



**Maratha Vidya Prasarak Samaj's
Karmaveer Adv. Baburao Ganpatrao Thakare College of Engineering**

An Autonomous Institute affiliated to Savitribai Phule Pune University, Pune

Udoji Maratha Boarding Campus, Gangapur Road, Nashik - 422 013, Maharashtra, India

Post-Graduate Program Syllabus

**First and Second Year M.Tech. Mechanical Engineering (Design Engineering)
(2024 Pattern) V1.1**

As per NEP 2020

Academic Year 2025-26

(Copy for Student Circulation Only)

**First Year M.Tech. Mechanical Engineering (Design Engineering)
Curriculum Structure (2024 Pattern) V1.1 Semester - I**

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
201101	PPC-1	Optimization Techniques	3	-	-	50	50	-	-	-	100	3	-	-	3
201102	PCC-2	Advanced Material Science	3	2	-	50	50	25	-	-	125	3	1	-	4
201103	PCC-3	Advanced Solid Mechanics	3	2	-	50	50	25	-	25	150	3	1	-	4
201104	MLC	Research Methodology & IPR @	4	-	-	50	50	-	-	-	100	4	-	-	4
201105X	PEC-I	Electives – I *	4	-	-	50	50	-	-	-	100	4	-	-	4
200106	VEC-1	Human Rights – 1 @	-	-	1	-	-	25	-	-	25	-	-	1	1
Total			17	4	1	250	250	75	-	25	600	17	2	1	20

Abbreviations: TH: Theory

PR: Practical

TU: Tutorial

CCE: Continuous Concrete Evaluation

ESE: End-Semester Examination

TW: Term Work

OR: Oral

TOT: Total

@ common to all branches.

**First Year M.Tech. Mechanical Engineering (Design Engineering)
Curriculum Structure (2024 Pattern) V1.1 Semester - II**

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
201201	PPC-4	Advanced Mechanical Vibrations	4	2	-	50	50	-	-	25	125	4	1	-	5
201202	PCC-5	Finite Element Analysis	3	2	-	50	50	25	-	-	125	3	1	-	4
201203	PCC-6	Kinematic Analysis and Synthesis	3	-	-	50	50	-	-	-	100	3	-	-	3
201104X	PEC-II	Electives – II **	3	-	-	50	50	-	-	-	100	3	-	-	3
200205	MLC	Introduction to Cyber Security @	3	2	-	50	50	25	-	-	125	3	1	-	4
200206	VEC-2	Human Rights – 2 @	-	-	1	-	-	25	-	-	25	-	-	1	1
Total			16	6	1	250	250	75	-	25	600	16	3	1	20

Abbreviations: TH: Theory

PR: Practical

TU: Tutorial

CCE: Continuous Concrete Evaluation

ESE: End-Semester Examination

TW: Term Work

OR: Oral

TOT: Total

@ common to all branches.

Second Year M.Tech. Mechanical Engineering (Design Engineering)
Curriculum Structure (2024 Pattern) V1.1 Semester - III

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
201301	SBC-I	Dissertation Phase - I	-	20	-	-	-	100	-	50	150	-	10	-	10
201302	ELC-I	Research Seminar	-	4	-	-	-	25	-	25	50	-	2	-	2
201303	VSEC-I	Skill Development Laboratory-I	-	4	-	-	-	50	-	-	50	-	2	-	2
201304	INT	Internship	-	8	-	-	-	50	-	50	100	-	4	-	4
200305	VEC-3	Introduction to Constitution @	-	-	2	-	-	50	-	-	50	-	-	2	2
Total			-	36	2	-	-	275	-	125	400	-	18	2	20

Abbreviations: TH: Theory

PR: Practical

TU: Tutorial

CCE: Continuous Concrete Evaluation

ESE: End-Semester Examination **TW:** Term Work

OR: Oral

TOT: Total

@ common to all branches.

Second Year M.Tech. Mechanical Engineering (Design Engineering)
Curriculum Structure (2024 Pattern) V1.1 Semester - IV

Course Code	Course Type	Course Name	Teaching Scheme (Hrs/Week)			Evaluation Scheme and Marks						Credits			
			TH	PR	TU	CCE	ESE	TW	PR	OR	TOT	TH	PR	TU	TOT
201401	SBC-II	Dissertation Phase - II	-	36	-	-	-	250	-	100	350	-	18	-	18
201402	VSEC-II	Skill Development Laboratory-II	-	4	-	-	-	50	-	-	50	-	2	-	2
Total			-	40	-	-	-	300	-	100	400	-	20	-	20

Abbreviations: TH: Theory

PR: Practical

TU: Tutorial

CCE: Continuous Concrete Evaluation

ESE: End-Semester Examination TW: Term Work

OR: Oral

TOT: Total

@ common to all branches.

Program Elective Course - I and II

Course Code	* Elective -I	Course Code	** Elective -II
201105A	Process Equipment Design	201204A	Advanced Composite Structure
201105B	Design of Material Handling Equipment	201204B	Design of Piping System
201105C	Industrial Tribology	201204C	Condition Monitoring
201105D	Energy Audit and Management	201204D	Robotics

List of Abbreviations Used with Percentage of Credits

Abbreviations	Course Type	Number of Courses	Credits	% of Credits
PCC	Program Core Courses	6	19	23.8
PEC	Program Elective Courses	2	07	8.8
PLC	Program Laboratory Courses	4	04	5.0
MLC	Mandatory Learning Courses	2	08	10.0
VEC	Value Education Courses	3	04	5.0
SBC	Skill-Based Courses	2	28	35.0
ELC	Experiential Learning Courses	1	02	2.5
VSEC	Vocational and Skill Enhancement Courses	2	04	5.0
INT	Internship	1	04	5.0
Total		23	80	100%

- **Summary of Credits and Total Marks:**

Semester	Credits	Marks
I	20	600
II	20	600
III	20	400
IV	20	400
Total	80	2000

- **Definition of Credit :**

The Post Graduate (P.G.) programmes will have credit system. The details of credit will be as follow.

1 Credit = 1 hour/week for lecture
= 2 hours/week for practical
= 1 hour/week for tutorial

Semester - I

Course Code: 201101	Course Name: Optimization Techniques	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Mathematics, Machine Design.

Course Objectives:

- To educate students on how to use optimization techniques to solve complex engineering problems.
- To develop the ability of students to create mathematical models for engineering problems.
- To develop analytical proficiency in solving linear optimization problems.
- To make the student conversant with modern optimization techniques.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply knowledge of optimization techniques to solve real-life mechanical engineering problems.

CO2: Identify and formulate optimization problems using the right technologies and approaches for solutions.

CO3: Use classical optimization techniques in the field of engineering.

CO4: Describe the fundamental knowledge of Linear Programming.

CO5: Apply concept of modern optimization techniques in problem solving.

Course Contents

UNIT-I: Introduction to Optimization

08 Hours

Introduction to optimization, classification of optimization problems, formulation of optimization problem, engineering applications of optimization.

UNIT-II: Introduction to Mathematical Modeling

08 Hours

Introduction to mathematical modeling, types of modeling. Objective function; constraints and constraint surface; mathematical modeling characteristics and limitations, formulation of design problems.

UNIT-III: Classical Optimization Techniques**08 Hours**

Single variable optimization, multi variable optimization with no constraint, equality constraint, in-equality constraint.

UNIT-IV: Linear Programming**08 Hours**

Standard form of linear programming, geometry of linear programming, simplex algorithm, two phases of the simplex method, primal-dual simplex method, sensitivity or post optimality analysis, applications in engineering.

UNIT-V: Modern Methods of Optimization**08 Hours**

Genetic algorithms, simulated annealing, particle swarm optimization, ant colony optimization, teaching learning based optimization, introduction to Artificial Neural Network (ANN).

Learning Resources:**Text Books:**

1. Introduction to optimum design, J.S. Arora, McGraw Hill, 198.
2. Design of thermal systems, W.F. Stoecker, McGraw Hill, 1989.
3. Optimization for engineering design - algorithms and examples, K.Deb, Prentice Hall, 1995.
4. R. K. Sundaram, A first course in optimization theory, 1996, Cambridge University Press, Cambridge.
5. R. Fletcher, Practical methods of optimization, 2nd Edition, Wiley, 2000, New York.

Reference Books:

1. Kreyszig, E. “Advanced Engineering Mathematics”, John Wiley & Sons, 7th Edition, 1993.
2. Chandrika Prasad. “Mathematics for Engineers”, Prasad Mudranalaya, 12th Edition, 1981.
3. Chandrika Prasad “Advanced Mathematics for Engineers”, Prasad Mudranalaya, 7th Edition, 1972
4. Spiegel, M.R. “Advanced Mathematics For Engineers and Scientists”, McGraw Hill., 1992.

Course Code: 201102	Course Name: Advanced Material Science	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week Practical : 2 Hours/Week	3 1	CCE : 50 Marks ESE : 50 Marks TW : 25 Marks

Prerequisite Courses:

- Material Science, Engineering Chemistry, Mathematics.

Course Objectives:

- Understand the mechanical properties of advanced engineering materials.
- Apply stress-strain analysis to assess material behavior.
- Conduct and interpret tensile and bending tests.
- Analyze plastic deformation using experimental and hardening models.
- Evaluate elastic-plastic equilibrium and residual stresses in materials.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the mechanical behaviour and material properties of advanced engineering materials.

CO2: Apply principles of stress-strain analysis to evaluate material behavior under various conditions.

CO3: Conduct and analyze tensile and bending tests to assess material behavior under various loading conditions.

CO4: Analyze plastic deformation behavior using experimental methods and advanced hardening models under various loading and temperature conditions.

CO5: Evaluate elastic-plastic equilibrium and residual stresses in materials under variable loading conditions.

Course Contents**UNIT-I: Advanced Engineering Materials****08 Hours**

Study of dual-phase alloys, High-Strength Low-Alloy (HSLA) steels, and lightweight non-ferrous alloys focusing on their stress-strain responses under both quasi-static and high strain rate loading conditions, analysis of composites, including their orthotropic characteristics design aspects and performance evaluation, study of polymers and plastics, covering their mechanical properties, various applications, and behaviour under different conditions, Exploration of smart and nano-materials highlighting their types, applications, distinctive properties, and impact on contemporary

engineering practices.

UNIT-II: Material's Response Analysis**08 Hours**

Exploration of elasticity, covering both isotropic and anisotropic types, and incorporating thermal expansion effects, analysis of shear stress and yield behavior, including octahedral shear stress, yield criteria, and yield surfaces and curves, use of Mohr's circle for graphical representation and transformation of stress and strain.

UNIT-III: Material Testing**08 Hours**

Performing uni-axial and biaxial tension tests to generate full-range and true stress-strain curves, applying corrections such as Bridgman correction, and assessing effects like temperature rise and the Bauschinger effect, conducting combined loading experiments, including tests for bending and torsion as well as three-point bending, analyzing and evaluating the phenomena of elastic recovery.

UNIT-IV: Plastic Behavior of Materials**08 Hours**

Experimental investigation of plastic deformations under both simple and complex loading conditions; Analysis of strain hardening and power law approximations, including isotropic, kinematic, and combined hardening models; Study of the theory of plastic flow, along with the strain-rate and temperature dependence of flow stress; Exploration of deformation theory of plasticity, thermo-plasticity, and the behaviour of metals with initial deformations.

