Vidya Pratishthan's

Kamalnayan Bajaj Institute of Engineering and Technology, Baramati.

(An Autonomous Institute)

Faculty of Science and Technology

Board of Studies

Mechanical Engineering

Syllabus

Second Year B. Tech.
Mechanical Engineering

(Pattern 2023)

(w.e.f. AY: 2024-25)

Syllabus: Second Year (SY B. Tech.) Mechanical Engineering

(Pattern 2023) w.e.f. AY:2024-2025

SEMESTER-III

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
		TH	PR	TUT	ACT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
BS23204	Advanced Mathematics for Mechanical Engineering	3	-	1	-	20	70	20	-	-	110	3	-	1	4
ME23201	Engineering Metallurgy	3	2	-	20	20	70	20	-	20	150	3	1	-	4
ME23202	Engineering Thermodynamics	3	2	-	20	20	70	20	-	20	150	3	1	-	4
ME23203	Mechanics of Material	3	2	-	20	20	70	20	20	-	150	3	1	-	4
ME23204	Fluid Mechanics	2	2	-	20	20	50	20	-	-	110	2	1	-	3
XXXXXXX	Multidisciplinary Minor	2	2	-	20	20	50	20	-	-	110	2	1	-	3
Total		**16**	**10**	**1**	**100**	**120**	**380**	**120**	**20**	**40**	**780**	**16**	**5**	**1**	**22**

SEMESTER-IV

Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
		TH	PR	TUT	ACT	ISE	ESE	TW	PR	OR	Total	TH	PR	TUT	Total
ME23211	Manufacturing Practices	3	2	-	20	20	70	20	20	-	150	3	1	-	4
ME23212	Theory of Machines	3	2	-	20	20	70	20	-	20	150	3	1	-	4
ME23213	Design of Machine Element	3	2	-	20	20	70	20	-	20	150	3	1	-	4
ME23214	Turbomachinery	2	2	-	20	20	50	20	-	-	110	2	1	-	3
XXXXXXX	Multidisciplinary Minor	2	2	-	20	20	50	20	-	-	110	2	1	-	3
OE23XX	Open Elective	2	-	-	-	-	50	-	-	-	50	2	-	-	2
ME23215	Computer Aided Geometric Modeling	-	4	-	-	-	-	20	40	-	60	-	2	-	2
Total		**15**	**14**	**-**	**100**	**100**	**360**	**120**	**60**	**40**	**780**	**15**	**7**	**-**	**22**

Dept. Academic Coordinator
Mr. S. C. Mahadik

Head of Department
Dr. M. S. Lande

Dean Academic
Dr. S. M. Bhosle

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Dr. R. S. Bichkar

Head
Department of Mechanical Engineering
VPKBIET Baramati - 413133

VPKBIET BARAMATI
Affiliated to S. P. P. U: Pune Id No./PU/PN/Engg./152/2000
PUNE (MS)

Multidisciplinary Minor (MDM) Subjects			
AI23051	AI & Machine Learning	ET23053	Internet of Things
AI23052	Data Science	CE23051	Waste Management
AI23053	Generative AI	CE23052	Green Building & Smart Cities
CO23051	Cloud Computing	ME23051	Introduction to 3D Printing Technologies
CO23052	High Performance Computing	ME23052	Introduction to Robotics & Automation
CO23053	Computer Graphics & Gaming	EL23051	Solar Tech
IT23051	Cyber Security	EL23052	Industrial Automation
IT23052	Full Stack Development	GS23051	Nano Technology
ET23051	Embedded Systems	GS23052	Linear Algebra and Statistics
ET23052	Drone Technology		

Open Electives (OE) Subjects			
OE2301	Digital Marketing	OE2311	Biotechnology
OE2302	Professional Leadership	OE2312	International Relations
OE2303	Organizational Behavior	OE2313	Universal Human Values
OE2304	Industrial Management	OE2314	Education Technology
OE2305	Disaster Management	OE2315	Design Thinking
OE2306	Energy Economic & Management	OE2316	Financial Literacy for Bharat#
OE2307	Operation Research	OE2317	Sustainability & Climate Change
OE2308	Intellectual Property Rights	OE2318	Agriculture Technology
OE2309	Cyber Laws	OE2319	Architectural Technology
OE2310	Bioinformatics		

<table>
<tr><th colspan="3">BS23204- Advanced Mathematics for Mechanical Engineering</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits:04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Tutorial : 01</td><td>Course Activity: -</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">Tut: 01 Hrs/Week</td><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td>OR Exam: -</td></tr>
<tr><td></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites: Differential & Integral calculus, Differential equations of the first order and first degree, Fourier series, Basics of Statistics: Collection, classification & representation of data, Vector algebra.

Objectives:

1. To familiarize the students with concepts and techniques in Ordinary & Partial differential equations, Statistics, Probability, Numerical Methods, Vector Calculus, and Applications of Partial Differential Equations.
2. The aim is to equip them with the techniques to understand advanced-level mathematics and its applications to enhance analytical thinking ability useful in their discipline.

Course Outcomes:

The students will be able to learn:

CO1: Solve higher-order linear differential equations using appropriate techniques to model and analyze mass-spring systems.

CO2: Analyze data using the concepts of dispersion, Skewness, and kurtosis.

CO3: Classify various probability distributions and apply them to analyze and interpret experimental data useful in their field.

CO4: Understand various numerical methods and apply them to solve systems of equations, and differential equations.

CO5: Understand the concepts of vector differentiation and integration, and apply them in their field.

CO6: Solve partial differential equations such as wave equations, heat equations, Laplace equation and its applications.

Course Contents

Unit-1: Linear Differential Equations (LDE) and Applications	**[07 Hrs.]**
Introduction, Solution of LDE, General method, short-cut method, Method of variation of parameters, Cauchy's, and Legendre's DE. Modeling of problems on mass-spring systems.	
Unit-2: Statistics	**[07 Hrs.]**
Measures of Dispersion, Moments, Skewness, and Kurtosis. Correlation and Regression Analysis: Least square method, Curve fitting: fitting of straight lines, and parabola.	
Unit-3: Probability and Probability Distributions	**[07 Hrs.]**
Probability, Theorems on probability, Random variables, Probability Mass function, Probability Density function, Mathematical Expectation. Probability distributions: Binomial, Poisson, and Normal, Test of hypothesis: Chi-square test.	
Unit-4: Numerical Methods	**[07 Hrs.]**
Roots of Equation: Newton-Raphson Method. **Solution of simultaneous equations:** Gauss Elimination Method with Partial pivoting, Gauss-Seidel Method. **Solutions of ordinary differential equations:** Euler's, Modified Euler's, Runge-Kutta 4th order methods.	
Unit-5: Vector Calculus	**[07 Hrs.]**
Vector differentiation, Directional derivative, Solenoidal, and Irrotational fields. Line, Surface, and Volume integrals, work done, Green's Lemma, Gauss's Divergence theorem, and Stoke's theorem.	
Unit-6: Applications of Partial Differential Equations (PDE)	**[07 Hrs.]**
Basic concepts, modeling of Vibrating String, Wave equation, One and two-dimensional Heat flow equations, Laplace Equation, Method of Separation of variables, use of Fourier series. Introduction to Fourier Transform (FT) and Laplace Transform.	

Text Books:

1. Higher Engineering Mathematics by B.V. Ramana (Tata McGraw-Hill).
2. Higher Engineering Mathematics by B. S. Grewal (Khanna Publication, Delhi).
3. Numerical Methods in Engineering and Science by B.S. Grewal (Khanna Publication).

Reference Books:

1. Advanced Engineering Mathematics, 10e, by Erwin Kreyszig (Wiley India).

2. Advanced Engineering Mathematics, 2e, by M. D. Greenberg (Pearson Education).

3. Advanced Engineering Mathematics, 7e, by Peter V. O'Neil (Cengage Learning).

4. Differential Equations, 3e by S. L. Ross (Wiley India).

5. Introduction to Probability and Statistics for Engineers and Scientists, 5e, by Sheldon M. Ross (Elsevier Academic Press).

