

**M.Tech. in Mechanical Engineering with
Machine Design Courses**

Course Contents
Academic Year 2019-20

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PC-MTMD101 Advance Stress Analysis
Course Pre-requisites: BTM302, BTM701

Course Objectives:

1. To develop the student's understanding of the foundations of stress and strain
2. To develop the student understands of the displacement field, Hooke's constitutive law.
3. To develop student's skills in analyzing stress problems through the application of the basic laws and equations.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Apply knowledge of failure theories appropriately to solve problems of practical interest with a variety of loading situations.
2. Analyze and calculate stress/strain distributions for 2D problems of elasticity using stress function approach and evaluate using IT tools like ANSYS, etc.
3. Describe stress strain measurement through experimental technique, and stress-strain relation of composite materials.
4. Describe various equipment required to preform the experimental stress-strain analysis.

Course content:

Sr.No.	Description	Hrs.
1	Analysis of Stress: Introduction to tensor analysis, stress tensors, Cauchy's stress principle, Principal stresses in three dimensions, Equilibrium equations, Octahedral stresses, and Mohr's stress circle.	5
2	Analysis of strain: Strain tensors, Strain transformation, Principal strains, Octahedral strains, Mohr Circle for strain, Equations of compatibility.	6
3	Stress -Strain Relations: Generalized Hooke's Law, Transformation of compatibility condition from strain components to stress components, Strain energy in an elastic body, St. Venant's principle, Uniqueness theorem.	6
4	Two dimensional Problems in Cartesian Coordinate system: Plane stress and plane strain problems, Stress function, Stress function for plane stress and plain strain cases, Solution of two-dimensional problems with different, loading conditions by the use of polynomials.	7
5	Introduction to fracture mechanics, Ductile & brittle fracture, LEFM (Elementary), Modes of failure, Griffith's Analysis & Energy Release rate, SIF & its determination, Westergaard's approach (Mode I & II-	10

	only elementary treatment),Fracture toughness,J integral(Elementary),Crack growth studies,Paris law Torsion of Prismatic Bars: General solution of the torsion problem, Torsion of circular and elliptic cross sections.	
6	Experimental stress Analysis: Introduction to Photo elasticity, Moir, Holography,Speckle Methods etc.	5
7	Strain Guage Technique: Strain measurement by resistance gauges, types of strain gauges, Equipment for indicating and recording strains transducer and its application.	5

Recommended Books:

1. T. G. Sitharam and L. Govindraju, "Applied Elasticity", Interline Publishers, Bangalore
2. Timoshenko, Stephen P.; James Norman Goodier (1970). Theory of Elasticity (Third Ed.). Tata McGraw-Hill India Edition.
3. Y. C. Fung, "Foundations of Solid Mechanics." Prentice- Hall Publishers.
4. Arthur P. Boresi, Richard J. Schmidt- Advanced Mechanics of Materials-Wiley (2003).
5. Advances in Engineering Vol -4- Fatigue Design Handbook (SAE)
6. Collins, Jack A. *Failure of materials in mechanical design: analysis, prediction, prevention.* John Wiley & Sons, 1993.
7. Singh, Sadhu. *Experimental Stress Analysis: A Text Book for Engineering Students.* Khanna publishers, 1982.
8. Dally, James W., and William F. Riley. "Experimental stress analysis." (1965).

Course Evaluation Scheme:

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PC-MTMD102 Computer Aided Design

Course Pre-requisites: BTM802, BT207

Course Objectives

The general objectives of the course are to enable the students to

1. Understand the basic analytical fundamentals that are used to create and manipulate geometric models in computer programs.
2. To visualize how the components looks like before its manufacturing or fabrication
3. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
4. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.
5. To understand the different types of curves like Bezier curve, B-Spline curve & Graphics Standards, Surfaces and G-V lines.
6. To understand different Algorithms for optimization of drawing of basic entities

Course Outcomes

Upon successful completion of the course, students should be able to

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid, and the technique of transformation of geometric entities using transformation matrix
2. Describe key neutral specifications and standards for product data
3. Design parts in modern parametric CAD systems for manufacturing on a Rapid Prototyping machine.
4. Footprints of emerging breakthrough technologies created in the areas of CAD and be able to apply C++ skills in the domain of CAD

Course content:

Sr. No.	Details	Hrs
Module 01	<p>INTRODUCTION & ELEMENTS OF INTERACTIVE COMPUTER GRAPHICS</p> <p>The design process, the role of modeling & communication, modeling using CAD, Product life cycle, Concurrent engineering in Product design & development, Collaborative Engineering, computers for design Process, CAD System Architecture.</p>	05
Module 02	<p>TECHNIQUES FOR GEOMETRIC MODELING</p> <p>Data translators like IGES methodology, DXF (Data Exchange Format), STEP, Jupiter Technology, curves, parametric representation of line, circle, ellipse & parabola constructive solid geometry (CSG), Boundary Representation (B-Rep), Geometric Construction methods and its requirements, Wire Frame Modeling, Solid Modeling, Surface Modeling, Parametric Modeling, feature based modeling, Constraint driven modeling, Feature recognition, Design by feature, generative family of parts.</p>	05

Module 03	<p>ALGORITHMS Evaluation criteria of CAD/CAM software, Line, circle, ellipse algorithm and C or C++ programming for the same. Two dimensional computer graphics, vector generation, the windowing transformation, three dimensional Computer graphics, viewing transformation, Homogeneous coordinates, Visual realism, Hidden line removal & hidden surface removal algorithm, light & shade ray tracing, automation, scripting, animation, write function calling, use a library, continuity C^1, C^2, G^1, G^2</p>	08
Module 04	<p>TRANSFORMATION, MAINPULATION 2D & 3D Transformations (Translation, Rotation, & Scaling & Magnification), Concatenations, Matrix representation, Problems & object oriented programming on Transformations. The parametric representation of geometry, Problems on Bezier, Cubic, B-Spline, rendering.</p>	07
Module 05	<p>DATA STORAGE Object transformation, mirror transformation, graphics modeling data structures, Bill of materials from attribute data, The use of Object Orientation & associatively, Engineering data management system, relational data base for design, object Oriental database, Structured Query language, Design information Systems. Artificial Intelligence in Design, Knowledge Enabled Engineering, Representation of Knowledge, and Knowledge base Engineering.</p>	06
Module 06	<p>EMERGING AREAS in CAD Virtual Prototyping, Design for Assembly and Dis- Assembly, VR and PLM introduction, Reverse Engineering and Data Capture techniques like Contact Inspection methods and Scanning methods</p>	05
Module 07	<p>CAD for Machine Elements and Sub-Assemblies</p> <ul style="list-style-type: none"> • Introduction to Object Oriented Programming • Develop Concepts of Mechanical Engineering CAD • Develop Algorithm, Flow Charts and Software for at least 5 Mechanical Engineering Design problems like Design of Gears, Design of Knuckle and cotter Joints etc. 	06

Recommended Books:

1. Groover, Mikell P. *Computer aided design and manufacturing*. 1987.
2. Zeid, Ibrahim. *CAD/CAM theory and practice*. McGraw-Hill Higher Education, 1991.
3. Hearn, Donald, M. Pauline Baker, and Bjarne Stroustrup. *Computer Graphics with OpenGL, 3/E*. Prentice-Hall, 2003.
4. McMahan, C. A., and J. Browne. "CAD/CAM: principles, practice and manufacturing management, 1998."
5. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju. *Cad/cam/cim*. New Age International, 2008.
6. Rao, Posinasetti Nageswara. *CAD/CAM: principles and applications*. Tata McGraw-Hill Education, 2004.
7. Neumann W.M., Sproul R.F., *Principle of Computer Graphics*, McGraw Hill Book Co. Singapore, 1989.
8. Rogers, David F., and J. Alan Adams. *Mathematical elements for computer graphics*. McGraw-Hill Higher Education, 1989.
9. ASIC/ Parasolid library.

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Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PC-MTMD103 Design Laboratory-I
Course Pre-requisites: BTM 352, BTM701

Course Objectives:

1. To study different types of stresses and strains induced in the mechanical components due to external loads in three dimensions.
2. To study the elastic behavior of different materials in three dimensions and different factors affecting failures of materials.
3. To study Geometric modeling and assembling of any mechanical system.
4. To make appropriate selection of CAD functionality to use as tools in the design process.

Course Outcomes:

Students will be able to...

1. Demonstrate knowledge about various types of loading and stresses induced in three dimensions.
2. Apply the knowledge of strain gauges for measuring strain in practical applications.
3. Apply knowledge of CAD to generate and interpret engineering technical drawings of parts and assemblies according to engineering design standards.
4. Demonstrate skill of modeling and assembling of any mechanical system.

List of Experiments (any 8)

Term work shall consist of any six experiments from the following

1. Experiments using strain gauges.
2. Measurement of strain, temperature effects
3. Fixing of gauges on surfaces.
4. Study of photoelastic bench for stress measurement.
5. Study of polariscope and calibration of disc, beam and tension model.
6. Application of strain gauge techniques: Lecture on strain gauge based methods, Cantilever beam and Portal frame.
7. Study of semiconductor based strain gauges
8. Case study on thermal stress analysis using different simulation platforms
9. Case study on stress analysis due to structural loading using different simulation platforms
10. Case study on stress analysis due to dynamic loading using different simulation platforms
11. Executing basic algorithms for generation of line, circle, ellipse in any programming language
12. Executing transformations and projection both in 2D and 3D in any programming language
13. Generating curves using any programming language
14. Creation of 3D assembly model.

PC-MTMD104 Design Laboratory-II

Course Pre-requisites: BTM802

Course Objectives:

1. To study the mathematical simulation software for analysis of single and multi degree freedom problem.
2. Perform experimentation and processing the data and demonstration of condition based maintenance tool.
3. To learn the various Techniques used in design of experiments and reliability engineering
4. To learn about wear, wear mechanisms, wear theories applied in machine elements.

Course Outcomes:

Students will be able to.....

1. Apply and analyze different systems using mathematical simulation software.
2. Demonstrate acquiring and processing of data.
3. Compile data and write technical reports.
4. Use different software's and interprets results of analysis.

List of Experiments:

Term work shall consists experiments from the following

1. Simulation study using mathematical simulation software (or any programming language) on
 - a. Single DOF system
 - b. Multi DOF system
2. Simulation study of the followings on any simulation platform
 - a. Modal analysis
 - b. Transient analysis
 - c. Harmonic analysis
 - d. Active vibration control
3. Experimentation
 - a. Acquiring time domain vibration data by using sensors (displacement / velocity / acceleration)
 - b. Demonstration of condition based maintenance tool using vibration techniques
4. Case study each on DOE and reliability engineering.
5. Case study on any one rapid prototyping machine.
6. At least two (02) problems each on design of hydrostatic bearings, design of brakes and clutches.
7. At least one case studies on application of tribology in machine elements based on the above syllabus.

MC-MTMD105 Research Methodology & IPR

Course Pre-requisites: BTM898

Course Objectives

1. To develop an ability to identify, formulate research problem.
2. To develop an ability to apply knowledge of research methodology to engineering Problems.
3. To develop an ability to investigate the phenomenon in a critical manner.
4. Develop critical thinking to find business opportunities and to solve questions related to industries.
5. To get knowledge on various kinds of research questions and research designs

Course Outcomes

Learner shall be able.

