept of latching & selection of a PLC.

Integration: Integration: Introduction & background, Advanced actuators, Pneumatic actuators, Industrial Robot, different parts of a Robot-Controller, Drive, Arm, End Effectors, Sensor & Functional requirements of robot.

Unit – IV	**12 Hrs**

Mechanical Actuation: Mechanical systems, types of motion, Cams, Gear trains, Ratchet & Pawl, Belt and chain drives, Mechanical aspects of motor selection.

Electrical Actuation System: Electrical systems, Mechanical switches, Solenoids, Relays, DC/AC Motors, Principle of Stepper Motors & servomotors.

Unit – V	**09 Hrs**

Pneumatic and Hydraulic systems: Actuating systems, Pneumatic and hydraulic systems, Classifications of Valves, Pressure relief valves, Pressure regulating/reducing valves, Pressure sequence valve, Cylinders and rotary actuators.

DCV& FCV: Principle & construction details, types of sliding spool valve, Solenoid operated, Symbols of hydraulic elements, Components of hydraulic system, functions of various units of hydraulic system.

Course Outcomes:

After going through this course the student will be able to:

CO1: Define various types of transducers used in industrial automation and machine control systems.

CO2: Explain the architecture of microprocessors system

CO3: Describe the working principle of mechanical, electrical, pneumatic and hydraulic actuators

CO4: Design ladder logic based PLC circuit to control various industrial activities

Reference Books

1. Nitaigour Premchand Mahalik, "Mechatronics-Principles, Concepts and Applications", Tata Mc Graw Hill –2003, ISBN:0070483744
2. Anthony Esposito, "Fluid Power", Pearson Education 6th Edition-2011, ISBN:0135136903
3. W.Bolton, "Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering", Pearson Education-2005, ISBN: 0273742868
4. Mechatronics by "HMT Ltd. – Tata Mc GrawHill -2000.ISBN: 007463643X

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	L	L	-	-	-	M	-	-	-	-
CO2	L	-	-	H	-	-	-	-	-	-	-
CO3	-	M	H	-	L	-	-	-	-	-	-
CO4	M	-	-	H	M	M	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	M	H
CO2	-	L
CO3	H	-
CO4	L	M

ROTOR DYNAMICS (Elective 6)						
Course Code	**:**	**16MMD332**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

Course Objective:

Graduates shall be able to

1. Understand the lubrication phenomenon rotor dynamics phenomena with the help of simple rotor models.
2. Identify the design parameters that determine the rotor dynamic behavior.
3. Recognize machine behavior due to anisotropy and be aware of the implications for balancing.
4. Examine the design, application, and reliability evaluation of bearings in rotating machinery applications

Unit 1

8 hours

Fluid Film Lubrication: Basic theory of fluid film lubrication, Derivation of generalized Reynolds equations, Boundary conditions, Fluid film stiffness and Damping coefficients, Stability and dynamic response for hydrodynamic journal bearing, Two lobe journal bearings.

Unit 2

10 hours

Stability of Flexible Shafts: Introduction, equation of motion of a flexible shaft with rigid support, Radial elastic friction forces, Rotary friction, friction Independent of velocity, friction dependent on frequency, Different shaft stiffness Constant, gyroscopic effects, Nonlinear problems of large deformation applied forces, instability of rotors in magnetic field.

Unit 3

12 hours

Turbo rotor System Stability by Transfer Matrix Formulation: General Turbo rotor system, development of element transfer matrices, the matrix differential equation, effect of shear and rotary inertia, the elastic rotors supported in bearings, numerical solutions

Turborotor System Stability by Finite Element Formulation: General turbo rotor system, generalized forces and co-ordinates system assembly element matrices.

Unit 4

8 hours

Consistent mass matrix formulation, Lumped mass model, linearized model for journal bearings, System dynamic equations Fix stability analysis non dimensional stability analysis, unbalance response and Transient analysis.

