Course Code		**:**	**1BMEA302C**	**MECHANICS OF MATERIALS**	**Semester**	**:**	**03**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

Demonstrate the ability to analyze and evaluate the behavior of engineering materials and structural members under axial, thermal, bending, shear, torsional, and pressure loads using the principles of strength of materials for safe and efficient mechanical design.

Course Outcomes:

After completion of the course, student will be able to:

CO1: To be able to understand the different types of physical loads, properties of the materials, such as stresses, strains, elasticity, deformation for varying cross section, compound bars, self-weight and thermal stresses..

CO2: Analyse the compound stresses analytically, and graphically. And cylinders exposed to internal and external pressures from the view point of stresses developed and change in their dimensions

CO3: To be able to understand the shear force and bending moment and estimate bending of beams of subjected to different loads with different end conditions of beams. Analyse the bending and shear stresses for different cross sections

CO4: To be able to understand the concept torque, stresses developed and the rigidity of the mechanical elements transmitting power or subjected to twisting moment. Columns with different end conditions subjected to axial loading.

UNIT–I	**11 Hrs**

Simple stress and strain: Introduction, stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation – Behavior in Tension for Mild steel and nonferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self-weight, Principle of super position. Stress in composite section: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain.

Temperature stresses (simple and compound bars).

UNIT–II	**11 Hrs**

Compound stresses: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle (introduction).

Thick and thin cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (compound cylinders not included).

UNIT-III	**10 Hrs**

Bending moment and Shear force in beams:

Introduction, Types of beams, loads and reactions, shear forces and bending moments, sign conventions, relationship between shear force and bending moments, shear force and bending moment diagrams for different beams subjected to concentrated loads, uniform distributed load

(udl) and couple for different types of beams.

Bending and shear stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, shear stress, symmetrical I and T sections.

UNIT-IV	**10 Hrs**

Deflection of beams: Introduction, differential equation for deflection, equations for deflections-Cantilever subjected to concentrated load at free end, UDL, simply supported beam subjected to point load at mid-span.UDL. **Torsion of circular shafts and Elastic stability of columns:** Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts. Introduction to columns, Euler's theory for axially loaded elastic long columns, derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula.

Text Books:

1. Engineering Mechanics of Solids by Egor P. Popov 2nd edition, 2019.

Reference Books:

1. K.V. Rao, G.C. Raju, 2007, Mechanics of Materials First Edition, Published by Subhas Stores.
2. James M. Gere, Thomson, 2004, Mechanics of materials Fifth edition, Cengage & CBS.
3. Ferdinand Beer & Russell Johnstan, 2003, Mechanics of materials seventh edition, TATA MaGrawHill-.
5. H. J.Sawant,Technical,2010, Mechanics of materials
6. S.S.Bhavikatti, , 2006, Strength of Materials second edition, Vikas publishing House – Pvt. Ltd.
7. R. C. Hibbeler, , 2005,Mechanics of materials Printice Hall Pearson publications
8. Dr.R.K.Bansal, 2010, strength of material fourth edition, Laxmi publications.

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	2 (WK1, WK2, WK3, and WK4)							1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO2	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO3	2 (WK1, WK2, WK3, and WK4)				1 (WK6 and WK8)			1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO4	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	

Course Code		**:**	**1BMEB303C**	**ENGINEERING THERMODYNAMICS**	**Semester**	**:**	**03**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

This course enables mechanical engineering students to acquire fundamental mechanical engineering knowledge and skills to understand concept, apply and solve basic engineering problems in manufacturing, energy, thermal, and automation systems.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Apply thermodynamic principles to analyse work, heat, energy and the First Law in various processes.

CO2: Evaluate thermodynamic cycles and the Second Law to determine performance and efficiency.

CO3: Analyse combustion and I.C. engine performance using thermodynamic principles and data.

CO4: Compute performance parameters of reciprocating compressors and refrigeration systems.

UNIT–I	**12 Hrs**

Work & Heat: Definition of work-according to mechanics, according to thermodynamics, examples, sign convention; Displacement work- PDV expressions for displacement work in various processes through p-v diagrams, Other types of work- Shaft work, paddle wheel work, work in straining a bar, free expansion work, electrical work; Heat- definition, units and sign convention; Comparison and differences between work and heat. Numerical Problems.

First Law of Thermodynamics: Joule's experiments; Statement of the First law of thermodynamics- cyclic, non-cyclic processes; Energy- modes of energy, internal energy, internal energy as a property; Specific heat- at constant volume, at constant pressure; Enthalpy; Extension of the First law to control volume- steady state-steady flow energy equation, important applications with line diagram. Numerical Problems.

UNIT–II	**10 Hrs**

Second Law of Thermodynamics: Energy- High grade, low grade; Heat reservoirs-heat source and heat sink; Heat engines-definition, schematic representation, thermal efficiency; Reversed heat engines-refrigerator, heat pump, COP; Second Law of Thermodynamics- Kelvin -Planck statement, PMM II, Clasius's statement; Equivalence of the two statements; Reversible and irreversible processes- definition, factors that make a process reversible and irreversible; Carnot cycle- processes involved in Carnot cycle, PV, TS and line diagram; Carnot principles; Thermodynamic temperature scale. Numerical Problems.

Gas Power Cycles: Air standard cycles- Carnot, Otto, Diesel, Dual and Stirling cycles, PV and TS diagrams, description / process, efficiency derivation, mean effective pressure derivation, comparison of Otto, Diesel and dual cycles; Numerical Problems.

UNIT-III	**10 Hrs**

Combustion Thermodynamics: Combustion- complete, incomplete; Air for combustion- theoretical, excess, problems;; problems; Enthalpy of formation – definition, determination of enthalpy of formation of compounds using tables, enthalpy and internal energy of combustion, Numerical problems; Combustion efficiency; Adiabatic flame temperature.

I.C. Engines: Geometrical properties of reciprocating engines; Performance parameters - indicated work, BP,

IP, MEP, SFC, SEC, A/F ratio, equivalence ratio, efficiencies (mechanical, thermal / fuel conversion, volumetric), engine specific weight, engine specific volume, relationship between performance parameters; engine design and performance data analysis; Dynamometer -definition, types (Rope break and eddy current), description; Methods of FP calculation; Measurement of fuel consumption and air consumption; Heat balance sheet; Numerical problems.

UNIT-IV	**10 Hrs**

Reciprocating Compressors: Air Compressor terminology; Operation of a single stage reciprocating air compressor; Work input of single stage- without clearance, representation on PV diagram for different processes, work done derivation for different process; Work input of single stage- with clearance, PV diagram, effect of clearance volume and volumetric efficiency; Adiabatic, isothermal and mechanical efficiencies; Multi-stage compressor- saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression; Numerical problems on single stage only.

Refrigeration: Vapour compression refrigeration system- dry compression, wet compression, superheated & sub cooling compression, their PH, TS diagram, description/process, analysis, refrigerating effect, capacity, power required, COP; Air cycle refrigeration- reversed Carnot cycle, analysis for non flow system and flow system; Reversed Brayton cycle- analysis as flow system; Numerical Problems.