1. To carry out literature survey methodically
2. To formulate the problem statement using research considerations.
3. To carry out data collection systematically and to carry out data analysis using various data analysis tools
4. To be able to investigate what can be patented .

Course Content:

Module No.	Description	Hrs.
1	Introduction to Research Definition of Research, How to define the research problem Various considerations for defining research problem	8
2	Literature Survey Search Engines, Source of Literature, Identifying the appropriate period for Literature, Key words Primary key words, secondary key words, research Gaps	4
3	Data collection Techniques <ul style="list-style-type: none"> • Interviews techniques, Structured semi-structured, unstructured interviews • Sampling Techniques, simple random sampling, Sample Size Calculation, Sample Design Case study method	6
4	Data Analysis Hypothesis , Null and alternate hypothesis statements, Z test, F test, T Test, Chi square Test, Annova	6
5	Simulation techniques <ul style="list-style-type: none"> • Monte Carlo Simulation, Simulation exercises for Product Design , Service Design , System Design	6
6	Intellectual property right Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	6

7	New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems	6
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Recommended Books:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers, Distributors.
2. Kothari, C.R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd ed), Singapore, Pearson Education.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age", 2016.
5. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Sr No.	Examinations	Module
1	T1	1, 2 and part of 3
2	T2	3, 4 and 5
3	End Exam	All modules 1 to 7

PC-MTMD203 System Modeling & Synthesis of Mechanisms

Course Pre-requisites: BTM402, BTM502

Course Objectives:

1. To Understand what is a model, types of models, purpose of models
2. To Learn the graphical and analytical techniques commonly used in the synthesis of mechanisms.
3. To Orient applications of analytical techniques by means of computer programs.
4. To simplify the mechanism for analysis purposes.

Course Outcomes:

At the end of the course the students shall be able to

1. Apply mathematically model for a given system and Mechanical Elements.
2. Apply the graphical and analytical techniques commonly used in the synthesis of mechanisms.
3. Formulate and solve problems of synthesis of mechanisms using modern IT tools and Synthesize mechanisms with 3 and 4 accuracy points.
4. Explain and discuss the theory and methodologies employed for design of mechanisms.

Course content:

M. No.	Description	Hrs.
1	Introduction to System and Mathematical Modeling System: Environment and variables, the state of a system, Physical Laws for Modeling of System, Representation of System in terms of Block Diagram, Reduction of Multiple Subsystems, Signal Flow Graph, Mason's Gain Formula.	6
2	Mathematical Modeling of Mechanical Elements – inertia, stiffness and damper	6
3	Basics of Mechanism: Rigid body, Kinematic pairs, Lower and Higher pair connections, Kinematic Chain, Mechanism, Four Bar Mechanism, Slider Crank Mechanism, Equivalent mechanisms. Type Synthesis, Number Synthesis, Dimensional Synthesis Type, Number & Dimensional synthesis, Accuracy points, Spacing of accuracy points, Chebyshev polynomials.	6
4	Four Bar Coupler Point Curve: Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem	6
5	The Euler Savary Equation and Cubic of Stationary Curvature: The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.	6
6	Linkage Synthesis with Three Accuracy Points (Geometric Methods): Concept of poles, relative poles, pole triangle of four bar and slider crank mechanism. Application in position generation, function generation problems.	6
7	Linkage Synthesis with Three Accuracy Points (Algebraic Method): Fredeinstain displacement equation of four bar linkage for three accuracy points, Crank-follower linkage synthesis angular velocities and acceleration Complex Number Method	6

Text Books:

1. Nicola Bellomo and Luigi Preziosi, "Modeling Mathematical Methods & Scientific Computations", 1995, CRC Press.
2. Mallik, Asok Kumar, Amitabha Ghosh, and Gunter Ditzrich. *Kinematic analysis and synthesis of mechanisms*. CRC Press, 1994.

Reference Books:

1. Vu, Hung V., and Ramin S. Esfandiari. Dynamic systems: modeling and analysis. McGrawHill Science, Engineering & Mathematics, 1997.
2. Beyer, Rudolf. "The kinematic synthesis of mechanisms." (1963).
3. Tao, Deh Chang. *Applied linkage synthesis*. Addison-Wesley Pub. Co., 1964.
4. Hartenberg, Richard Scheunemann, and Jacques Denavit. *Kinematic synthesis of linkages*. McGraw-Hill, 1964.

Term work:

Assignment containing numerical problem based on above topics and seminars

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PC-MTMD204 Advanced Finite Element Methods
Course Pre-requisites: BTM703

Course Objectives:

1. To provide the student with knowledge and analysis skills in applying basic laws in mechanics
2. Steps used in solving the problem by finite element method.
3. To expose students to some of the recent trends and research areas in finite elements.

Course Outcome:

Upon successful completion of the course, students should be able to

1. Formulate simple types of finite elements and apply appropriate boundary conditions.
2. Apply finite element method for obtaining solutions to problems in solid mechanics, steady and transient analysis to be conducted.
3. Assess stresses and strains in complex mechanical systems and interpret structural behavior of components by analyzing post processor result.
4. Practical applications related to solver theory.

Course content:

M. No.	Description	Hrs.
1	Introduction: Element Matrices: Direct stiffness Method, Properties of global stiffness Matrix, Analysis of simply supported beam, One dimensional linear element: Division of region into elements The Linear Element, weight Residual integral Evaluation of the Integral. Variational approach, Glerkin's Methods.	6
2	FE procedures for 1D formulations: FE formulation of 1D bar, 2D plane strain, plane stress, and axisymmetric elements; 3D linear elastic continuum, Iso-parametric mapping; numerical integration.	6
3	FE procedures for 2D formulations: Two Dimensional Elements: Linear Triangular Elements, Rectangular Elements, The displacement functions, Element Shape Functions: Evaluating shape functions Two Dimensional Field equations: Coordinate Systems, Integral equations for the element Matrices, Heat transfer by conduction: two dimensional fins, Long and convection Two Dimensional bodies.	6
4	FE Applications in Solid Mechanics: The axial force members, potential energy formulations. The Truss Element, Beam element, plane frame element, Review of tensor algebra; Yield surface, flow rule and hardening rules.	6
5	FE procedures for 3D formulations: FE formulation for 3D problems, Total Lagrangian and updated Lagrangian descriptions; Quadrilater elements, Tetrahedran element – Jacobian matrix – Stiffness matrix.	6

6	FEA Solver Theory Overview of using the flow solver, Pressure based solver, Density based solver, Matrix discretization, Multigrid method, Full Multigrid (FMG) Initialization.	6
7	Advances in FEA: FEM Computations Solution Methods FEM Modeling and Preprocessing FEM Hardware and Post processing Survey of some FE Software Systems, Dynamic system analysis.	6

Recommended Books:

1. Reddy, Junuthula Narasimha. *An introduction to the finite element method*. Vol. 2, no. 2.2. New York: McGraw-Hill, 1993.
2. K. J. Bathe, *Finite Element Procedures*, Prentice-Hall of India Private Limited, New Delhi, 1996
3. Chandrupatla, Tirupathi R., Ashok D. Belegundu, T. Ramesh, and Chaitali Ray. *Introduction to finite elements in engineering*. Vol. 2. Upper Saddle River, NJ: Prentice Hall, 2002.
4. Zienkiewicz, Olek C., and Robert L. Taylor. *The finite element method for solid and structural mechanics*. Butterworth-heinemann, 2005.
5. Segerlind, Larry J., and H. Saunders. "Applied finite element analysis." (1987): 329-330.
6. A First Course in the Finite Element Method/Daryl L Logan/Cengage Learning/5th Edition

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

PC-MTMD205 Design Laboratory-III

Course Pre-requisites: MTMD101, MTMD104

Course Objectives:

1. To expand student's knowledge in the area of linear-elastic fracture mechanics and the stress analysis of cracked bodies with a focus on metallic structures using simulations.
2. To develop student understands of the relationship between the energetic approach and the stress analysis of cracked bodies using simulation tools.
3. To study the finite element analysis software.
4. To apply Finite Element Analysis for real life mechanical component.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Analyze nature of stresses around a cracked body by applying principles of linear elastic fracture mechanics and compute stress intensity factors using simulation tools.
2. Interpret the result of a fracture mechanics analysis for metallic structures using simulation tools.
3. Analyze different mechanical components using mathematical simulation software.
4. Apply and analyze different mechanical components using FEA software.

List of Experiments:

1. To Compute space intensity factor using FEM (Displacement Method).
2. To Compute space intensity factor using FEM (Stress Method).
3. Computation of J integral using numerical method.
4. Computation of CTOD for CT specimen using FEM.
5. Develop numerical code for crack growth rate under fatigue load.
6. Finite element analysis (FEA) of minimum 03 mechanical components using mathematical simulation software (or any programming language) which must include structural, thermal and coupled structural-thermal analysis.
7. Finite Element Analysis of a real life mechanical component subjected to both structural and thermal loading, using Mathematical Simulation Software (or any programming language) and Finite Element Analysis Software.

PC-MTMD206 Design Laboratory-IV
Course Pre-requisites: BTM703

Course Objectives:

1. To introduce the concepts of analysis and synthesis of mechanisms.
2. To develop a broad and basic comprehension of different methods of analysis for the determination of motion characteristics of linkage mechanisms.
3. To learn some Case studies of Design of Power Transmission System [mechanical and hydraulic systems] to reinforce their concepts.
4. Learn efficient computational procedures to solve optimization problems.

Course Outcomes:

Students will be able to.....

1. Develop graphical and analytical synthesis techniques and careful problem formulation and solution skills.
2. Develop an ability to solve mechanism problems that may involve selection, specification, design and sizing of mechanisms to accomplish a given task.
3. Analyze vibration characteristics, wear and life of critical components of power transmission systems.
4. Use Matlab and implement optimization algorithms.

Detailed Laboratory content

1. Linkage design and experimental verification.
2. Assembly of mechanisms from links and joints, study of mobility.
3. Design and selection of linkage mechanisms for specific applications.
4. Analysis of an existing mechanism/machine or synthesis of a new mechanism to perform a prescribed task.
5. Calculate sizing of elements of transmission systems like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail.(any 5)
6. Case studies on Power Transmission System Design.
7. Implementation of KKT theorem in Matlab
8. Simplex algorithm in Matlab
9. Implementation of Newton's method in Matlab
10. Implementation of Secant method in Matlab

PC-MTMD299 Seminar/Mini Project

Course Pre-requisites: MTMD105

Course Outcomes:

1. Student will be able to apply the skill of presentation and communication techniques
2. Student will be able to use the knowledge of the fundamentals of subjects to search the related literature
3. Student will be able to analyze the available resources and to select most appropriate one

Course content (Seminar):

Sr.no.	Description	Hrs.
1	The student gathers and presents information/data about seminar topic allotted to him/her. The report and presentation shall include review of literature, case studies if applicable and findings about recent trends in the area of seminar topic. On completion of the work the student shall prepare a report and will give a Seminar on the report.	48

Course Content (Mini Project):

Sr.no.	Description	Hrs.
1	The mini project work extends for a single semester and exposes the student to develop and present his/her work related to specific topic. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	48

Guidelines for Seminar-II/Mini Project

1. Seminar/ mini project should be based on thrust areas in Mechanical Engineering (Machine Design aspect is appreciated)
2. Students should do literature survey and identify the topic of seminar/ mini project and finalize in Consultation with mentor/Guide/Supervisor.
3. Students should use multiple literature and understand the topic and compile the report in standard format as in front of Examiners.