6. Partial Differential Equations for Scientists and Engineers by S. J. Farlow (Dover Publications, 1993).

Guidelines for Lab /TW Assessment

1. Tutorials for the subject shall be engaged in a minimum of three batches (batch size of 22 students) per unit including Matlab-based assignments on the Numerical methods.
2. Term work shall consist of six assignments (one per unit) and evaluation is based on performance and continuous internal assessment.

<table>
<tr><th colspan="3">ME23201- Engineering Metallurgy</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits:04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td>OR Exam: 20 Marks</td></tr>
<tr><td></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites:

Higher Secondary Science Courses, Engineering Physics, Engineering Chemistry.

Objectives:

1. To impart fundamental knowledge of material science and engineering.
2. To establish significance of structure property relationship.
3. To explain various characterization techniques.
4. To indicate the importance of heat treatment on structure and properties of materials.
5. To explain the material selection process.

Course Outcomes:

On completion of the course, learner will be able to

CO1. COMPARE crystal structures and ASSESS different lattice parameters.

CO2. CORRELATE crystal structures and imperfections in crystals with mechanical behaviour of materials.

CO3. DIFFERENTIATE and DETERMINE mechanical properties using destructive and nondestructive testing of materials.

CO4. IDENTIFY & ESTIMATE different parameters of the system viz., phases, variables, component, grains, grain boundary, and degree of freedom. etc.

CO5. ANALYSE effect of alloying element & heat treatment on properties of ferrous & nonferrous alloy.

CO6. SELECT appropriate materials for various applications.

Course Contents

Unit-1: Crystal Structures and Deformation of Materials	**[08 Hrs.]**
Crystal Structures: Study of Crystal structures BCC, FCC, HCP and lattice parameters & properties, Crystal imperfections, and Diffusion Mechanisms. **Material Properties:** Mechanical (Impact, hardness, etc.), Electrical, optical and Magnetic properties. **Deformation of Materials:** Elastic deformation, Plastic deformation: slip, twinning, work hardening, recovery, recrystallization and grain growth, Fracture: Types of fractures (brittle, ductile), Creep & Fatigue failures.	
Unit-2: Material Testing and Characterization Techniques	**[06 Hrs.]**
Destructive Testing: Tensile Test, Impact test and Hardness test **Non-Destructive Testing:** Dye Penetrant Testing (DPT) Magnetic Particle Testing (MPT) Ultrasonic Testing (UT) Eddy Current Testing (ECT) Radiography Testing (RT) (Principle and Applications only). **Microscopic Techniques:** Sample Preparation and etching procedure, optical microscopy, Electronic microscopy - only SEM, TEM and X-ray diffraction (Principle and Applications only). **Macroscopy:** Sulphur printing, flow line observation, spark test.	
Unit-3: Phase Diagrams and Iron-Carbon Diagram	**[09 Hrs.]**
Solid solutions: Introduction, Types, Humerothery rule for substitutional solid solutions **Solidification:** Nucleation & crystal growth, solidification of pure metals, solidification of alloys. **Phase Diagrams:** Cooling curves, types of phase diagrams, Gibbs phase rules **Iron-Carbon Diagram:** Iron-carbon equilibrium diagrams in detail with emphasis in the invariant reactions.	
Unit-4: Heat Treatments	**[08 Hrs.]**

Austenite transformation in steel: Time temperature transformation diagrams, continuous cooling transformation diagrams. Retained austenite and its effect Steps in Heat treatment and Cooling Medium.

Heat Treatment Processes: Introduction, Annealing (Full annealing, Process annealing, Spheroidise annealing, isothermal annealing, stress relief annealing), Normalising, Hardening, Tempering, Austempering, Martempering, Sub-Zero Treatment, Hardenability.

Surface Hardening: Classification, Flame hardening, Induction hardening, Carburising, Nitriding, Carbonitriding.

Unit-5: Ferrous Materials	**[07 Hrs.]**

Carbon Steel: Classification, types & their composition, properties and Industrial application

Alloy Steels: Classification of alloy steels & Effect of alloying elements, examples of alloy steels, (Stainless steel, Tool steel) sensitization of stainless steel.

Designation of carbon steel and alloy steels as per IS, AISI, SAE Standards

Cast Iron: Classification, types & their composition, properties and Industrial application of (White CI, Gray CI, SG CI, Malleable Cast and alloy Cast Iron). Microstructure and property relationship of various ferrous Materials

Unit-6: Non-Ferrous Materials	**[07 Hrs.]**

Classification of Non-Ferrous Metals: Study of Non-ferrous alloys with Designation, Composition, Microstructure.

Mechanical & other properties for Industrial Applications: Copper and its Alloys (Gilding Metal, Cartridge Brass, Muntz Metal, Tin Bronze, Beryllium Bronze), Aluminium and its Alloy (LM5, Duralumin, Y-Alloy, Hinduminum), Nickel and its Alloys (Invar, Inconel), Titanium and its Alloys (α Alloys, α-β Alloys), Cobalt and its Alloys (Stellite Alloys, Alnico), Bearing Alloys (Classification, lead based alloys, tin based alloys),

Composite Materials : Introduction: Definitions, Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites.

Text Books:

1. Dr. V. D. Kodgire & S. V. Kodgire, “Material Science & Metallurgy For Engineers”, Everest Publication.
2. William D. Callister, “Materials Science and Engineering an Introduction”, Jr, John Wiley & Sons, Inc.

Reference Books:

1. A. K. Bhargava, C.P. Sharma, “Mechanical Behaviour & Testing of Materials”, P H I Learning Private Ltd.

2. Raghvan V., “Material Science & Engineering'', Prentice Hall of India, New Delhi.

3. Avner, S.H., “Introduction to Physical Metallurgy”, Tata McGraw-Hill.

4. Higgins R. A., “Engineering Metallurgy'', Viva books Pvt. Ltd.

5. George Ellwood Dieter, “Mechanical Metallurgy”, McGraw-Hill.

6. Smith, W.F, Hashemi, J., and Prakash, R., “Materials Science and Engineering in SI Units”, Tata McGraw Hill Education Pvt. Ltd.

Activity (Any Two)

1. Exploration of engineering Alloy (Name, composition, properties, microstructure, Heat treatment, Designation/ Specification & applications) - One student one Alloy or material

2. Examine aspects of component form material and manufacturing process point of view (Name, Material, Drawing, Manufacturing Process, properties, microstructure, Heat treatment, & specific applications) - For example spur gear, Needle etc. One student one component

3. Creep and Fatigue Test (Virtual Lab IIT Bombay)

4. Fluorescence Microscope (Virtual Lab IIT Bombay)

5. Industrial Visits to provide awareness and understanding of the course, Compulsory Industrial Visit must be arranged for the students. The Industrial Visit must be preferably to Material & Metallurgy related like Engineering Cluster, NDT Lab, and Nearby NABL lab or any manufacturing unit with material orientation Student must submit a properly documented Industrial Visit Report.

Guidelines for Lab /TW Assessment

Total 8 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments, and Activities.

1. Destructive testing - Hardness Testing Rockwell / Brinell Hardness test.

2. Vickers / Poldi Hardness Test

3. Impact Test for Steel, Aluminum, Brass and Copper (Charpy/Izod)

4. Non Destructive testing - Dye Penetrant Test/ Magnetic Particle test/ Ultrasonic Test

5. Steps for Specimen Preparation for microscopic examination & Demonstration of Optical Metallurgical microscope

6. Observation and Drawing of Microstructure of Steels, Cast Iron of various compositions

7. Observation and Drawing of Microstructure of Non Ferrous Metals of various compositions

8. Heat Treatment of steels based on relative hardness

9. Tensile test on Universal Testing Machine.

<table>
<tr><th colspan="3">ME23202- Engineering Thermodynamics</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits: 04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>Oral Exam: 20 Marks</td></tr>
<tr><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites:

Higher Secondary Science courses, Engineering Mathematics - I and II, Engineering Physics, Engineering Chemistry

Objectives:

1. To understand the fundamental concepts and Laws of thermodynamics and their applications.
2. To be acquainted with Entropy generation and Exergy Analysis.
3. To understand the equations and processes governing the ideal gas behavior and its cycles.
4. To understand the behaviour of a Pure substance and to analyze Vapour power cycles.

Course Outcomes:

On completion of the course, learner will be able to

CO1. DESCRIBE the basics of thermodynamics with heat and work interactions.