Text Books:

1. P. K. Nag, Engineering Thermodynamics, 7th Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2025.
2. B. K. Venkanna, 2010, Basic Thermodynamics (2nd edition), PHI learning.
3. B. K. Venkanna, 2012, Applied Thermodynamics (2nd), PHI learning.
4. Yunus A. Çengel and Michael A. Boles, Thermodynamics: An Engineering Approach (SI Units), 9th Edition, McGraw Hill Education, 2019.
5. Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner and Margaret B. Bailey, Fundamentals of Engineering Thermodynamics (SI Version), 9th Edition, John Wiley & Sons, 2018.

Reference Books:

1. C. P. Arora, Engineering Thermodynamics, 2nd Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2017.
2. R. K. Rajput, Engineering Thermodynamics, 5th Edition, Laxmi Publications (P) Ltd., New Delhi, 2018.
3. Y. V. C. Rao, An Introduction to Thermodynamics, Universities Press (India) Pvt. Ltd., Hyderabad, 2010.

Web links and Video Lectures (e-Resources)

1. https://www.youtube.com/watch?v=z2eUCNHkxEA&list=PLbMVogVj5nJRL8ZVcaoXG_Bbw2G3NX5N9
2. https://www.youtube.com/watch?v=2LPQX4F-GoA&list=PLwdnzlV3ogoWV-_n1YItO933MxgPXfEiM
3. https://www.youtube.com/watch?v=AwLpST3vlS4
4. https://www.youtube.com/watch?v=l-zpLE6-tXU
5. https://www.youtube.com/watch?v=ayNVAysI1M4&list=PL2eVdW9UnFjquCJyHn1wHEtjkakUinnCZ

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2 (WK1, WK2, WK3)	1 (WK1, WK2, WK3)	–	–	1 (WK2)	–	–	–	–	–	1 (WK8)	2	-
CO2	2 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	1 (WK5)	1 (WK8)	1 (WK2, WK6)	1 (WK5, WK7)	–	–	–	–	1 (WK8)	2	1
CO3	2 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	2 (WK5)	1 (WK8)	2 (WK2, WK6)	1 (WK5, WK7)	–	–	–	–	1 (WK8)	2	2
CO4	2 (WK1, WK2, WK3, WK4)	1 (WK1, WK2, WK3)	2 (WK5)	1 (WK8)	2 (WK2, WK6)	1 (WK5)	–	–	–	–	1 (WK8)	2	1

Course Code		**:**	**1BMEC304C**	**Metrology and Instrumentation**	**Semester**	**:**	**03**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

This course enables mechanical engineering students to acquire the theoretical knowledge, practical skills, and regulatory understanding required to design, operate, and calibrate measurement systems and apply these in various manufacturing sectors.

Course Outcomes:

CO1: Apply basic metrology principles, linear standards, slip gauges, and tolerance systems for precise measurement and assembly.

CO2: Apply the knowledge of comparators, angular measurement tools, interferometry, and thread/gear measurement techniques for measurement.

CO3: Analyse the measurement system stages and identify errors for accurate data acquisition

CO4: Determine various entities like force, torque, pressure, temperature, and strain using the principles of measuring instruments.

UNIT–I	**11 Hrs**

STANDARDS OF MEASUREMENT: Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, subdivision of standards, line and end standard, comparison, transfer from line standard to end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-87, M-112), Numerical problems on building of slip gauges.

SYSTEM OF LIMITS, FITS, TOLERANCES AND GAUGING: Definition of tolerance, Specification in assembly, Principle of inter changeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963), geometrical tolerance, positional - tolerances, hole basis system, shaft basis of system, numerical on fits, classification of gauges, brief concept of design of gauges (Taylor's principles), Types of gauges -plain plug gauge, ring gauge, gauge materials.

UNIT–II	**11 Hrs**

COMPARATORS AND ANGULAR MEASUREMENT: Introduction to Comparator, Characteristics, classification of comparators, mechanical comparators -Johnson Microcenter, Sigma Comparators, dial indicator, Optical Comparators -principles, Zeiss ultra optimeter, Electrical Comparators - principles, LVDT, Pneumatic Comparators, back pressure gauges, Solex Comparators. Angular measurements, Bevel Protractor, Sine Principle and. use of Sine bars, Sine centre, angle gauges, Clinometers

INTERFEROMETER AND SCREW THREAD GEAR MEASUREMENT: Interferometer Principle of interferometer. Optical flats. Terminology of screw threads, measurement of effective diameter of screw threads by 3-wire method, Best size wire. Toolmakers microscope, gear terminology, use of gear tooth Vernier calliper and gear tooth micrometre.

UNIT-III	**10 Hrs**

MEASUREMENTS AND MEASUREMENT SYSTEMS: Definition, Significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect. Errors in Measurements, Classification of Errors. Transducers, Transfer efficiency, Primary and Secondary transducers, electrical, Mechanical, advantages of

each type transducers.

INTERMEDIATE MODIFYING AND TERMINATING DEVICES: Mechanical systems, inherent problems, Electrical intermediate modifying devices, input circuitry and telemetry. Terminating devices, Mechanical, Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters.

UNIT-IV	**10 Hrs**

MEASUREMENT OF FORCE AND TORQUE, PRESSURE: Principle, analytical balance, proving ring, Torque measurement, Prony brake, hydraulic dynamometer. Pressure Measurements, Principle, use of elastic members, Bridgeman gauge, Mcloed gage, Pirani Gauge.

TEMPERATURE AND STRAIN MEASUREMENT: Resistance thermometers, thermocouple, law of thermocouple materials used for construction, pyrometer, Optical Pyrometer. Strain Measurements, Strain gauge, methods of strain measurement.

Text Books:

1. "Mechanical measurements" - Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006
2. Engineering Metrology And Measurements by N.V. Raghavendra ,Professor& Head Department of Mechanical Engineering,The National Institute of Engineering,MysoreL. Krishnamurthy ,Professor, Department of Mechanical Engineering,The National Institute of Engineering,Mysore, Published in India by ,Oxford University Press,YMCA Library Building, 1 Jai Singh Road, New Delhi 110001, India,© Oxford University Press 2013

Reference Books:

1. ROY D. MARANGONI & JOHN H. LIENHARD V THOMAS G. BECKWITH, 2025 "Mechanical measurements" 6th Ed., Pearson/Prentice Hall, Upper Saddle River, NJ.
2. R.K.Jain 2022 "Engineering Metrology" -, Khanna Publishers.
3. I.C.Gupta, "Engineering Metrology" 2018, Dhanpat Rai Publications, Delhi.
4. "Mechanical measurements" - R.K.Jain
5. Doebelin, Ernest O.|Manik, Dhanesh N. ,2018 "Measurement Systems", McGRAW Hill Book Co.

Web links and Video Lectures (e-Resources):

1. https://www.bbau.ac.in/dept/UIET/Study%20MAterials%20for%20EME-403.pdf.
2. https://mrcet.com/downloads/digital_notes/ME/III%20year/MSE%20%20Digital%20Notes.pdf.
3. https://www.bbau.ac.in/dept/UIET/Study%20MAterials%20for%20EME-403.pdf.
4. https://www.stannescet.ac.in/cms/staff/qbank/MECH/Notes/ME3592-METROLOGY%20ANDMEASUREMENTS-1020725174-ME3592-MM%20ALL%20UNITS%20NOTES.pdf

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	2 (WK1, WK2, WK3, and WK4)							1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO2	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO3	2 (WK1, WK2, WK3, and WK4)							1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO4	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	

Note: All knowledge profile elements (WKs) mapped to a particular Program Outcome (PO) may not necessarily be addressed by all Course Outcomes (COs) of a course. For example, PO5 is addressed through CO2 and CO3 primarily using WK6, even though WK2 is also associated with PO5 at the program level. However, WK2 is not addressed by these COs in this course.