Assessment Guidelines:

1. Quality of Literature survey and Novelty in the topic
2. Relevance to the specialization
3. Understanding of the topic
4. Quality of Written and Oral Presentation

EC-MDPE01 Program Elective: Machine Dynamics and Advance Vibration
Course Pre-requisites: BTM502

Course Objectives:

1. Understand Un-damped, damped, forced SDOF and MDOF systems and its relation to a vibrating system.
2. Understand how to derive eqs. of motion for two degree of freedom systems or higher.
3. Understand how to find frequencies using Rayleigh and Dunkerley Methods.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Analyze motion of rigid bodies in space and calculate dynamic forces/moments.
2. Solve for response of un-damped, damped, forced SDOF and MDOF mechanical vibrating systems.
3. Design vibration control system.
4. Estimate response of non-linear vibration system using iterative or graphical methods.

Course content:

Sr. No.	Description	Hrs.
1	Dynamics of Particle: Kinematics of particles: Rectilinear Motion, Plane Curvilinear Motion, Rectangular Coordinates Normal and Tangential Coordinates, Polar Coordinates. Kinetics of particles: Newton's Second law Equation of motion, Work and kinetic Energy, Potential Energy, Impulse and Momentum.	6
2	Dynamics of rigid body: Plane Kinematics of rigid body: Absolute Motion, Relative Velocity, Instantaneous center of Zero velocity, Relative Acceleration. Plane Kinetics of rigid body: Work and energy principle. Three dimensional dynamics of rigid body, Euler's equations of motions, Impulse momentum formulation, Work energy formulation.	6
3	Discrete Vibration Damped and undamped free vibration, Special cases: Oscillatory, non-oscillatory and critically damped motions, Forced harmonic vibration, Magnification factor, Logarithmic decrement, Generalized and principal coordinates, Derivation of equations of motion, Newton's Method, Energy Method, Lagrange's equation, Influence coefficient method, Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Modal analysis: undamped, Modal analysis: damped.	8
4	Continuous vibration Equations of motion and boundary conditions, natural frequencies and mode shapes. Vibration of strings, Longitudinal and torsional vibration of rods, Transverse vibration of beams, Rayleigh's energy method, Rayleigh-Ritz method, Matrix iteration method.	6
5	Practical application of vibration Vibration isolation, Vibration absorber, Tuned and damped absorber, Introductory concept of rotor dynamics, Jeffcott rotor model.	6

6	Basics of non-linear vibration – causes of non – linearity – formulation. Solution methods iterative, Graphical, Method of isoclines. Stability of equilibrium state and type of singularity. Limits cycles.	5
7	Brief introduction to experimental modal analysis Signal generation, measuring and conditioning instruments, signal analysis instruments, Vibration signatures and standards, Virtual Lab experiments.	5

Recommended Books:

1. Rao, Singiresu S., and Fook Fah Yap. *Mechanical vibrations*. Vol. 4. New York: Addison-Wesley, 1995.
2. Leonard Meirovitch- *Fundamentals of Vibrations*- McGraw-Hill Companies (2000)
3. *Engineering Mechanics Dynamics* (7th Edition)- J.L. Meriam,L.G.Kraige
4. Shames, I. H. "Engineering mechanics: statics and dynamics, 1996."*PrenticeHall of India, New Delhi*: 911-960.Non – linear mechanical vibration – Srinivasan
5. Kelly, S. Graham. "Fundamentals of mechanical vibrations." (1992).
6. *Theory & Practice of Rotor Dynamics*
7. *Mechanical Vibrations NPTEL Lectures* (<http://nptel.ac.in/courses/112103112/>)
8. Reference websites on Virtual Lab experiments
<http://vlab.co.in/>
<http://iitg.vlab.co.in/?sub=62&brch=175>
<http://mdmv-nitk.vlabs.ac.in/>

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE02 Program Elective: Additive Manufacturing
Course Pre-requisites: BTM 405

Course Objectives:

1. To study the fundamentals of rapid prototyping and tooling technologies.
2. To study basic concepts of rapid prototyping and their application in product development.
3. To study different working materials and systems used in rapid prototyping techniques
4. To study layering techniques in rapid prototyping systems

Course Outcomes:

At the end of the course the students shall be able to

1. Describe working principles of rapid prototyping techniques
2. Select proper rapid prototyping techniques for specific technical applications.
3. Select an appropriate material and tools to develop a given product using rapid prototyping Machine.
4. Design layering technique for rapid prototyping

Course Content:

Sr. No.	Syllabus	Hrs
1.	Rapid Prototyping <ul style="list-style-type: none"> • Historical Development • Applications: Design, Planning, Manufacturing and Tooling • Applications: Automotive, Jewelry, Coin and Bio-Medical • Fundamentals of Rapid Prototyping, Design Process • Rapid Prototyping Process Chain 	6
2.	Subsystems of RP Machine <ul style="list-style-type: none"> • Subsystems of RP machine <ul style="list-style-type: none"> o Optical System o Mechanical Scanning System o Computer Interfacing hardware, DAQs o Signal Flow, 3D Model to RP Prototype • Introduction to 3D Modeling Softwares (Auto-CAD, PROE, CATIA, IDEAs etc.) • Slicing and Scan Path Generation Algorithms • Data Conversion and Transmission • File Formats, IGES, STL • Preprocessing and Post-processing 	6
3.	Liquid Based Rapid Prototyping Systems <ul style="list-style-type: none"> • Materials • Stereolithography • Solid Ground Curing • Solid Object UV (Ultra-Violet) Printer • Two Laser System • Micro-stereolithography. 	6
4.	Solid Based Rapid Prototyping Systems <ul style="list-style-type: none"> • Materials • LOM (Laminated Object Manufacturing) System • FDM (Fuse Deposition Modeling) System • Multi-Jet Modeling (MJM) System • Model Maker and Pattern Master • Shape Deposition Manufacturing Process 	6

5.	Powder Based Rapid Prototyping Systems <ul style="list-style-type: none"> • Materials • SLS (Selective Laser Sintering) • (3DP) Three-Dimensional Printing • (LENS) Laser Engineered Net Shaping • (MJS) Multiphase Jet Solidification • (EBM) Electron Beam Melting 	6
6.	Advances in RP Systems and Case Studies <ul style="list-style-type: none"> • Advances in RP: Resolution & Accuracy issues, Integrated Hardening Process, Two Photon Process for Micro/Nano Fabrication, Reverse Engineering Process and Applications. 	6
7.	Case Study: Wind-Tunnel Testing with RP Models Case Study: Investment Casting with RP Case Study: Fabrication of microlens arrays Case Study: Fabrication of Scaffolds for medical applications	6

Term Work

1. Assignments based on each module.
2. Seminar based on recent advances in the subject
3. At least one Case study

Reference Books:

1. Chua C.K., Leong K.F., and Lim C.S., “Rapid Prototyping Principles and Applications”, World Publishing Co. Pte.Ltd.
2. James O. Hamblen, and Michael D. Furman, “Rapid Prototyping of Digital Systems”, Kluwer Academic Publishers.
3. Kenneth G. Cooper, “Rapid Prototyping Technology Selection and Application”, 2001, Marcel Dekker Inc, New York.
4. Ali Kamrani, EmadAbouel Nasr, “Rapid Prototyping Theory and Practice”, 2006, Springer Inc.
5. BopayaBidanda, Paulo J. Bartolo, “Virtual Prototyping and Bio Manufacturing in Medical Applications”, 2008, Springer Inc.
6. I. Gibson, D.W. Rosen, and B. Stucker, “Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing”, 2010, Springer Inc.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE03 Program Elective: Design for Manufacturing and Assembly
Course Pre-requisites: BTM801, BTM802, BTM898

Course Objectives:

1. To study the fundamentals of rapid prototyping and tooling technologies.
2. To study practical applications of rapid prototyping in product development.
3. Exposure to different working materials and systems used in rapid prototyping techniques
4. To study layering techniques in rapid prototyping systems

Course Outcomes:

At the end of the course, the student should be able to

1. Understand the product development cycle
2. Know the manufacturing issues that must be considered in the mechanical engineering design process
3. Know the principles of assembly to minimize the assembly time
4. Know the effect of manufacturing process and assembly operations on the cost of product.

Course Contents:

Sr. No.	Syllabus	Hrs
1.	Introduction Need Identification and Problem Definition, Concept Generation and Evaluation, Embodiment Design, Selection of Materials and Shapes.	6
2.	Properties of Engineering Materials, Selection of Materials – I, Selection of Materials – II, Case Studies – I, Selection of Shapes, Co-selection of Materials and Shapes, Case Studies – II,	6
3.	Selection of Manufacturing Processes, Review of Manufacturing Processes, Design for Casting, Design for Bulk Deformation Processes, Design for Sheet Metal Forming Processes, Design for Machining, Design for Powder Metallurgy, Design for Polymer Processing, Co-selection of Materials and Processes, Case-Studies – III	8
4.	Design for Assembly, Review of Assembly Processes, Design for Welding – I, Design for Welding – II, Design for Brazing and Soldering,	6
5.	Design for Adhesive Bonding, Design for Joining of Polymers, Design for Heat Treatment, Case-Studies - IV	6
6.	Design for Reliability, Failure Mode and Effect Analysis and Quality, Design for Quality,	5
7.	Design for Reliability, Approach to Robust Design, Design for Optimization	5

Reference Books:

1. M F Ashby and K Johnson, Materials and Design - the art and science of material selection in product design, Butterworth-Heinemann, 03.
2. G Dieter, Engineering Design - a materials and processing approach, McGraw Hill, NY, 00.
3. M F Ashby, Material Selection in Mechanical Design, Butterworth-Heinemann, 1999.
4. T H Courtney, Mechanical Behavior of Materials, McGraw Hill, NY, 00.
5. K G Swift and J D Booker, Process selection: from design to manufacture, London: Arnold, 1997.
6. S S Rao, Engineering Optimization: theory and practice, John Wiley, NY, 1996.

7. G Boothroyd, P Dewhurst and W Knight, Product design for manufacture and assembly, John Wiley, NY: Marcel Dekkar, 1994.
8. J G Bralla, Handbook for Product Design for Manufacture, McGraw Hill, NY, 1998.
9. Houldcroft, Which Process – an introduction to welding and related processes and guide to their selection, Cambridge, Abington Pub., 1990.
10. ASTM Design handbook.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE04 Program Elective: Tribology in Design

Course Pre-requisites: BTM701, BTM 801

Course Objectives:

1. To provide overview of tribology and practical implications in machine elements.
2. To understand the material properties, nature of surfaces, their topography and surface characterization techniques.
3. To understand the genesis of friction, the theories/laws.
4. To learn about wear, wear mechanisms, wear theories applied in machine elements.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Apply the principles of lubrication, lubrication regimes, and theories of hydrodynamic, elasto hydrodynamic and mixed / boundary lubrication.
2. Explain essentials of tribotesting and experimental techniques in Tribology.
3. Discuss and formulate tribological modelling and simulation.
4. Design of mechanical components from the aspect of friction, wear and lubrication.