UNIT-V: Governing Elastic-Plastic Equilibrium**08 Hours**

Fundamental equations governing elastic-plastic behavior, Analysis of residual stresses and strains within materials, examination of interactions between plastic and rigid bodies, study of bending and torsion in elastic-plastic bodies, including their response to variable loading conditions, application of shakedown theorems to evaluate material stability and safety.

Learning Resources:**Text Books:**

1. Engineering Materials 1: An Introduction to Properties, Applications and Design by Michael F. Ashby and David R.H. Jones.
2. Mechanical Metallurgy by George E. Dieter.
3. Mechanics of Composite Materials by Robert M. Jones.
4. Composite Materials: Science and Engineering by Krishan K. Chawla.
5. Introduction to Polymer Science and Chemistry: A Problem-Solving Approach by Robert W. Lyons and Paul A. Leary.
6. Engineering Plastics: An Introduction to Engineering Plastics by Charles A. Harper.
7. Smart Materials and Structures by M. A. Male and M. H. A. Hargreaves.

8. Introduction to Nano-materials and Nanotechnology by Joseph J. D. and Thomas J. Over.
9. Heat Treatment, Selection, and Application of Tool Steels by William E. Bryson.
10. Principles of Heat Treatment by J. A. Charles and J. W. Burch.
11. Mechanics of Materials by Ferdinand P. Beer, E. Russell Johnston Jr., John T. De Wolf, and David F. Mazurek.

Reference Books:

1. Fundamentals of Materials Science and Engg, William D. Callister, Jr., John Wiley & Sons.
2. Mechanical Metallurgy, George E. Dieter, McGraw Hill Book Company, 1988.
3. Theory of Plasticity, J. Chakrabarty, Elsevier, 2006.
4. Foundations of Theory of Plasticity, L. M. Kachanov, Dover Publications, 2004.
5. Theory of Plasticity and Metal Forming Processes, Sadhu Singh, Khanna Publishers.
6. Mechanical Behavior of Materials, W.F.Hosford, Cambridge University Press, 2005
7. Plasticity for Structural Engineers, W.F. Chen, Da-Jian Han, Springer.

Weblink for MOOC / NPTEL Links:

1. Materials Science and Engineering by IIT Madras –
https://onlinecourses.nptel.ac.in/noc23_mm17
2. Mechanical Behavior of Materials by IIT Madras –
https://onlinecourses.nptel.ac.in/noc23_me53
3. Composite Materials by IIT Kharagpur –
https://onlinecourses.nptel.ac.in/noc23_mm18
4. Introduction to Polymer Science by IIT Madras –
https://onlinecourses.nptel.ac.in/noc23_ce41
5. Nanomaterials by IIT Madras – https://onlinecourses.nptel.ac.in/noc23_mm16
6. Heat Treatment of Metals by IIT Madras – https://onlinecourses.nptel.ac.in/noc23_mm15
7. Mechanics of Materials by IIT Kharagpur – https://onlinecourses.nptel.ac.in/noc23_me52
8. Rheology of Fluids by IIT Madras – https://onlinecourses.nptel.ac.in/noc23_me56

List of Practicals:

1. Elasto-plastic analysis of a tensile test specimen using FEM software.
2. Determination of full range stress strain curve for mild steel and aluminum specimen as per ASTM -E8M.
3. Determination of friction and wear of dry sliding contacts using friction and wear test rig.
4. To study the toughness or energy absorbing properties of various composite materials under two types of impact tests.

Course Code: 201103	Course Name: Advanced Solid Mechanics	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week Practical : 2 Hours/Week	3 1	CCE : 50 Marks ESE : 50 Marks TW : 25 Marks OR : 25 Marks

Prerequisite Courses:

- Mechanics, Strength of Materials.

Course Objectives:

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

Course Outcomes:

After successful completion of the course, the learner will be able to:

- CO1:** Apply knowledge of theory of elasticity to solve problems of practical interest with a variety of loading situations.
- CO2:** Apply the knowledge of torsion to solve complex problems of circular, noncircular, conical shafts and thin walled members.
- CO3:** Apply basic field equations to torsion, bending and two dimensional problems, energy methods and plastic hinges.
- CO4:** Apply the knowledge of contact stresses for determining stresses for two bodies in contact subjected to load normal and tangent to contact area.
- CO5:** Evaluate stresses using various analysis techniques.

Course Content:**UNIT-I: Theory of Elasticity****08 Hours**

Compatibility equations in two and three dimensions, free body diagram of complicated structures and stress calculations, stress functions in rectangular and cylindrical coordinate systems, evaluation of stresses in flat rectangular plates with different clamp and load conditions evaluation of the stresses in the flat and circular plate with center hole(s) using stress function.

UNIT-II: Theory of Torsion**08 Hours**

Torsion of prismatic bars of solid section and thin walled section. Analogies for torsion, membrane analogy, fluid flow analogy and electrical analogy. Torsion of conical shaft, bar of variable

diameter, thin walled members of open cross section in which some sections are prevented from warping, torsion of non-circular shaft.

UNIT-III: Stresses in Beams

08 Hours

Concept of shear centre in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear centre for thin wall beam cross section, open section with one axis of symmetry, general open section, and closed section. Curved beams (Winkler-Bach formula), combined bending and torsion, equivalent bending moment, equivalent torque, combined bending, torque and internal pressure. Moving loads on beams.

UNIT-IV: Contact Stresses

08 Hours

Geometry of contact surfaces, method of computing contact stresses and deflection of bodies in point contact, Stress for two bodies inline contact with load normal to contact area and load normal and tangent to contact area, gear contacts, contacts between cam and follower, ball bearing contacts.

UNIT-V: Experimental Stress Analysis

08 Hours

Dimensional analysis, analysis techniques, strain gauges, types of strain gauges, materials, configuration, instrumentation, characteristics of strain gauge measurement, theory of photo-elasticity, elements of polariscope, simple and circular polariscope, fringes in dark and white field, isoclinic and isochromatic fringe patterns, evaluation of stresses from these fringe patterns.

Learning Resources:

Text Books:

1. T. G. Sitharam and L. Govindraj, Applied Elasticity, Interline Publishers, Bangalore.
2. Singh, Sadhu. Experimental Stress Analysis: A Text Book for Engineering Students. Khanna publishers, 1982.
3. Advanced Mechanics of Materials– Cook and Young, Prentice Hall.
4. Advanced Mechanics of Solids, L S Shrinath, Tata McGraw Hill.

Reference Books:

1. Advanced Strength and Applied Stress Analysis–Richard G. Budynas, McGraw Hill.
2. Advanced Mechanics of Materials–Boresi, Schmidt, Sidebottom, Willey.
3. Theory of Elasticity–Timoshenko and Goodier, McGraw Hill.
4. Advanced Strength of Materials–Den Hartog.
5. Experimental Stress Analysis–Dally & Riley.
6. Mechanics of Materials E J Hern, Butterwoth.

7. Strength of Materials, Singer Andru Pytel, Pearson.
8. Dally, James W., and William F. Riley. Experimental stress analysis. (1965).

Web link for MOOC / NPTEL Links:

1. www.youtube.com/playlist?list=PLbRMhDVUMngcbhsZgRWuYCi2kKQwQ0Av1
2. www.youtube.com/watch?v=_2d8YsXwm7M
3. www.nptel.ac.in/courses/112107146

List of Practicals: (First 2 experiments are compulsory, any 3 experiments from remaining)

1. Measurement of strain in cantilever beam using strain gauge
2. Contact stress analysis using FEM software
3. Study of polariscope and calibration of disc, beam and tension model
4. Assignment on Fixing of gauges on surfaces
5. Assignment on theory of elasticity problems
6. Case study on stress analysis due to structural loading using any simulation platform
7. Case study on stress analysis due to dynamic loading using any simulation platform
8. Determination of shear center for thin walled beam cross-section

Course Code: 201104	Course Name: Research Methodology & IPR	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week	4	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Students should complete undergraduate courses in engineering/technology.

Course Objectives:

- To provide an overview of the research problem and describe the functions of literature survey in research.
- To explain the statistical and probability analysis.
- To explain the art of writing research reports and papers.
- To understand the patenting process and its commercial aspects.
- To explain patent rights and new developments in IPR.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand research problem formulation, approaches of investigation of solutions for research problems and literature survey.

CO2: Apply the principles of statistics and probability analysis in research.

CO3: Acquire skills in research proposal/paper writing.

CO4: Discover the importance of IPR.

CO5: Understand patent rights and new developments in IPR.

Course Content:**UNIT-I: Research Problem and Literature Survey 11 Hours**

Research Problem: Meaning of research problem, sources of research problem, characteristics of a good research problem, and errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problems, data collection, benchmarking, analysis, interpretation.

Literature survey: Effective literature studies approaches, analysis, Plagiarism, its importance and software's, research ethics, research gap, writing objectives of research studies.

UNIT-II: Statistics and Probability Analysis 10 Hours

Statistical Analysis: Introduction, Sources of error and uncertainty, One-Dimensional Statistics:

combining errors and uncertainties, t-test, ANOVA statistics.

Probability Analysis: Classical and empirical probability, axioms of probability, conditional probability, Bayes' rule, law of total probability and law of total expectation.

UNIT-III: Technical Writing

11 Hours

Characteristics of effective technical writing, developing a Research proposal, format of the research proposal, financial heads of the research project, research paper writing, abstracting and indexing of journals, impact factor, h index, research paper submission and review process, writing responses to reviewer's comments, Publications.

UNIT-IV: Intellectual Property

10 Hours

Patents, designs, trade and copyright, the process of filing patents, designs, trade and copyright, examination, examination report, writing responses to the examination report, patent grant, commercialization, patenting under PCT and its advantages, case studies.

UNIT-V: Patent Rights and New Developments in IPR

10 Hours

Scope of patent rights, Licensing and transfer of technology, patent information and databases, geographical Indications. Administration of patent system, new developments in IPR, IPR of biological systems, computer software etc.

Learning Resources:

1. Research Methodology: Methods and Trends, by Dr. C. R. Kothari.
2. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville.
3. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition.
4. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd.
5. Mayall, Industrial Design, McGraw Hill.
6. Niebel, Product Design, McGraw Hill.
7. T. Ramappa, Intellectual Property Rights under WTO, S. Chand.
8. Paul L. Meyer, Introductory probability and statistical applications, Addison-Wesley Publishing Company, 1970.

Web link for MOOC / NPTEL Links:

1. www.ipindia.gov.in
2. www.nptel.ac.in/courses/121106007

Course Code: 201105A	Course Name: Process Equipment Design	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week	4	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Engineering Thermodynamics, Heat Transfer.

Course Objectives:

- To acquire knowledge of process equipment design;
- To create awareness about design criteria;
- To optimize the design parameters and then cost estimation;
- To introduce various design standards;
- To aware learner about mechanical design of heat exchangers like condensers, evaporators, reboilers, crystallizers and distillation columns.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Understand the process of equipment design.

CO2: Explain the different design criteria.

CO3: Optimize the design parameters and able to estimate cost.

CO4: Analyze the different design codes and standards.

CO5: Apply the process of equipment design to industrial equipment.

Course Contents**UNIT-I: Introduction to Process Design** **11 Hours**

Basic concepts in process design, block diagrams for flow of processes, material flow balance, design pressures and temperatures, design stresses.