CO2. APPLY laws of thermodynamics to steady flow and non-flow processes.

CO3. APPLY the concepts of energy efficiency, energy availability, exegetic efficiency and limits of energy conservation for best possible designs.

CO4. DETERMINE heat transfer, work transfer & other important thermodynamic properties for the processes undergone by ideal gas.

CO5. DETERMINE the properties of steam and their effect on performance of vapour power cycle.

CO6. ANALYSE the performance of steam generator.

Course Contents

Unit-1: Basic Concepts and Definitions	**[8 Hrs.]**
Fundamentals - System; Control volume; Property, State; Process; Temperature, Definition of thermal equilibrium and Zeroth law; Temperature scales; Various Thermometers- Definition of heat; examples of heat/work interaction in systems **Work -** Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes; electrical, magnetic, gravitational, spring and shaft work **First Law of Thermodynamics:** Concept of heat and work, Sign convention and its conversion. First law of thermodynamics, Joules experiments, Equivalence of heat and work.	
Unit-2: Laws of Thermodynamics	**[8 Hrs.]**
Application of first law: Application of first law to flow and non-flow Processes and Cycles. Steady flow energy equation (SFEE), Applications of SFEE to various devices such as Nozzle, Turbine, Compressors, Boilers etc. PMM-I kind. **Second Law of Thermodynamics:** Limitations of first law of thermodynamics, Heat Engine, Refrigerator and Heat pump, Efficiency and Coefficient of Performance (COP), Kelvin-Planck & Clausius Statement of the Second law of Thermodynamics, PMM-II kind, Equivalence of the two statements, Concept of Reversibility and Irreversibility, Carnot Theorem, Carnot Cycle.	
Unit-3: Entropy and Availability	**[08 Hrs.]**
Entropy: Entropy as a property, Clausius Inequality, Principle of increase of Entropy, Entropy changes for an Open and Closed System, Concept of Entropy generation. Entropy- a measure of Disorder. **Availability:** Available and Unavailable Energy, Concept of Availability, Availability of heat source at constant temperature and variable temperature, Availability of non-flow and steady-flow Systems.	
Unit- 4: Ideal Gas	**[07 Hrs.]**
Ideal Gas definition, Properties of Ideal Gas, Gas Laws- Boyle's law, Charle's law, Avagadro's Law, Equation of State, Ideal Gas constant and Universal Gas constant, Ideal gas Processes on P-v and T-s diagrams, Constant Pressure, Constant Volume, Isothermal, Adiabatic, Polytropic, Throttling Processes (Open and Closed systems), Calculations of Heat transfer, Work done, Internal Energy, Change of Entropy for an ideal gas.	

Air standard cycles:- Otto cycle, Diesel cycle, Dual cycle.

Unit-5: Properties of Pure substances & Vapour Cycle	**[8Hrs.]**

Properties of Pure substances: Formation of steam, Phase changes, Properties of steam, Use of Steam Tables, Study of P-v, T-s and h-s plots (Mollier Chart) for steam, Dryness fraction and its determination, Study of steam calorimeters (Barrel, Separating, Throttling and combined) Non-flow and Steady flow Vapour Processes, Change of Properties, Work and Heat transfer, Change of Entropy.

Vapour Cycle: Rankine Cycle, Comparison of Carnot cycle and Rankine cycle, Introduction to Steam Power Plant, Efficiency of Rankine Cycle, Relative Efficiency, Effect of Varying operating parameters like Superheat, Boiler and Condenser Pressure on performance of Rankine cycle.

Unit-6: Steam Generators and Performance Calculations	**[8 Hrs.]**

Steam Generators: Classification, Constructional details of low-pressure boilers, Primary Features of high pressure (Power) boilers, Location, Construction and working principle of boiler, Boiler mountings and accessories, Boiler fuels and their properties, Instrumentations required for safe and efficient operation, Introduction to IBR Act.

Performance Calculations: Equivalent Evaporation, Boiler efficiency, Heat balance Sheet. Boiler Draught: Classification, Necessity of Draught, Natural draught, Determination of Height of chimney, Diameter of chimney, condition for maximum discharge, forced draught, Induced draught, Balanced draught, Draught losses.

Text Books:

1. 1. P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications, 6th Edition, 2017.

2. R. K. Rajput, "Engineering Thermodynamics", EVSS Thermo, Laxmi Publications ISBN: 9788131800584, 5th Edition 2016.

3. P. L Ballaney, "Thermal Engineering", Khanna Publishers, ISBN: 978-81-7409-031-7, 5th Edition 2010.

4. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill, ISBN: 9781259006197, 5th Edition, 2017.

Reference Books:

1. Rayner Joel, "Basic Engineering Thermodynamics", AWL-Addison Wesley, ISBN : 9789812358356, 5th Edition, 1999.

2. Cengel and Boles, "Thermodynamics an Engineering Approach", McGraw Hill, ISBN-13: 978-9339221652, 8th Edition, 2017.

3. G. Van Wylen, R. Sonntag and C. Borgnakke, "Fundamentals of Classical Thermodynamics", John Wiley & Sons, ISBN-13 : 978-0471593959, 4th Edition, 1994.

4. Holman J.P, "Thermodynamics", McGraw Hill, ISBN-13 : 978-0070296336, 4th Edition, 1887.

5. M Achuthan, "Engineering Thermodynamics", PHI, ISBN-13 :9788120338456, 2nd Edition 2013.

6. M. L. Mathur and R.P. Sharma, "A course in Internal combustion engines", Dhanpat Rai & Co. ISBN-13 : 978-9383182428, 2018.

7. Steam Tables/Data book.

Guidelines for Lab /TW Assessment (Minimum 8 Experiments should completed)

1. Demonstration and calibration of temperature sensors used in various thermal systems.
2. Measurement of Specific Heat of Solid/Liquids.
3. Determination of fuel properties like flash point, pour point and fire point.
4. Determination of HCV of solid or gaseous fuel using Bomb or Junker's calorimeter respectively.
5. Demonstration on Orsat Apparatus.
6. Determination of dryness fraction of steam using combined separating and throttling calorimeter.
7. Trial on boiler to determine boiler efficiency, equivalent evaporation and Energy Balance.
8. Energy and Exergy analysis of any thermal system.
9. Trial on reciprocating air compressor to find volumetric and thermal efficiency.
10. Trial IC Engines to find thermal efficiency.

Course Activity

For the assessment of course activity students must complete at least two activities out of following.

1. A case study on design and selection of solar system for home using laws thermodynamics
2. A course study on load calculation and selection of refrigeration system for applications like room cooling, computer lab cooling, car cooling, ice factory, domestic refrigerator etc.
3. Development of software program to analyses and predict the performance of any thermal system.
4. Visit to any Industry having boiler to study the construction and working of boiler. Its presentation.

ME23203 - Mechanics of Material		
Teaching Scheme:	**Credits: 04**	**Examination Scheme:**
TH: 03 Hrs/Week	**Theory : 03** **Practical : 01**	**Course Activity: 20 Marks**
		In-Semester Exam: 20 Marks
		End-Semester Exam: 70 Marks
PR: 02 Hrs/Week		**PR Exam: 20 Marks**
		Term-Work: 20 Marks

Prerequisite Courses

Engineering Mathematics- I and II, Physics and Engineering Mechanics

Course Objectives

1. To acquire basic knowledge of stress, strain due to various types of loading.
2. To draw Shear Force and Bending Moment Diagram for transverse loading.
3. To determine Bending, Shear stress, Slope and Deflection on Beam.
4. To solve problems of Torsional shear stress for shaft and Buckling for the column.
5. To apply the concept of Principal Stresses and Theories of Failure.
6. To utilize the concepts of Solid Mechanics on application based combined mode of loading.

Course Outcomes

On completion of the course, learner will be able to

CO1. DEFINE various types of stresses and strain developed on determinate and indeterminate members.

CO2. DRAW Shear force and bending moment diagram for various types of transverse loading and support.

CO3. COMPUTE the bending stresses and shear stresses on a beam.

CO4. CALCULATE torsional shear stress in shaft and buckling on the column.

CO5. APPLY the concept of principal stresses and theories of failure to determine stresses on a 2-D element.