Course content:

Sr.No.	Description	Duration (hrs)
1	Introduction: Overview of Tribology, Lubricants selection for general application and special application such as low temperatures high temperature, extreme pressure etc.	6
2	Friction and Wear: Types of wear and basic mechanism of wear, Wear properties of friction and antifriction metallic and non metallic materials, experimental techniques in evaluation of materials.	6
3	Fluid film journal bearing: petroff equation, Reynolds equation, short bearing and long bearing, full and partial journal bearings of infinite length, design of journal bearings for steady loads and varying loads.	6
4	Hydrodynamic lubrication and bearing design: Basic concept, hydrodynamic lubrication: design of plain fixed pad and tilting pad, slider bearing for study and varying loads.	6
5	Introduction to design of aerostatic bearings, and its applications Elasto-hydrodynamic lubrication: Principle, application to antifriction bearings, cams and gears, Fault diagnosis in bearings and its solutions.	6
6	Antifriction bearing: Rolling Contact Bearings, Bearing types and selection of rolling contact bearing for different applications/loading condition. Static and dynamic load capacity, life rating.	6
7	Application of Tribology in mechanical elements: Design of mechanical components against wear. Design of friction surfaces used in clutches and brakes. Design of IC engine component against wear, Design of seals.	6

Term work:

1. At least four (04) problems each on design of hydrostatic bearings, design of hydrodynamic journal bearing, design of rolling element bearings, design of brakes and clutches.
2. At least one case studies on application of tribology in machine elements based on the above syllabus.

Text Books:

1. Hirani, Harish. Fundamentals of Engineering Tribology with applications. Cambridge University Press, 2016.

Reference Books:

1. Szeri, Andras Z. *Fluid film lubrication: theory and design*. Cambridge University Press, 2005.
2. ABHATIA, J. "Advance in Industrial Tribology." (1998)
3. Chattopadhyay, Ramnarayan. *Surface wear: analysis, treatment, and prevention*. ASM international, 2001.
4. Mang, Theo, Kirsten Bobzin, and Thorsten Bartels. *Industrial tribology: tribosystems, friction, wear and surface engineering, lubrication*. John Wiley & Sons, 2011.
5. Neale, Michael J., ed. *Lubrication: A Tribology Handbook*. Butterworth-Heinemann, 1993.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE05 Program Elective: Reliability Engineering and Design of Experiments
Course Pre-requisites: BTM605 and BTM704

Course Objectives:

1. To understand the basic concepts, principles of engineering experimentation and reliability engineering.
2. To learn the various Techniques used in design of experiments and reliability engineering.
3. To analyze the engineering experiments and apply Design of experiments (DOE) techniques for case studies.

Course Outcomes:

At the end of the course the students shall be able to

1. Understand the experimental planning, evaluation procedure and analysis used in industrial environment.
2. Apply the techniques of design of experiments (DOE) for engineering application
3. Learn the evaluation techniques (for example: MTTF and failure rates) for Reliability Engineering.
4. Use DOE and reliability techniques for engineering applications using industrial case studies.

Course Content:

Module No.	Syllabus	Hours
1.	Design of Experiments (DOE): Introduction to Engineering experiments, Measurement of physical parameters, selection of instruments, static and dynamic characteristics of response, Planning of experiments.	6
2.	Measurements and statistical estimation of errors, Basic statistics and data analysis for sample population and distributions, Hypothesis testing, Analysis of Variance (ANOVA)	6
3.	Single and multi variate regression analysis, Linear and non linear regression, Randomization and Blocking, Complete and in complete block designs.	6
4.	Full factorial design (2 level and 3 level experiments), Fractional factorial design, Response surface Methodology, Taguchi techniques for design of experiments.	6
5.	Probability and Distributions for reliability, Reliability management, quality specifications for products/systems, redundancy and diversity evaluation techniques.	6
6.	Reliability Network Modeling (series, parallel, m out of n systems), Network evaluation techniques (conditional probability, cut set, tie set, tree diagram)	6
7.	Failure types, Time dependent reliability, Application of MTTF, MTBF, MTTR for reliability assessment.	6

Term Work

1. Assignments containing numerical problems based on each module.
2. Seminar based on recent advances in the subject

3. At least one Case study each on DOE and reliability engineering.

Text Books:

1. Jiju Antony, Design of Experiments for engineers and scientists, 2003.
2. Patrick, D. O. *Practical reliability engineering*. John Wiley, 1985.

Reference Books:

1. Doebelin, Ernest O. *Engineering experimentation: planning, execution, reporting*. McGraw Hill College, 1995.
2. Pieruschka, Erich. *Principles of reliability*. Prentice-Hall, 1963.
3. Madhav S. Phadke, Quality Engineering using Robust Design, 1989.
4. Douglas C. Montgomery, Design and Analysis of Experiments, 2013.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE06 Program Elective: System Modeling and Analysis

Course Pre-requisites: BTM502, BTM503

Course Objectives:

After this course students will be able to:

1. Understand what is a model, types of models, purpose of models
2. Understand the need for quantification and understand the limits of quantification
3. Be able to transform loose facts into an insightful model, to be used as input for requirements discussions and system design and verification
4. Be able to use scenario analysis as a means to cope with multiple alternative specifications and or designs
5. Apply problem-driven light-weight simulations and understand their value and purpose in early design decisions

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Apply mathematical modelling for mechanical Elements, systems, hydraulic/pneumatic element and systems.
2. Describe transfer function representation
3. Analyse system response and stability.
4. Compute transient response of first and second order system.

Course content:

Mod. No.	Description	Duration (hrs)
1	Mathematical modeling of mechanical elements – inertia, stiffness and damper	6
2	Mathematical modeling of mechanical systems- vehicles, articulated vehicle and other mechanical systems	6
3	Mathematical modeling of hydraulic elements and system- pneumatic elements and system.	6
4	Transfer function representation, block diagram, State variable representation, matrix equation.	6
5	Numerical methods and some other solution methods.	6
6	System response and stability – Static and dynamic stability of vehicles and articulated vehicles.	6
7	Transient response of first and second order system – Steady state response – step response, ramp response, impulse response, sinusoidal response, input – convolution integral, stability of system.	6

Recommended Books:

1. Vu, Hung V., and Ramin S. Esfandiari. *Dynamic systems: modeling and analysis*. McGraw-Hill Science, Engineering & Mathematics, 1997.
2. Ellis, John Ronaine. *Vehicle dynamics*. Random House Business, 1969.
3. Kobayashi, Hisashi, and Brian L. Mark. *System modeling and analysis: Foundations of system performance evaluation*. Pearson Education India, 2009.

Term work:

Assignment based on above topics and seminars.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE07 Program Elective: Process Equipment Design
Course Pre-requisites: BTM502, BTM801

Course Objectives:

The objective of this course is to:

- Learn reading of essential design documents such as P&ID and vessel data sheets.
- Prepare student to obtain sizes of important process equipment components subjected to different types of loading.
- Make students to handle stress/thermal analysis of pressure components using advanced methods such as finite element method.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Explain and interpret essential design documents such as PFD, P&ID, vessel specification
2. Calculate size of various process equipment components using design rules as well as IT tools.
3. Design vessels, heat exchangers and allied auxiliary components.
4. Discuss loadings, failure modes for process equipment design.

Course content:

M. No.	Description	Duration (Hrs)
1	Role of process equipment engineer in Chemical industry, organization and working of EPC company, Interpretation of process diagrams such as P&ID, equipment layout drawing. Classification of vessels such as tank, flat, bottomed and vertical cylinder tank, vertical cylindrical and horizontal vessels with formed ends as well as spherical or modified spherical vessels. Classification of materials for pressure vessels, Introduction to various process equipments, codes and standards, applications of first principle using ASME codes	8
2	Criteria in vessel design. Elastic bending, plastic instability, cyclic loading stress reversals. Brittle rupture and creep rupture, Membrane theory.	6
3	Design of pressure components such as shell, head, cone for internal pressure loading. Design of cylindrical shells against external pressure; design of stiffener rings, Stress categorization, Manufacturing aspects PWHT, weld consideration design	6
4	Advanced design topics such as nozzle reinforcement calculation, bolted flange design, selection of gaskets. Elementary stress analysis of pressure parts using finite element methods, Fitness for service assessment	6
5	Design of supports for tall vertical vessels; skirt support subjected to wind and seismic loads, design of saddle supports for horizontal vessels.	6
6	Design of storage tanks, Design of jacketed vessels.	6
7	Elementary heat exchanger design. Tubesheet thickness calculations, baffle plate design	4

Recommended Books:

1. Brownell, Lloyd E., and Edwin H. Young. *Process equipment design: vessel design*. John Wiley & Sons, 1959.
2. Harvey, John F., and H. Saunders. "Theory and design of pressure vessels." (1987)
3. Mahajan, Kanti K. "Design of process equipment: selected topics." (1985).
4. Couper, James R., W. Roy Penney, and James R. Fair. *Chemical process equipment revised 2E: selection and design*. Gulf Professional Publishing, 2009.
5. IS codes and ASME section
6. Heat Exchanger by Singh and Soler.

Term work:

Assignment based on above topics and seminars, Group projects and mini projects on complete vessel, Group design activities, plant visits

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE09 Program Elective: Micro-Electro Mechanical Systems
Course Pre-requisites: BTM405, BTM503

Course Objectives

1. To introduce basic concepts of MEMS and its applications.
2. To introduce sensors and actuators in Micro-domain.
3. To study modelling and simulation techniques for various applications.
4. Apply knowledge of micro fabrication techniques and applications to the design and manufacturing of an MEMS device or a micro system

Course Outcomes: Learner will be able to...

1. Select appropriate sensors and actuators for a given MEMS application.
2. Select a micro-fabrication technique for a specific MEMS fabrication process.
3. Model and simulate a given MEMS system
4. Design MEMS

Course content:

M. No.	Description	Hrs.
1	Introduction to MEMS & Applications <ul style="list-style-type: none"> • Introduction to Micro-Electro-Mechanical Systems, • Applications and Materials, • Advantages & Disadvantages of Micro-sensors, and micro-actuators. 	6
2	Sensors and Actuators in Micro-domain <ul style="list-style-type: none"> • Concept of Sensors & Actuators, • Sensing & Actuation Principles: Mechanical Sensing, Capacitive, Electrostatic, Electromagnetic, Piezo Resistive, Piezo Electric, Thin Films, Shape Memory Alloys • Comb Drive Actuation & Sensing, Micro-mechanisms, Air-Bag Sensors, Chemical Sensors 	6
3	Fabrication Methods Microfabrication Methods (VLSI Techniques) <ul style="list-style-type: none"> • Positive and Negative Photoresists, • Bulk Micromachining, • Surface Micromachining, • Etching (Isotropic and Anisotropic), • Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques. 	4
4	3D High Aspect Ratio Fabrication Techniques <ul style="list-style-type: none"> • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc 	6
5	Modelling and Simulation Techniques <ul style="list-style-type: none"> • Scaling Laws, Governing Equations • Modelling of Mechanical Structures via classical methods, Newtons Laws, Thermal Laws, Fluid Flow Analysis • Micro-mechanism modelling and analysis techniques : Lumped Parameter Modelling and Distributed Parameter Modeling 	6

	<ul style="list-style-type: none"> • Modelling of Micro-channel as heat exchanger, accelerometers, microhinges, compound microstructures. • Linear & Nonlinear Model. 	
6	<p>Characterization Techniques Topography Methods (Optical, Electrical and Mechanical Methods)</p> <ul style="list-style-type: none"> • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes), SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes) Mechanical Structure Analysis • Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric) • Interferometry Techniques, • SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle Pattern Interferometry), • Laser Techniques, Laser Doppler Vibro-meters Fluid, Thermal and Chemical Analysis • Thermal Analysis Techniques (Theoretical and Experimental), • Fluid Flow Pattern Analysis, • Electro-chemical Analysis, PIV Techniques -spectroscopy 	8
7	<p>Introduction to Advances of MEMS and Nanotechnology</p> <ul style="list-style-type: none"> • CNT (Carbon Nano Tubes) Applications, its properties, and Fabrication Method, • Nano-mechanical Systems (NEMS), • Nano-tribology, & nano-indentation techniques, • Domestic and Industrial Applications of nanotechnology • Social and Ethical Implications of nanotechnology in Society 	6