UNIT-II: Design Criteria **11 Hours**

Factor of safety, minimum shell thickness and corrosion allowance, weld joint efficiency, design loading, stress concentration and thermal stresses, failure criteria.

UNIT-III: Optimization and Estimation **10 Hours**

Optimization techniques such as Lagrange's multiplier and golden section method, cost and profitability estimation.

UNIT-IV: Design Standards**10 Hours**

Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA. API-650, BS-1500 and 1515.

UNIT-V: Equipment Design**10 Hours**

Mechanical design of heat exchangers like condenser, evaporator, reboiler, crystallizer, and distillation column.

Learning Resources:**Reference Books:**

1. Process Equipment Design by Lloyd E. Brownell and Edwin H. Young, Wiley Inter-Science.
2. Process Equipment Design by M.V. Joshi, Mc-Millan.
3. Equipment Design: Mechanical Aspects by ShabinaKhanam. IIT Roorkee.
4. Process Heat Transfer: Principles and Applications by Robert W. Serth. Elsevier.
5. Handbook of Chemical Process Equipment Design by Nicholas P. Cheremisinoff. Butterworth-Heinemann.

Weblink for MOOC / NPTEL Links:

1. www.onlinecourses.nptel.ac.in/noc21_ch18/preview
2. www.digitalskills.iitmpravartak.org.in/course_details.php?courseID=224
3. www.archive.nptel.ac.in/courses/103/107/103107143/
4. www.archive.nptel.ac.in/courses/103/105/103105210/

Course Code: 201105B	Course Name: Design of Material Handling Equipment	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week	4	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Engineering Mechanics, Strength of Material, Design of Machine elements.

Course Objectives:

- To understand the knowledge of materials management for logistics and supply chain operations.
- To acquaint students with material handling management functions - planning, purchase, controlling, storing, dispatching and standardizing.
- To understand lifting materials in load chain and material handling systems
- To acquired knowledge of bulk material handling systems
- To get the knowledge of Automation in the material handling system.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Understand basics of material handling systems.

CO2: Understand principles of material handling systems.

CO3: Select the material handling equipment.

CO4: Study the bulk material handling systems.

CO5: Understand Automation in material handling.

Course Contents**UNIT-I: Materials Handling Equipment****11 Hours**

Material handling system: Principles and features of material handling system, importance, terminology, objectives and benefits of better material handling, selection of material handling equipment, factors affecting for selection. Definition of unit load, advantages and disadvantages, load unitization process and handling methods, pallets, skids and containers, alternative methods of handling, packaging for materials handling.

UNIT-II: Design of Hoists**11 Hours**

Basic equipment types, classification of handling equipment, definition of unit load, advantages and disadvantages, load unitization process and handling methods, pallets, skids and containers, alternative methods of handling, packaging for materials handling.

UNIT-III: Load lifting Attachments**10 Hours**

Load chains and types of ropes used in material handling system, forged, standard and Ramshorn hooks, crane grabs and clamps, grab buckets; electromagnet, design consideration for conveyor belts; drums, sheaves, sprockets.

UNIT-IV: Bulk Material Handling Systems**10 Hours**

Objectives of storage, bulk material handling, gravity flow of solids through slides and chutes, storage in bins and hoppers, screw conveyor, vibratory conveyor, pneumatic and hydraulic conveyor: classification, types, principles of operation.

UNIT-V: Automation in Warehouse and Safety**10 Hours**

Storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation, Control of hoisting & conveying machinery, material handling in direct-line, production and automated lines, safety and design; safety regulations and discipline.

Learning Resources:**Text Books:**

1. N. Rudenko, Material Handling Equipment, Peace Publishers.
2. James M. Apple, Material Handling System Design, John-Wiley and Sons.
3. John R. Immer, Material Handling McGraw Hill.
4. Colin Hardi, Material Handling in Machine Shops. Machinery Publication Co. Ltd.
5. M.P.Nexandrn, Material Handling Equipment, MIR Publication.
6. C. R. Cock and J. Mason, Bulk Solid Handling, Leonard Hill Publication Co. Ltd.
7. Spivakovsy, A.O. and Dyachkov, V.K., Conveying Machines, Volumes I and II, MIR Publishers.
8. Kulwiac R. A., Material Handling Hand Book, John Wiley Publication.

Reference Books:

1. Conveyor Equipment Manufacturer's Association, Belt conveyors for bulk materials, 6th edition, The New CEMA Book
2. Rudenko N., Materials handling equipment for industry, Elnvee Publishers, 1970
3. Ishwar G Mulani and Mrs. Madhu I Mulani, Engineering Science and application design

for belt conveyor, Madhu I. Mulani, 2002.

4. Spivakovsy A.O. and Dyachkov V.K., Conveying Machines, Volumes I and II, MIR Publishers, 1985.
5. Alexandrov, M., Materials Handling Equipments, MIR Publishers, 1981.
6. Boltzharol, A., Materials Handling Handbook, The Ronald press company 1958.

e-Books:

1. Bulk solids handling: equipment selection and operation by Dr. D. McGlinchey
2. Materials Handling Equipment by Michael G. Kay.

Course Code: 201105C	Course Name: Industrial Tribology	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week	4	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Engineering Mathematics, Engineering Mechanics, Material Science, Strength of Materials, Fluid Mechanics, Dynamics of Machines, Machine Design.

Course Objectives:

- To provide necessary concepts, knowledge and skills in Engineering Tribology with design aspect.
- To impart knowledge on friction and methods to minimize wear of engineering components.
- To provide hands on training with design of bearing, friction, wear test rig for lab purpose.

Course Outcomes:

On completion of the course, learner will be able to:

- CO1:** Apply theories of friction and wear to various practical situations by analyzing the physics of the process.
- CO2:** Select materials and lubricants to suggest a tribological solution to a particular situation.
- CO3:** Design a hydrodynamic bearing and measure the performance parameters using various bearing charts.
- CO4:** Analyze the behavior of bearing in different lubrication regimes.
- CO5:** Decide on the condition monitoring techniques based on performance of tribological components.

Course Contents**UNIT-I: Introduction of Tribology****11 Hours**

Definition and Scope of tribology, Nature of metallic surface, surface geometry, measurement of surface topography, quantifying surface roughness, contact between surfaces Friction, the laws of friction, measurement of friction, origin of friction, theories of friction adhesion- theory, extension of the adhesion theory.

UNIT-II: Wear Measurement**11 Hours**

Types of wear, adhesive wear, Archard's law, abrasive wear, erosion wear, factors affecting corrosive wear, wear map, various wear testing methods - pin on disc, pin on drum, slurry wear, air jet and water jet erosion as per ASTM standards.

UNIT-III: Surface Treatments**10 Hours**

Surface treatments with or without change of composition, surface coating- welding, flame, spraying, plasma spraying, electroplating and electroless coating, chemical vapour deposition (CVD) and physical vapour deposition (PVD), super hard coatings.

UNIT-IV: Design of Hydrodynamic Bearings**10 Hours**

Mechanism of pressure development, classification, idealized journal bearing, oil film thickness, pressure distribution, load carrying capacity. Failure Case Studies. Elasto-hydrodynamic lubrication Pressure-viscosity term in Reynold's equation, hertz theory, Ertel-Grubin equation, lubrication of spheres.

UNIT-V: Antifriction Bearings**10 Hours**

Ball and roller bearings, geometry of ball bearings, radial load distribution, stresses and deformations, lubrication of ball bearings. Failure case studies. **Condition Monitoring of Equipment's:** condition monitoring techniques, lubricant, corrosion, temperature & surface roughness monitoring. Failure case studies. Nano /micro tribology, green tribology.

Learning Resources:**Text Books:**

1. Principles of Lubrication, Camaron, Longman's Green Co. Ltd.
2. Tribology in Machine Design, T. A. Stolarski.
3. Tribology in Industries – S.K. Shrivastava -S. Chand & Company Ltd., New Delhi, 2001.
4. Bearing Design in Machinery, Engineering Tribology and Lubrication - A. Harnoy- Marcel Dekker Inc., 2003.

Reference Books:

1. Engineering Tribology- Prasanta Sahoo - Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
2. Fundamentals of Tribology – S.K. Basu, S.N. Sengupta, B.B. Ahuja – PHI Learning Pvt.Ltd., 2010.
3. Tribology Handbook M.J. Neele.
4. Engineering Tribology – G.W. Stachowiak, A.W. Batchelor – Elsevier India Pvt. Ltd., New Delhi.
5. Introduction to Tribology of Bearings – B.C. Majumdar – S. Chand & Company Ltd., New Delhi.
6. Rolling Bearing Analysis – T.A. Harris – John Wiley & Sons, Inc., New York 4. Engineering Tribology – J. Williams - Cambridge University Press, 2004.

7. Fundamental of Friction and Wear of Metals – ASM
8. The Design of Aerostatic Bearings – J. W. Powell
9. Theory Hydrodynamic Lubrication, Pinkush and Sterrolight.

e-Books:

1. <https://nptel.ac.in/courses/112102015>
2. <https://archive.nptel.ac.in/courses/112/102/112102014/>
3. https://nitsri.ac.in/Department/Mechanical%20Engineering/NPTEL____Mechanical_Engineering_-_Tribology.pdf
4. https://onlinecourses.nptel.ac.in/noc24_me75/preview

Course Code: 201105D	Course Name: Energy Audit and Management	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week	4	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Heat transfer, Applied Thermodynamics.

Course Objectives:

- To impart the knowledge to the students about energy conservation, energy audit and energy management.
- To inculcate the systematic knowledge and skill in assessing the energy efficiency, energy auditing and energy management.
- To carry out an energy audit of institute/industry/organization.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Explain the energy audit and role of energy management.

CO2: Explain the role of financial management.

CO3: Explain the role of project management.

CO4: Analyze the energy conservation performance of thermal utilities.

CO5: Analyze the energy conservation performance of electrical systems.

Course Contents**UNIT-I: Energy Audit and Management****11 Hours**

Definition, energy audit- need, types of energy audit, energy management (audit) approach- understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments.

UNIT-II: Financial Management**11 Hours**

Investment - need, appraisal and criteria, financial analysis techniques - simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis, financing options, Energy performance contracting and role of Energy Service Companies (ESCOS).

UNIT-III: Project Management**10 Hours**

Definition and scope of project, technical design, financing, contracting, implementation and performance monitoring, implementation plan for top management, planning budget, procurement procedures, construction, measurement and verification.

UNIT-IV: Evaluation of Thermal Utilities**10 Hours**

Energy performance opportunities and assessment of boilers and furnaces (numerical on direct method), heat exchangers, cooling towers, DG sets, fans & blowers, pumps, compressors, compressed air systems and HVAC systems. Assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.

UNIT-V: Energy Efficient Technologies in Electrical Systems**10 Hours**

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls.

Learning Resources:**Text Books:**

1. Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I to IV.

Reference Books:

1. Barney L. Capehart, Wayne C. Turner and William J. Kennedy, Guide to Energy Management, Seventh Edition, The Fairmont Press Inc., 2012.
2. Craig B. Smith, Energy Management Principles, Pergamon Press, 2015.
3. Hamies, Energy Auditing and Conservation; Methods, Measurements, Management and Case Study, Hemisphere Publishers, Washington, 1980.
4. Albert Thumann P.E. CEM, William J. Younger CEM, Handbook of Energy Audit, The Fairmont Press Inc., 7th Edition.
5. Wayne C. Turner, Energy Management Handbook, The Fairmont Press Inc., Georgia.

e-Books:

1. www.npcindia.gov.in
2. <http://www.bee-india.nic.in>
3. www.aipnpc.org (for entire course material along with case studies).