CO6. APPLY the concept of theories of failure to determine stresses on a 2-D element.

Course Contents

Unit I	**Simple stresses & strains**	**[07 Hr.]**
Simple Stress & Strain: Introduction to types of loads (Static, Dynamic & Impact Loading) and various types of stresses with applications, Hooke's law, Poisson's ratio, Modulus of Elasticity, Modulus of Rigidity, Bulk Modulus. Interrelation between elastic constants, Stress-strain diagram for ductile and brittle materials, factor of safety, Stresses and strains in determinate and indeterminate beam, homogeneous and composite bars under concentrated loads. Isotropic & Anisotropic Material.		
Unit II	**Shear Force & Bending Moment Diagrams**	**[08 Hr.]**
SFD & BMD: Introduction to SFD, BMD with application, SFD & BMD for statically determinate beam due to concentrated load, uniformly distributed load, uniformly varying load, couple and combined loading, Relationship between rate of loading, shear force and bending moment, Concept of zero shear force, Maximum bending moment, point of contra-flexure.		
Unit III	**Bending stresses and Shearing Stresses**	**[08 Hr.]**
Bending Stress on a Beam: Introduction to bending stress on a beam with application, Theory of Simple bending, assumptions in pure bending, derivation of flexural formula, Moment of inertia of common cross section (Circular, Hollow circular, Rectangular, I & T), Bending stress distribution along the same cross-section Shear Stress on a Beam: Introduction to transverse shear stress on a beam with application, shear stress distribution diagram along the Circular, Hollow circular, Rectangular, I & T cross-section.		
Unit IV	**Torsion, Buckling**	**[08 Hr.]**
Torsion of circular shafts: Introduction to torsion on a shaft with application, Basic torsion formulae and assumption in torsion theory, Torsion in stepped and composite shafts, Torque transmission on strength and rigidity basis, Torsional Resilience Buckling of columns: Introduction to buckling of column with its application, Different column conditions and critical, safe load determination by Euler's theory. Limitations of Euler's Theory.		
Unit V	**Principal Stresses**	**[07 Hrs.]**

Principal Stresses: Introduction to principal stresses with application, Transformation of Plane Stress, Principal Stresses and planes (Analytical method and Mohr's Circle), Stresses due to combined Normal and Shear stresses.	
Unit VI Theories of Elastic failure	**[07 Hr.]**
Introduction to theories of failure with application, Maximum principal stress theory, Maximum shear stress theory, Maximum distortion energy theory, Maximum principal strain theory, Maximum strain energy theory.	

Text Books:

1. R. K. Bansal, "Strength of Materials", Laxmi Publication
2. S. Ramamurtham, "Strength of material", Dhanpat Rai Publication
3. S.S. Rattan, "Strength of Material", Tata McGraw Hill Publication Co. Ltd.
4. B.K. Sarkar, "Strength of Material", McGraw Hill New Delhi
5. Singer and Pytel, "Strength of materials", Harper and row Publication

Reference Books:

1. Egor. P. Popov, "Introduction to Mechanics of Solids", Prentice Hall Publication
2. G. H. Ryder, "Strength of Materials", Macmillan Publication
3. Beer and Johnston, "Strength of materials", CBS Publication
4. James M. Gere, "Mechanics of Materials", CL Engineering

Guidelines for Activities

The student shall complete the following activity

Self-learning Study Assignments and Presentations.

Following topics will be distributed among the group of 3-5 Students and groups need to present and also submit the slides/poster on TW file.

a. Experimental stress analysis, Strain Gauges rosette with case study.
b. Residual stresses and Fatigue life with case study.
c. Effect of heat treatment on the mechanical properties of a metal with case study.
d. Mechanical properties of materials, Stresses and Design of components with case study.
e. Failure Mode Analysis and Stresses with case study.

Guidelines for Laboratory Conduction

The Termwork shall consist of completion of Practicals, Practical examination will be conducted on the virtual lab.

Practical (Any 6 experiments out of experiment no 1 to 8 from the following list whereas experiment no. 9 is mandatory. Minimum One experiment must be performed on IoT platform-Virtual Lab):

1. Tension test for Ductile material on Universal Testing Machine.
2. Tension test for Brittle material on Universal Testing Machine.
3. Compression test for Brittle material on Universal Testing Machine.
4. Shear test of ductile material on Universal Testing Machine.
5. Measurement of stresses and strains using strain gauges.
6. Experimental verification of flexural formula in bending for cantilever, Simple supported beam.
7. Experimental verification of deflection of beam formula for simply supported beam
8. Experimental verification of torsion formula for circular bar using V Lab
9. Verification of results of any one from experiments no 1-8 using any FEA software tools.

<table>
<tr><th colspan="3">ME23204- Fluid Mechanics</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits: 03</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 02 Hrs/Week</td><td rowspan="4">Theory : 02
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 50 Marks</td></tr>
<tr><td>Oral Exam: –</td></tr>
<tr><td colspan="2"></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites Courses: Engineering Mathematics - I, Engineering Mathematics - II, Engineering Mechanics, Engineering Physics

Objectives:

1. To understand basic properties of fluids and to learn to establish relation between flow parameters.
2. To learn fluid statics and basics of flow visualization
3. To understand Bernoulli's theorem and its applications.
4. To understand losses in flow, drag and lift forces.

Course Outcomes:

On completion of the course, learner will be able to

CO1. CONSTRUCT mathematical correlation considering dimensionless parameters, also DETERMINE various properties of fluid

CO2. APPLY the laws of fluid statics, UNDERSTAND the concepts of buoyancy and IDENTIFY types of fluid flow and terms associated in fluid kinematics

CO3. APPLY principles of fluid dynamics to laminar flow

CO4. ESTIMATE friction and minor losses in internal flows and DETERMINE boundary layer formation over an external surface

Course Contents

Unit I: Properties of Fluids & Dimensional Analysis	**[08 Hr.]**
Properties of Fluid: Definition of fluid, concept of continuum, density, specific weight, specific gravity, viscosity, viscosity laws, types of fluid and rheology, measurement of viscosity, application based numerical on viscosity-flow through pipe, lubrication, bearing, brake fluids, parallel plates, rotating shafts etc., vapor pressure surface tension, capillarity, compressibility. **Dimensional Analysis:** Introduction, system of dimensions, Dimensional homogeneity, Buckingham-Pi Theorem, repeating variables, dimensionless numbers and their physical significance. **Similitude & Model Testing:** Model & prototype, similarity, model laws, application of model studies.	
Unit II: Fluid Statics & Kinematics	**[10 Hr.]**
Laws of fluid statics: forces acting on a fluid element, pascal's law, hydrostatics law, hydraulic ram. Pressure measurement: pressure scale, piezometer, barometer, manometer - simple, inclined, differential, micro manometer, inverted **Forces acting on surfaces immersed in fluid**: total pressure and center of pressure on submerged plane surfaces, curved surface submerged in liquid. **Buoyancy**: flotation, stability of bodies **Fluid Kinematics:** Flow description methods, types of flows, velocity and acceleration fields, continuity equation in 1D & 3D flow, flow visualization (path line, stream line and streak line), Introduction to stream tube, angularity, vorticity, stream function and velocity potential function, flow net.	
Unit III: Fluid Dynamics	**[08 Hr.]**
Euler's equation of motion differential form and Navier Stokes equation, Euler's equation of motion along streamline, Bernoulli's theorem and modified Bernoulli's theorem, stagnation pressure, HGL, TEL **Flow measurement**: venturimeter, orifice meter, pitot tubes, static pitot tube, introduction to coriolis flow meter, introduction to orifices, notches & weirs **Laminar flow**: Entrance region theory, velocity and shear Stress distribution for laminar flow through pipe, Couette flow, velocity profile of turbulent flow	
Unit IV: Internal & External Flow	**[08 Hr.]**

Internal Flow: Losses - major & minor losses, hydro dynamically smooth and rough boundaries, Moody's chart, compounding of pipes & equivalent pipe, siphons, transmission of power

External Flow: Boundary layer formation over a flat plate, boundary layer thickness, displacement thickness, momentum thickness and energy thickness, boundary layer separation and methods to control separation, drag and lift concepts, types of drag, drag & lift coefficient, aerofoil, bluff body, streamline body

Text Books:

1. R. K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publication, 9th Edition.
2. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics", Standard Book House 9th Edition.
3. Cengel & Cimbla, "Fluid Mechanics",TATA McGraw-Hill, 10th Edition.

