Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(An Autonomous Institution Affiliated to University of Mumbai)

Munshi Nagar, Andheri (W), Mumbai – 400 058.

Course Contents

PG Programme in Mechanical Engineering

M.Tech. in Machine Design
(2018 – 2019)

Table of Contents

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	Two Dimensional Problems in Polar Coordinate System: Strain-displacement relations, Compatibility equation, Stress-strain relations, Stress function and biharmonic equation, Antisymmetric problems, Effect of circular holes on stress distribution in plates. Torsion of Prismatic Bars: General solution of the torsion problem, Torsion of circular and elliptic cross sections.	**8**
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 (CAD)
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	**INTRODUCTION & ELEMENTS OF INTERACTIVE COMPUTER GRAPHICS** 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.	**05**
Module 02	**TECHNIQUES FOR GEOMETRIC MODELING** 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.	**05**
Module 03	**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,	**08**

Module 04	**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.	**07**
Module 05	**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.	**06**
Module 06	**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	**05**
Module 07	**CAD for Machine Elements and Sub-Assemblies** • 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 BjarneStroustrup. *Computer Graphics with OpenGL, 3/E*. Prentice-Hall, 2003.
4. McMahon, C. A., and J. Browne. "CADCAM: principles, practice and manufacturing management, 1998."
5. Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju. *Cad/cam/cim*. New Age International, 2008.
6. Rao, PosinasettiNageswara. *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.

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 consists 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.

Practical Examination shall be based on above mentioned experiments and oral.

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.

Practical examination is to be conducted based on above experiments and oral.

MC-MT001: 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 carry out research on engineering problems.
4. To develop an ability to investigate the phenomenon in a critical manner.
5. Develop critical thinking to find business opportunities and to solve questions related to industries.
6. To get knowledge on various kinds of research questions and research designs

Course Outcomes

Learner shall be able.

1. To carry out literature survey by using various research considerations
2. To formulate the problem statement using research considerations.
3. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Rightto be promoted among students in general & engineering in particular.
4. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits..

Course Content:

Module No.	Description	Hrs.
1	**Introduction** Definition of Research: Research Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Definition and Dimension of a Theory, Functions and Characteristics; Types of Theory: General Theory and Particular/Empirical Theory. Cases and their Limitations; Causal Relations. Philosophy and validityof research. Objectives of research.	**8**
2	**Characteristics of research** Various functions that describe characteristics ofresearch such as systematic, valid, verifiable, empirical and critical approach.	**4**
3	**Types of research** Pure and applied research. Descriptive and explanatory research. Qualitative and quantitative approaches.	**6**
4	**Research Procedure** Formulating the Research Problem, Literature Review, Developing the objectives, preparing the research design including sample Design, Sample size.	**6**
5	**Considerations in selecting research problem** Relevance, interest, available data,choice of data, Analysis of data, generalization and interpretation of analysis	**6**
6	**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, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.	**6**

Term Work: Tutorial work consists on class room tutorial session based on above course content.

Description of Tutorial Topics	Hrs.
1. Definition and characteristics of research	4
2. Types of research	4
3. Research procedure	4
4. Considerations of research	4
5. Outcome of research	4
6. IPR	4

Recommended Books:

- Dawson, Catherine, 2002, *Practical Research Methods*, New Delhi, UBS Publishers' Distributors.
- Kothari, C.R.,1985, *Research Methodology-Methods and Techniques*, New Delhi, Wiley Eastern Limited.
- Kumar, Ranjit, 2005, *Research Methodology-A Step-by-Step Guide for Beginners*, (2^{nd} 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.	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-MTMD201: 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 structurs.
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 KIc/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.	**8**
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, KIc 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.	**6**
7	Fracture mechanics design process, Numericals, Practical Case studies.	**4**

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.

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-MTMD202 Advanced Finite Element Methods
Course Pre-requisites: BTM703

Course Objectives:
1. To provide the student with some knowledge and analysis skills in applying basic laws in mechanics
2. Integration by parts to develop element equation for a spring element
3. Steps used in solving the problem by finite element method.

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, Static, transient bukling analysis to be conducted.
3. Discuss variational and Galerkin method for Stiffness Matrix formulation.
4. Assess stresses and strains in complex mechanical systems and interpret structural behavior of components by analyzing post processor result.