Course Code: 200106	Course Name: Human Rights – 1	
Teaching Scheme	Credit	Evaluation Scheme
Tutorial : 1 Hours/Week	1	TW : 25 Marks

Expected Prerequisite Courses: Nil

Course Objectives:

- To familiarize students with the concept, nature, and evolution of human rights and duties.
- To sensitize students, to the interdependence of rights and duties across personal, social, and global contexts.
- To highlight legal instruments, and role of UN agencies in human rights promotion.
- To promote awareness about international human rights instruments such as the Universal Declaration of Human Rights (UDHR) and the role of United Nations.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the concept, nature, and evolution of human rights and duties.

CO2: Discuss the relationship between rights and duties at individual, societal, and global levels.

CO3: Explain legal instruments and their framework.

CO4: Describe International perspectives of human rights, and summarize UN system and human rights bodies.

Course Contents

UNIT-I: Basic Concepts

04 Hours

Significance of values and their linkage with human rights, human values: dignity, liberty, equality, justice, ethics, morals, unity in diversity. Meaning and significance of human rights education, objectives and models of human rights education.

UNIT-II: Perspective of Rights and Duties

04 Hours

Concept, meaning, and analysis of rights, types of rights: natural, legal, claim, liberty, positive and negative, individual and group, universal rights, concept and types of duties: moral, legal, positive, negative, perfect, imperfect, relationship between rights and duties, role of national law and responsibilities of individuals and states.

UNIT-III: Legal Instruments and Framework**04 Hours**

Introduction of legal instruments and their binding nature. Human rights and Indian Constitution, International legal instruments: charter, conventions covenant, declaration, treaties, protocols, resolutions executive orders, and statutes. Role of UN agencies and international conferences in human rights promotion.

UNIT-IV: United Nations and Human Rights**04 Hours**

International and national perspectives of human rights. Overview of the UN system and human rights bodies, Universal Declaration of Human Rights (UDHR): background, significance, and analysis of key articles, human rights and fundamental freedoms: equality, liberty, social justice, and dignity, contemporary challenges and the way forward.

Term Work

Term work shall consist of handwritten a minimum of 08 assignments (Two per unit). The course teacher will decide the assignments based on the content.

Learning Resources:**Text Books:**

1. Introduction to Human rights and duties by Dr. T.S.N. Sastry Published by SPPU, Pune.
2. Human rights of vulnerable and disadvantaged groups by Dr. T.S.N. Sastry Published by SPPU, Pune.
3. P.K. Pandey (Ed) Human Rights , APH Publishing Corporation, 2012.

Reference Books:

1. Andrew Clapham : Human Rights Lexion, Oxofrd University Press; 2005.
2. Andrew Clapham:Human Rights A very short Introduction; 2007, Oxford University Press.
3. Magdalena Sepulveda and others: Human Rights : Hand Book, 2004 University for Peace of the United Nations.
4. Human rights and Vulnerable Groups available at http://www.sagepub.com/upmdata/11973_Chapter_5.pdf
5. Vulnerability and Vulnerable Groups; available at <http://siteresources.worldbank.org/INTSRM/Publications/20316319/RVA.pdf>

Web link for MOOC / NPTEL Links:

1. <https://www.youtube.com/watch?v=Y-yBzLNHIyk>
2. <https://www.youtube.com/watch?v=wDWPiWAJplA>

Semester - II

Course Code: 201201.	Course Name: Advanced Mechanical Vibrations	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 4 Hours/Week Practical : 2 Hours/Week	4 1	CCE : 50 Marks ESE : 50 Marks OR : 25 Marks

Prerequisite Courses:

- Physics, Engineering Mathematics, Engineering Mechanics, Dynamics Machinery.

Course Objectives:

- To develop the mathematical model of Multi degree freedom System and formulate the equation of motion.
- To Analyse equation of motion of continuous systems and response to transient vibration system
- To study measure of vibration and analyse the measured data
- To study control of vibration.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Compute the free and forced vibration responses of multi degree of freedom systems.

CO2: Analyse equation of motion of continuous systems.

CO3: Analyse response to transient vibration system.

CO4: Measure and analyse vibration of machines.

CO5: Apply vibration control techniques.

Course Content:

UNIT-I: Multi Degree Freedom System

11 Hours

Free vibration equation of motion, stiffness and flexibility influence coefficients, Lagrange's equations, Eigen values Eigen vector problems, modal analysis, forced vibrations of un-damped system, modal analysis, Holzer's Method, Transfer Matrix Method, Methods of Matrix iterations.

UNIT-II: Continuous System

11 Hours

Transverse vibrations of string, longitudinal vibration of rods, torsional vibrations of shaft, lateral vibrations of simply supported and cantilever beams, equations of motion and boundary conditions, forced vibration of beams.

UNIT-III: Transient Vibrations**10 Hours**

Laplace transformation, response to step input, response to an impulsive input, response to a pulse input-rectangular pulse and half sinusoidal pulse.

UNIT-IV: Vibration Measurement**10 Hours**

FFT analyzer, vibration exciters, accelerometer, signal analysis, time domain and frequency domain analysis of signals, experimental modal analysis, machine conditioning and monitoring, fault diagnosis, vibration severity chart.

UNIT-V: Vibration Control**10 Hours**

Balancing of rotating machine, in-situ balancing of rotors, control of natural frequency, vibration isolation and vibration absorbers, Passive, active and semi-active control, free layer and constrained layer damping.

Learning Resources:**Text Books:**

1. Theory of Vibrations with Applications, W. T. Thomson, Pearson Education, Delhi
2. Mechanical Vibrations, S. S. Rao, Pearson Education, Delhi
3. Mechanical Vibrations, G K Groover, Nem Chand & Bros, Roorkee, India
4. Fundamentals of Vibration, Leonard Meirovitch, McGraw Hill International Edison.

Reference Books:

1. Principles of Vibration Control: Ashok Kumar Mallik, Affiliated East-West Press, New Delhi.
2. Mechanical Vibrations, A H Church, John Wiley & Sons Inc
3. L. Meirovich, Elements of Vibration Analysis, 2nd Ed. Tata McGraw Hill Book Company, 2007.

Web link for MOOC / NPTEL Links:

1. <https://nptel.ac.in/courses/112107212>

List of Practicals (Any Five):

1. Determination of Natural Frequencies & Modal analysis of beam using FFT Analyzer.
2. Vibration analysis of any mechanical component using FEA software.
3. A Case study on Fault Diagnosis of rotating machines.
4. Forced vibration analysis of system subjected to Harmonic excitation using FEA software.
5. To study the dynamic vibration absorber system and its characteristics for different excitation frequency and amplitude and masses.
6. Experimental analysis of unbalance fault using FFT Analyzer.

Course Code: 201202	Course Name: Finite Element Analysis	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week Practical : 2 Hours/Week	3 1	CCE : 50 Marks ESE : 50 Marks TW : 25 Marks

Prerequisite Courses:

- Solid Mechanics, Numerical and Statistical Methods, Engineering Mathematics, Manufacturing Processes, Fluid Mechanics, Heat and Mass Transfer.

Course Objectives:

- Understand the basic concepts of Finite Element Method (FEM) and Characteristics of various elements required for analysis.
- Understand the approaches of FEM and to find displacement and stresses over the body and effect of temperature.
- Develop the knowledge and skills needed to effectively evaluate the results using Finite Element Analysis (FEA).
- Apply computational technique to solve complex solid mechanics problems and its loading states.
- Study the applications of CAE in the various domains of the Mechanical Engineering.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the different techniques used to solve mechanical engineering problems.

CO2: Derive and use 1-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.

CO3: Derive and use 2-D element stiffness matrices and load vectors from various methods to solve for displacements and stresses.

CO4: Evaluate and solve non-linear and dynamic analysis problems by analyzing the results obtained from analytical and computational method.

CO5: Analyze and apply various numerical methods for different types of analysis.

Course Contents**UNIT-I: Fundamental Concepts of FEA****08 Hours**

Introduction: Solution methodologies to solve engineering problems, governing equations, mathematical modelling of field problems in engineering, brief history of FEM.

Discrete and Continuous Models: Advantages and disadvantages, weak formulation, variational methods of approximation – Rayleigh-Ritz methods, Galerkin method of weighted residuals.

UNIT-II: 1D Elements**08 Hours**

Types of 1D elements, displacement function, global and local coordinate systems, polynomial form of interpolation functions- linear, quadratic and cubic, properties of shape function, primary and secondary variables. Formulation of elemental stiffness matrix and load vector for bar (using elimination and penalty approach), truss and beam using any approach, formulation of load vector due to uniform temperature change.

UNIT-III: 2D Elements**08 Hours**

Two-Dimensional Stress Analysis: Plane Stress/Strain problems in 2D elasticity, constitutive relations, Constant Strain Triangle (CST), Linear Strain Rectangle (LSR), displacement function, Pascal's triangle, compatibility and completeness requirement, geometric isotropy, convergence requirements, strain field, stress field, formulation of element stiffness matrix and load vector for plane stress/strain problems.

UNIT-IV: Non-Linear and Dynamic Analysis**08 Hours**

Non-Linear Analysis: Introduction to non-linear problems, comparison of linear and non-linear analysis, types of non-linearities, stress-strain measures for non-linear analysis, analysis of geometric, material non-linearity, solution techniques for non-linear analysis, Newton - Raphson method, essential steps in non-linear analysis.

Dynamic Analysis: Introduction to dynamic analysis, comparison of static and dynamic analysis, time domain and frequency domain, types of loading, simple harmonic motion, free vibration, boundary conditions of free vibration and solution.

UNIT-V: Applications of FEM**08 Hours**

Computer Implementation: Pre-processor, processor, post-processor, automatic mesh generation techniques, mesh quality checks, h and p refinements, symmetry – mirror/plane, axial, cyclic and repetitive, node numbering scheme.

Durability Analysis: Durability, reliability and fatigue, FEA based fatigue analysis viz: Stress-Life approach (S-N method) and Strain-Life approach (E-N method).

Crash Analysis: Introduction, explicit time integration schemes, implicit integration schemes.

Noise Vibration and Harshness (NVH) Analysis: NVH concepts, terminology, FEA for structural dynamics, FEA for acoustics.

Learning Resources:**Text Books:**

1. Gokhale N. S., Deshpande S. S., Bedekar S. V. and Thite A. N., Practical Finite Element Analysis, Finite to Infinite, Pune.
2. S. S. Bhavikatti, Finite Element Analysis, New Age International Publishers.
3. Chandrupatla T. R. and Belegunda A. D., Introduction to Finite Elements in Engineering, Prentice Hall India.
4. G Lakshmi Narasaiah, Finite Element Analysis, BS Publications / BSP Books.
5. J. N. Reddy, An Introduction to the Finite Element Method, Mcgraw Hill Series in Mechanical.
6. P. Seshu, Text book of Finite Element Analysis, PHI Learning Private Limited, New Delhi.