Course Code		**:**	**1BMED305C**	**Materials Engineering**	**Semester**	**:**	**03**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

This course enables mechanical engineering students to apply principles of materials science and engineering to analyze structure–property relationships, interpret phase diagrams, and evaluate the mechanical behaviour of materials and alloys under varying compositions, temperatures, and loading conditions.

Course Outcomes:

After completion of the course student will be able to

CO1: Apply Fick's laws for diffusion and analyse mechanical behaviour of materials.

CO2: Analyse failure mechanisms such as fatigue, creep, and fracture, and interpret phase diagrams including eutectic and paratactic systems using tie-line and lever rule.

CO3: Interpret iron-carbon phase diagrams and TTT diagrams, and explain the effects of alloying elements on phase transformation and mechanical properties of steels.

CO4: Evaluate corrosion mechanisms and methods of prevention and Identify the properties, composition, and applications of ferrous and non-ferrous alloys.

UNIT–I	**10 Hrs**

Fundaments concepts of unit cell, space lattice, unit cells for cubic structure and HCP, coordination numbers and atomic packing factor for different cubic structures. Crystal imperfections – point, line, surface and volume defects. Diffusion mechanism, Fick's laws of diffusion.

Concepts of stress and strain, tensile properties, Impact test of materials, Hardness – Rockwell, Vickers and Brinell hardness testing. Plastic deformation.

UNIT–II	**11 Hrs**

Fatigue: fracture tests, S-N curves, factors affecting fatigue life and protection methods. Creep: the creep curves, mechanism of creep, creep resistant materials. Types, stages in cup and cone fracture.

Solid solutions:

Types, rules of governing the formation of solid solutions. Phase diagrams: basic terms, Gibbs phase rules, cooling curves, construction of phase diagrams, interpretation of equilibrium diagrams (use of tie line and Lever rule), types of phase diagrams (Eutectic systems, peritectic, eutectoid, peritectoid reactions). Problems on phase diagrams.

UNIT-III	**11 Hrs**

Iron – iron carbide equilibrium phase diagram, phases in Fe-Fe_3C system, invariant reactions, microstructure of slowly cooled steels, effect of alloying elements on Fe-Fe_3C diagram. The TTT diagrams, drawing of TTT diagrams, TTT diagrams for eutectoid steels, effect of alloying elements.

Heat Treatment:

Annealing, normalizing, hardening, Induction hardening, harden ability, Jominy end-quench test.

UNIT-IV	**10 Hrs**

Ferrous Materials: Properties, Composition and uses of Grey cast iron, malleable iron, S.G iron and steel

Non Ferrous Metals: Copper alloys-brasses and bronzes. Aluminum alloys-Al-Cu, Al-Si, Al-Zn alloys.

Corrosion: Corrosion and its prevention: Galvanic cell, the electrode potentials, polarization, passivation. General methods of corrosion prevention by alloying, stress corrosion cracking.
Text Books:
1. "Materials Science and Engineering", V. Raghavan, Prentice-Hall of India Pvt. Ltd., 5th Edition, 2004, New Delhi. 2. "Material Science", R. K. Rajput, S. Chand & Company Ltd., Revised Edition, 2015, New Delhi. 3. "Engineering Materials: Properties and Selection", Kenneth G. Budinski and Michael K. Budinski, Pearson Education, 9th Edition, 2010, New Delhi. 4. "Foundations of Materials Science and Engineering", William F. Smith and Javad Hashemi, McGraw-Hill Education, 5th Edition, 2010, New Delhi.
Reference Books:
1. "Materials Science & Engineering- An Introduction", William D.Callister Jr. Wiley India Pvt. Ltd. 6th Edition, 2006, New Delhi. 2. "Essentials of Materials For Science And Engineering", Donald R. Askeland, Pradeep P.PhuleThomsonEngineering, 2006. 3. "Introduction to Material Science for Engineering", 6th edition James F. Shackel ford. Pearson, Prentice Hall,New Jersy, 2006. "Physical Metallurgy, Principles & Practices", V Raghavan.PHI 2nd Edition 2006, New
Web links and Video Lectures (e-Resources):
1. Bhattacharya,B., Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, http://nptel.ac.in/courses/112104122/ 2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials.

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

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CO1	2 (WK1, WK2, WK3, and WK4)							1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO2	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO3	2 (WK1, WK2, WK3, and WK4)				1 (WK6 and WK8)			1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	
CO4	2 (WK1, WK2, WK3, and WK4)	1 (WK1, WK2, WK3, and WK4)						1 (WK1, WK2, WK3, and WK4)			1 (WK8)	1	

Course Code		**:**	**1MBEE311L**	**Material Testing and Instrumentation Lab**	**Semester**	**:**	**03**
L:T:P		**:**	**0:0:2**		**Course Type**	**:**	**PCCL**
Hours/Sem.	**Practical**	**:**	**26 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**-**		**SEE Marks**	**:**	**50**
	Exam	**:**	**04 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**30 Hrs**		**Credits**	**:**	**03**

Professional Competency:

Perform material testing and precision measurement operations using standard laboratory equipment to evaluate Mechanical properties of engineering materials, calibrate measuring instruments and generate reliable data for quality control, inspection and manufacturing applications.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Perform impact, hardness, tensile, and compression tests using standard material testing equipments and record the mechanical properties of engineering materials.

CO2: Calibrate, operate and use precision measuring instruments, namely LVDT, load cell, micrometer, pressure gauge, thermocouple, optical flats, slip gauges, and the sine bar setup to obtain accurate displacement, dimensional, force, pressure, temperature, surface flatness, and angular measurements.

PART-A: MATERIALS TESTING LABARATORY	**14 Hrs**

1. Charpy and Izod impact tests
2. Brinell hardness test
3. Vickers hardness test
4. Rockwell hardness test
5. Tensile test
6. Compression test

PART-B: INSTRUMENTATION LABARATORY	**12 Hrs**

1. Calibration of LVDT
2. Calibration of Load cell
3. Calibration of Micrometer using slip gauges
4. Measurements of angle using Sine bar
5. Calibration of Pressure gauge
6. Calibration of Thermocouple
7. Optical flats

Text Books:

1. "**Materials Science & Engineering – An Introduction**", William D. Callister Jr., Wiley India Pvt. Ltd., 6th Edition, 2006, New Delhi.
2. "**Mechanical Measurements**", Thomas G. Beckwith, Roy D. Marangoni and John H. Lienhard V, Pearson Education, 6th Edition, 2007, New Delhi.

Reference Books:

1. "Mechanical Measurements and Instrumentation", R. K. Rajput, S. Chand & Company Ltd., 2nd Edition, 2008, New Delhi.
2. "A Textbook of Strength of Materials", R. K. Bansal, Laxmi Publications Pvt. Ltd., 6th Edition, 2018, New Delhi.

3. “Engineering Metrology and Measurements”, N. V. Raghavendra and L. Krishnamurthy, Oxford University Press, 2nd Edition, 2018, New Delhi.