Recommended Books:

1. Julian W. Garden, Vijay K. Varadan and Osama O. Awadelkarim “Microsensors MEMS and Smart devices”, John Wiley and sons, Ltd.
2. Nadim Mulaf and Kirt Williams, “An Introduction to Microelectromechanical systems Engineering”, Artech House.
3. Nicolae Lobontiu and Ephrahim Garcia, “Mechanics of Microelectromechanical systems”, Kluwer Academic Publication.
4. Stanley Wolf and Richard Tauber, “Silicon Processing for the VLSI era Volume -1 Technology”, Lattice press.
5. Vijay K. Varadan, K.J. Vinoy and S. Gopalkrishnan, “Smart Material Systems and MEMS: Design and Development Methodologies”, John Wiley and sons Ltd.
6. Bhushan, “Springer Handbook of Nanotechnology”, Springer Inc.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

Term work:

- Assignments based on each modules of syllabus

EC-MDPE10 Program Elective: Entrepreneurship Development and Management
Course Pre-requisites: BTM704

Course Objectives:

1. To acquaint with entrepreneurship and management of business
2. Understand Indian environment for entrepreneurship
3. Idea of EDP, MSME

Course Outcomes:

Learner will be able to...

1. Understand the concept of business plan and ownerships
2. Interpret key regulations and legal aspects of entrepreneurship in India
3. Understand government policies for entrepreneurs

Course content:

M. No.	Description	Hrs
1	Overview Of Entrepreneurship: Definitions, Roles and Functions/Values of Entrepreneurship, History of Entrepreneurship Development, Role of entrepreneurship in the National Economy, Functions of an Entrepreneur, Entrepreneurship and Forms of Business Ownership Role of Money and Capital Markets in Entrepreneurial Development: Contribution of Government Agencies in Sourcing information for Entrepreneurship	7
2	Business Plans And Importance Of Capital To Entrepreneurship: Preliminary and Marketing Plans, Management and Personnel, Start-up Costs and Financing as well as Projected Financial Statements, Legal Section, Insurance, Suppliers and Risks, Assumptions and Conclusion, Capital and its Importance to the Entrepreneur.	5
3	Entrepreneurship And Business Development: Starting a New Business, Buying an Existing Business, New Product Development, Business Growth and the Entrepreneur Law and its Relevance to Business Operations	6
4	Women's Entrepreneurship Development, Social entrepreneurship-role and need, EDP cell, role of sustainability and sustainable development for SMEs, case studies, exercises	6
5	Indian Environment for Entrepreneurship: key regulations and legal aspects , MSMED Act 2006 and its implications, schemes and policies of the Ministry of MSME, role and responsibilities of various government organisations, departments, banks etc., Role of State governments in terms of infrastructure developments and support etc., Public private partnerships, National Skill development Mission, Credit Guarantee Fund, PMEGP, discussions, group exercises etc.	6
6	Effective Management of Business: Issues and problems faced by micro and small enterprises and effective management of M and S enterprises (risk management, credit availability, technology innovation, supply chain management, linkage with large industries), exercises, e-Marketing	6
7	Achieving Success In The Small Business: Stages of the small business life cycle, four types of firm-level growth strategies, Options – harvesting or closing small business Critical Success factors of small business	6

Recommended Books/Websites:

1. Poornima Charantimath, Entrepreneurship development- Small Business Enterprise, Pearson Education
2. Robert D Hisrich, Michael P Peters, Dean A Shapherd, Entrepreneurship, latest edition, The McGrawHill Company
3. Dr T. N. Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi
4. Dr C. N. Prasad, Small and Medium Enterprises in Global Perspective, New century Publications, New Delhi
5. Vasant Desai, Entrepreneurial development and management, Himalaya Publishing House
6. MaddhurimaLall, ShikahSahai, Entrepreneurship, Excel Books
7. Rashmi Bansal, STAY hungry STAY foolish, CIIE, IIM Ahmedabad
8. Law and Practice relating to Micro, Small and Medium enterprises, Taxmann Publication Ltd.
9. Kurakto, Entrepreneurship- Principles and Practices, Thomson Publication
10. Laghu Udyog Samachar
11. www.msme.gov.in
12. www.dcmesme.gov.in
13. www.msmetraining.gov.in

Term work:

- Assignments based on above modules
Seminar based on recent advances in the subject
- At least one Case study on industry

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE11 Program Elective: Design of Power Transmission Systems
Course Pre-requisites: BTM801

Course Objectives:

1. After learning this Course the student will understand the Detail Design Procedure of the Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison
2. The student will learn Components like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail and will be in position to design and select them suitably.
3. The student will also learn some Case studies of Design of Power Transmission System [mechanical and hydraulic systems] to reinforce their concepts.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Select and design various mechanical and hydraulic power transmission system.
2. Analyze vibration characteristics, wear and life of critical components of power transmission systems.
3. Calculate sizing of elements of transmission systems like couplings, belts, chains, gears, brakes, clutches, shafts, bearing, housing pumps, valves in detail.
4. Discuss case studies on power transmission system design.

Course content:

M. No.	Course Details	Hour
1.	Different types of prime movers, characteristics, limitation application and selection	2
2.	Transmission Systems – Mechanical, Hydraulic, Pneumatic general description and comparison Components like couplings, belts, chains, gears, etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	8
3.	Components like brakes, clutches, shafts, bearing, housing pumps, valves etc used. Their limitations and use in specific applications. Typical example of mechanical and hydraulic systems.	12
4.	Analysis for applications (automobile m/c Tool, Process engineering) and data for design- Selection of components, Standard components use and selection.	4
5.	Synthesis above and get complete solution.	4
6.	Analysis of the solution further with respect to vibration, wear, life of critical components, reliability, assembly, maintenance and cost.	4
7.	Case studies on Power Transmission System Design	8

Term Work

- Assignments based on above modules
- Seminar based on recent advances in the subject
- At least one Case study conducted at industry

Text and Reference books

1. Vicker's Industrial Hydraulics Manual, Eaton Hydraulics Training, 5th Edition, 1999.
2. Rohner, Peter. *Industrial hydraulic control: a textbook for fluid power technicians*. Prentice Hall, 1987.
3. Pippenger, John J. Hicks, Tyler G. John J. Pippenger, and Tyler G. Hicks. *Industrial hydraulics*. 1979.
4. Fundamentals of Pneumatics – Festo didactic GmbH & Co., 2000.
5. Esposito, Anthony. *Fluid power with applications*. Prentice-Hall International, 2000.
6. Bhandari, V.B, *Design of Machine Elements*, Tata McGraw Hill Education Pvt Ltd.
7. Shigley, J.E and C R Mischke, *Mechanical engineering Design*, McGraw Hill Inc.
8. Spotts, M F and T E Shoup, *Design of Machine Elements*, Prentice Hall Inc.
9. Spotts, M F, *Mechanical Design Analysis*, Prentice Hall Inc.
10. John J .Pippenger and Dudley A. Peace, *Basic Fluid Power*, Prentice Hall Inc.
11. Fundamentals of Pneumatics, *Electro-Pneumatics and Electro-Hydraulics*, FESTO Didactic, 2000
12. Michael J. Pinches and John G. Ashby, *Power Hydraulics*, Prentice Hall Inc.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE12 Program Elective: Optimization Techniques in Design

Course Pre-requisites: BTM605, BT207

Course Objectives:

1. To introduce tools and techniques for optimization to engineering applications
2. To understand the formulation of design equations for mechanical systems.
3. To understand algorithms and methods used for optimization for design of mechanical systems.
4. To design and select optimum configuration of mechanical components and systems.

Course Outcomes:

At the end of the course the students shall be able to

1. Explain different approaches to optimize mechanical systems.
2. Create programs based on different optimization algorithms using IT tools, such as Minitab, MATLAB, etc.
3. Calculate optimum solution to linear and non-linear problems.
4. Apply the numerical and optimization understanding for finalizing design of mechanical designs.

Course content:

M. No	Description	Hrs
1	Need for optimization and historical development classification and formulation of optimization problem, classical optimization methods, Calculas based methods, Enumerative schemes, Rendom search algorithms,	07
2	Evolutionary algorithms, Genetic algorithms, Evolutionary programming, Evaluation Strategies, Classifier Systems.	07
3	Optimum design of mechanical elements: Purpose and applications of optimum design. Effects of manufacturing errors, characteristics of meachnical systems	07
4	Selection of optimum configuration, critical regions materials and dimensions,	05
5	Formulation of primary and subsidiary design equations, Limit equations, Normal redundant and incompatible specifications. General techniques.	05
6	Digital computers in optimum design. Exact and Interactive techniques	05
7	Optimal design of elements and systems, shafts gears, bearings, springs, high speed machinery, cams etc. Case studies.	06

Text Books:

1. Rao, Singiresu S., and S. S. Rao. *Engineering optimization: theory and practice*. John Wiley & Sons, 2009.
2. Deb, Kalyanmoy. *Optimization for engineering design: Algorithms and examples*. PHI Learning Pvt. Ltd., 2012.

Reference Books

3. Mital, K.V., 1996. *Optimization methods in operations research and systems analysis*. New Age International.
4. Taha, Hamdy A. *Operations Research: An Introduction (For VTU)*. Pearson Education India, 1982.
5. Bury, Karl. *Statistical distributions in engineering*. Cambridge University Press, 1999.
6. Fogel, David B. *Artificial intelligence through simulated evolution*. Wiley-IEEE Press, 2009.

Term work: Assignments containing numerical problems based on each module.

Seminar based on recent advances in subject.