Unit 5

10 hours

Critical Speed: Dunkerley's method, Rayleigh's method, Stodola's method. Rotor Bearing System: Instability of rotors due to the effect of hydrodynamic oil layer in the bearings, support flexibility, Simple model with one concentrated mass at the centre

Blade Vibration: Centrifugal effect, Transfer matrix and Finite element, approaches

References
1. Cameron, "Principles of Lubrication", Longman Publishing Group, 1986,ISBN: 977-85-233-5217-3
2. Bolotin , "Theory of elastic stability", Macmillan, 1963, ISBN: 978-63-213-1117-3
3. Adams M. L. Jr, "Rotating Machinery Vibration: From Analysis to troubleshooting, Marcel Dekker, Inc., New York.2001, ISBN: 0072-83-113-1217-1
4. Timoshenko , "Vibration Problems in Engineering", Oxford City Press, 2011 ISBN: 778-76-223-2217-8
5. Zienkiewicz, "The finite element method in engineering science", McGraw-Hill, 1971 ISBN: 975-66-113-2217-1

Course Outcomes: At the end of the course students will be able to

CO1: Emphasize on vibration phenomena exhibited by the machine undergoing high vibration.

CO2: Analyze rotor dynamics and vibration analysis as it relates to machinery condition monitoringsystems.

CO3:Implement proper steps to prevent torsional vibration problems occurring in rotating equipments.

CO4: Ability to develop FE procedures for blade vibration.

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	H	M	-	-	H	-	-	-	-	-
CO2	M	-	-	M	-	-	L	-	-	-	-
CO3	-	L	-	-	H	-	-	-	-	-	-
CO4	H	-	L	L	-	-	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	M
CO2	-	-
CO3	L	-
CO4	M	L

DESIGN OF SMART STRUCTURES (Elective 7)						
Course Code	**:**	**16MMD341**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3 Hrs.**

Course Objective:

Graduates will be able to

1.To model different types of smart materials and to design simple smart structures.

2.Perform detailed analysis of the response of systems exhibiting shape memory effects

3.Apply mechanisms of MR fluids for minimizing damping

4. Illustrate the response of materials exhibiting piezoelectricity and piezo resistivity

Unit 1

8 hours

Smart Structures: Types of Smart Structures, Potential Feasibility of Smart Structures, Key Elements Of Smart Structures, Applications of Smart Structures. Piezoelectric materials, Properties, piezoelectric Constitutive Relations, Depoling and Coersive Field, field strain relation. Hysteresis, Creep and Strain Rate effects, Inchworm Linear Motor.

Unit 2

12 hours

Beam Modeling: Beam Modeling with induced strain Rate effects, Inchworm Linear Motor Beam Modeling with induced strain Actuation-single Actuators, dual Actuators, Pure Extension, Pure Bending harmonic excitation, Bernoulli-Euler beam Model, problems, Piezo electrical Applications

Shape memory Alloy: Experimental Phenomenology, Shape Memory Effect, Phase Transformation, Tanaka's Constitutive Model, testing of SMA Wires, Vibration Control through SMA, Multiplexing. Applications Of SMA and Problems

Unit 3

12 hours

ER and MR Fluids: Mechanisms and properties, Fluid Composition and behaviour, The Bingham Plastic and Related Models, Pre-Yield Response. Post-Yield flow applications in Clatches, Dampers and Others.

Vibration Absorbers: series and Parallel Damped Vibrations (Overview), Active Vibration Absorbers, fibre Optics, Physical Phenomena, Characteristics, Sensors, Fibre Optics in Crack Detection, applications.

Unit 4

8 hours

Control of Structures: Modeling, Control Strategies and Limitations, Active Structures in Practice **MEMS** – Mechanical Properties of MEMS Materials, Scaling of Mechanical Systems, Fundamentals of Theory, The Intrinsic Characteristics of MEMS, Miniaturization, Microelectronics Integration.

Unit 5

8 hours

Devices: Sensors and Actuators, Conductivity of Semiconductors, Crystal Planes and Orientation, (Stress and Strain Relations, Flexural Beam Bending Analysis Under Simple Loading Conditions), Polymers in MEMS, Optical MEMS Applications.