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Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	2 (WK1, WK2 and WK3)	2 (WK1, WK2 and WK3)	-	-	-	1 (WK1 and WK7)	1 (WK9)	1	1	-	-	2	-
CO2	2 (WK1, WK2 and WK3)	2 (WK1, WK2 and WK3)	-	-	-	1 (WK1 and WK7)	1 (WK9)	1	1	-	-	2	-

Course Code		**:**	**1MBEF312L**	**Mechanical Drawing Lab**	**Semester**	**:**	**03**
L:T:P		**:**	**1:0:2**		**Course Type**	**:**	**PCCL**
Hours/Sem.	**Teaching**	**:**	**14 Hrs**		**CIE Marks**	**:**	**50**
	Practical	**:**	**26 Hrs**				
	Learning (TW)	**:**	**12 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**08 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**60 Hrs**		**Credits**	**:**	**02**

Professional Competency:

Develop the ability to prepare, interpret, and communicate engineering drawings using standard drafting practices, geometric dimensioning and tolerancing (GD&T), engineering conventions, and assembly drawing techniques to support mechanical design, manufacturing, and industrial engineering applications.

Course Outcomes:

After completing the course, students will be able to:

CO 1: Apply conventions used in engineering drawing, including freehand sketching, geometric dimensioning and tolerancing (GD&T), and standard symbols.

CO 2: Produce freehand sketches and orthographic projections, incorporating surface texture symbols and appropriate dimensioning styles.

CO 3: Create engineering drawings that meet industrial standards and develop assembly drawings from individual part drawings.

CO 4: Demonstrate proficiency in using engineering drawing instruments, materials, and standard drafting techniques.

PART-A	**15 Hrs**

Drafting:

1. Dimensioning, Scales and Tolerance
2. Surface finish, Conventions, Abbreviations and Symbols
3. Applications of GD & T in Engineering practice
4. Sections of solids, Orthographic conversion (Miscellaneous Problems)
5. Component drawing reading 3 examples

PART-B: INSTRUMENTATION LABARATORY	**20 Hrs**

Assembly Drawing (Any one)

1. Stop valve • Plummer block

Free hand sketching of the following (Any Two)

2. Carburetor • Connecting rod • Machine vice
3. Couplings • Screw jack • Knuckle joint

Text Books:

1. K. R. Gopalakrishna, "Machine Drawing", Subhas Publications, 23rd edition, Aug-2017.
2. N. D. Bhatt, "Machine Drawing", Charotar publishing house, Pvt. Ltd., 50th Edition, Jan-2014

Reference Books:

1. K L Narayana, P Kannaiah and K Venkata Reddy, "Machine Drawing", New Age Publications, 3rd edition, 2006.
2. Geometrical tolerancing on technical drawings IS:8000
3.

Web Links and Video Lectures (e-Resources):
https://www.nptel.ac.in/courses/112103019 https://www.iitg.ac.in/mech/resources/nptel/ https://test.imtmaelearn.in/local/staticpage/view.php?page=gdandt&

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	**3** (WK1, WK2, WK3, WK4)	**2** (WK1, WK2, WK3, WK4)	-	-	-	-	-	**1**	-	-	**1**	-	**2**
CO2	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	**1** (WK9)	**1**	**1**	-	**1** (WK8)	-	**2**
CO3	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**
CO4	-	**2** (WK1, WK2, WK3, WK4)	**2** (WK5)	-	-	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**

Course Code		**:**	**1MBEG313L**	**Spreadsheets for Engineers**	**Semester**	**:**	**03**
L:T:P		**:**	**1:0:2**		**Course Type**	**:**	**PCCL**
Hours/Sem.	**Teaching**	**:**	**14 Hrs**		**CIE Marks**	**:**	**50**
	Practical	**:**	**26 Hrs**				
	Learning (TW)	**:**	**12 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**08 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**60 Hrs**		**Credits**	**:**	**02**

Professional Competency:

Develop the ability to prepare, interpret, and communicate engineering drawings using standard drafting practices, geometric dimensioning and tolerancing (GD&T), engineering conventions, and assembly drawing techniques to support mechanical design, manufacturing, and industrial engineering applications.

Course Outcomes:

After completing the course, students will be able to:

CO 1: Apply conventions used in engineering drawing, including freehand sketching, geometric dimensioning and tolerancing (GD&T), and standard symbols.

CO 2: Produce freehand sketches and orthographic projections, incorporating surface texture symbols and appropriate dimensioning styles.

CO 3: Create engineering drawings that meet industrial standards and develop assembly drawings from individual part drawings.

CO 4: Demonstrate proficiency in using engineering drawing instruments, materials, and standard drafting techniques.

PART-A	**15 Hrs**

Drafting:

6. Dimensioning, Scales and Tolerance
7. Surface finish, Conventions, Abbreviations and Symbols
8. Applications of GD & T in Engineering practice
9. Sections of solids, Orthographic conversion (Miscellaneous Problems)
10. Component drawing reading 3 examples

PART-B: INSTRUMENTATION LABARATORY	**20 Hrs**

Assembly Drawing (Any one)

1. Stop valve • Plummer block

Free hand sketching of the following (Any Two)

2. Carburetor • Connecting rod • Machine vice
3. Couplings • Screw jack • Knuckle joint

Reference Books:

1. Michael Alexander “Microsoft Excel 365 Bible”, 2nd Edition, 2025
2. David H. Ringstrom “Microsoft 365 Excel for Dummies”, 1st Edition, 2025,

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	**3** (WK1, WK2, WK3, WK4)	**2** (WK1, WK2, WK3, WK4)	-	-	-	-	-	**1**	-	-	**1**	-	**2**
CO2	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	**1** (WK9)	**1**	**1**	-	**1** (WK8)	-	**2**
CO3	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**
CO4	-	**2** (WK1, WK2, WK3, WK4)	**2** (WK5)	-	-	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**

Course Code		**:**	**BMEA403C**	**MANUFACTURING TECHN0LOGY**	**Semester**	**:**	**04**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

This course enables mechanical engineering students to acquire knowledge, technical skills, practical abilities, and professional attitudes needed to work effectively in manufacturing industries that use automation, production systems. It also enables technical expertise with digital, analytical, and interpersonal skills. These competencies enable students to understand operation of manufacturing systems efficiently, maintain high-quality standards, and contribute to the success of manufacturing and production environments.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Understand, Identify and select suitable manufacturing processes and apply the fundamental concepts of manufacturing process, casting, and pattern making sand moulding process for production of engineering components.

CO2: Understand, Identify and select suitable welding, advanced welding process and metallurgical aspects of welding for production of engineering components.

CO3: Understand and Apply the fundamental concepts of Forming, Rolling and Sheet Metal operations in production of Engineering components.

CO4: Understand and analysis the theory of metal cutting operations for production of engineering components.

UNIT–I	**12 Hrs**

Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process.

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns.

Sand Moulding: Types of base sand, requirement of base sand. Types of sand moulds. Moulding sand mixture ingredients (base sand, binder & additives. Method used for sand moulding.

Cores: Definition, Need, Types. Method of making cores, Binders used. Concept of Gating & Rise ring. Casting defects causes, features and remedies.

Study of important moulding processes: Green sand, Core sand, Dry sand, Sweep mould, CO2 mould, Shell mould, Investment mould & Full mould.

UNIT–II	**11 Hrs**

Welding: Definition, Principles, Classification, Application, Advantages & limitations of welding.