At least one case study based on any one optimization method.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE13 Program Elective: Advanced Engineering Materials
Course Pre-requisites: BTM304

Course Outcomes:

At the end of the course the student will

1. Demonstrate an understanding of mechanics, physical and chemical properties of materials including metals, ceramics, polymers and composites
2. Understand existence of imperfections and their effects on mechanical properties of materials and cause of failure
3. Demonstrate understanding of phase diagrams and their use in predicting phase transformation and microstructure
4. Understand and predict various types of failures using concept of fracture mechanics, creep and effect of impact
5. Know Electrical, Thermal, Optical and Magnetic Properties of metals, ceramics, polymers and composites
6. Understand the economic considerations in usage and recycling of materials in human use

Units	Content	Hours
1	Introduction, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids: Historical perspective of Materials Science. Why study properties of materials? Classification of materials. Advanced Materials, Future materials and modern materials, Atomic structure. Atomic bonding in solids, Crystal structures, Crystalline and noncrystalline materials. Miller indices. Anisotropic elasticity. Elastic behaviour of composites. Structure and properties of polymers. Structure and properties of ceramics.	8
2	Imperfections in Solids and Mechanical Properties of Metals, Diffusion, Dislocations and Strengthening Mechanisms: Point defects. Theoretical yield point. Line defects and dislocations. Interfacial defects. Bulk or volume defects. Atomic vibrations; Elastic deformation. Plastic deformation. Interpretation of tensile stress-strain curves Yielding under multiaxial stress. Yield criteria and macroscopic aspects of plastic deformation. Property variability and design factors, Diffusion mechanisms. Steady and non-steady state diffusion. Factors that influence diffusion. Non-equilibrium transformation and microstructure, Dislocation and plastic deformation. Mechanisms of strengthening in metals. Recovery, recrystallization and grain growth. Strengthening by second phase particles. Optimum distribution of particles. Lattice resistance to dislocation motion.	6
3	Phase Diagrams Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Kinetics of nucleation and growth. The iron-carbon system. Phase transformations. Transformation rate effects and TTT diagrams. Microstructure and property changes in iron-carbon system.	6
4	Failure:	4

	Fracture. Ductile and brittle fracture. Fracture mechanics. Impact fracture. Ductile brittle transition. Fatigue. Crack initiation and propagation. Crack propagation rate. Creep. Generalized creep behaviour. Stress and temperature effects	
5	Applications and Processing of Metals and Alloys, Polymers, Ceramics, and composites: Types of metals and alloys. Fabrication of metals. Thermal processing of metals. Heat treatment. Precipitation hardening. Types and applications of ceramics. Fabrication and processing of ceramics, Mechanical behaviour of polymers. Mechanisms of deformation and strengthening of polymers. Crystallization, melting and glass transition. Polymer types. Polymer synthesis and processing, Particle reinforced composites. Fibre reinforced composites. Structural composites, Failure nature of composites.	6
6	Electrical, Thermal, Optical and Magnetic Properties and economic Considerations: Electrical conduction. Semi conductivity. Super conductivity. Electrical conduction in ionic ceramics and in polymers. Dielectric behaviour. Ferroelectricity. Piezoelectricity Heat capacity. Thermal expansion. Thermal conductivity. Thermal stresses Diamagnetism and Paramagnetism. Ferromagnetism. Antiferromagnetism and ferrimagnetism. Influence of temperature on magnetic behaviour. Domains and Hysteresis, Basic concepts. Optical properties of metals. Optical properties of non-metals. Application of optical phenomena.	6
7	Economic, Environmental and Social Issues of Material Usage - Economic considerations. Environmental and societal considerations. Recycling issues. Life cycle analysis and its use in design	6

Reference Books:

1. Materials Science and Engineering, William D. Callister, Jr, John Wiley & sons, 07.
2. Modern Physical Metallurgy and Material Engineering, Science, Process, application, Smallman R.E., Bishop R J, Butterworth Heinemann, Sixth Ed., 1999.
3. “Essentials of Materials For Science And Engineering” by Donald R Askeland, Cengage; 2 edition (2013)
4. “Physical Metallurgy, Principles and Practices” by V Raghavan. Prentice Hall India Learning Private Limited; 2 edition (2006)
5. Mechanical Metallurgy by George E. Dieter, McGraw Hill Publications

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE14 Program Elective: Mechanics of Composite Materials
Course Pre-requisites: BTM898

Course Outcomes:

The student should be able to

1. Student will be able to understand the basic concepts and difference between composite materials with conventional materials.
2. Students will be able to understand role of constituent materials in defining the average properties and response of composite materials on macroscopic level.
3. Students will be able to apply knowledge for finding failure envelopes and stress-strain plots of laminates.
4. Students will be able to develop a clear understanding to utilize subject knowledge using computer programs to solve problems at structural level.

Units	Content	Hours
1	Introduction Definition and characteristics, Overview of advantage and limitations of composite materials, Significance and objectives of composite materials, Science and technology, current status and future prospectus	6
2	Basic Concepts and Characteristics Structural performance of conventional material, Geometric and physical definition, Material response, Classification of composite materials, Scale of analysis; Micromechanics, Basic lamina properties, Constituent materials and properties, Properties of typical composite materials.	6
3	Elastic Behavior of Unidirectional Lamina Stress-strain relations, Relation between mathematical and engineering constants, transformation of stress, strain and elastic parameters	6
4	Strength of Unidirectional Lamina Micromechanics of failure; failure mechanisms, Macro-mechanical strength parameters, Macromechanical failure theories, Applicability of various failure theories	6
5	Elastic Behavior of Laminate Basic assumptions, Strain-displacement relations, Stress-strain relation of layer within a laminate, Force and moment resultant, General load–deformation relations, Analysis of different types of laminates.	6
6	Stress and Failure Analysis of Laminates Types of failures, Stress analysis and safety factors for first ply failure of symmetric laminates,	6
7	Micromechanics of progressive failure; Progressive and ultimate laminate failure, Design methodology for structural composite materials	6

Reference Books:

1. Isaac M. Daniels, Ori Ishai, “Engineering Mechanics of Composite Materials”, Oxford University Press, 1994.
2. Bhagwan D. Agarwal, Lawrence J. Broutman, “Analysis and Performance of fiber composites”, John Wiley and Sons, Inc. 1990.
3. Mathews, F. L. and Rawlings, R. D., “Composite Materials: Engineering and Science”,

CRC Press, Boca Raton, 03.

4. Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 04.

5. Mazumdar S. K., “Composaites Manufacturing – Materials, Product and Processing Engineering”, CRC Press, Boca Raton, 02.

6. Robert M. Jones, “Mechanics of Composite Materials”, Taylor and Francis, Inc., 1999.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE15 Program Elective: Robotics

Course Pre-requisites: BTM402

Course Outcomes:

At the end of the course students will be able to

1. Understand basic terminologies and concepts associated with Robotics and Automation
2. Demonstrate comprehension of various Robotic sub-systems
3. Understand kinematics and dynamics to explain exact working pattern of robots
4. Aware of the associated recent updates in Robotics

Units	Content	Hours
1	<p>Introduction: Basic Concepts such as Definition, three laws, DOF, Misunderstood devices etc., Elements of Robotic Systems i.e. Robot anatomy, Classification, Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device, etc. Automation - Concept, Need, Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.</p>	6
2	<p>Robot Grippers: Types of Grippers, Design aspect for gripper, Force analysis for various basic gripper system. Sensors for Robots: - Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.</p>	6
3	<p>Drives and control systems: Types of Drives, Actuators and its selection while designing a robot system. Types of transmission systems, Control Systems -Types of Controllers, Introduction to closed loop control Control Technologies in Automation:- Industrial Control Systems, Process Industries Verses, Discrete-Manufacturing Industries, Continuous Verses Discrete Control, Computer Process and its Forms. Control System Components such as Sensors, Actuators and others.</p>	6
4	<p>Kinematics: Transformation matrices and their arithmetic, link and joint description, Denavit – Hartenberg parameters, frame assignment to links, direct kinematics, kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and static forces in manipulators: - Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations</p>	6
5	<p>Machine Vision System: Vision System Devices, Image acquisition, Masking, Sampling and quantisation, Image Processing Techniques, Noise reduction methods, Edge detection, Segmentation. Robot Programming :- Methods of robot programming, lead through programming, motion interpolation, branching capabilities, WAIT, SIGNAL and DELAY commands, subroutines,</p>	6

	Programming Languages: Introduction to various types such as RAIL and VAL II etc, Features of type and development of languages for recent robot systems.	
6	Modeling and Simulation for manufacturing Plant Automation: Introduction, need for system Modeling, Building Mathematical Model of a manufacturing Plant, Modern Tools- Artificial neural networks in manufacturing automation, AI in manufacturing, Fuzzy decision and control, robots and application of robots for automation. Artificial Intelligence:- Introduction to Artificial Intelligence, AI techniques, Need and application of AI.	6
7	Other Topics in Robotics: - Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and associated mass, New Trends & recent updates in robotics	6

References:

Text Books:

1. John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 04
2. Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986.
3. Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 01.
4. Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education.
5. Industrial Automation: W.P. David, John Wiley and Sons.

Reference Books:

1. Richard D. Klafter , Thomas A. Chemielewski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 02.
2. Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

EC-MDPE16: Advance Fracture Mechanics

Course Pre-requisites: MTMD101

Course Objectives:

1. To expand student's knowledge in the area of linear-elastic fracture mechanics and the stress analysis of cracked bodies with a focus on metallic structures.
2. To develop student's ability to compute crack-tip stress-intensity factors for two and three-dimensional cracked bodies of LEFM.
3. To develop student understands of the relationship between the energetic approach and the stress analysis of cracked bodies.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Analyze nature of stresses around a cracked body by applying principles of linear elastic fracture mechanics and compute stress intensity factors.
2. Interpret the result of a fracture mechanics analysis for metallic structures and relate the same to ASME/API.
3. Explain experimental methods for K_{Ic}/J - testing using various types of test specimens.
4. Evaluate the fracture related failures.

Course content:

Sr. No.	Description	Hrs.
1	Introduction- background, Kinds of failure, modes of failure, brittle and ductile fracture.	4
2	Energy Consideration- Introduction, Griffith analysis, energy release rate.	6
3	Stress in cracked bodies- Stress intensity factor, determination of SIF, CTOD.	8
4	J integral- Definition, scope, path independence.	8
5	Test methods- introduction, K_{Ic} test technique, J testing, various test specimens.	4
6	Fatigue- introduction, terminology, S-N curve, fractures due to fatigue, Paris law for design of components.	4
7	Fracture mechanics design process, Principles of fracture safe design & fracture control plans, Fail safe & safe life design, Damage tolerant design & leak before break criterion, Numericals, Practical Case studies, Fibre composites & their fracture mechanics	8

Recommended Books:

1. Kumar, Prashant, and Kumar Prashant. *Elements of fracture mechanics*. Tata McGraw-Hill Education, 2009.
2. Anderson, Ted L. *Fracture mechanics: fundamentals and applications*. CRC press, 2005.
3. Maiti, S. K. *Fracture Mechanics: Fundamentals and Applications*. Cambridge University Press, 2015.
4. Kanninen, Melvin F., and Carl L. Popelar. "Advanced fracture mechanics." (1985).