Reference Books:

1. Sukumar Pati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill, 1st Edition.
2. Munson, Young and Okiishi, "Fundamentals of Fluid Mechanics", Wiley India, 9th Edition.
3. Potter Wiggert, " Mechanics of Fluids", Cengage Learning, 4th Edition.
4. Fox, Pichard, "Introduction to Fluid Mechanics", McDonald- Wiley
5. F. M. White, "Fluid Mechanics", TATA McGraw-Hill, 10th Edition.
6. Kundu, Cohen, Dowling, "Fluid Mechanics", Elsevier India.
7. Chaim Gutfinger David Pnueli, "Fluid Mechanics" Cambridge University press.
8. Edward Shaughnessy, Ira Katz James Schaffer, "Introduction to Fluid Mechanics", Oxford University Press

Web References

1. https://nptel.ac.in/courses/112/105/112105171/
2. https://nptel.ac.in/courses/112/104/112104118/
3. https://nptel.ac.in/courses/112/105/112105269/
4. http://www.efluids.com/efluids/books/efluids_books.htm
5. http://web.mit.edu/hml/ncfmf.html
6. http://www.efluids.com/efluids/pages/edu_tools.htm
7. https://spoken-tutorial.org/tutorial-search/?search_foss=OpenFOAM&search_language=

Guidelines for Laboratory Conduction

The student shall complete the following experiments as a Term Work

The Student is evaluated based on the completion of Practical, Assignments and Detailed Mini project / Industrial Visit Report/Simulation of fluid flow / Programming using any suitable software.

Practical

1. Determination of pressure using manometers (minimum two)
2. Determination of fluid viscosity and its variation with temperature.
3. Determination of Metacentric height of floating object.
4. Determination of Reynolds number and flow visualization of laminar and turbulent flow using Reynolds apparatus.
5. Verification of modified Bernoulli's equation.
6. Calibration of Orifice meter/ Venturi Meter /Notch.
7. Determination of minor/major losses through metal/non-metal pipes.
8. Mini project/Industrial visit/Simulation of fluid flow/Programming using any suitable software such as Scilab, OpenFOAM, ANSYS, etc

Activity (Any One):

1. Visit any industry involving fluid flow process to understand the piping system and various losses in energy of the fluid during flow.
2. Poster presentation by group on any topic related to advanced fluid mechanics or computational fluid dynamics.
3. Simulation of any real life fluid flow process using any suitable software such as Scilab, OpenFOAM, ANSYS, etc.

<table>
<tr><th colspan="3">ME23211- Manufacturing Practices</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits: 04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td>PR Exam: 20 Marks</td></tr>
<tr><td></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites:

Engineering Physics, Material Science and Metallurgy.

Objectives:

1. Describe various sand and permanent mold casting methods, procedure and mold design aspects.
2. Understand basics of metal forming processes, equipment and tooling.
3. Understand sheet metal forming operations and die design procedures.
4. Classify, describe and configure the principles of various welding techniques.
5. Understand plastic processing techniques.
6. To know about composites, its fabrication processes.

Course Outcomes:

On completion of the course, learner will be able to

CO1. SELECT appropriate moulding, core making and melting practice and estimate pouring time, solidification rate and DESIGN riser size and location for sand casting process

CO2. UNDERSTAND mechanism of metal forming techniques and CALCULATE load required for flat rolling

CO3. DEMONSTRATE press working operations and APPLY the basic principles to DESIGN dies and tools for forming and shearing operations

CO4. CLASSIFY and EXPLAIN different welding processes and EVALUATE welding characteristics

CO5. DIFFERENTIATE thermoplastics and thermosetting and EXPLAIN polymer processing techniques

CO6. UNDERSTAND the principle of manufacturing of fibre-reinforced composites and metal matrix composites

Course Contents

Unit-1: Casting Processes	**[07 Hrs.]**
Introduction to casting processes, Patterns: Pattern materials, types of pattern, allowances pattern design, Moulding sand, Properties of moulding sands, Core making, Melting practices and furnaces, Pouring and Gating system design, Numerical estimation to find mold filling time, Riser design and placement, Principles of cooling and solidification of casting, Directional and Progressive solidification Estimation of solidification rate, Cleaning and Finishing of casting, Defects and remedies, Principle and equipments of Permanent mould casting, Investment casting, Centrifugal casting, Continuous casting	
Unit-2: Metal Forming Processes	**[08 Hrs.]**
Plastic deformation. Stress-strain diagram for different types of material, Hot and Cold working, Factors affecting plastic deformation, Yield criteria, Concept of flow stress, Forming Limit diagram **Rolling Process:** Rolling terminology, Friction in rolling, Calculation of rolling load Forging: Open and closed die forging, Forging operations Extrusion: Types, Process parameter **Wire and Tube Drawing:** Wire and tube drawing process, Die profile Friction and lubrication in metal forming, Forming defects, causes and remedies for all forming processes	
Unit-3: Sheet Metal Forming	**[07 Hrs.]**
Types of sheet metal operations, Press working equipment and terminology, Types of dies, Clearance analysis, Estimation of cutting forces, Centre of pressure and blank size determination, Design of strip lay-out, Blanking die design, Introduction to Drawing, Bending dies, Methods of reducing forces, Formability and forming limit diagrams.	
Unit-4: Welding Processes	**[08 Hrs.]**
Classification of joining processes, Welding terminology and types of joints **Arc Welding Processes:** Principles and equipments of Single carbon arc welding, FCAW, TIG, MIG, SAW **Resistance Welding:** Spot, Seam and Projection weld process, Heat balance in resistance welding Gas Welding and Cutting, Soldering, brazing and braze welding Welding Metallurgy and Heat Affected Zone, Weld inspection, Defects in various joints and their remedies.	
Unit-5: Processing of polymers	**[07 Hrs.]**

Thermoplastics and Thermosetting, Processing of polymers, Thermoforming, Extrusion

Moulding: Compression moulding, Transfer moulding, Blow moulding, Rotation moulding, Injection moulding - Process and equipment

Extrusion of Plastic: Type of extruder, extrusion of film, pipe, Cable and Sheet – Principle Pressure forming and Vacuum forming

Unit-6: Manufacturing of Composites	**[08 Hrs.]**

Introduction to composites, Composite properties, Matrices, Fiber reinforcement

Composite Manufacturing Processes: Hand lay-up Process, Spray lay-up, Filament winding process, Resin transfer molding, Pultrusion, and Compression molding process, Vacuum impregnation process, Processing of metal matrix composites, Fabrication of ceramic matrix composites, Carbon-carbon composites, Polymer matrix and nano-composites.

Text Books:

1. P. N. Rao, "Manufacturing Technology Vol. I & II", Tata McGraw Hill Publishers.
2. P. C. Sharma, "Production Engineering", Khanna Publishers.

Reference Books:

1. R. K. Jain, "Production Technology", Khanna Publishers.
2. K. C. Chawala, "Composite Materials", Springer, ISBN 978-0387743646, ISBN 978-0387743653.
3. Brent Strong, "Fundamentals of Composites Manufacturing: Materials, Methods", SME Book series.

Activity (Any One):

1. Visit any foundry / casting industry to demonstrate various stages of casting and make a report on it. (To study and observe various stages of casting through demonstration of the sand casting process from pattern making, sand mold preparation and melting and pouring of metal.)
2. Visit to Sheet metal forming industry and prepare a report on it.
3. Visit the Rolling mill / Wire/Tube drawing unit / Forging plant and prepare a report on it.
4. Manufacturing a Product / Job using various manufacturing operations.