Arc Welding: Principle, Metal Arc welding **(MAW)**, Flux Shielded Metal Arc Welding **(FSMAW)**, Inert Gas Welding **(TIG & MIG)** Submerged Arc Welding **(SAW)** and Atomic Hydrogen Welding processes. **(AHW)**

Special type of welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermite welding, Laser welding and **Electron beam welding**: **METALLURGICAL ASPECTS IN WELDING:** Structure of welds, Formation of different zones during welding. Heat affected zone **(HAZ).** Welding defects – Detection causes & remedy

UNIT-III	10 Hrs
Forming: Metal forming: processes & classification of metal forming processes. Cast product vs wrought products **Forging:** classification, forging equipments (any two) forging die defects in forging. **Rolling:** Types of rolling mills, Variables of rolling process, Rolling defects **Drawing & Extrusion:** Drawing equipment drawing die Drawing of wires, pipes Difference between drawing & extrusion. Various types of extrusion processes. Defects in extruded numerical on drawing product. **Sheet Metal Operations:** Blanking, piercing, punching Trimming, and Shearing.	
UNIT-IV	**10 Hrs**
Theory of Metal Cutting Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; Mechanics of chip formation, Types of chips, Orthogonal and oblique cutting, Merchant's thin shear plane model, shear angle and its significance, Merchant circle diagram .tool life Numerical problems. Cutting tool materials and applications.	

Text Books:

Author/s last Name, initial (Year), Book Title (edition), Publisher

1. Serope Kalpakjian & Steven R. Schmid" Manufacturing Engineering and Technology" 9th Edition (2025) Person Publications
2. Mahmood Alam et al. "Manufacturing Processes: Metal Forming, Machining, Metal Casting, Welding and Additive Manufacturing" Edition 2025, De Gruyter Bill Publishers.
3. DheerendraKumar Triwedi "Manufacturing Process" Edition 2025 AICTE Approved Book, Khanna Publishers.
4. Ajay Kumar, Parveen Kumar, Yang Liu (Eds.) "Industry 4.0 Driven Manufacturing Technologies" Edition 2024, Springer.
5. Vasdev Malhotra, "Advanced Manufacturing Processes" Edition 2024, CRC Press / Routledge.
6. Sandip Kunar, Prasenjit Chatterjee, M. Sreenivas Reddy, "Optimization of Advanced Manufacturing Processes", andip Kunar, Prasenjit Chatterjee, M. Sreenivas Reddy, Edition 2025 Apple Academic Press / CRC Press.
7. Sandip Kunar, T. Jagadeesha, Gurudas Mandal (Eds.) "Digital Manufacturing: Processes and Applications"Edition 2025 Wiley,
8. Sandip Kunar, Prasenjit Chatterjee, M. Sreenivas Reddy," Optimization of Advanced Manufacturing Processes", Edition 2025, Apple Academic Press / CRC Press.

Reference Books:

1. Groover M. P., Automation, Production Systems and CIM, 2008, Prentice Hall of India,
2. Ibrahim Zeid, Mastering CAD/CAM, 2008, 4th edition, Tata McGraw Hill
3. P. N. Rao, CAD/CAM Principles and Applications, 3nd Edition 2018, McGraw Hill Education (India) Private Limited
4. Computer Integrated Manufacturing, Bharat Vijamuri, 4th Edition, 2018. Sunstar Publisher,

Web links and Video Lectures (e-Resources):

http://elearning.vtu.ac.in/
https://sjcit.ac.in/vtu-consortium-e-resources/
https://www.dsce.edu.in/e-resources-publishers-wise
https://www.advancedmanufacturing.org/
https://crridom.gov.in/open-access-e-resources
https://ess.inflibnet.ac.in/subject_list.php?subject=Manufacturing+Engineering

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	1 (WK1, WK3,)	-	-	-	1(WK6)	WK 5	-	1	-	-	1	1	--
CO2	1 (WK1, WK3,)	-	-	-	-	WK 5	-	1	-	-	1	1	-
CO3	1(WK1, WK3,)	-	-	-	-	-	-	1	-	-	1	1	-
CO4	2(WK1, WK3,)	-	-	-	1(WK6)	WK 5	-	1	-	-	1	1	-

Course Code		**:**	**1BMEB404C**	**Fluid Mechanics**	**Semester**	**:**	**04**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**42 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90 Hrs**		**Credits**	**:**	**03**

Professional Competency:

This course enables the students to apply the principles and equations of fluid mechanics to analyse, measure, and solve engineering problems involving fluid flow, pressure systems, pipe networks, and basic CFD applications in mechanical engineering.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Determine pressure forces on surfaces by applying fluid statics principles and explain the properties of fluids.

CO2: Apply kinematic and dimensional analysis equation to solve problems involving fluid flow.

CO3: Apply dynamic equations and flow measurement tools for practical applications of fluid flow.

CO4: Analyze laminar and turbulent flow in pipes and evaluate head losses.

UNIT–I	**11 Hrs**

Introduction to fluids and properties of Fluids: Introduction to fluid mechanics and its relevance to mechanical systems, Fluid properties such as density, viscosity, capillarity, surface tension, vapor pressure, compressibility, Classification of fluids, Newton's Law of Viscosity. Numericals.

Fluid Statics: Pascal's law and hydrostatic law, Pressure and pressure measurement: manometers – piezometers and differential manometers, Forces on immersed surfaces – vertical and inclined surface, Buoyancy, Numerical.

UNIT–II	**10 Hrs**

Fluid Kinematics: Flow types: steady/unsteady, uniform/non-uniform, laminar/Turbulent, rotational/irrotational, Continuity equation (1D and Cartesian) – derivation and applications, velocity and acceleration in fluid flow – local and convective, Flow field representations: stream function and velocity potential, Types of flow visualization: streamlines, streaklines, pathlines, Numericals.

Dimensional Analysis: Dimensional homogeneity and fundamental dimensions, Rayleigh's method and Buckingham π-theorem, Dimensionless numbers: Reynolds, Froude, Euler, Mach, Weber – significance and use, Similarity, model laws, and types of similarity, Numerical.

UNIT-III	**11 Hrs**

Fluid Dynamics: Euler's equation of motion, Bernoulli's equation – derivation and applications, Momentum equation and applications (pipe bends, forces on nozzles), Numericals.

Flow measurement devices: Venturimeter, orifice meter, pitot tube and notches: rectangular, triangular – discharge calculations, Numericals.

Turbulent Flow and Pipe Losses: Darcy-Weisbach equation – major losses, Minor losses – entry, exit, bends, fittings, Numericals.

UNIT-IV	**10 Hrs**

Laminar Flow: Laminar flow through circular pipes – Hagen-Poiseuille equation**,** Velocity profiles for laminar and turbulent flow, Transition from laminar to turbulent flow – Reynolds number, Numericals.

Boundary Layer Flow: Development of boundary layer –Lift and Drag, concepts, thicknesses,

Numericals.
Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications.

Text Books:

1. R.K. Bansal, *"A Textbook of Fluid Mechanics and Hydraulics"*, Laxmi Publications, 10th edition 2019.
2. Dr. Jagadish lal ,"Fluid Mechanics and hydraulics", Metropolitan Book Co-Ltd, 9th edition 2018,

Reference Books:

1. Kumar.D.S , "Fluid Mechanics and Fluid Power Engineering", Kataria and Sons, 9th edition, 2016.
2. Yunus A. Cengel & John M. Cimbala, "*Fluid Mechanics: Fundamentals and Applications",* McGraw Hill, 5th edition 2022.
3. Modi & Seth , *"Hydraulics and Fluid Mechanics",* Standard Book House, 23rd edition, 2018.
4. Munson,Young, Okiishi & Hebsch ,"Fundamentals of Fluid Mechanics", John Wiley Publication, 9thEdition 2021.