Course Outcomes: At the end of the course students will be able to

CO1: Understand the behavior and applicability of various smart materials, beam models
CO2:Design detailed response of systems exhibiting shape memory effect
CO3: Perform modeling and control of active structures in practice
CO4: Apply the techniques to produce solutions to industrial problems using smart structures and materials

References

1. Smart Materials and Structures - M. V. Gandhi and B. So Thompson, Chapman and Hall, London; New York, 1992 (ISBN: 0412370107).
2. Smart Structures and Materials - B. Culshaw, Artech House, Boston, 1996 (ISBN :0890066817).
3. Smart Structures: Analysis and Design - A. V. Srinivasan, Cambridge University Press, Cambridge; New York, 2001 (ISBN: 0521650267).
4. Piezoelectric Sensors: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors. Materials and Amplifiers, Springer, Berlin; New York, 2002 (ISBN: 3540422595).
5. Piezoelectric Actuators and ultrasonic Motors - K. Uchino, Kluwer Academic Publishers, Boston, 1997 (ISBN: 0792398114).

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	-	L	H	-	M	H	-	-	-	-	-
CO2	L	-	-	M	-	-	-	-	-	-	-
CO3	-	M	-	-	H	L	-	-	-	-	-
CO4	H	-	L	L	-	-	L	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	H
CO2	L	L
CO3	-	-
CO4	M	L

DESIGN OF PRESSURE VESSELS (Elective 7)						
Course Code	**:**	**16MMD342**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**04**		**SEE Duration**	**:**	**3**

Course Objective:

Graduates will be able to

1.Understand basic design procedure for pressure vessel, using ASME code

2.Impart basic knowledge of design of pressure vessels and piping system

3.To Analyze stresses in pressure vessels of different shapes

4. To enable the students to design piping systems

Unit 1

5 hours

Introduction: Methods for determining stresses – Terminology and Ligament Efficiency – Applications; Introduction to ASME cods for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles;

Unit 2

12 hours

Stresses In Pressure Vessels: Introduction – Stresses in a circular ring, cylinder – Membrane stress Analysis of Vessel Shell components – Cylindrical shells, spherical Heads, conical heads – Thermal Stresses –Discontinuity stresses in pressure vessels.

Bending of circular plates and determination of stresses in simply supported and clamped circular plate; Thermal stresses; Stress concentration in plate having circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle, rupture and creep. Theory of reinforced opening and reinforcement limits

Unit 3

12 hours

Design Of Vessels: Design of Tall cylindrical self-supporting process columns –Supports for short, vertical and horizontal vessels – stress concentration – at a variable Thickness transition section in a cylindrical vessel, about a circular hole, elliptical openings. Theory of Reinforcement – pressure vessel Design. Introduction to ASME pressure vessel codes.

Unit 4

10 hours

Buckling of Vessels: Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.

Unit 5

9 hours

Piping: Introduction – Flow diagram – piping layout and piping stress Analysis. Design of piping system as per B31.1 piping code. Piping components - bends, tees, bellows and valves.Types of piping supports and their behaviour; Introduction to piping Codes and Standards.

References

1. John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors, 1987.

ISBN-12: 975-87-223-2301-5
2. Henry H. Bedner, "Pressure Vessels, Design Hand Book, CBS publishers and Distributors, 1987.ISBN-0-07-2118256-4
3. Stanley, M. Wales, "Chemical process equipment, selection and Design. Butterworths series in Chemical Engineering, 1988.. ISBN-14: 985-88-123-1302-7
4. William. J., Bees, "Approximate Methods in the Design and Analysis of Pressure Vessels and Piping", Pre ASME Pressure Vessels and Piping Conference, 1997. ISBN-11: 973-97-221-1801-4
5. ASME Pressure Vessel and Boiler code, Section VIII Div 1, 2, and 3.

Course Outcomes: At the end of the course students will be able to

CO1: Ability to analyse thin plates and shells for various types of stresses.
CO2. Design shells, end closures and nozzles of pressure vessels using ASME codes.
CO3. Analyse buckling of vessels and their failures due to external loads.
CO4: To identify, formulate, and solve simple problems in piping systems

Scheme of Continuous Internal Evaluation (CIE)

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE)

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	-	-	M	H	L	-	-	-	-	-
CO2	-	-	L	-	-	-	L	-	-	-	-
CO3	M	H	-	L	-	M	-	-	-	-	-
CO4	-	-	H	-	M	-	-	-	-	-	-

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	-	H
CO2	H	L
CO3	-	-
CO4	M	M

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	**:**	**16MMD35**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:6:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**30 min**

GUIDELINES FOR INTERNSHIP

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to produce product and provide services.