5. Barson, J. M., and Stanley T. Rolfe. "Fracture and Fatigue Control in Structures: applications of fracture mechanics." *American Society for Testing and Materials, West Conshohocken, PA* (1999): 194.
6. Gdoutos, Emmanuel. *Fracture mechanics criteria and applications*. Vol. 10. Springer Science & Business Media, 2012.
7. KRY Simha
8. Handbook by Tada,Sih&Paris
9. Use of visual videos for the course.
10. Hull D. An Introduction to composite materials,Cambridge University Press,1981
11. Agarwal,B.D and Broutman,L.J. Analysis and performance of fibre composites,John Wiley,1980

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

MDAU1 AUDIT I: ENGLISH FOR RESEARCH PAPER WRITING

Course Pre-requisites: BTM406

Course outcomes:

Students will be able to:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title

Ensure the good quality of paper at very first-time submission

Course Content:

Units	Content	Hours
1	Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	3
2	Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction	3
3	Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.	3
4	Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,	3
5	Skills are needed when writing the Methods, skills needed when writing the Results	3
6	Skills are needed when writing the Discussion, skills are needed when writing the Conclusions	3
7	Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission	3

Reference Books:

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

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

MDAU2 AUDIT I: CONSTITUTION OF INDIA

Course Pre-requisites: BT025

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

Course Content:

Units	Content	Hours
1	➤ History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)	3
2	➤ Philosophy of the Indian Constitution: Preamble Salient Features	3
3	➤ Contours of Constitutional Rights & Duties: ➤ Fundamental Rights ➤ Right to Equality ➤ Right to Freedom ➤ Right against Exploitation ➤ Right to Freedom of Religion ➤ Cultural and Educational Rights ➤ Right to Constitutional Remedies ➤ Directive Principles of State Policy ➤ Fundamental Duties.	3
4	➤ Organs of Governance: Model Curriculum of Engineering & Technology PG Courses [Volume - II][194] ➤ Parliament ➤ Composition ➤ Qualifications and Disqualifications ➤ Powers and Functions	3

	<ul style="list-style-type: none"> ➤ Executive ➤ President ➤ Governor ➤ Council of Ministers ➤ Judiciary, Appointment and Transfer of Judges, Qualifications ➤ Powers and Functions 	
5	<ul style="list-style-type: none"> ➤ Local Administration: ➤ District's Administration head: Role and Importance, ➤ Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. ➤ Pachayati raj: Introduction, PRI: Zila Pachayat. 	3
6	<ul style="list-style-type: none"> ➤ Elected officials and their roles, CEO Zila Pachayat: Position and role. ➤ Block level: Organizational Hierarchy (Different departments), ➤ Village level: Role of Elected and Appointed officials, ➤ Importance of grass root democracy 	3
7	<ul style="list-style-type: none"> ➤ Election Commission: ➤ Election Commission: Role and Functioning. ➤ Chief Election Commissioner and Election Commissioners. ➤ State Election Commission: Role and Functioning. ➤ Institute and Bodies for the welfare of SC/ST/OBC and women 	3

Reference Books:

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

MDAU3 -AUDIT II: DISASTER MANAGEMENT

Course Pre-requisites: BTM399, BTM499

Course Outcomes: -Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and Humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Units	Content	Hours
1	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	3
2	Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.	3
3	Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics	3
4	Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.	3
5	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment,	3
6	Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	3
7	Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	3

Reference Books:

1. R. Nishith, Singh AK, “Disaster Management in India: Perspectives, issues and strategies “New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.),” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi.
3. Goel S. L. , Disaster Administration And Management Text And Case Studies” ,Deep &Deep Publication Pvt. Ltd., New Delhi.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

MDAU4: AUDIT II: STRESS MANAGEMENT BY YOGA

Course Pre-requisites: BT107

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

Unit	Content	Hours
1	➤ Definitions of Eight parts of yog. (Ashtanga)	3
2	➤ Yam and Niyam. Do`s and Don`t`s in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan	3
3	Yoga & The Brain ➤ Brain Based Learning ➤ The Brain ➤ Teaching to the Developing Brain ➤ Supporting the Learning Brain with Yoga	3
4	Social Emotional Learning	3
5	POSITIVE CLASSROOM MANAGEMENT ➤ Transitions and Engagement ➤ Dynamic Teaching ➤ Understanding Behavior ➤ Classroom Boundaries	3
6	THE YOGA ENVIRONMENT ➤ Clothing ➤ Assistants • ➤ Adjustments	3
7	➤ Asan and Pranayam i) Various yog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- ➤ Types of pranayam	3

Suggested reading

1. ‘Yogic Asanas for Group Tarining-Part-I’ : Janardan Swami Yogabhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

VAMD101 Value Added Course: Internet of Things

Course Pre-requisites: General knowledge of networking, sensing, databases, programming, and related technology

Course Objectives:

Upon successful completion of the course, students will be

- Explored to the interconnection and integration of the physical world and the cyber space.
- They are also able to design & develop IOT Devices.

Course Outcomes:

After successful completion of the course student should be able to

1. Describe the theory related to Internet of things
2. Apply theoretical knowledge of IOT in practice
3. Select the hardware & software for different applications.
4. Develop an application using IOT hardware & software

Course Content:

Sr. No.	Syllabus	Hrs
1.	Introduction Fundamentals of Internet of Things (IOT), Components in IOT, Architecture of IOT, Security, Privacy, Advantages, Applications: Smart Vehicles, Medical, Smart city, Smart Supply Chain etc.	2
2.	Enabling Technologies of IOT Technology Roadmap, RFID, Augmented Reality, Blue Tooth, Zigbee, WiFi, RFLinks, MEMS etc	2
3.	Programming the Microcontroller for IOT Cloud computing and IOT – Arduino/Equivalent Microcontroller platform – Setting up the board - Programming for IOT – Reading from Sensors - Communication-Connecting microcontroller with mobile devices – communication through Bluetooth and USB – connection with the internet using WiFi / Ethernet	2
4.	Resource Management Understanding the Elements of IOT (Sensors, Connectivity through network, Application Layer), Overview of Sensors, Gateways, Sensors Available in Market, Selecting the Right Sensor for the Right Use case, Considerations for Mounting Sensors for Right Results	2
5.	IOT PROTOCOLS Network Overview, Various Types of Networks, Network Protocols, Selecting the Right Network for the Right Use case, Network Challenges for IOT: Connecting sensors, Integrating with Application Platform	2
6.	IOT Platforms Introduction, Necessity of IOT Platform, Industrial Grade Platform, Key IOT Platform Features, IOT Platform Architecture, Getting access to IOT platforms, Introduction to Model based development on IOT platforms	2
7.	Challenges & Opportunities of IOT New business markets in IOT, IOT Design Challenges, IOT Design Opportunities, Technological challenges faced by IOT devices	2

Tutorial Work:

It consists of at least one tutorial and/or assignments and/or hands-on exercises from each module of the curriculum mentioned for the course.

Text Books:

1. Dieter Uckelmann et.al, “Architecting the Internet of Things”, Springer, 2011.

Reference Books:

1. Charalampos Doukas, “Building Internet of Things with the Arduino”, Create space, April 2002

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

VAMD102: Value Added Course: Introduction to Big Data Analytics
Course Pre-requisites: BTM 301, BTM 401

Course Objectives:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Manage business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course Outcomes:

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionable insights.

Course Content:

Sr. No.	Syllabus	Hrs
1.	Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.	2
2.	Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.	2
3.	Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.	2
4.	Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.	2
5.	Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor	2

	Model, Overbooking Model, Cash Budget Model.	
6.	Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.	2
7.	Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.	2

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

VAMD203: Value Added Course: Introduction to AI and Machine Learning

Course Pre-requisites: Mathematics, Knowledge of programming language (Python preferred),

Course Objective:

The students after studying these topics should be able to

1. understand applications of Artificial Intelligence and Machine Learning for engineering applications
2. apply suitable algorithms for simple engineering problems

Course Outcomes:

Upon successful completion of the course, students should be able to

1. discuss applications of Artificial Intelligence for engineering problem solving
2. apply fundamental concepts in machine learning and select popular machine learning algorithms for engineering problem solving
3. compose computer code for solving problems using machine learning algorithms
4. explain advanced machine learning concepts such as Neural Network, Reinforcement Learning.

Course Content:

Module No.	Details	Hrs.
01	Artificial Intelligence, Intelligent agents, types of learning, steps involved in problem solving using Machine Learning	2
02	Linear regression, Decision trees, overfitting	2
03	Instance based learning, Feature reduction, Collaborative filtering-based recommendation	2
04	Logistic Regression, Support Vector Machine, Kernel function and Kernel SVM	2
05	Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network	2
06	Clustering: k-means, adaptive hierarchical clustering	2
07	Introduction to Reinforcement Learning	2

Term Work/Laboratory:

Journal work shall consist of e-folder with computer code for solution to problems based on each module.

Text Books:

1. Tom Mitchell, Machine Learning, First Edition, McGraw- Hill (1997).
2. Stuart Russel and Peter Norvig, Artificial Intelligence – A modern approach, Pearson (2015)
3. Ethem Alpaydin, Introduction to Machine Learning, PHI (2015).
4. Gopal M., Applied Machine Learning, McGraw Hill (2018)

Sardar Patel College of Engineering Andheri (West), Mumbai 400 058
Academic Year: 2019-20

Sr. No.	Examination	Module
1	T-I	1,2
2	T-II	3,4
3	End Sem	1 to 7

VAMD204: Value Added Course: Introduction to Augmented Reality
Course Pre-requisites: MTMD102

Prerequisite:- General knowledge of CAD Modelling

Course Objectives:

- Explore the basic concepts of Augmented Reality.
- They are also able to design & develop AR application.

Course Outcomes:

After successful completion of the course student should be able to

1. Describe the theory related to Augmented Reality
2. Apply theoretical knowledge of AR in practice
3. Select the hardware & software for different applications.
4. Develop interactive augmented reality applications for both PC based mobile devices using a variety of novel input devices

Course Content:

Sr. No.	Syllabus	Hrs
1.	Introduction History of AR, Basics of Augmented Reality, Architecture/Framework, Various applications of AR in Automotive & Auto Component industries, Construction Managemen, Education etc. AR Browsers, Marker & Marker less AR	2
2.	Enabling Technologies of Augmented Reality Mobile, Camera, Cloud Computing, Unity, AR with Google Sketch up	2
3.	Remote Maintainence/Training using AR Architecture, Benefits, Challenges	2
4.	Lighting and Illumination Issues in AR Conversion of CAD Model to AR Model	2
5.	HOLOLENS INTERFACE	2
6.	Integration of AR Integration with IOT. Integarting with CRM, New market Opportunities of AR, Business models, Revenue models & AR in Other Fields	2
7.	Challenges & Opportunities of AR New business markets in AR, Technological challenges faced by AR	2

Term Work:

- It consists of at least one tutorial and/or assignments and/or hands-on excercises from each module of the curriculum mentioned for the course.
- One Presentation / Seminar related to AR
- Mini Project

Text Books:

1. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition. Wiley-IEEE Press, 2003/2006.
2. Steve Aukstakalnis Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR

3. Jonathan Linowes, Krystian, Augmented Reality for Developers, 2017.
4. Stephen Cawood and Mark Fiala, Augmented Reality: A practical guide

Augmented Reality (AR) Course Evaluation Scheme:

Students shall select an Mechanical or any interdisciplinary application & apply concepts of AR, learned during theory & tutorial/Practical. Following evaluation scheme will be adopted for the evaluation of the course.

Sr. No.	Examination	Module
1.	T-I	1,2 and part of 3
2.	T-II	Remaining part of 3,4 and part of module 5
3.	End Sem	1 to 7

OPTH301 Open Elective: Industrial Safety
Course Pre-requisites: BTM803/BTM898

Course Outcomes:

At the end of the course students will be able to

1. Understand basic safety norms, rules and regulations and hazards
2. Understand maintenance of utility systems and its service life expectancy
3. Understand fault and diagnostics and preventive measures
4. Understand repair cycles of machines and trouble shootings

Course Content:

Units	Content	Hours
1	Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.	4
2	Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.	4
3	Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity Lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods	4
4	Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.	4
5	Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor	4
6	Troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive Maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets	
7	Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance	

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPTH302 Open Elective: Operations Research

Course Pre-requisites: BTM803

Course Outcomes:

At the end of the course, the student should be able to

1. Students should be able to apply the dynamic programming to solve problems of discrete and continuous variables.
2. Students should be able to apply the concept of non-linear programming
3. Students should be able to carry out sensitivity analysis
4. Student should be able to model the real world problem and simulate it.