Web links and Video Lectures (e-Resources):

1. https://fluidmechanics.com
2. https://onlinecourses.nptel.ac.in/noc23_ce65/preview
3. http://ftp.demec.ufpr.br/disciplinas/TM240/Marchi/Bibliografia/White_2011_7ed_Fluid-Mechanics.pdf
4. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/fluid-mechanics
5. https://en.wikipedia.org/wiki/Fluid_mechanics

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	2 (WK1, WK2 and WK3)	1 (WK1, WK2 and WK3)						1			1	1	
CO2	2 (WK1, WK2 and WK3)	1 (WK1, WK2 and WK3)						1			1	1	
CO3	2 (WK1, WK2 and WK3)	1 (WK1, WK2 and WK3)			1 (WK6)			1			1	1	
CO4	2 (WK1, WK2 and WK3)	1 (WK1, WK2 and WK3)						1			1	1	

Course Code		:	**1BMEC405C**	**Theory of Machines**	**Semester**	:	**04**
L:T:P		:	**3:0:0**		**Course Type**	:	**PCC**
Hours/Sem.	**Teaching**	:	**42 Hrs**		**CIE Marks**	:	**50**
	Learning (TW+SL)	:	**42 Hrs**		**SEE Marks**	:	**50**
	Exam	:	**06 Hrs**		**Total Marks**	:	**100**
	Total Hrs.	:	**90 Hrs**		**Credits**	:	**03**

Professional Competency:

At an entry level in industry, the student will **synthesize, analyze, and balance multi-link mechanisms, gear transmissions, and cam profiles** to ensure automated machinery and rotating equipment operate with exact kinematic timing, proper force distribution, and zero destructive vibration.

Course Outcomes:

After completion of the course, student will be able to:

CO1: **Apply** kinematic principles to determine the mobility (DOF), inversions, and operational patterns of mechanisms and quick-return/intermittent machinery.

CO2: **Analyze** force distributions using static equilibrium methods and resolve balancing criteria for single and multi-plane rotating masses.

CO3: **Evaluate** the dynamic characteristics, controlling forces, and stability constraints of centrifugal governors and **determine** the gyroscopic stabilizing couples on moving vehicles.

CO4: **Design** functional cam profiles for defined follower motions and **calculate** velocity ratios and torque bounds for simple, compound, and epicyclic gear trains.

UNIT-I	**11 Hrs.**

INTRODUCTION: DEFINITIONS: Link or element, kinematic pairs, Mobility or degrees of freedom (DOF), constrained motion: completely, partially or successfully constrained and incompletely Constrained. Kinematic chain, Mechanism, Structure, Machine, Grubler's criterion (without derivation), Mobility of Mechanism, Numericals on DOF of mechanisms, Inversion. Kinematic chains and inversions: Inversions of Four bar chain, Single slider crank chain and Double slider crank chain.

MECHANISMS: Quick return motion mechanisms - Whitworth mechanism and Crank and slotted lever mechanism. Straight line motion mechanisms – Peaucellier's mechanism. Intermittent Motion mechanisms – Geneva mechanism and Ratchet and Pawl mechanism. Pantograph.

UNIT–II	**10 Hrs.**

STATIC FORCE ANALYSIS: Introduction: Static Equilibrium. Equilibrium of Two and Three Force Members. Members with Two Forces and Torque, Free Body Diagrams, Principle of Superposition. Static Force Analysis of Four Bar Mechanism and Single Slider-Crank Mechanism without friction. Numericals.

BALANCING OF ROTATING MASSES: Static and Dynamic Balancing, Balancing of Single Rotating Mass by Balancing Masses in Same plane and in Different planes. Balancing of Several Rotating Masses by Balancing Masses in Same plane and in Different planes. Numericals.

UNIT–III	**10 Hrs.**

GOVERNORS: Types of Governors, Force Analysis of Porter and Hartnell governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Numericals.

GYROSCOPE: Vectorial Representation of Angular Motion, Gyroscopic Couple, Effect of Gyroscopic Couple on Plane Disc, Aeroplane, Ship, Stability of Four Wheelers, Numericals.

UNIT–IV	**11 Hrs.**

GEAR TRAINS: Simple gear trains, Compound gear trains for large speed reduction, Reverted gear Train, Epicyclic gear trains, Tabular method of finding velocity ratio of epicyclic gear trains, Torque calculations in epicyclic gear train, Numericals.

CAMS: Types of cams, Types of followers, Displacement, Velocity and Acceleration time curves for cam profiles. Follower motions including Uniform velocity, SHM, Uniform acceleration and retardation (UAR) and Cycloidal motion. Numericals on construction of cam profiles.

Text Books:

1. Rattan S. S, "Theory of Machines", McGraw-Hill Education, 5th edition 2019.
2. Sadhu Singh, "Theory of Machines: Kinematics and Dynamics", Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi, 3rd edition 2011/2012.
3. R. S. Khurmi and J. K. Gupta, "Theory of Machines", Eurasia Publishing House Pvt. Ltd. Ram Nagar, New Delhi, 14th edition, 2020

Reference Books :

1. Joseph E. Shigley, John J. Uicker, and Gordon R. Pennock "Theory of Machines and Mechanisms", Cambridge University Press, 6th edition, **2023.**
2. Robert L. Norton, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines", McGraw-Hill Higher, 6th edition, 2019**.**
3. Thomas Bevan, "Theory of Machines", Pearson Education India, 3rd Edition. 2009 / 2010.

Web Links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/112104121 (Kinematics of Machines, IIT Kanpur)
https://www.youtube.com/watch?v=vzM_-Rr5mtw Mechanisms EVERY Mechanical Engineer
https://www.youtube.com/watch?v=0MYF8YCf2jQ Levers and 4 Bar Linkages
https://www.youtube.com/watch?v=XvYNqj4awM8 Four bar linkages for 3D printing - Guide with examples
https://www.youtube.com/watch?v=2PCmGley3gs Mechanical Linkages - Everyday Applications
https://www.youtube.com/watch?v=CZuBeBztzSY Mechanical Design (Part 5: Four Bar Linkage)
https://www.youtube.com/watch?v=ASIl3HWTT4U How Centrifugal Governors Work
https://www.youtube.com/results?search_query=Planetory+gear+trains+animations
https://www.youtube.com/watch?v=QwXK4e4uqXY Gear ratios
https://www.youtube.com/watch?v=TzJkD87eQNI What makes planetary gearboxes so amazing?