Guidelines for Lab / TW Assessment

Practical's (Perform minimum 6 Practical's out of 7)

1. Demonstration of arc welding technique TIG (Non-Consumable electrode)/ MIG (Consumable Electrode). A job drawing to be prepared by an instructor with details of welding process parameters, and weld joint design such as edge preparation, type and size of electrode used, welding current, voltage etc.
2. Demonstration of Resistance / Gas welding. A job drawing to be prepared by an instructor with details of welding process parameters, and weld joint design such as edge preparation, type and proportion of gas/electrodes used, types of gas / welding current, voltage etc.
3. Demonstration of injection molding process on any one plastic component like bottle, bottle caps, machine handles etc. / by additive manufacturing process.
4. Demonstration on cylindrical grinding/surface grinding operations, measurement of surface roughness produced and estimation of machining time.
5. Demonstration of Machining operations on Lathe.
6. Demonstration of Machining Operations on Milling Machine.
7. Demonstration on indexing mechanism. Calculation of index cranks and index plate movement by simple/compound/differential indexing and manufacture of spur gear on a milling machine using indexing head.

<table>
<tr><th colspan="3">ME23212- Theory of Machines</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits: 04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td>OR Exam: 20 Marks</td></tr>
<tr><td></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites:

Engineering Mathematics - I and II, Engineering Physics, Engineering Mechanics, Geometric Modeling & Drafting

Objectives:

1. To make the students conversant with kinematic analysis of mechanisms applied to real life and industrial applications.
2. To develop the competency to analyze the velocity and acceleration in mechanisms using analytical and graphical approach.
3. To develop the skill to propose and synthesize the mechanisms using graphical and analytical techniques.
4. To develop the competency to understand & apply the principles of gear theory to design various applications.
5. To develop the competency to design a cam profile for various follower motions.

Course Outcomes:

On completion of the course, learner will be able to

CO1. APPLY kinematic analysis to simple mechanisms

CO2. ANALYZE velocity and acceleration in mechanisms by vector and graphical method

CO3. SYNTHESIZE a four bar mechanism with analytical and graphical methods

CO4. APPLY fundamentals of gear theory as a prerequisite for gear design

CO5. CONSTRUCT cam profile for given follower motion

Course Contents

Unit-1: Fundamentals of Mechanism	**[07 Hrs.]**
Kinematic link, Types of links, Kinematic pair, Types of constrained motions, Types of Kinematic pairs, Kinematic chain, Types of joints, Mechanism, Machine, Degree of freedom, Mobility of Mechanism, Inversion, Grashoff's law, Four-Bar Chain and its Inversions, Slider crank Chain and its Inversions, Double slider crank Chain and its Conversions, Mechanisms with Higher pairs, Equivalent Linkages and its Cases - Sliding Pairs in Place of Turning Pairs, Spring in Place of Turning Pairs, Cam Pair in Place of Turning Pairs	
Unit-2: Kinematic Analysis of Mechanisms: Analytical Method	**[07 Hrs.]**
Analytical methods for displacement, velocity and acceleration analysis of slider crank Mechanism, Velocity and acceleration analysis of Four-Bar and Slider crank mechanisms using Vector and Complex Algebra Methods. Computer-aided Kinematic Analysis of Mechanism like Slider crank and Four-Bar mechanism, Analysis of Single and Double Hook's joint	
Unit-3: Kinematic Analysis of Mechanisms: Graphical Method	**[08 Hrs.]**
Displacement, velocity and acceleration analysis mechanisms by Relative Velocity Method (Mechanisms up to 6 Links), Instantaneous Centre of Velocity, Kennedy's Theorem, Angular Velocity ratio Theorem, Analysis of mechanism by ICR method (Mechanisms up to 6 Links), Coriolis component of Acceleration (Theoretical treatment only)	
Unit-4: Synthesis of Mechanisms	**[07 Hrs.]**
Steps in Synthesis: Type synthesis, Number Synthesis, Dimensional synthesis, Tasks of Kinematic synthesis - Path, function and motion generation (Body guidance), Precision Positions, Chebychev spacing, Mechanical and structural errors Graphical Synthesis: Inversion and relative pole method for three position synthesis of Four-Bar and Single Slider Crank Mechanisms Analytical Synthesis: Three position synthesis of Four-Bar mechanism using Freudenstein's equation, Blotch synthesis	
Unit-5: Kinematics of Gears	**[08 Hrs.]**

Gear: Classification

Spur Gear: Terminology, law of gearing, Involute and cycloidal tooth profile, path of contact, arc of contact, sliding velocity, Interference and undercutting, Minimum number of teeth to avoid interference, Force Analysis (theoretical treatment only)

Helical and Spiral Gears: Terminology, Geometrical Relationships, virtual number of teeth for helical gears

Bevel Gear & Worm and Worm Wheel: Terminology, Geometrical Relationships

Gear Train: Types, Analysis of Epicyclic gear Trains, Holding torque - simple, compound and Epicyclic gear Trains, Torque on Sun and Planetary gear Train, compound Epicyclic gear Train

Unit-6: Cam, Followers & Governors	**[07 Hrs.]**

Introduction, Classification of Followers and Cams, Terminology of Cam Displacement diagram for the Motion of follower as Uniform velocity, Simple Harmonic Motion (SHM), Uniform Acceleration and Retardation Motion (UARM), Cycloid motion, Cam Profile construction for Knife-edge Follower and Roller Follower, Cam jump Phenomenon

Governors- Introduction, Types and applications of governors (Centrifugal Governor, Watt Governors, Porter Governor, Proell Governor) Theoretical treatment only

Text Books:

1.S. S. Rattan, “Theory of Machines”, Third Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi.

2. Bevan T, “Theory of Machines”, Third Edition, Longman Publication

3. G. Ambekar, “Mechanism and Machine Theory”, PHI

4. J. J. Uicker, G. R. Pennock, J. E. Shigley, “Theory of Machines and Mechanisms”, Fifth Edition, International Student Edition, Oxford

Reference Books:

1. Paul E. Sandin, “Robot Mechanisms and Mechanical Devices Illustrated”, Tata McGraw Hill Publication
2. Stephen J. Derby, “Design of Automatic Machinery”, 2005, Marcel Dekker, New York
3. Neil Sclater, “Mechanisms and Mechanical Devices Sourcebook”, Fifth Edition, Tata McGraw Hill Publication
4. Ghosh Malik, “Theory of Mechanism and Machines”, East-West Pvt. Ltd.
5. Hannah and Stephans, “Mechanics of Machines”, Edward Arnolde Publication
6. R. L. Norton, “Kinematics and Dynamics of Machinery”, First Edition, McGraw Hill Education (India) P Ltd. New Delhi
7. Sadhu Singh, “Theory of Machines”, Pearson
8. Dr. V. P. Singh, “Theory of Machine”, Dhanpatrai and Sons
9. C. S. Sharma & Kamlesh Purohit, “Theory of Machine and Mechanism”, PHI
10. M.P. Groover, “Automation, production systems and computer-integrated manufacturing”, Prentice-Hall of India Pvt. Ltd, New Delhi

Web References

1. https://nptel.ac.in/courses/112104121/ (NPTEL1, Kinematics of Machines, Prof. Ashok K Mallik, IIT Kanpur)
2. https://nptel.ac.in/courses/112/106/112106270/ (NPTEL2, Theory of Mechanism, Prof. Sujatha Srinivasan, IIT Madras)
3. https://nptel.ac.in/courses/112/105/112105268/ (NPTEL3, Kinematics of Mechanisms and Machines, Prof. Anirvan DasGupta, IIT Kharagpur)
4. https://nptel.ac.in/courses/112/105/112105236/ (NPTEL4, Mechanism and Robot Kinematics, Prof.Anirvan DasGupta, IIT Kharagpur)
5.http://www.cdeep.iitb.ac.in/webpage_data/nptel/Mechanical/RoboticsCourse/Course_home_lect1.html (NPTEL5, Introduction to Robotics and Automation, IIT Bombay)

Guidelines for Lab /TW Assessment

The student shall complete the following activity as a Term Work
Total 10 experiments from the following list must be performed. Term Work of the Student is evaluated based on the completion of Practical, Assignments using Drawing Aids, Assignments using Software & Programming Languages, Assignments using Virtual Laboratory and Detailed Industrial Visit Report.

Practical (Experiment # 1 is compulsory and Select any Two from Experiment # 2 to 4)

1. To make a model of any mechanism by using waste material by the group of 4 to 6 students and to give a presentation using PPTs.