(2) Explain the importance of management and resource utilization

(3) Comprehend the importance of team work, protection of environment and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) The duration of the internship shall be for a period of 8 weeks on full time basis between II semester final exams and beginning of III semester.
2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.
3) Internship must be related to the field of specialization or the M.Tech program in which the student has enrolled.
4) Students undergoing internship training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.
5) Every student has to write and submit his/her own internship report to the designated faculty.
6) Students have to make a presentation on their internship activities in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the internship final report. However interim or periodic reports and reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.
7) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
8) The broad format of the internship final report shall be as follows
    - Cover Page
    - Certificate from College
    - Certificate from Industry / Organization
    - Acknowledgement
    - Synopsis
    - Table of Contents
    - Chapter 1 - Profile of the Organization – Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
    - Chapter 2 - Activities of the Department -
    - Chapter 3 – Tasks Performed – summaries the tasks performed during 8 week period
    - Chapter 4 – Reflections – Highlight specific technical and soft skills that you acquired during internship

- References & Annexure

Course Outcomes:

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of the Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries 35%
(2) Ability to comprehend the functioning of the organization/ departments 20%
(3) Importance of resource management, environment and sustainability 25%
(4) Presentation Skills and Report 20%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL TRAINING

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to industrial products & processes
(2) Explain the importance of skilling, training and resource management.
(3) Comprehend the importance of team work, communication and sustainable solutions.
(4) Imbibe values, professional ethics for life long learning.

1) The duration of industrial training must be for a minimum of 1 week and maximum of 8 weeks on full time basis.
2) Industrial Training in which students pays a fee to the organization / industry will not be considered.
3) He/she can undergo training in one or more industry /organization.
4) The student must submit letters from the industry clearly specifying his / her name and the duration of the training provided by the company with authorized signatures.
5) Industrial training must be related to the field of specialization or the M.Tech program in which the student has enrolled.
6) Students undergoing industrial training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.
7) Every student has to write and submit his/her own industrial training report to the designated faculty.
8) Students have to make a presentation on their industrial training in front of the departmental cmmittee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.
9) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
10) The broad format of the industrial training report shall be as follows
    - Cover Page
    - Certificate from College
    - Training Certificate from Industry / Organization
    - Acknowledgement
    - Executive Summary
    - Table of Contents
    - Chapter 1 - Profile of the Organization –Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 2 – Details of the Training Modules
    - Chapter 3 – Reflections – Highlight specific technical and soft skills that you acquired

    References & Annexure

Course Outcomes:

After going through the industrial training the student will be able to:

CO1: Understand the process of applying engineering knowledge to solve industrial problems
CO2: Develop skills through training relevant to industrial requirement
CO3: Communicate effectively and work in teams
CO4: Imbibe ethical practices and develop it as life skill.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):
The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation on the application of engineering knowledge 25%
(2) Ability to comprehend the importance of skilling and training 25%
(3) Importance of communication, professional ethics, sustainability 20%
(4) Oral Presentation and Report 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL VISITS

Course Learning Objectives (CLO):
The students shall be able to:
(1) Understand the role of industries and service organization in meeting the demands of the society.
(2) Explain the working of different industries and organizations with an engineering perspective
(3) Comprehend the importance of team work, communication and sustainable solutions.
(4) Imbibe values, professional ethics for life long learning.

1) Student must visit a minimum of THREE organizations/industry. The duration of the visit per organization must be for ONE full day, during which he/she must comprehend the importance of organization structure, function of various departments, application of engineering knowledge, resource management, importance to environment and safety, professional ethics.
2) It is mandatory to visit ONE private multi-national company or public sector industry / organization, ONE medium-small enterprise and ONE rural based or NG organization.
3) The student must submit letter from the industry clearly specifying his / her name and the date

of visit to the industry with authorized signatures.