CO-PO-WK Mapping Matrix:

COs	PO1 (EK)	PO2 (PA)	PO3 (DD)	PO4 (INV)	PO5 (MT)	PO6 (EW)	PO7 (ET)	PO8 (TW)	PO9 (COM)	PO10 (PM)	PO11 (LL)	PSO1	PSO2
CO1	3 (WK1, WK2, WK3)	2 (WK1, WK2, WK3)	—	—	—	—	—	1	—	—	1 (WK8)	1	—
CO2	3 (WK1, WK2, WK3, WK4)	3 (WK1, WK2, WK3, WK4)	2 (WK5)	1 (WK5)	—	—	—	—	—	—	—	1	—
CO3	3 (WK1, WK2, WK3)	2 (WK1, WK2, WK3)	—	1 (WK5)	—	2 (WK5)	—	—	—	—	1 (WK8)	1	—
CO4	3 (WK1, WK2, WK3, WK4)	2 (WK1, WK2, WK3, WK4)	2 (WK5)	—	2 (WK6)	—	—	—	—	—	1 (WK8)	1	—

Course Code		**:**	**1BMED406C**	**Robotics and AI**	**Semester**	**:**	**04**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCC**
Hours/Sem.	**Teaching**	**:**	**42Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW+SL)	**:**	**42Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**06Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**90Hrs**		**Credits**	**:**	**03**

Professional Competency:

Apply the principles of robotics and artificial intelligence to analyze, design, implement, and evaluate robotic systems by integrating kinematics, sensing, actuation, control, and intelligent decision-making techniques for industrial automation and real-world engineering applications.

Course Outcomes:

CO1: Explain the basic components, types, and applications of robots and AI systems.

CO2: Analyze kinematic structures and transformations for robotic manipulators.

CO3: Apply sensing, actuation, and control techniques in robotic automation.

CO3: Evaluate the use of AI techniques such as search, learning, and neural networks in robotics.

UNIT-I **12 Hrs.**

Basics of Robotics: History and evolution of robotics, Robot anatomy: links, joints, configurations, Classifications and types of robots, Degrees of freedom and workspace, Robot Kinematics and Dynamics Direct and inverse kinematics, Homogeneous transformations, Denavit–Hartenberg (D-H) parameters Introduction to dynamics and trajectory planning

UNIT–II **08 Hrs.**

Sensors and Perception: Internal vs. external sensors, Vision systems, LIDAR, Encoders, Proximity and Tactile sensors, Sensor Integration and Data Fusion. *Actuation and Control:*
Types of actuators: Electric, Pneumatic, Hydraulic
Robot control strategies: Open-loop and Closed-loop, PID control, Force and Torque control, Introduction to motion planning.

UNIT–III **10 Hrs.**

Fundamentals of AI: Definition and scope of AI, Applications of AI in mechanical and manufacturing systems, Problem-solving methods: State-space, Production systems.Search and Knowledge Representation:
Uninformed search: BFS, DFS, Informed search:A*,
Knowledge representation: Semantic networks, Frames, Rules, Expert systems: structure and applications in robotics.

UNIT–IV **12 Hrs.**

Machine Learning in Robotics: Supervised, unsupervised, and reinforcement learning, Use of datasets and training models for robotics, Applications in autonomous navigation and pattern recognition.Neural Networks and Fuzzy Logic: Basic neural network structures, Learning rules and training, Fuzzy logic: sets, rules, inference system, Applications in control and decision-making in robotics.

Text Books

1. M. P. Groover, M. Weiss, R. N. Nagel, and N. G. Odrey**, Industrial Robotics: Technology, Programming, and Applications,** 1st ed. New York, NY, USA: McGraw-Hill, 1986.
2. Imran and K. Gopalakrishnan, **AI for Robotics: Toward Embodied and General Intelligence in the Physical World**. Berkeley, CA, USA: Apress, 2025

Reference Books

1. S.K. Saha, Introduction to Robotics, McGraw-Hill Education.
2. N.P. Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press.
3. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, Wiley.
4. Peter Corke, Robotics, Vision and Control, Springer.
5. Russell &Norvig, Artificial Intelligence: A Modern Approach, Pearson.

6. Rajiv Kapoor, Robotics and Industrial Automation, Khanna Publishers.

Web links and Video Lectures (e-Resources):

- NPTEL course on Industrial Robotics
- https://youtu.be/VGFpV3Qj4as?si=lK0zExJOMjctt3K6
- https://youtu.be/mMc_PIemSnU
- https://youtu.be/xwUKQcT1bKc

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	2 (WK3)					1 (WK7)					1	2	1
CO2	3 (WK2, WK3)	3 (WK2)	2 (WK5)	1 (WK8)	2 (WK6)						2	3	2
CO3	3 (WK3, WK4)	2 (WK3)	3 (WK5)	2 (WK6)	2 (WK6)						2	3	2
CO4	3 (WK4)	3 (WK4)	3 (WK5)	2 (WK8)	3 (WK6)	1 (WK7)					2	3	3

Course Code		**:**		**MANUFACTURING TECHNOLOGY LAB**	**Semester**	**:**	**04**
L:T:P		**:**	**3:0:0**		**Course Type**	**:**	**PCCL**
Hours/Sem.	**Practical**	**:**	**26 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**00 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**04 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**30 Hrs**		**Credits**	**:**	**01**

Professional Competency:

Apply manufacturing processes, machine tools, and workshop practices to fabricate, inspect, and evaluate engineering components while following safety, quality, and professional standards. Develop practical skills in conventional manufacturing processes to produce engineering components with the required accuracy and quality. Operate machine tools and workshop equipment safely and efficiently to perform machining, fitting, welding, and inspection operations. Select appropriate manufacturing processes, tools, and machining parameters to fabricate components as per engineering drawings and specifications. Demonstrate professional workshop practices by ensuring safety, precision, quality control, and teamwork during manufacturing operations.

Course Outcomes:

After completion of the course student will be able to

CO1. Demonstrate the preparation of sand specimens and evaluate their mechanical properties

CO2. Perform foundry operations by preparing molding sand mixtures and constructing green sand mould using single-piece and split patterns

CO3. Utilize forging tools to perform basic forging operations such as upsetting, drawing, and bending to produce simple forged components.

CO4. Apply the principles of manufacturing processes such as turning, milling, drilling, grinding, and fitting to produce components as per given specifications

PART A

Sand Testing:

1. Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2. To determine permeability number of green sand, core sand and raw sand.
3. To determine AFS fineness no. and distribution coefficient of given sand sample.
4. Studying the effect of the clay and moisture content on sand mould properties

PART B

Foundry Practice:

1. Use of foundry tools and other equipment for Preparation of molding sand mixture. Preparation of green sand molds kept ready for pouring in the following cases:
2. Using two molding boxes (hand cut molds).
3. Using patterns (Single piece pattern and Split pattern).
4. Preparation of green sand molds kept ready for pouring in the following cases: Incorporating core in the mold.(Core boxes).

PART C

Forging Practice:

1. Use of forging tools and other forging equipment.
2. Preparing minimum three forged models involving upsetting, drawing and bending operations

PART D	
Machining Practice: 1. Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, and Countersinking. Machining time calculations.	
Text Books:	
Author/s last Name, initial (Year), Book Title (edition), Publisher 1. Serope Kalpakjian & Steven R. Schmid" Manufacturing Engineering and Technology" 9th Edition (2025) Person Publications 2. Mahmood Alam et al. "Manufacturing Processes: Metal Forming, Machining, Metal Casting, Welding and Additive Manufacturing" Edition 2025, De Gruyter Bill Publishers. 3. DheerendraKumar Triwedi "Manufacturing Process" Edition 2025 AICTE Approved Book, Khanna Publishers. 4. Ajay Kumar, Parveen Kumar, Yang Liu (Eds.) "Industry 4.0 Driven Manufacturing Technologies" Edition 2024, Springer.	
Reference Books:	
1. Groover M. P., Automation, Production Systems and CIM, 2008, Prentice Hall of India, 2. 2.Ibrahim Zeid, Mastering CAD/CAM, 2008, 4th edition, Tata McGraw Hill 3. 3.P. N. Rao, CAD/CAM Principles and Applications, 3nd Edition 2018, McGraw Hill Education (India) Private Limited. 4. .Computer Integrated Manufacturing, Bharat Vijamuri, 4th Edition, 2018. Sunstar Publisher,	
Web links and Video Lectures (e-Resources):	