2. Speed and torque analysis of epicyclic gear train to determine holding torque.

3. To study and verify cam jump phenomenon.

4. To study manufacturing of gear using gear generation with rack as a cutter and to generate an involute profile.

Assignments using Drawing Aids (Experiment #1,2 and 5 are compulsory and Select any One from Experiment #3-4)

Do following graphical assignments on Half Imperial drawing sheet:

1. To solve two problems on velocity and acceleration analysis using relative velocity and acceleration method.

2. To solve two problems on velocity analysis using the ICR method.

3. To draw a conjugate profile for any general type of gear tooth.

4. To study various types of gearboxes.

5. To draw cam profile for any two problems with combination of various follower motion with radial and off-set cam.

Assignments using Software (Any Three Assignments - Minimum one computer programming based and Minimum one based on use of software)

Do following assignments by using Software or by using Coding/Programming Languages:

1. To design a simple Planer Mechanism by using any software (Geogebra, SAM, Working Model, any 3D Modelling Software, etc.)

2. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Slider Crank Mechanism using Analytical Method

3. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for Kinematic Analysis of Hooke's joint Mechanism using Analytical Method

4. To generate a Cam Profile using any Modelling Software (Mech Analyser, any 3D Modelling Software)

5. To synthesize the Four-Bar and Slider Crank Mechanism (Geogebra, SAM, any 2D/3D Modelling Software)

6. To do computer programming (using software/programming languages like C, Python, Scilab, Matlab etc.) for the Synthesis of Mechanism using Chebychevs spacing, Freudensteins equation and function generation

Assignments using Virtual Laboratory (minimum Two experiments)

Please visit the links given below for exploring experiments on Kinematics of Machinery using

Virtual Laboratory. Write a Brief Reports of using Virtual Laboratory to perform following assignment:

1. Mechanics-of-Machines Lab (All Experiments), http://mm-nitk.vlabs.ac.in/index.html
2. Mechanisms and Robotics - Oldham Coupling Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html
3. Mechanisms and Robotics - Quick Return Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html
4. Mechanisms and Robotics - CAM Follower Mechanism, http://vlabs.iitkgp.ernet.in/mr/index.html

Activity (Any one of the following):

1. Identify mechanisms in real life and Analyze for types and number of links, pairs, obtain degrees of freedom. Submit the model and working video of the mechanism.
2. Design a simple Mechanism in real life application by using any 3D Modelling Software.

<table>
<tr><th colspan="3">ME23213- Design of Machine Elements</th></tr>
<tr><th>Teaching Scheme:</th><th>Credits: 04</th><th>Examination Scheme:</th></tr>
<tr><td rowspan="2">TH: 03 Hrs/Week</td><td rowspan="4">Theory : 03
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 70 Marks</td></tr>
<tr><td>OR Exam: 20 Marks</td></tr>
<tr><td></td><td></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites:

The following concepts are essential to understand:
Material elastic behavior, stress, strain, their relationship, failure modes, different theories of failure, and their applications. Additionally, it is important to comprehend the design cycle, and basis of design considerations such as strength, rigidity, manufacture, assembly and cost, standards, and codes. One should also be familiar with preferred sizes and series, tolerances, types of fits, construction of SMD and BMD, as well as roots of equations and interpolation rules.

Course Objectives:

1. **UNDERSTAND** the various design considerations, design procedures, and select materials for a specific application.
2. **CALCULATE** the stresses in machine components due to various types of loads and failure.
3. **ANALYZE** machine components subjected to variable loading for finite and infinite life.
4. **DESIGN** various machine components such as shafts, couplings, keys, screws, joints, springs.

Course Outcomes:

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

CO1. DESIGN AND ANALYZE the cotter and knuckle Joints and components subjected to eccentric loading.

CO2. DESIGN shafts, keys, and couplings under static loading conditions.

CO3. ANALYZE different stresses in screws and APPLY those in the procedure to design screw jack.

CO4. EVALUATE dimensions of machine components under fluctuating loads.

CO5. EVALUATE & INTERPRET the stress developed on the different types of threaded and welded joints.

CO6. APPLY the design and development procedure for different types of springs.

Course Contents

Unit 1 Design of Simple Machine Components	**06 Hrs.**
The meaning of the design, engineering design, phases of design, design considerations, stress-strain considerations, factor of safety, Service factor, Design of the Cotter & Knuckle joint, and Design of components subjected to eccentric loading, Levers and its types.	
Unit 2 Design of Shafts, Keys and Couplings	**06 Hrs.**
Shaft design on the Strength basis, torsional rigidity basis and lateral rigidity basis, Design of shaft as per A.S.M.E. code., Types of keys and their design. Design of Flange Coupling and Bushed-Pin Flexible Coupling.	
Unit 3 Design of Screws	**06 Hrs.**
Terminology of Power Screw, Torque analysis and Design of power screws with square and trapezoidal threads, Collar friction torque, Self-locking screw, Efficiency of a square threaded screw, Efficiency of self-locking screw, Design of screw and nuts. Re-circulating Ball Screw (Theoretical treatment only).	
Unit 4 Design against Fluctuating loads	**06 Hrs.**
Stress concentration and its factors, Reduction of stress concentration factors, fluctuating stresses, fatigue failures, endurance limit, S-N curve, Notch sensitivity, Endurance limit, Endurance strength modifying factors, Soderberg, Gerber, Goodman Lines, Modified Goodman diagrams.	
Unit 5 Threaded and Welded joints	**06 Hrs.**
Introduction to threaded joints, Bolts of uniform strength, locking devices, and Eccentric load perpendicular and parallel to the axis of the bolt. Introduction and types of welded joints, eccentrically loaded joints, welded joints subjected to bending moment.	
Unit 6 Design of Springs	**06 Hrs.**
Types and applications of springs, Stress and deflection equations for helical compression Springs, Design of helical springs, surge in spring, Design of Multi-leaf springs, Nipping of Leaf springs.	

Books and other resources

Text Books:

1. Bhandari V.B., Design of Machine Elements, Tata McGraw Hill Publication Co. Ltd.
2. Shigley J.E. and Mischke C.R., Mechanical Engineering Design, McGraw Hill Publication Co. Ltd.

References Books:

1. Spotts M.F. and Shoup T.E., Design of Machine Elements, Prentice Hall International.
2. Juvinal R.C., Fundamentals of Machine Components Design, John Wiley and Sons.
3. Black P.H. and O. Eugene Adams, Machine Design, McGraw Hill Book Co. Inc.
4. Willium C. Orthwein, Machine Components Design, West Publishing Co. and Jaico Publications House.
5. Hall A.S., Holowenko A.R. and Laughlin H.G, Theory and Problems of Machine Design, Schaum's Outline Series.
6. C. S. Sharma and Kamlesh Purohit, Design of Machine Elements, PHI Learning Pvt. Ltd.
7. D. K. Aggarwal & P. C. Sharma, Machine Design, S.K Kataria and Sons.
8. P. C. Gope, Machine Design: Fundamentals and Applications, PHI Learning Pvt. Ltd.
9. Design Data - P.S.G. College of Technology, Coimbatore.
10. K. Mahadevan, K. Balveera Reddy, Design Data Handbook for Mechanical Engineers, CBS Publishers.

Term Work

Term work shall consist of **"TWO"** design projects. Each project shall consist of two imperial-size sheets – one involving assembly drawing with a parts list and overall dimensions and the other involving detailed drawings of individual components. Manufacturing tolerances, surface finish symbols and geometric tolerances should be specified to make it a working drawing. Use software for analysis and design proficiently.

A design report giving all necessary calculations of the design of components and assembly should be submitted in a separate file. The design project should be "Design of Machine Elements" comprising various Machine elements covered in the syllabus. Where necessary, the design data book shall be used to select materials and standardized components. The drawings of one project shall be completed using any design and drafting software. The **ORAL** shall be based on Term Work.

Course Activity

The course activity shall be internally presented in the form of a PowerPoint presentation, by a group of three to five students. A printout of the PPT is to be submitted. The topics for the presentations are as follows.