Reference Books:

1. K. J. Bathe, Finite Element Procedure, Prentice-Hall of India (P) Ltd., New Delhi.
2. Cook R. D., Finite Element Modeling for Stress Analysis, John Wiley and Sons Inc.
3. G.R. Liu S. S. Quek, The Finite Element Method- A Practical Course, Butterworth Heinemann.
4. Fagan M. J., Finite Element Analysis Theory and Practice, Harlow Pearson/Prentice Hall.
5. S. Moaveni, Finite element analysis, theory and application with Ansys, Pearson, Third Edition.
6. David V. Hutton, Fundamental of Finite Element Analysis, Tata McGraw-Hill, 2017.
7. Mukhopadhyay M and Sheikh A. H., Matrix and Finite Element Analyses of Structures, Ane Books Pvt. Ltd.
8. Daryl L. Logan, A First Course in the Finite Element Method, Fourth Edition, Thomson Canada Limited.
9. O.C. Zienkiewicz, The Finite Element Method: Its Basis and Fundamentals, Sixth Edition, Elsevier Butterworth-Heinemann.

List of Practicals:

1. Stress and deflection analysis of short and long beams with different end conditions and cross-sections subjected to different loading conditions (i.e., point load – force & moment, distributed load etc.) using FEA software.
2. Stress and deflection analysis of thin and thick rectangular and circular plates/shells with different end conditions subjected to different loading conditions (i.e., point load – force and moment, distributed load etc.) using FEA software.
3. Model analysis of any mechanical component.
4. Coupled analysis of any mechanical components.
5. Case study on fatigue/crash/NVH analysis.

Course Code: 201203.	Course Name: Kinematic Analysis and Synthesis	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Physics, Engineering Mathematics, Engineering Mechanics, Dynamics Machinery.

Course Objectives:

- To develop the understanding of the planar and complex mechanisms.
- To develop the understanding of synthesis of mechanisms using analytical and graphical methods.
- To develop skills in analyzing spatial mechanisms.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Develop analytical equations describing the relative position, velocity and acceleration of all moving links.

CO2: Analyze and animate the movement of planar and spherical four-bar linkages.

CO3: Formulate and solve four position synthesis problems for planar and spherical four-bar linkages by graphical method.

CO4: Formulate and solve four position synthesis problems for planar and spherical four-bar linkages by analytical method.

CO5: Select, configure and synthesize mechanical components into complete systems.

Course Content:**UNIT-I: Introduction to Kinematics and Complex Mechanisms 08 Hours**

Review of concepts related to kinematic analysis of mechanisms, degree of freedom, Grashoff's and Grubler's criteria, transmission and deviation angles, mechanical advantage, review of graphical and analytical methods of velocity and acceleration analysis of simple mechanisms. Types of complex mechanisms, velocity-acceleration analysis of complex mechanisms by the normal acceleration method and auxiliary point method, introduction to Goodman's method.

UNIT-II: Curvature Theory 08 Hours

Fixed and moving centrodes, inflection circle, Euler-Savary equation, Bobillier constructions,

cubic of stationary curvature, Ball's point and applications in dwell mechanisms.

UNIT-III: Graphical Synthesis of Planar Mechanism

08 Hours

Types, number and dimensional synthesis, function generation, path generation and rigid body guidance problems, accuracy (precision) points, Chebychev spacing, types of errors, graphical synthesis for function generation and rigid body guidance with two and three accuracy points using Relative pole method and inversion method, center point and circle point curves, Bermester points, branch and order defects, synthesis for path generation.

UNIT-IV: Analytical Synthesis of Planar Mechanism

08 Hours

Freudenstein's equation, synthesis for four accuracy points, compatibility condition, introduction to complex numbers method of synthesis, the dyad, center point and circle point circles, ground pivot specifications, three accuracy point synthesis using dyad method, Robert Chebychev theorem, Cognate linkages.

UNIT-V: Kinematics of Spatial Mechanisms

08 Hours

Transformations describing planar finite displacements, planar finite transformations, identity transformation, rigid-body transformations, spatial transformations Denavit-Hartenberg parameters, matrix method of analysis of spatial mechanisms.

Learning Resources:

Text Books:

1. Theory of Machines and Mechanisms, A. Ghosh and A.K.Mallik, Affiliated East- West Press.
2. Theory of Machines and Mechanisms, J. E. Shigley and J. J. Uicker, 2nd Ed., McGraw-Hill.

Reference Books:

1. Kinematic Synthesis of Linkages, R. S. Hartenberg and J. Denavit, McGraw-Hill.
2. Mechanism Design - Analysis and Synthesis (Vol. 1 and 2), A. G. Erdman and G. N. Sandor, Prentice Hall of India.
3. Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines, Robert L.Norton, Tata McGraw-Hill, 3rd Edition.
4. Kinematics and Linkage Design, A.S. Hall, Prentice Hall of India.

Web link for MOOC / NPTEL Links:

1. https://www.youtube.com/watch?v=xIRI2fDbn_Q
2. <https://www.youtube.com/watch?v=yDEJxYGAoso>

Course Code: 201204A.	Course Name: Advanced Composite Structure	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Design, Mechanics, Engineering Mathematics.

Course Objectives:

- To develop the understanding of the behavior, and applications of composite materials.
- To develop skills in testing composite materials, measuring their properties.
- To develop skills in analyzing composite structure.
- To achieve proficiency in designing composite structures.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand the types, behavior and applications of composite materials.

CO2: Apply the knowledge of mechanical behavior of lamina to evaluate the properties of composites.

CO3: Analyze the composite structures by different governing equations.

CO4: Analyze the material properties of composites by testing.

CO5: Design and optimize the composite structures.

Course Contents**UNIT-I: Introduction to Composite Materials 08 Hours**

Introduction, types – fibrous, laminate, particulate, combination, polymer matrix composites, metal matrix composites, mechanical behavior of composite material, applications.

UNIT-II: Mechanical Behavior of Lamina 08 Hours

Anisotropy, Orthotropy, stiffness, engineering constants, uniaxial and biaxial strength of lamina, failure theories – maximum stress, maximum strain, Tsai-Hill, Hoffman, Tsai-Wu, computational procedure, applicability, mechanics approach to stiffness and strength.

UNIT-III: Analysis of Laminated Plates 08 Hours

Design of composite structure bending, buckling and vibration of laminated plates - governing

equations, simply supported laminated plates – deflection under distributed transverse load, buckling under in-plane load, vibration.

UNIT-IV: Testing of Composite Materials

08 Hours

Characterization of constituent materials, physical characterization of composite material, determination of tensile, compressive and shear properties, determination of inter-laminar fracture toughness, bi-axial testing, characterization of composites with stress concentration.

UNIT-V: Design of Composite Structures

08 Hours

Structural design procedure, configuration selection, joints, design requirements, failure criteria, design analysis, optimization.

Learning Resources:

Text Books:

1. Introduction to Composite Materials by J. A. C. and M. B. H.
2. Mechanics of Composite Materials and Structure by E. K. and B. D.
3. Composite Materials: Testing and Design by J. M. and D. T.
4. Design and Analysis of Composite Structures by L. M. and C. S.

Reference Books:

1. Mechanics of Composite Materials, Robert M. Jones, Taylor & Francis.
2. Introduction to Composite Materials Design by Ever J. Barbero.
3. Engineering Mechanics of Composite Materials, Isaac M. Daniel and Ori Ishai, Oxford University Press.
4. Mechanics of Composite Materials by Robert M. Jones.
5. Mechanics of Composite Materials, Autar K. Kaw, CRC Press.
6. Fundamentals of Composite Material Mechanics by Peter J. Svoloda.
7. Mechanics and Analysis of Composite Materials, Valery V. Vasiliev and Evgeny V. Morozov, Elsevier.
8. Composite Materials Testing and Design by G. G. A. C. and M. L. J.

MOOC / NPTEL / YouTube:

1. <https://www.coursera.org/instructor/~9971288>
2. <https://www.coursera.org/learn/cam-design-manufacturing-mechanical-engineers>
3. <https://www.udemy.com/course/fundamentals-of-composite-materials/?couponCode=SKILLS4SALEA>
4. <http://www.ae.iitkgp.ac.in/ebooks/>
5. <https://nptel.ac.in/courses/101104010>
6. <https://www.youtube.com/watch?v=VMH6qbED7pg>

Course Code: 201204B.	Course Name: Design of Piping Systems	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Machine Design, Fluid Mechanics, Thermodynamics.

Course Objectives:

- Understand the principles and standards for piping system design.
- Apply advanced design techniques to ensure system reliability and efficiency.
- Analyze the impact of various factors on piping system performance.
- Develop skills in using industry-standard software for piping design and analysis.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Apply relevant codes, standards, and best practices to ensure safe and efficient piping system design.

CO2: Perform detailed stress analysis to address issues such as thermal expansion, pressure fluctuations, and dynamic loading.

CO3: Design efficient and maintainable piping layouts considering accessibility, safety and integration with other systems.

CO4: Apply relevant codes, standards, and best practices to ensure safe and efficient piping system design.

CO5: Proficiently use piping design and analysis software (e.g., AutoCAD P&ID, CAESAR II) to model, simulate, and evaluate piping systems.

Course Content:**UNIT-I: Introduction to Piping Systems, Materials and Components 08 Hours**

Overview of piping systems in various industries (oil & gas, chemical, water treatment), design objectives and considerations, overview of relevant codes and standards (ASME B31.1, ASME B31.3, API, etc.), selection criteria for piping materials (metals, plastics, composites), pipe fittings, valves and supports, corrosion and material degradation.

UNIT-II: Fluid Flow and Thermodynamics**08 Hours**

Basic fluid dynamics principles (flow regimes, pressure drop calculations), Heat transfer and thermal expansion, Fluid properties and their impact on design.

UNIT-III: Pipe Layout and Design**08 Hours**

Piping layout principles and optimization, stress analysis techniques for piping systems (bending, thermal, and pressure stresses), design for fatigue and dynamic loading, design for maintenance and accessibility, design for fatigue and dynamic loading, integration with other systems (electrical, instrumentation).

UNIT-IV: Design Codes and Standards**08 Hours**

Detailed study of relevant codes (ASME B31.1, ASME B31.3), compliance and safety considerations, case studies of code applications.

UNIT-V: Advancement in Piping Design, Software Tools & Simulation**08 Hours**

Expansion joints and flexible connections, seismic and dynamic analysis, high-pressure and high-temperature piping systems, introduction to piping design software (AutoCAD P&ID, CAESAR II, pipe flow expert), simulation and analysis techniques, hands-on software practice.

Learning Resources:**Text Books:**

1. Piping and Pipeline Engineering by George A. Antaki.
2. Industry standards and codes (ASME B31.1, ASME B31.3).

Reference Books:

1. Piping Handbook by Nicholas C. Yaw.
2. Process Piping Design Handbook by John J. McKetta Jr.

Web link for MOOC / NPTEL Links:

1. <https://www.coursera.org/specializations/design-of-industrial-piping-systems>
2. [Designing Piping Systems : Pipe Fittings Flanges Valves | Udemy](#)

Group Project:

1. Design and analysis of a piping system for a specific application.

Course Code: 201204C.	Course Name: Condition Monitoring	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Dynamics of Machinery, Advanced mechanical vibration.

Course Objectives:

- Understand some basic concepts of condition monitoring.
- Understand the fault diagnosis using vibration analysis and oil analysis.
- Apply signal conditioning.
- Study condition monitoring of bearing, gears and electrical machines.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Understand condition monitoring and predictive maintenance techniques.