Course content:

M. No.	Description	Hrs.
1	Review of linear FEA: FE formulation of 1D bar, 3D linear elastic continuum, 2D plane strain, plane stress, and axisymmetric elements; Iso-parametric mapping; numerical integration.	**6**
2	FE formulation for 1D plasticity: Elastic-perfectly plastic material; Isotropic and kinematic hardening; Integration algorithms for 1D plasticity; FE formulation; Newton-Raphson method for solving nonlinear equilibrium equations; 1D visco-plasticity and integration algorithm.	**6**
3	Continuum theories of plasticity: Review of tensor algebra; Yield condition, flow rule and hardening rules; loading and unloading conditions; Drucker's stability postulates; Convexity and normality; J2 flow theory of plasticity and visco-plasticity, Gurson model.	**6**
4	FE procedures for 2D and 3D plasticity: Integration algorithms for rate independent plasticity—explicit forward Euler and implicit backward Euler; Return mapping algorithm; visco-plasticity; FE formulation; Consistent linearization; Algorithmic and consistent tangent modulii; Treatment of incompressible deformation (Locking); B-bar method.	**6**
5	FE procedures for large deformation problems: Continuum mechanics—deformation gradient, polar decomposition, Green-Lagrange strain, rate of deformation, Cauchy stress, P-K stresses, Balance laws; Principle of objectivity and isotropy	**6**
6	Constitutive equations for hyperelasticity; Neo-Hookean model; FE formulation—Total Lagrangian and updated Lagrangian descriptions; Tangent Stiffness Matrix. Introduction to finite strain plasticity.	**6**

7	Contact Problems: Condition of impenetrability; Gap elements for modelling contact; Tangent stiffness matrix and force vectors for 2D frictionless contact problems.	**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. Rajasekaran, Sanguthevar. *Finite element analysis in engineering design*. S. Chand, 2008.
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. Desai, Chandrakant S., and John Fredrick Abel. *Introduction to the finite element method; a numerical method for engineering analysis*. Van Nostrand Reinhold, 1971.
5. Zienkiewicz, Olek C., and Robert L. Taylor. *The finite element method for solid and structural mechanics*. Butterworth-heinemann, 2005.
6. Segerlind, Larry J., and H. Saunders. "Applied finite element analysis." (1987): 329-330.
7. BEM by Amin, Narosa publishing house.
8. R.D Cook,PleshMalkus

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-MTMD203 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.

Practical examination is to be conducted based on above experiments and oral.

PC-MTMD204 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

Practical examination is to be conducted based on above experiments and oral.

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 literautre 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 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 Energyy, 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 Rapid Prototyping and Tooling
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 diffrerent working matrials 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** • 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** • Subsystems of RP achine 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** • Materials • Stereolithography • Solid Ground Curing • Solid Object UV (Ultra-Violet) Printer • Two Laser System • Micro-stereolithography.	6
4.	**Solid Based Rapid Prototyping Systems** • 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** • Materials • SLS (Selective Laser Sintering)	6

	• (3DP) Three-Dimensional Printing • (LENS) Laser Engineered Net Shaping • (MJS) Multiphase Jet Solidification • (EBM) Electron Beam Melting	
6.	**Advances in RP Systems and Case Studies** • 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 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 basic concepts of rapid prototyping and their application in product development.
3. To study diffrerent working matrials 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 ofManufacturing 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, Coselection 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. 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 Tribology in Design
Course Pre-requisites: BTM701, BTM 801

Course Objectives:

1. To provide overview of tribology and practical implifications 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 against wear.

Course content:

Sr.No.	Description	Duration (hrs)
1	Introduction: Overview of Tribology, Lubricants selection for general application and special application such as low tempratures 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.	6
6	Antifriction bearing: Rolling Contact Bearings, Bearing types and selsction of rolling contact bearing for different applications/loading condition. Static and dynamic load capacity, left 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 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 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 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 catogarization, 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-MDPE08 Analysis and Synthesis of Mechanisms
Course Pre-requisites: BTM402, BTM502

Course Objectives:

1. To Learn the graphical and analytical techniques commonly used in the synthesis of mechanisms.
2. To Orient applications of analytical techniques by means of computer programs.
3. To simplify the mechanism for analysis purposes.