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	2(WK1, WK3,)					1(WK5,		1			1	1	
CO2	2(WK1, WK2, WK3,)					2(WK5,)		1			1	1	
CO3	1(WK1, WK3,)			1(WK1, WK2, WK3)		3(WK5,)		1			1	1	
CO4	2(WK1, WK2, WK3,)			2(WK1, WK2, WK3,)		1(WK5,)		1			1	1	

Course Code		**:**	**1BMEF412L**	**Computer Aided Machine Drawing**	**Semester**	**:**	**04**
L:T:P		**:**	**1:0:2**		**Course Type**	**:**	**PCCL**
Teaching		**:**	**14 Hrs**				
Hours/Sem.	**Practical**	**:**	**26 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**12 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**08 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**60 Hrs**		**Credits**	**:**	**02**

Professional Competency:

Apply computer-aided design (CAD) principles using SOLIDWORKS to create, analyze, assemble, and communicate engineering designs by developing accurate 2D drawings, 3D models, and assemblies of mechanical components that satisfy functional and industrial design requirements.

Course Outcomes:

After completion of the course student will be able to

CO1: Summarize the sketching, navigational, modeling, assembly commands used in SOLIDWORKS software.

CO2: Predict the conversion of pictorial views into orthographic projections of simple machine parts with or without section.

CO3: Model solid models (3D drawings) of machine parts like joints and couplings

CO4: Analyze and assemble the machine components and convert to 2D drawings in assembly or in single unit.

CO5: Employ the information prepared by industry/customer to construct functioning of the mechanical system

PART-A	**08 Hrs**

11. **Orthographic views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.

PART - B	**08 Hrs**

Keys, Joints & Couplings:

- Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.
- Flanged coupling and universal coupling (Hooks' Joint)

PART – C	**16 Hrs**

Assembly Modelling and Drafting (Part drawings should be given) Any four

1. Plummer block (Pedestal Bearing)
2. I.C. Engine connecting rod
3. Screw jack (Bottle type)
4. Tailstock of lathe
5. Machine vice
6. Tool Head of shaper

Reference Books:

1. K L Narayana, P Kannaiah and K Venkata Reddy, "Machine Drawing", New Age Publications, 3rd edition, 2006.
2. Geometrical tolerancing on technical drawings IS:8000

Web links and Video Lectures (e-Resources):
https://www.nptel.ac.in/courses/112103019 https://www.iitg.ac.in/mech/resources/nptel/ https://test.imtmaelearn.in/local/staticpage/view.php?page=gdandt&

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**
CO1	**3** (WK1, WK2, WK3, WK4)	**2** (WK1, WK2, WK3, WK4)	-	-	-	-	-	**1**	-	-	**1**	-	**2**
CO2	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	**1** (WK9)	**1**	**1**	-	**1** (WK8)	-	**2**
CO3	-	**2** (WK1, WK2, WK3, WK4)	**3** (WK5)	-	**3** (WK6)	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**
CO4	-	**2** (WK1, WK2, WK3, WK4)	**2** (WK5)	-	-	**1** (WK1, WK5, WK7)	-	**1**	**1**	-	**1** (WK8)	-	**2**

Course Code		**:**	**1BMEG413L**	**Fluid Mechanics and Machinery Lab**	**Semester**	**:**	**04**
L:T:P		**:**	**0:0:2**		**Course Type**	**:**	**PCCL**
Hours/Sem.	**Practical**	**:**	**26 Hrs**		**CIE Marks**	**:**	**50**
	Learning (TW)	**:**	**00 Hrs**		**SEE Marks**	**:**	**50**
	Exam	**:**	**04 Hrs**		**Total Marks**	**:**	**100**
	Total Hrs.	**:**	**30 Hrs**		**Credits**	**:**	**01**

Professional Competency:

Develop the ability to prepare, interpret, and communicate engineering drawings using standard drafting practices, geometric dimensioning and tolerancing (GD&T), engineering conventions, and assembly drawing techniques to support mechanical design, manufacturing, and industrial engineering applications.

Course Outcomes:

After completion of the course, student will be able to:

CO1: Conduct experiments to determine fluid properties and analyze flow characteristics using calibrated measuring devices.

CO2: Analyze fluid flow in pipes and systems to evaluate discharge, flow coefficients, and energy losses through experimental methods.

CO3: Evaluate the performance of pumps, blowers, and hydraulic turbines by determining their operating characteristics and efficiencies.

CO4: Interpret experimental results, analyze fluid jet behavior and hydraulic systems, and prepare Technical reports using modern laboratory tools and safety practices.

PART-A	**15 Hrs**

1. Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer.
2. Determination of discharge of a given pipe flow using Venturimeter
3. Determination of discharge of a given pipe flow using Orifice meter
4. Calibration of contracted V – Notch.
5. Determination of Coefficient of head loss in a sudden contraction and Sudden Expansion and friction factor.
6. To calculate Friction Factor for a give Pipe Line.
7. To calculate Friction Factor for Minor Loss in pipes.

PART - B	**15 Hrs**

1. Impact of jet on flat and curved plates
2. Performance test on Pelton turbine.
3. Performance test on Francis turbine.
4. Performance test on centrifugal pump
5. Performance test on Reciprocating Pump.
6. Performance test on Blower.

Reference Books:

1. Kumar.D.S , "Fluid Mechanics and Fluid Power Engineering", Kataria and Sons, 9th edition, 2016.
2. Yunus A. Cengel & John M. Cimbala, "*Fluid Mechanics: Fundamentals and Applications",* McGraw Hill, 5th edition 2022.
3. Modi & Seth , *"Hydraulics and Fluid Mechanics",* Standard Book House, 23rd edition, 2018.

4. Munson,Young, Okiishi & Hebsch ,"Fundamentals of Fluid Mechanics", John Wiley Publication, 9th Edition 2021.
Web links and Video Lectures (e-Resources):
https://www.nptel.ac.in/courses/112103019 https://www.iitg.ac.in/mech/resources/nptel/ https://test.imtmaelearn.in/local/staticpage/view.php?page=gdandt&

Table: Matrix to describe the mapping of COs with POs (considering WKs) and PSOs

Course Outcomes (COs)	Program Outcomes and (WKs)											Program Specific Outcomes (PSOs)	
	1	2	3	4	5	6	7	8	9	10	11	1	2
CO1	3 (WK1, WK2, WK3, WK4)	2 (WK3, WK4)	1 (WK5)	2 (WK8)	3 (WK6)	–	–	–	1 (WK 9)	1	–	3	2
CO2	3 (WK1, WK2, WK3, WK4)	3 (WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK6)	1 (WK7)	–	–	1 (WK 9)	1	–	3	2
CO3	3 (WK1, WK2, WK3, WK4)	3 (WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK6)	1 (WK7)	–	–	1 (WK 9)	1	1 (WK8)	3	3
CO4	3 (WK1, WK2, WK3, WK4)	3 (WK3, WK4)	2 (WK5)	3 (WK8)	3 (WK6)	2 (WK7)	1 (WK7)	–	2 (WK 9)	2	2 (WK8)	3	3