1. Material Innovations in Machine Design
2. Automation and Robotics in Machine Design
3. Failure Analysis and Reliability Engineering
4. Energy Efficiency in Machine Element Design
5. Impact of Industry 4.0 on Machine Design
6. Sustainability in Machine Design
7. Wear and Corrosion Resistance in Harsh Environments
8. Vibration and Noise Control in Industrial Machinery
9. Human-Centered Design in Machine Elements
10. Standards and Regulations in Machine Element Design

<table>
<tr><th colspan="3">ME23214- Turbomachinery</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits: 03</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="2">TH: 02 Hrs/Week</td><td rowspan="4">Theory : 02
Practical : 01</td><td>Course Activity: 20 Marks</td></tr>
<tr><td>In-Semester Exam: 20 Marks</td></tr>
<tr><td rowspan="2">PR: 02 Hrs/Week</td><td>End-Semester Exam: 50 Marks</td></tr>
<tr><td>Oral Exam: –</td></tr>
<tr><td colspan="2"></td><td>Term-Work: 20 Marks</td></tr>
</table>

Prerequisites: Fluid Mechanics, Thermodynamics, Engineering Mathematics

Course Objectives:

1. To provide the knowledge of basic principles, governing equations and applications of Turbomachines.
2. To provide the students with opportunities to apply basic thermos-fluid dynamics flow equations to Turbomachines.
3. To explain construction and working principles of Turbomachines.
4. To evaluate the performance characteristics of Turbomachines.

Course Outcomes:

On completion of the course the learner will be able to;

CO 1: VERIFY impulse momentum principle using flat, inclined and curved surfaces and INVESTIGATE performance characteristics of hydraulic turbines.

CO 2: DETERMINE performance parameters of impulse and reaction steam turbine along with discussion of nozzles, governing mechanism & losses.

CO 3: MEASURE performance parameters of single & multistage centrifugal pumps along with discussion of cavitation and selection.

CO 4: EXPLAIN performance parameters of centrifugal compressor along with discussion of theoretical aspects of axial compressor.

Course Contents

Unit 1: Impact of Jet and Hydraulic Turbines	**[08 Hrs.]**
Introduction and Impact of Jet: Introduction to Turbomachines (Hydraulic & Thermal), Classification of Turbo machines, Applications of Turbomachines. Impulse momentum principle and its application to fixed and moving flat, inclined, and curved plate/vanes. Velocity triangles and their analysis, work done equations, vane efficiency (No numerical) **Hydraulic Turbines:** Introduction to Hydro power plant, Classification of Hydraulic Turbines, Concept of Impulse and Reaction Turbines. Construction, Principle of Working, design aspects, velocity diagrams and its analysis of Pelton wheel, Francis, and Kaplan turbines, Degree of reaction, Draft tube: types and efficiencies, governing of hydraulic turbines, Cavitation in turbines.	
Unit 2: Steam Turbines	**[08 Hrs.]**
Steam Nozzle: Equations for velocity and mass flow rate (No derivation, no numerical) **Steam Turbines**: Construction and working of Impulse and Reaction steam turbine, velocity diagram, work done efficiencies, Multi-staging, compounding, Degree of reaction, losses in steam turbine, governing of steam turbines	
Unit 3: Centrifugal Pumps	**[07 Hrs.]**
Introduction & classification of rotodynamic Pumps, Main Components of Centrifugal Pump, Construction and Working of Centrifugal Pump, Types of heads, Velocity triangles and their analysis, Effect of outlet blade angle, Work done and Efficiency, Series and parallel operation of pumps, Priming of pumps, specific speed	
Unit 4: Rotary Compressors	**[07 Hrs.]**
Centrifugal Compressors: Classification of Centrifugal Compressor, construction and working, velocity diagram, flow process on T-S Diagram, Euler's work, actual work input, various losses in Centrifugal Compressor **Axial flow compressors:** Construction and working, stage velocity triangle and its analysis, enthalpy entropy diagram, stage losses and various efficiencies of axial flow compressors, [No numerical]	

Text Books:

1. R. K. Bansal, "Fluid Mechanics & Hydraulic Machines", Laxmi Publication, 9th Edition.
2. Modi P. N. and Seth S. M, "Hydraulics and Fluid Mechanics", Standard Book House 9th Edition.

Reference Books:

1. B. U. Pai, "Turbomachines", Wiley India.
2. R. Yadav, Steam and Gas Turbines and Power Plant Engineering, Central Publication house.
3. Turbines, Compressors & Fans, S.M. Yahya, Tata-McGraw Hill

Term Work

The student shall complete the following activity as a Term Work:

1. Verification of Impulse Momentum Principle.
2. Study of Unit quantities, Specific speed and performance characteristics of hydraulic turbines.
3. Study and Trial on Impulse water Turbine and plotting the main and operating characteristics.
4. Study and Trial on any one hydraulic Reaction Turbine and plotting the main and operating characteristics.
5. Study on Convergent-Divergent Air/Steam nozzle
6. Study of Cavitation, NPSH, Thoma's cavitation factor, maximum suction lift.
7. Study and Trial on Centrifugal Pump and plotting the operating characteristics.
8. Study of Surging, stalling and choking phenomenon in compressors, performance characteristics of Centrifugal and Axial flow Compressors.
9. Visit to hydro/steam power plant and report to be submitted.
10. Visit to Pumping Station and report to be submitted.

OR

Design of Pumping system installation using Manufacturers catalog, specific to housing or industrial application.

Activity (Any One):

1. Visit to hydro/steam power plant to understand construction and working of the type of turbine employed and to observe the power generation process of the respective power plant.

2. Visit to Pumping Station to understand the construction and working of various types of pumps used in the pumping station and to understand the water supply and distribution system.
3. Power point presentation by group on any topic related to advanced fluid mechanics or computational fluid dynamics.
4. Simulation of flow process in any turbo machine using any suitable software such as Scilab, OpenFOAM, ANSYS, etc.

ME23215- Computer Aided Geometric Modeling		
Teaching Scheme:	**Credits:02**	**Examination Scheme:**
TH: –	**Practical : 02**	**Course Activity: —**
		In-Semester Exam: —
		End-Semester Exam: —
PR: 04 Hrs/Week		**PR Exam: 40 Marks**
		Term-Work: 20 Marks

Prerequisites: Systems in Mechanical Engineering, Engineering Graphics.

Objectives:

1. To develop an ability to Create 2-D Sketches and Edit Dimensions.
2. To apply basic concepts of 3D modeling, viewing and evaluate mass properties of components
3. To develop an ability to Create assembly models of simple machine components
4. To develop an ability to Create surface models of simple machine components

Course Outcomes:

CO1- UNDERSTAND basic concepts of geometric modeling

CO2 - CONSTRUCT solid models using various modeling techniques

CO3 - CONSTRUCT assemblies of part models using proper assembly mating conditions

CO4 - UTILIZE knowledge of curves and surfacing features and methods to create complex solid geometry

CO5 -UNDERSTAND basics of CAD customization

The student shall complete the following activity as a Term Work Journal

PRACTICAL:

The student shall complete the following Practical in laboratory using suitable CAD modeling software.

1. Two assignments on 2-D sketching with geometrical and dimensional constraints.
2. Four assignment on Solid modeling for simple mechanical component.
3. Two assemblies of machine components like knuckle joint, coupling, Plummer block etc. and one assembly Modeling by importing parts/components from free online resource.
4. One assignment on surface modeling.
5. Demonstration on CAD Customization.

Activity:

1. Modeling of any mechanical component used in real life application and its manufacturing using additive manufacturing (This activity is to be carried out in a group of 4-6 students)

Text Books:

1.Bhat N. D., "Machine Drawing", Charotar Publications, New Delhi 2014

2. Ajeet Siingh, " Machine Drawing", Mc Graw Hill Publications, New Delhi 2012

Reference Books:

1. Ostrowsky, O., Engineering Drawing with CAD Applications, ELBS, 1995

2. Vukašinovic, Nikola and Duhovnik, Jože, (2019), "Advanced CAD Modeling: Explicit, Parametric, Free-Form CAD and Re-engineering", Springer, ISBN-13: 978-3030023980

3. Bucalo, Joe and Bucalo, Neil, (2007), "Customizing SolidWorks for Greater Productivity", Sheet Metal Guy, LLC, ISBN-13: 978-0979566608

4. Programming Manuals of Softwares.

Dept. Academic Coordinator	Head of Department	Dean Academic	Principal
Mr. S. C. Mahadik	Dr. M. S. Lande	Dr. S. M. Bhosle	Dr. R. S. Bichkar

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