Course Outcomes:

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

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

Course content:

M. No.	Description	Hrs.
1	**Basics of Mechanism:** Rigid body, Kinematic pairs, Lower pairs connections, Higher pair connections, Kinematic chain, Mechanism, Four bar mechanism, Slider crank mechanism, Transmission, deviation and pressure angles, Equivalent mechanisms	**6**
2	**Type Synthesis, Number Synthesis, Dimensional Synthesis** Type synthesis, Number synthesis, Dimensional synthesis, Accuracy points, Spacing of of accuracy points, Chebyshev polynomials.	**6**
3	**Four Bar Coupler Point Curve:** Four bar linkage, coupler curve equation, double points and symmetry, Roberts-Chebyshev theorem	**6**
4	**The Euler Savary Equation and Cubic of Stationary Curvature:** The Euler Savary equation and the Inflection circle, The cubic of stationary curvature.	**6**
5	**Linkage Synthesis with ThreeAccuracy 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**
6	Linkage Synthesis with Four Accuracy Points (Geometric Methods): Concept of opposite pole quadrilateral, Center point curve, Circle point curve, Application in position 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 Linkage Synthesis with Three Accuracy Points: Complex Number Method	**6**

Text Books:

1. Mallik, Asok Kumar, AmitabhaGhosh, and Gunter Dittrich. *Kinematic analysis and synthesis of mechanisms*. CRC Press, 1994.

Reference Books:

1. Beyer, Rudolf. "The kinematic synthesis of mechanisms." (1963).
2. Tao, Deh Chang. *Applied linkage synthesis*. Addison-Wesley Pub. Co., 1964.
3. Hartenberg, Richard Scheunemann, and Jacques Denavit. *Kinematic synthesis of linkages*. McGraw-Hill, 1964.
4. Tesar, Delbert. *Graphical Procedures for Kinematic Synthesis of Mechanisms*. University of Florida, 1975.

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

EC-MDPE09 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** • 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** • 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) • 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** • LIGA, • AMANDA, • Microstereolithography, • IH-Process, • X-Ray Techniques, • Ion-beam Lithography etc	6
5	**Modelling and Simulation Techniques** • 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 • Modelling of Micro-channel as heat exchanger, accelerometers, microhinges, compound microstructures.	6

	• Linear & Nonlinear Model.	
6	**Characterization Techniques** Topography Methods (Optical, Electrical and Mechanical Methods) • Microscopy, STM (Scanning Tunneling Microscopes), • SEM (Scanning Electron Microscopes),SPM (Scanning ProbeMicroscopes), 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 PatternInterferometry), • Laser Techniques, Laser Doppler Vibro-metersFluid, Thermal and Chemical Analysis • Thermal Analysis Techniques (Theoretical and Experimental), • Fluid Flow Pattern Analysis, • Electro-chemical Analysis, PIV Techniques -spectroscopy	**8**
7	**Introduction to Advances of MEMS and Nanotechnology** • 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 andSmart devices", John Wiley and sons, Ltd.
2. NadimMulaf and Kirt Williams, "An Introduction to Microelectromechanical systems Engineering", Artech House.
3. NicolaeLobontiu 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 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 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

Reference

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.

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 Optimization Techniques in Design
Course Pre-requisites: BTM605, BT207

Course Objectives:

1. To introducetools 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, Evalution 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 Advanced Engineering Materials
Course Pre-requisites: BTM304

Course Outcomes:
At the end of the course the student will
1. Demonstarte 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 humen 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, Atomicstructure. 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 ironcarbon system.	6
4	Failure: Fracture. Ductile and brittle fracture. Fracture mechanics. Impact	4

	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, Mechanicalbehaviour 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	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 Para magnetism. 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)

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 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 Mechaincs 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., "Composaite 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 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. Demontrate 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	**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.	6
2	**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.	6
3	**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.	6
4	**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	6
5	**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, Programming Languages: Introduction to various types such as RAIL	6

	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

MDAU1: English fir 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 : 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

	➢ Executive ➢ President ➢ Governor ➢ Council of Ministers ➢ Judiciary, Appointment and Transfer of Judges, Qualifications ➢ Powers and Functions	
5	➢ 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	➢ 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	➢ 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: 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 : 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 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 excercises 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: 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. Mange 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 Model, Overbooking Model, Cash Budget Model.	2

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: 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)

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

VAMD204: 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, Educationt 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

DS-MTMD396 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 literautre work the student shall prepare a report and will give a Seminar on the report.	**48**

DS-MTMD397 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

SEMESTER III

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

SEMESTER IV

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 disuss 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.