CO2: Select appropriate instruments for vibration analysis.

CO3: Apply vibration monitoring techniques to detect the faults.

CO4: Monitor condition of bearing, gear, pumps and electrical machines using vibration analysis.

CO5: Apply oil and particle analysis for condition-based maintenance.

Course Content:

UNIT-I: Condition Monitoring

08 Hours

Introduction to condition monitoring. Predictive maintenance basics, maintenance philosophies, evolution of maintenance philosophies, plant machinery classification and recommendations, principles of predictive maintenance, predictive maintenance techniques, basic vibration theory, limits and standards of vibration.

UNIT-II: Signal Processing

08 Hours

Data acquisition, collection of vibration signal – vibration transducers, characteristics and mountings, conversion of vibrations to electrical signal, Fast Fourier transform (FFT) analysis, time waveform analysis, phase signal analysis, spectral signal processes.

UNIT-III: Machinery Fault Diagnosis I

08 Hours

Time and frequency domain analysis to identify unbalance, Eccentricity, bent shaft, misalignment,

mechanical looseness, resonance, crack, Rotor rubs, Belt drive faults.

UNIT-IV: Machinery Fault Diagnosis II**08 Hours**

Fault diagnosis of rolling element bearings and journal bearing, faults related to gearbox, vane defects in pumps, fault in fans and blowers, faults in electrical machines.

UNIT-V: Oil and Particle Analysis**08 Hours**

Condition-based maintenance and oil analysis, setting up an oil analysis program, oil analysis sampling methods, lubricant properties, contaminants in lubricants, particle analysis techniques-spectrometric analysis, infrared analysis, wear particle analysis, XRF (X-ray fluorescence) spectroscopy.

Learning Resources:**Text Books:**

1. Theory of Vibration with Applications, Thomson, W. T., CBS Publishers and Distributors, New Delhi.
2. Introductory Course on Theory and Practice of Mechanical Vibrations, Gupta K., New Age International Ltd.
3. Practical Machinery Vibration Analysis and Predictive Maintenance, C. Scheffer, PareshGirdhar, Elsevier.
4. Vibratory Condition Monitoring of Machines, J. S. Rao, Narosa Publishing House, New Delhi.

Reference Books:

1. Shock and Vibration Handbook, Cyril M. Harris, Allan G. Piersol, McGraw-Hill Publishing Co.
2. V. Wowk, Machinery Vibration Measurement and Analysis, McGraw-Hill, Inc., 1991
3. R.B. Randall, Vibration-based Condition Monitoring, Wiley 2021.

Web link for MOOC / NPTEL Links

1. <https://nptel.ac.in/courses/112105232>

Course Code: 201204D.	Course Name: Robotics	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week	3	CCE : 50 Marks ESE : 50 Marks

Prerequisite Courses:

- Engineering Mechanics, Theory of Machines, Mechatronics, Basics of Electrical and Electronics Engineering, Control system.

Course Objectives:

- To get acquainted with basic components of robotic systems.
- To study various gripper mechanisms and sensors and understand role of suitable control system.
- To understand statistics and kinematics of robots.
- To develop competency in obtaining desired motion of the robot.
- To study various programming methods in robotics.
- To understand need of modern techniques in robotics.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Identify different type of robot configuration with relevant terminology.

CO2: Select suitable sensors, actuators and drives for robotic systems.

CO3: Understand kinematics in robotic systems.

CO4: Design robot with desired motion with suitable trajectory planning.

CO5: Select appropriate robot programming for given application.

Course Content:

UNIT-I: Introduction of Robotics

08 Hours

Introduction: Basic concepts, laws of robotics, robot anatomy, classification, structure of robots, point to point and continuous path robotic systems. Robot performance- resolution, accuracy, repeatability, dexterity, compliance, RCC device, applications.

Robot Grippers: Types of grippers, design of gripper, force analysis for various basic gripper systems.

UNIT-II: Sensor and Control System**08 Hours**

Robotic Sensors: characteristics of sensing devices, classification, selection and applications of sensors. Types of sensors, need for sensors and vision system in the working and control of a robot. GPS, IMU, vision, PVDF tactile (construction, working and selection).

Drives and Control Systems : Types and selection of drives, actuators and transmission systems, types of controllers, closed loop control, second order linear systems and their control, control law of partitioning, trajectory-following control, modeling and control of a single joint, force control.

UNIT-III: Kinematics of Robotics**08 Hours**

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 of two joints, solvability, algebraic and geometrical methods.

Velocities and Static Forces in Manipulators: Motion of the manipulator links, Jacobians, singularities, static forces, Jacobian in force domain.

UNIT-IV: Dynamics of Robotics**08 Hours**

Introduction to dynamics, trajectory generations, motion planning and control: joint and Cartesian space trajectory planning and generation, potential field method for motion planning manipulator mechanism design, force control and hybrid position / force control.

UNIT-V: Vision System and Robot Programming**08 Hours**

Machine Vision System: Vision system devices, image acquisition, masking, sampling and quantization, image processing techniques, masking, sampling and quantization, 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: Robot language structure, introduction to various types such as RAIL and VAL II.

Learning Resources:**Text Books:**

1. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.

Reference Books:

1. Groover M.P. Automation, production systems and computer integrated manufacturing -

Prentice Hall of India.

2. S. B. Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication.
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education.
4. Mathia, Robotics for Electronics Manufacturing, Cambridge Uni. Press, India.
5. A Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford University Press.
6. R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Publication.

Course Code: 200205	Course Name: Introduction to Cyber Security	
Teaching Scheme	Credit	Evaluation Scheme
Theory : 3 Hours/Week Practical : 2 Hours/Week	3 1	CCE : 50 Marks ESE : 50 Marks TW : 25 Marks

Expected Prerequisite Courses:

- Computer Networks & Security.

Course Objectives:

- To understand the fundamental concepts, terminologies, and increasing threat landscape in cyber security.
- To identify and analyze different forms of cybercrimes, attacks, and malicious activities across digital platforms.
- To explore the legal framework, national and international cyber laws, and regulations governing cyber security.
- To understand and evaluate data privacy, data security principles, and compliance mechanisms.
- To develop skills to manage organizational cyber security through policies, risk assessment, audit, incident response, and governance strategies.

Course Outcomes:

After successful completion of the course, learner will be able to:

- CO1:** Explain the core concepts and terminology of cyber security and modern cyber threat landscape.
- CO2:** Identify and classify various cybercrimes, social engineering attacks, and reporting procedures.
- CO3:** Examine cyber laws, legal provisions, and ethical considerations related to emerging technologies.
- CO4:** Analyze data privacy, data protection laws, and big data security concerns at national and international levels.
- CO5:** Develop cyber security plans, policies, and apply risk management and governance principles in organizations.

Course Contents**UNIT-I: Overview of Cyber Security****08 Hours**

Cyber security increasing threat landscape, cyber security terminologies - cyberspace, attack, attack vector, attack surface, threat, risk, vulnerability, exploit, exploitation, hacker, non-state actors, cyber terrorism, critical IT and national critical infrastructure, cyberwarfare.

UNIT-II: Cyber Crimes**08 Hours**

Types of cyber crime, cyber crimes targeting computer systems and mobiles, online scams and frauds, darknet - illegal trades, drug trafficking, human trafficking, social media scams and frauds, crime against persons, social engineering attacks, cyber police stations, crime reporting procedure, hacking and cracking, types of hacker.

UNIT-III: Cyber Laws**08 Hours**

Cyber-crime and legal landscape around the world, IT Act, 2000 and its amendments. Limitations of IT Act, 2000. Cyber crime and punishments, Cyber laws, legal and ethical aspects related to new technologies - AI/ML, IoT, blockchain, darknet and social media, cyber laws of other countries, case studies.

UNIT-IV: Data Privacy and Data Security**08 Hours**

Defining data, meta-data, big data, non-personal data. Data protection, data privacy and data security, personal data protection bill and its compliance, data protection principles, big data security issues and challenges, data protection regulations of other countries- General Data Protection Regulations (GDPR), 2016 Personal Information Protection and Electronic Documents Act (PIPEDA), social media- data privacy and security issues.

UNIT-V: Cyber Security Management, Compliance and Governance**08 Hours**

Cyber security plan - cyber security policy, cyber crises management plan, business continuity, risk assessment, types of security controls and their goals, cyber security audit and compliance, national cyber security policy and strategy.

Learning Resources:**Text Books:**

1. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd.
2. Information Warfare and Security by Dorothy F. Denning, Addison Wesley.

Reference Books:

1. Security in the Digital Age: Social Media Security Threats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform.
2. Data Privacy Principles and Practice by Natraj V. & Ashwin Shriram, CRC Press.
3. Information Security Governance, Guidance for Information Security Managers by W. KragBrothy, 1st Edition, Wiley Publication.
4. Auditing IT Infrastructures for Compliance by Martin Weiss, Michael G. Solomon, 2nd Edition, Jones Bartlett Learning.

Web link for MOOC / NPTEL Links:

1. SWAYAM Course: “Introduction to Cyber Security” by Dr. Jeetendra Pande
https://onlinecourses.swayam2.ac.in/nou25_cs18/preview
2. NPTEL Course: “Cyber Security and Privacy”, IIT Madras by Prof. Saji K Mathew
<https://nptel.ac.in/courses/106106248>
3. Coursera Course “Introduction to Cyber Security”
<https://www.coursera.org/specializations/intro-cyber-security>
4. SWAYAM Course: “Cyber Laws” by Dr Vishal Goyal, Punjabi University, Patiala
https://onlinecourses.swayam2.ac.in/cec25_cs04/preview

Activity based Learning (Suggested Activities in Class)

1. Flipped Classroom
2. Role Play on Cyber Crime Trials
3. Case Study Analysis
4. Group Discussions on Global Cyber Law Trends
5. Quizzes/Assignment.

List of Practicals

1. Identify the platforms for reporting cyber-crimes.
2. Registering complaints on a social media platform.
3. Prepare password policy for computer and mobile device.
4. List out security controls for computer and implement technical security controls in the personal computer.
5. List out security controls for mobile phone and implement technical security controls in the personal mobile phone.
6. Log into computer system as an administrator and check the security policies in the system.

Course Code: 200206	Course Name: Human Rights – 2	
Teaching Scheme	Credit	Evaluation Scheme
Tutorial : 1 Hours/Week	1	TW : 25 Marks

Expected Prerequisite Courses:

- Human Rights – 1.

Course Objectives:

- To develop the concept of vulnerability and its relationship with human rights, including dimensions of social exclusion and discrimination.
- To foster the knowledge of human rights related to indigenous peoples and vulnerable groups.
- To cultivate the knowledge of human rights pertaining to socially and economically disadvantaged groups.
- To explore the existing challenges, issues regarding human rights, and strengthen the knowledge of domain-specific human rights.

Course Outcomes:

After successful completion of the course, the learner will be able to:

CO1: Explain the concept of vulnerability, including dimensions of social exclusion and discrimination.

CO2: Describe the human rights of indigenous people and vulnerable groups.

CO3: Discuss the human rights of Socially and Economically Disadvantaged Groups.

CO4: Apply the domain-specific human rights in their professional field.