Course Content:

Unit	Content	Hours
1	Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis,	5
2	Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming	6
3	Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem – CPM/PERT	5
4	Scheduling and sequencing – single server and multiple server models – deterministic inventory models –	5
5	Inventory Control Models, Probabilistic inventory control models – Geometric Programming.	5
6	Competitive Models, Single and Multi-channel Problems, Sequencing Models	5
7	Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation	5

Reference Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

OPTH303 Open Elective: Cost Management of Engineering Projects
Course Pre-requisites: BTM803

Course Outcomes:

At the end of the course students will be able to

1. Estimate project cost and project commissioning
2. Analyse cost behaviour in project
3. Know different project strategies
4. Apply quantitative techniques for cost management of engineering projects

Course Content:

Unit	Content	Hours
1	Introduction and Overview of the Strategic Cost Management Process	4
2	Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational Control; Provision of data for Decision-Making.	4
3	Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and Documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process	8
4	Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.	8
5	Pricing strategies: Pareto Analysis. Target Costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.	6
6	Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.	6
7	Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.	6

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

OPTH304 Open Elective: Waste to Energy
Course Pre-requisites: BTM504

Course Outcomes:

At the end of the course students will be able to

1. Classify waste from energy recovery point of view
2. Know biomass pyrolysis and gasification
3. Understand biomass combustion
4. Understand working of biogas plant and importance of biomass energy programme in India

Course Content:

1	Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors	6
2	Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.	6
3	Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.	6
4	Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.	6
5	Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion	6
6	Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion	6
7	Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.	6

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OPTH305 Essentials for NX Designers

Course Pre-requisites: None

Course Objectives:

1. Document design intent.
2. Create and edit parametric solid models.
3. Create Assembly Structures and Drawings.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Get an idea about Design Intent and parametric CAD system.
2. Create 3D CAD models using NX.
3. Prepare assemblies using essential tools in NX assembly environment.
4. Create drawing for manufacturing or presentation.

Course Content:

Sr.No.	Description	Hrs.
1	Getting to know the NX interface and Coordinate Systems	6
2	Documenting design intent and Creating parts with sketches	10
3	Creating and editing Parametric models	6
4	Examining the structure and working with secondary features	10
5	Modifying geometry of imported parts using synchronous technology	4
6	Loading and working with assemblies	10
7	Creating simple drawings	10

Course Evaluation Scheme:

Sr. No.	Examination	Module
4.	T-I (Online MCQs)	1 and 2
5.	T-II (Online MCQs)	3 and 4
6.	End Sem (Tool Test)	1 to 7

OPTH306 Advanced Simulation

Course Pre-requisites: None

Course Objectives:

1. Fundamentals of stress and strain.
2. Understand Displacement Field and Hooke's Constitutive law.
3. Analyze stress problems with the application of basic laws and equations.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Applying Numerical Methods to solve problems with variety of loading situations.
2. Working with Stress-Strain relation of ductile and brittle materials.
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze various types of Engineering Problems and interpolate the results.

Course Content:

Sr.No.	Description	Hrs.
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	8
2	Geometry Simplification and Meshing	8
3	Working with the results and interpolation	8
4	Solving Structural Static Analysis, Buckling Analysis and Natural Frequency Analysis	8
5	Solving Thermal, Response and Nonlinear Analysis	8
6	Solving Symmetry, Assembly FEM and Contact & Gluing problems	8
7	Flexible Body Analysis and Optimization	8

Course Evaluation Scheme:

Sr. No.	Examination	Module
7.	T-I	1 and 2
8.	T-II	3 and 4
9.	End Sem	1 to 7

OPTH307 Composite and Structure Assembly

Course Pre-requisites: None

Course Objectives:

1. Understanding the Structure of Composites.
2. Creating Laminates.
3. Analyzing composite structure problems.

Course Outcomes:

Upon successful completion of the course, participants should be able to

1. Create Laminate Composite Structures.
2. Understand Laminate Failure Theory.
3. Analyze Composite Structures and interpolate the results.
4. Optimize Laminate Composite Structures.

Course Content:

Sr.No.	Description	Hrs.
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	8
2	Creating Finite Element Models	8
3	Solving various type of Analysis	8
4	Introduction to Composite Structure, Creating Laminates using zone based Process and Ply based Process.	8
5	Modeling 3D laminates, Solving and Post Processing	8
6	Laminate Theory and Failure Analysis	8
7	Laminate Dynamic Analysis and Optimization	8

Course Evaluation Scheme:

Sr. No.	Examination	Module
10.	T-I	1 and 2
11.	T-II	3 and 4
12.	End Sem	1 to 7

OPTH308 Collaborative Engineering using Team center

Course Pre-requisites: None

Course Objectives:

1. To Organize, Manage and Secure product data using Teamcenter
2. To Integrate NX with Teamcenter
3. To 3D Model using NX in Teamcenter Integrated Environment

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Organize, Manage and secure the product data.
2. To Assign, Perform and Track the workflow process.
3. Defining the Assembly Structure in integrated mode.
4. Understand Part Modeling Techniques using NX.

Course Content:

Sr.No.	Description	Hrs.
1	Introduction to Teamcenter	2
2	Creating and Managing Datasets and Items	4
3	Creating and Managing Product Structure	10
4	Initiating and Managing Workflow Tasks	10
5	Viewing and Working with Visualization	6
6	Creating Part Models and Assemblies	8
7	How to Integrate NX with Teamcenter	16

Course Evaluation Scheme:

Sr. No.	Examination	Module
13.	T-I (Online MCQs)	1,2 and 3
14.	T-II (Online MCQs)	4 and 5
15.	End Sem (Tool Test)	1 to 7

OPTH309 Technomatix process

Course Pre-requisites: None

Course Objectives:

1. Process Designer Basics
2. Simulating a work cell using Robcad
3. Defining Kinematics using Robcad.

Course Outcomes:

Upon successful completion of the course, students should be able to

1. Understanding how to work with Process Designer software.
2. Manage Engineering and Manufacturing data in Process Designer.
3. Creating Robot workcell Layout and sequence of operation
4. Creating automatic kinematics and parameters in Robcad

Course Content:

Sr.No.	Description	Hrs.
1	Process Designer Interface and Environment	6
2	Productivity Tools and Placement commands	6
3	Creating and Saving Engineering Data	4
4	Robot Workcell Layout, Modeling and Kinematics	10
5	Workcell and Robot Simulation Techniques	6
6	Automatic Kinematics Creation	14
7	Kinematic Functions	10

Course Evaluation Scheme:

Sr. No.	Examination	Module
16.	T-I (Online MCQs)	1,2 and 3
17.	T-II (Online MCQs)	4 and 5
18.	End Sem (Tool Test)	1 to 7

OPTH310 Advanced Finite Element Analysis

Course Pre-requisites: None

Course Objectives:

1. To develop participants understanding using NX solvers.
2. Analyze stress problems with application of basic laws and equations.
3. Solve various types of Engineering Problems.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Work effectively with NX Solvers.
2. Working with Nastran input deck file (create, modify and edit).
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze various types of Engineering Problems and interpolate the results.

Course Content:

Sr.No	Description	Hrs
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	8
2	Introduction to Finite Element Analysis and Solution Control	8
3	Working with Nodes and Elements	8
4	Applying Constraints and loads	8
5	Understanding Special caeses, Model quality and File Management	8
6	Working with Pre Processing	8
7	Working with Post Processing	8

Course Evaluation Scheme:

Sr. No.	Examination	Module
1.	T-I	1,2 and 3
2.	T-II	4 and 5
3.	End Sem	1 to 7

OPTH311 Thermal and Flow Analysis

Course Pre-requisites: None

Course Objectives:

1. Fundamentals of Heat Transfer.
2. Understanding Energy Equations.
3. Analyze Thermal and Flow problems.

Course Outcomes:

Upon successful completion of the course, Participants should be able to

1. Apply Finite Element Method to solve Thermal Problems.
2. Apply Finite Volume Method to solve Flow Problems.
3. Analyze and calculate stress/strain distributions for 1D, 2D and 3D problems.
4. Analyze the Coupled Thermal Fluid problems.

Course Content:

Sr. No	Description	Hrs
1	Understanding the concepts of Modeling, Assembling and Drawing using NX	8
2	Meshing and Applying loading and boundary conditions	8
3	Simulation and Validation	8
4	Introduction to Thermal Analysis (Conduction, Convection and Radiation)	8
5	Thermal Simulation	8
6	Introduction to Flow analysis and Creating Fluid Volumn	8
7	Flow Simulation and Mapping Results	8

Sr. No.	Examination	Module
1.	T-I	1,2 and 3
2.	T-II	4 and 5
3.	End Sem	1 to 7

DS-MTMD398 Seminar on Literature Review

Course Pre-requisites: MTMD 299

Course Outcomes:

1. Student will be able to search literature related to the project topic
2. Student will be able to analyse finding of literature review
3. Student will be able to identify research gap
4. Student will be able to integrate the knowledge to define the problem statement appropriately
5. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques

Course content:

Sr. No.	Description	Hrs.
1	The project work extends through the third and fourth semester. The project work is defined based on the interest of the students to specialize in a particular area. Students are expected to carry out independent research work on the chosen topic and submit a report for evaluation. The work at this stage may involve review of literature, laboratory experimental work, case study, field data collection and analysis etc. On completion of the exhaustive literature work the student shall prepare a report and will give a Seminar on the report.	48

DS-MTMD399 Dissertation Seminar Stage-I

Course Pre-requisites: MTMD 299

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for formulation / fabrication of the desired project
4. Student will be able to analyze the available resources and to select most appropriate one

Course content:

Sr.no.	Description
1	Student shall finalize a theme, related to mechanical engineering (design engineering area) for the dissertation work. Student shall prepare a report on the theme outlining importance of the theme of the study, objective, scope of work, methodology, and a review of literature published in the relevant area. The student shall present seminars on this report.

Guidelines for Dissertation

Students should do literature survey and identify the problem for Dissertation and finalize in consultation with Guide/Supervisor. Students should use multiple literatures and understand the problem. Students should attempt solution to the problem by analytical/simulation/experimental methods. The solution to be validated with proper justification and compile the report in standard format.

Guidelines for Assessment of Dissertation I

Dissertation I should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization
4. Clarity of objective and scope

DS-MTMD498-Dissertation- Seminar Stage-II
Course Pre-requisites: MTMD398/ MTMD399

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for execution of the desired project and validation of the results obtained
4. Student will be able to analyze the experimental data/ findings

Course content:

Sr.no.	Description	Hrs.
1	Student shall study the problem of dissertation in the light of outcome of Stage I and Stage II seminars. On completion of data collection, analysis, and inferencing, the student shall prepare an interim report and shall present a seminar on the work done, before the submission of Synopsis.	48

Guidelines for Assessment of Dissertation II

Dissertation II should be assessed based on following points

1. Quality of Literature survey and Novelty in the problem
2. Clarity of Problem definition and Feasibility of problem solution
3. Relevance to the specialization or current Research / Industrial trends
4. Clarity of objective and scope
5. Quality of work attempted
6. Validation of results
7. Quality of Written and Oral Presentation

DS-MTMD499: Dissertation & Viva-Voce

Course Pre-requisites: MTMD398/ MTMD399/MTMD498

Course Outcomes:

1. Student will be able to apply principles of ethics and standards, skill of presentation and communication techniques
2. Student will be able to integrate the knowledge of the fundamentals of subjects to search the related literature and devise solution
3. Student will be able to use knowledge for formulation / fabrication of the desired project
4. Student will be able to analyze the experimental data/ findings and discuss the merits and limitations of the project work

Course content:

Sr.no.	Description
1	On finalization of the dissertation student shall submit the dissertation report. The student shall have to appear for a Viva-voce examination for the dissertation.