4) Industrial visit must be related to the field of specialization or the M.Tech program in which the student has enrolled.
5) Every student has to write and submit his/her own report on each industrial visit and submit the report to the designated faculty advisor for evaluation.
6) A photograph outside the industry with the name and logo of the industry in the background along with the students and faculty members could be included in the report.
7) Students have to make a presentation on their industrial visit in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.
8) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.
9) The broad format of the industrial visit report shall be as follows
    - Cover Page
    - Certificate from College
    - Acknowledgement
    - Synopsis / Executive Summary
    - Table of Contents
    - Chapter 1 - Profile of the PSU or MNC – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 2 – Profile of the SME – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
    - Chapter 3 - Profile of the NGO – must include Organizational structure, services, Manpower, Societal Concerns, Professional Practices
    - Chapter 4 – Comparative Analysis of PSU/MNC – SME – NGO
    - References & Annexure (Permission letters from the organizations for the visit & photographs)

Course Outcomes:

After going through this course the student will be able to:

CO1: Classify the role of different industries and organization in addressing the needs of the society.

CO2: Explain the process of applying engineering knowledge in industries and organizations.

CO3: Describe the importance of communication and team work

CO4: Recognize the importance of practicing professional ethics and need for life skills.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries 25%
(2) Ability to comprehend the functioning of the organization/ departments 30%
(3) Importance of resource management, environment and sustainability 20%
(4) Presentation Skills and Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

TECHNICAL SEMINAR						
Course Code	**:**	**16MMD36**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the technological developments in their chosen field of interest
(2) Explain the scope of work and challenges in the domain area
(3) Analyze these engineering developments in the context of sustainability and societal concerns.
(4) Improve his/her presentation skills and technical report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project
4) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1:Identify topics that are relevant to the present context of the world
CO2: Perform survey and review relevant information to the field of study.
CO3: Enhance presentation skills and report writing skills.
CO4: Develop alternative solutions which are sustainable

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

1) Topic – Technical Relevance, Sustainability and Societal Concerns 15%
2) Review of literature 25%
3) PresentationSkills 35%
4) Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L

IV SEMESTER

MAJOR PROJECT						
Course Code	**:**	**16MMD41**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:52:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**26**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

The students shall be able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate good verbal presentation and technical report writing skills.
4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Major project will have to be done by only one student in his/her area of interest.
2. Each student has to select a contemporary topic that will use the technical knowledge of their program of specialization.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to three.
5. The project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
6. The standard duration of the project is for 16 weeks, however if the guide and the evaluation committee of the department, after the assessment feel that the work is insufficient and it has to be extended, then the student will have to continue as per the directions of the guide and the committee.
7. It is mandatory for the student to present his/her work in one of the international conferences or publish the research finding in a reputed unpaid journal with impact factor.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.

CO2: Communicate the solutions through presentations and technical reports.

CO3: Apply project and resource managements skills, professional ethics, societal concerns

CO4: Synthesize self-learning, sustainable solutions and demonstrate life long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of: guide, two senior faculty members, one industry member and Head of the Department.

Phase	Activity	Weightage
I 5th week	Synopsis, Preliminary report for the approval of selected topic along with literature survey, objectives and methodology.	20%
II 10th week	Mid-term progress review shall check the compliance with the objectives and methodology presented in Phase I, review the work performed.	40%

III 15th week	Oral presentation, demonstration and submission of project report. After this presentation, the student will have one week time to correct / modify his report to address the issues raised by the committee members.	40%

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief write-up about the project 5%
2. Formulation of Project Objectives & Methodology 20%
3. Experiments / Analysis Performed; Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	H	H	M	L	M	L				
CO2				L				M	H		
CO3					L	M	M			H	
CO4					L	M	H	M			H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	L	H
CO3	M	H
CO4	H	H

SEMINAR						
Course Code	**:**	**16MMD42**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

1) Understand the technological developments in their chosen field of interest
2) Explain the scope of work and challenges in the domain area
3) Analyze these engineering developments in the context of sustainability, societal concerns and project management.
4) Improve his/her verbal presentation and report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project topic.
4) Topics could be in multidisciplinary areas and strongly address the technical design issues.
5) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
6) The students must mandatorily address legal, ethical issues as related to the topic of study.
7) The student shall make an attempt to perform financial / cost analysis or apply project management tools as related to his/her topic of study.
8) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify topics that are relevant in the present context of the world and relate it to sustainability and societal relevance.

CO2: Perform literature/market/product survey and analyse information to the field of study.

CO3: Enhance presentation and report writing skills.

CO4: Develop creative thinking abilities.

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of TWO senior faculty members. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

- Topic – Technical Relevance, Sustainability and Societal Concerns 15%
- Literature Review 25%
- Presentation Skills 35%
- Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L