Course Contents

UNIT-I: Foundations

04 Hours

Human rights and vulnerability: Meaning, causes of social exclusion, discrimination, and intersectionality. **Legal frameworks:** Universal Declaration of Human Rights (UDHR), International Covenant on Civil and Political Rights (ICCPR), International Covenant on Economic, Social and Cultural Rights (ICESCR), Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), Convention on the Rights of the Child (CRC),

Convention on the Rights of Persons with Disabilities (CRPD); **Constitutional rights:** Role of judiciary and human rights commissions. Role of advocacy groups.

UNIT-II: Rights of Vulnerable Groups

04 Hours

Concepts of vulnerable groups, including women and **Gender minorities:** Gender equality, violence, and children's rights. Child protection laws, child labor, and abuse. **Persons with Disabilities:** Definition, barriers, inclusive development, and indigenous and ethnic minorities: cultural identity, land/resource rights, and constitutional safeguards. **Human rights of vulnerable groups:** Stateless persons, sex workers, migrant workers, refugees, HIV/AIDS victims, and migration rights.

UNIT-III: Socially and Economically Disadvantaged Groups

04 Hours

Concept of disadvantaged groups. **Older persons:** neglect, health, social security measures, other groups: people with chronic illness, victims of conflict/terrorism, other indigenous, backwards groups, and minorities in India, labor protection.

UNIT-IV: Challenges, Way Forward and Domain Specific Human Rights

04 Hours

Existing challenges: Poverty, inequality, marginalization and weak enforcement. **Emerging issues:** Globalization, climate change, digital divide and surveillance. **Towards inclusion:** Community participation, policy reform, education, empowerment and civil society role.

Domain Specific Human Rights

Civil Engineering: Right to life and safety, right to water and sanitation, right to a clean, healthy, and sustainable environment, ethical and sustainable development, minimize risk of legal disputes, project delays, and community resistance.

Computer Engineering: Science, technology and human rights. Data privacy and surveillance ethics. Real-world human rights challenges in Tech industries, digital sovereignty and cyber security. AI governance and ethical regulation.

Mechanical Engineering: Right to safety and protection: safe design of machines, tools, and systems. Right to health and workplace environments. Minimizes health risks and promotes comfortable, accessible, human-friendly systems. Right to human dignity over commercial profit.

E&TC Engineering: Technology and online expression, website blocking and content filtering. Balancing national security, public order, and freedom of expression, privacy rights and data protection, digital inclusion and the digital divide, emerging technologies and future challenges.

Business Administration: Right to equality, dignity, and non-discrimination; fair wages and decent working conditions; protection against harassment. Rights to privacy, safe workplaces,

social security, and freedom of association. Managerial responsibilities and ethical leadership. An inclusive and productive workplace.

Term Work

Term work shall consist of handwritten a minimum of 08 assignments (Two per unit). The course teacher will decide the assignments based on the content.

Learning Resources:

Text Books:

1. Introduction to Human rights and duties by Dr. T.S.N. Sastry Published by SPPU, Pune.
2. Human rights of vulnerable and disadvantaged groups by Dr. T.S.N. Sastry Published by SPPU, Pune.
3. P.K. Pandey (Ed) Human Rights, APH Publishing Corporation, 2012.

Reference Books:

1. Andrew Clapham: Human Rights Lexion, Oxofrd University Press; 2005.
2. Andrew Clapham: Human Rights A very short Introduction; 2007, Oxford University Press.
3. Magdalena Sepulveda and others: Human Rights : Hand Book, 2004 University for Peace of the United Nations.
4. Human rights and Vulnerable Groups available at http://www.sagepub.com/upmdata/11973_Chapter_5.pdf
5. Vulnerability and Vulnerable Groups; available at <http://siteresources.worldbank.org/INTSRM/Publications/20316319/RVA.pdf>

Web link for MOOC / NPTEL Links:

1. <https://www.youtube.com/watch?v=Y-yBzINHIyk>
2. <https://www.youtube.com/watch?v=wDWPiWAJplA>

Semester - III

Course Code: 201301	Course Name: Dissertation Phase - I	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 20 Hours/Week	10	TW : 100 Marks OR : 50 Marks

Prerequisite Courses:

- Seminar, Research Proposal Writing.

Course Objectives:

- Identify gaps in existing literature or technologies and propose innovative solutions.
- Apply theoretical knowledge to practical scenarios to design, implement, and test solutions.
- Develop project planning, time management, and organizational skills.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Review relevant literature, including books and national/international peer-reviewed journals, and consult experts on the chosen research topic.

CO2: Use various software, computational, and analytical tools effectively.

CO3: Design and develop an experimental set up/ equipment/test rig.

Course Contents:

Project Work Stage - I is an essential part of the overall project. In this stage, the student is expected to complete a portion of the project, which includes defining the problem statement, reviewing related literature, providing a project overview, outlining the implementation plan (using tools like UML diagrams, ER diagrams, block diagrams, PERT charts, etc.), and designing the layout or setup.

Guidelines for Conduction:

Coordinator needs to assign a domain specific guide / mentor to every student. The finalization of project topic will be considered with the concern of the mentor only. The dissertation stage - I work will be assessed by a panel of examiners of which one is necessarily an external examiner. The assessment will be broadly based on literature study, work undergone, Algorithm / method understanding, content delivery, presentation skills, documentation and report. The continuous assessment of the progress needs to be documented unambiguously. For standardization and

documentation, it is recommended to follow the formats and guidelines in the dissertation workbook approved by the department. All the mentors must encourage their students to initiate the process of copyright registration for their dissertation work as part of academic compliance and intellectual property protection.

Instructions for Students:

The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms-conference and/or peer reviewed journals. The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation of the frequency of the activities in the sole discretion of the PG coordination.

- Identify the Problem statement of recent trends in Mechanical Engineering.
- Study of Literature and previous work related to the problem identified.
- Analysis and study of design, flowchart and other diagrams which are related to the solution.
- Representation and study of Methods / Algorithms to solve the problem.
- 30% or Partial implementation of the solution to the identified problem.
- Every student is required to present and publish a Review paper at International Journal (International Peer Review)
- All M.Tech students are required to initiate the process of copyright registration for their dissertation work as part of academic compliance and intellectual property protection.
- Students can present their work through PPTs and any supporting documents.
- At the end of semester, every student must submit THREE copies of the manuscript of their work by following the instructions and specified format given by the coordinator

Learning Resources:

Text Books:

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar
2. Design Thinking: Understanding How Designers Think and Work, : Nigel Cross

Reference Books:

1. TThe Craft of Research, Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams
2. Project Management for Engineering and Technology, John M. Nicholas, Herman Steyn.

Web link for MOOC / NPTEL Links:

1. NPTEL – Research Methodology
<https://nptel.ac.in/courses/121/107/121107007/>
2. Coursera – Academic Research and Writing (University of California)
<https://www.coursera.org/learn/academic-research-writing>
3. edX – Research Methods (University of London)
<https://www.edx.org/course/research-methods>
4. Future Learn – Project Management for Research
<https://www.futurelearn.com/courses/project-management-for-research>

Course Code: 201302	Course Name: Research Seminar	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 4 Hours/Week	2	TW : 25 Marks OR : 25 Marks

Prerequisite Courses:

- Research Methodology Concepts.

Course Objectives:

- To identify the latest topic in the field of design engineering.
- To carry out literature surveys and problem identification.
- Enhance presentation and report writing skills

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Identify the research seminar topic in the field of design engineering by literature survey.

CO2: Understand how research papers are written and understand modeling, theory, concept, and simulation related to the topic of interest.

CO3: Effectively communicate the research seminar topic through oral presentation.

CO4: Prepare a detailed seminar report.

Course Contents:

Research seminar topic will be based on dissertation phase-I, considering recent trends in the field of mechanical engineering. This seminar will be mainly focuses on domain introduction, Study of literature related to the topic and study of methodology or techniques which are going to get implemented in the project. The student shall submit the duly certified seminar report in standard format, also students will have to present their work in any International Conference for satisfactory completion of the work by the concerned guide and head of the department.

Guidelines for Topic Selection:

1. Individual students need to study recent topics in the field of mechanical design engineering under the guidance of an allocated guide.
2. Students can choose topic related to mechanical design engineering, considering recent trends and its societal importance.
3. The extensive literature survey, mathematical modeling of particular methods,

experimentation and valuable conclusion is expected from seminar study.

4. Seminar report should be submitted as a compliance of term work.
5. Technical paper presentation in any International Conference is MANDATORY as the outcome of the seminar.
6. Total Duration: 48 Contact hours and additional 48 hours should be spent by students on completion of related activities and requirements.

Suggested Rubrics for TW / PR:

Assessment Parameter	Criterion	Review Assessment Weightage
AP 1	Preparation of PPTs <ul style="list-style-type: none"> ● Organization of contents ● Visual Aids 	20 M
AP 2	Presentation Skills <ul style="list-style-type: none"> ● Subject Knowledge ● Communication skills ● Gesture & Postures 	30 M
AP 3	Viva Voce	10 M
AP 4	Report/s <ul style="list-style-type: none"> ● Organization of contents ● Visual Aids and Conclusion 	20 M
AP 5	Technical Presentation at international Conference	20 M
	Total Weightage (TW and OR)	100 M

Note: All the above parameters are mandatory for granting the TW / OR.

Course Code: 201303	Course Name: Skill Development Laboratory – I Software Skills	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 4 Hours/Week	2	TW : 50 Marks

Prerequisite Courses:

- Solid Modelling and Drafting, Strength of Material, CAD/CAM and automation, Computer Aided Engineering, Computational Fluid Dynamics, Computational Multi Body Dynamics, Project Based Learning, Internship/Mini project.

Course Objectives:

- Understand Finite Element Analysis (FEA) Principles: Gain a fundamental understanding of the principles of Finite Element Analysis (FEA) and how Ansys software applies these principles in engineering simulations
- Perform Structural Analysis: Learn to perform linear and non-linear structural analyses, including static, dynamic, and modal analyses, to assess the mechanical behavior of materials and structures
- Apply Ansys to Real-World Engineering Problems: Engage in hands-on projects that require application of Ansys software to solve real-world engineering problems across various industries.

Course Outcomes:

On completion of the course, learner will be able to:

CO1: Demonstrate the principles of Finite Element Analysis (FEA) to solve intricate engineering problems, encompassing both static and dynamic structural analyses.

CO2: Execute structural analyses, both linear and non-linear, with the ability to perform static, dynamic, and modal analyses, and accurately interpret the outcomes.

CO3: Invent yourself to face the challenges of future technologies and their associated problems.

List of Practicals:

1. Modeling and analysis of any Mechanical system.
2. Design and Simulation (MBD) of a Mechanical system.
3. Mini project focusing on a practical application. Students are required to select a problem of their preference and validate the solution by comparing it with experimental data or a research paper.

Learning Resources:**Text Books:**

1. Oliver, D. W., Kelliher, T. P., Keegan, Jr., J. G., (1997), “Engineering Complex Systems With Models and Objects,” McGraw-Hill, ISBN: 978-0070481886
2. Bi, Zhuming (2018), “Finite Element Analysis Applications: A Systematic and Practical Approach, Academic Press, ISBN: 9780128099520
3. Space & Missile Systems Center, (2004), “SMC Systems Engineering Primer & Handbook: Concepts, Processes, and Techniques,” SMC, U.S. Air Force.

Reference Books:

1. Rao, J.S., (2011), “Kinematics of Machinery Through Hyper Works,” Springer, ISBN: 9789400711556.
2. Nikravesh, P.E., (2019), “Planar multibody dynamics: formulation, programming with MATLAB®, and applications,” CRC Press, ISBN: 9781138096127.
3. Rao, J.S., (2017), “Simulation Based Engineering in Fluid Flow Design,” Springer, ISBN:9783319463810.

Web link for MOOC / NPTEL Links:

1. <https://archive.nptel.ac.in/courses/112/104/112104193/>
2. <https://archive.nptel.ac.in/courses/112/106/112106130/>
3. <https://archive.nptel.ac.in/courses/112/105/112105308/>
4. <https://archive.nptel.ac.in/courses/105/108/105108141/>
5. <https://archive.nptel.ac.in/courses/112/104/112104205/>

Kinematic and Dynamic analysis of Serial Robot Manipulators:

1. <https://youtu.be/zZXjkYHuKPk>
2. <https://youtu.be/7g6lkEBMUcU>
3. https://youtu.be/DeWcz_KlqLM
4. <https://youtu.be/01eC4Ibd5gk>
5. <https://youtu.be/JyTX1tqbPw8>
6. <https://youtu.be/DDJE195AVj0>
7. <https://youtu.be/q41GsFM9BTA>
8. <https://youtu.be/4YyxrnPfmm4>
9. https://youtu.be/rn4HVfPYq_U

Course Code: 201304	Course Name: Internship	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 8 Hours/Week	4	TW : 50 Marks OR : 50 Marks

Course Objectives:

- To develop industry-relevant skills, professional ethics, and workplace etiquette through experiential learning.
- To promote exposure to current industry practices, tools, and trends, facilitating a bridge between academic learning and industrial applications.
- To develop interpersonal, communication, and collaborative skills by working in diverse professional environments.
- To prepare students for future employment through firsthand experience, understanding of industry expectations, and professional networking.

Course Outcomes:

After successful completion of the course, learner will be able to:

- CO1:** Apply theoretical knowledge and engineering principles to real-world industry problems and professional practices.
- CO2:** Demonstrate proficiency in tools, techniques, and methodologies relevant to the internship domain.
- CO3:** Exhibit professional behavior, including teamwork, time management, ethics, and communication skills in a workplace environment.
- CO4:** Effectively communicate findings and insights through well-structured reports and professional presentations.

Guidelines for Topic Selection:

1. Individual student needs to attempt for OJT/ Internship in an industry in the field of Mechanical Design Engineering.
2. If not received any OJT/ Internship, student can choose in-house mini project related to Mechanical Design Engineering.
3. Students need to submit a detailed report and present their work to an evaluation committee

appointed by the Head of the Department.

Evaluation Criteria:

The student will be evaluated by the panel based on the below criteria. Weightage for each criterion will be determined by the evaluation committee and will be informed to the students. The following is the suggested marks allocation.

Criteria	Description	Weightage (Term Work Out of 100)	Weightage (Term Work Out of 50)	Marks Allotted
1.	Relevance of the area of work.	20	--	20 M
2.	Performance of the task/s.	20	--	20 M
3.	Crucial learning's from the work and maintaining daily workbook.	30	--	30 M
4.	Report Preparation.	30	--	30 M
5.	Clarity and structure of presentation.	--	15	15 M
6.	Articulation of key learnings.	--	15	15 M
7.	Response to questions.	--	20	20 M
	Grand Total	100	50	150

Course Code: 200305	Course Name: Introduction to Constitution	
Teaching Scheme	Credit	Evaluation Scheme
Tutorial : 2 Hours/Week	2	TW : 50 Marks

Course Objectives:

- To provide an understanding of the historical foundations and evolution of the Indian Constitution.
- To help students appreciate the structure, philosophy, and key principles of the Constitution.
- To create awareness about rights, duties, governance mechanisms, and federal structure in India.
- To enable future managers/engineers to understand the legal environment affecting business, technology, and society.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Explain the historical background and development of the Indian Constitution.

CO2: Interpret the core constitutional philosophy of justice, liberty, equality and fraternity.

CO3: Analyze the structure and functions of major constitutional bodies.

CO4: Understand citizens' fundamental rights, duties, and responsibilities.

CO5: Evaluate the role of constitutional provisions in business, technology, and society.

Course Contents

UNIT-I: Philosophy of the Indian Constitution

08 Hours

Constitutional History of India, Features of Indian Constitution, Preamble - Source and Objects, Sovereign and Republic, Socialist and Secular, Democratic - Social and Economic Democracy, Justice - Social, Economic and Political, Liberty - Thought, Expression, Belief, Faith and Worship, Equality - Status and Opportunity, Fraternity, Human Dignity, Unity and Integrity of the Nation.

UNIT-II: Fundamental Rights

07 Hours

Right to equality, Right to freedoms, Right against exploitation, Right to freedom of religion, Cultural and educational rights, Right to property Right to constitutional remedies.

UNIT-III: Directive Principles of State Policy**07 Hours**

Equal Justice and free legal aid, Right to work and provisions for just and humane conditions of work, Provision for early childhood, Right to education and SC, ST, weaker section, Uniform Civil Code, Standard of Living, nutrition and public health, Protection and improvement of environment, Protection and improvement of environment, Separation of Judiciary from executive, Promotion of International peace and security.

UNIT-IV: Fundamental Duties**08 Hours**

Duty to abide by the Constitution, Duty to cherish and follow the noble ideals, Duty to defend the country and render national service, Duty to value and preserve the rich heritage of our composite culture, Duty to develop scientific temper, humanism, the spirit of inquiry & reform, Duty to safeguard public property and abjure violence, Duty to strive towards excellence.

Learning Resources:**Text Books:**

1. D.D. Basu – Introduction to the Constitution of India (LexisNexis Publications).
2. M. Laxmikanth – Indian Polity (McGraw Hill Education).
3. J.N. Pandey – Constitutional Law of India (Central Law Agency).

Reference Books:

1. Subhash Kashyap – Our Constitution National Book Trust
2. P.M. Bakshi – The Constitution of India Universal Law Publishing
3. M. V. Pylee – India's Constitution S. Chand Publishing
4. B.K. Sharma – Introduction to the Constitution of India Pearson.

Web link for MOOC / NPTEL Links:

1. NPTEL – Constitutional Government & Democracy in India
<https://nptel.ac.in/courses/117104055>

Assignments

Term work shall consist of handwritten a minimum of 08 assignments (Two per unit). The course teacher will decide the assignments based on the content.

Semester - IV

Course Code: 201401	Course Name: Dissertation Phase - II	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 36 Hours/Week	18	TW : 250 Marks OR : 100 Marks

Prerequisite Courses:

- Research Methodology Concepts.

Course Objectives:

- Identify gaps in existing literature or technologies and propose innovative solutions.
- Apply theoretical knowledge to practical scenarios to design, implement and test solutions.
- Develop project planning, time management and organizational skills.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Review relevant literature, including books and national/international peer-reviewed journals, and consult experts on the chosen research topic.

CO2: Use various software, computational, and analytical tools effectively.

CO3: Design and develop an experimental set up/ equipment/test rig.

Course Contents:

In Dissertation Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of selection of technology, installations, implementations, testing, results, measuring performance, discussions using data tables as per parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions.

Guidelines for Conduction:

The student has to exhibit the continuous progress through regular reporting, presentations, and proper documentation of the frequency of the activities in the sole discretion of the PG coordination. The continuous assessment of the progress needs to be documented unambiguously. It is recommended to continue with guidelines and formats as mentioned in the Dissertation Workbook approved by the department. The dissertation stage - II work will be assessed by a panel

of examiners of which one is necessarily an external examiner. The assessment will be broadly based on results, comparisons and implementation of Algorithm / method. The continuous assessment of the progress needs to be documented unambiguously. For standardization and documentation, it is recommended to follow the formats and guidelines in the dissertation workbook approved by the department.

Instructions for Students:

The students are expected to validate their study undertaken by publishing it at standard platforms. The investigations and findings need to be validated appropriately at standard platforms – peer reviewed journals.

- Implementation and Representation of Methods / Algorithms to solve the problem.
- 100% implementation of the solution to the identified problem.
- Every student is required to publish a final paper at the International Journal (International Peer Review) by maintaining the standards of IPR.
- Students can present their work through PPTs and any supporting documents.
- At the end of semester, every student must submit THREE copies of the manuscript of their work by following the instructions and specified format given by the coordinator.

Learning Resources:

Text Books:

1. Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar
2. Design Thinking: Understanding How Designers Think and Work: Nigel Cross.

Reference Books:

1. The Craft of Research, Wayne C. Booth, Gregory G. Colomb, Joseph M. Williams
2. Project Management for Engineering and Technology, John M. Nicholas, Herman Steyn.

Web link for MOOC / NPTEL Links:

1. NPTEL – Research Methodology
<https://nptel.ac.in/courses/121/107/121107007/>
2. Coursera – Academic Research and Writing (University of California)
<https://www.coursera.org/learn/academic-research-writing>
3. edX – Research Methods (University of London)
<https://www.edx.org/course/research-methods>
4. Future Learn – Project Management for Research
<https://www.futurelearn.com/courses/project-management-for-research>

Course Code: 201402	Course Name: Skill Development Laboratory – II (Research Proposal Writing)	
Teaching Scheme	Credit	Evaluation Scheme
Practical : 4 Hours/Week	2	TW : 50 Marks

Prerequisite Courses:

- Under-Graduate Project Work.

Course Objectives:

- To define research proposal and the project management lifecycle.
- To identify the parts of a research proposal and the basic principles of project management.
- To draft a project based research proposal.

Course Outcomes:

After successful completion of the course, learner will be able to:

CO1: Carry out critical literature review.

CO2: Prepare a project plan and budget.

CO3: Write and present a project based research proposal.

Course Content:**UNIT-I: Introduction 10 Hours**

Definition of project proposal, types of project proposal.

UNIT-II: Contents of Research Proposal 08 Hours

Introduction, review of literature, aims and objectives, research design and method, ethical considerations, budget, appendices, citations.

UNIT-III: Budget and Project Planning 08 Hours

Principles of financial planning and control, types of budgets (operational, capital, etc.), cost estimation techniques, detailed budget development, budget forecasting and adjustments, cost control and variance analysis, resource planning and scheduling, techniques for effective resource utilization.

Learning Resources:**Text Books:**

1. Writing a Research Proposal: Practical Guide by John K. Smith and John W. Adams, Sage Publications.
2. Research Proposals: A Practical Guide by Patrick McGowan, Academic Press.

Reference Books:

1. The Research Proposal: A Guide for Research Students and Early Career Researchers by Peter L. Berger and Kathryn R. Smith Publisher: Rout ledge.
2. Writing a Research Proposal: Practical Guide by John K. Smith and John W. Adams Publisher: Sage Publications.

Web link for MOOC / NPTEL Links:

1. <https://www.westminster.ac.uk/study/postgraduate/research-degrees/entry-requirements/how-to-write-your-research-proposal>
2. https://masterclasses.nature.com/?gad_source=1&gclid=CjwKCAjwlbu2BhA3EiwA3yXyu0IwlWf0hLxZBaQ9uRsq96XMwXRL8CwnGdnEjxujf-Y_8aJAcNmgxoC_2MQAvD_BwE#nmo

List of Practicals:

1. Write a research proposal to a national funding agency such as DST, MNRE and AICTE etc. for resolving a real World issues.