BVVS
BASAVESHWAR BVVS
BASAVESHWAR ENGINEERING COLLEGE, BAGALKOT - 587102
BE. in Mechanical Engineering
Scheme of Teaching and Examinations
(2022-23 admitted 1st year students and 2023-24admitted Lateral Entry Students)
(Academic Year 2024-25)

III SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				
					Theory/ Lecturer	Tutorials	Practical / Drawing	Self - Study	Duration in Hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	S					
1	PCC	22UME311C	Mechanics of Materials	ME	3	0	0	0	03	50	50	100	3
2	IPCC	22UME312C	Manufacturing Process	ME	3	0	2	0	03	50	50	100	4
3	IPCC	22UME313C	Material Science and Engineering	ME	3	0	2	0	03	50	50	100	4
4	PCC	22UME314C	Basic Thermodynamics	ME	3	0	0	0	03	50	50	100	3
5	PCCL	22UME315L	Introduction to Modelling and Design for Manufacturing	ME	0	0	2	0	03	50	50	100	1
6	ESC	22UME32XX	ESC/ETC/PLC	ME	3	0	0	0	01	50	50	100	3
7	UHV	22UHS317L	**Social Connect and Responsibility**	Any Dept	0	0	0	1	01	100	---	100	1
8	AEC/ SEC	22UME33XX	Ability Enhancement Course/Skill Enhancement Course - III	ME	If the course is a theory 1	0	0	0	01 If the course is a laboratory 02	50	50	100	1

					0	0	2	0					
9	MC	22UHS001M	Yoga	Yoga Teacher	0	0	2	0	02	100	---	100	0
		22UHS002M	National Service Scheme (NSS)	NSS Coordinator									
		22UHS003M	Physical Education (PE) (Sports and Athletics)	PE Director									
		22UHS004M	Music	Music Teacher									
TOTAL									**18**	**550**	**350**	**900**	**20**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S=** Self -Study, **CIE**: Continuous Internal Evaluation, **SEE**: Semester End Evaluation:. ESC: Engineering Science Course, ETC: Emerging Technology Course.

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Engineering Science Course (ESC/ETC/PLC)[L-T-P::3- 0-0]			
22UME321C	Electric and Hybrid Vehicle Technology	22UME322C	Internet of Things (IoT)
22UME3213C	Smart Materials & Systems	22UME324C	Waste handling and Management
Ability Enhancement Course – III			
22UME331C	Advanced Python Programming [0-0-2]	22UME332C	Spreadsheet for Engineers [0-0-2]
22UME333C	Introduction to Virtual Reality [0-2-0]	22UME334C	Tools in Scientific Computing [0-0-2]

Professional Core Course (IPCC): Refers to Professional Core Course Theory Integrated with practical's of the same course. Credit for IPCC can be 04 and its Teaching– Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (B.E./B.Tech.) 2022-23 may please be referred.

National Service Scheme /Physical Education/Yoga: All students have to register for any one of the courses namely National Service Scheme (NSS), Physical Education (PE)(Sports and Athletics), Yoga(YOGA) and Music with the concerned coordinator of the course during the first week of III semesters. Activities shall be carried out between III semesters to the VI semester (for 4 semesters). Successful completion of the registered course and requisite CIE score is mandatory for the award of the degree. The events shall be appropriately scheduled by the colleges and the same shall be reflected in the calendar prepared for the NSS, PE, and Yoga activities. These courses shall not be considered for vertical progression as well as for the calculation of SGPA and CGPA, but completion of the course is mandatory for the award of degree.

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IV SEMESTER

Sl. No.	Course	Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				
					Theory/ Lecturer	Tutorials	Practical / Drawing	Self - Study	Duration in Hours	CIE Marks	SEE Marks	Total Marks	Credits
					L	T	P	S					
1	PCC	22UME411C	Applied Thermodynamics	ME	3	0	0	0	03	50	50	100	3
2	IPCC	22UME412C	Machining Science & Metrology	ME	3	0	2	0	03	50	50	100	4
3	IPCC	22UME413C	Fluid Mechanics	ME	3	0	2	0	03	50	50	100	4
4	PCCL	22UME414L	Mechanical Measurements and Metrology lab	ME	0	0	2	0	03	50	50	100	1
5	ESC	22UME42XC	ESC/ETC/PLC -IV	ME	3	0	0	0	03	50	50	100	3
6	AEC	22UMEXXX	AEC-IV	ME	1	0	0	0	01	50	50	100	1
7	BSC	22XXXXXX	Biology For Engineers	BT	3	0	0	1	01	50	50	100	3
8	UHV	22XXXXXX	Universal Human Values	HSS	1	0	0	0	01	50	50	100	1
9	MC	22UHS001M	Yoga	Yoga Teacher	0	0	2	0	02	100	---	100	0
		22UHS002M	National Service Scheme (NSS)	NSS Coordinator									
		22UHS003M	Physical Education (PE) (Sports and Athletics)	PE Director									

		22UHS004M	Music	Music Teacher									
TOTAL									**20**	**500**	**400**	**900**	**20**

PCC: Professional Core Course, **PCCL**: Professional Core Course laboratory, **UHV**: Universal Human Value Course, **MC**: Mandatory Course (Non-credit), **AEC**: Ability Enhancement Course, **SEC**: Skill Enhancement Course, **L:** Lecture, **T**: Tutorial, **P**: Practical **S=** Self study: Skill Development Activity, **CIE**: Continuous Internal Evaluation, **SEE**:Semester End Evaluation. K :This letter in the course code indicates common to all the stream of engineering.

Engineering Science Course (ESC/ETC/PLC) [L-T-P::3-0-0]			
22UME421C	Non Traditional Machining	22UME422C	Micro Electro Mechanical Systems
22UME423C	Environmental Studies	22UME424C	Robotics and Automation
Ability Enhancement Course / Skill Enhancement Course - IV			
22UME431C	Introduction to AI & ML [0-0-2]	22UME434C	Introduction to Data Analytics [0-0-2]
22UME433C	Digital Marketing [0-2-0]	22UME432C	Introduction to Programming in C++ [0-0-2]

MECHANICS OF MATERIALS		Semester	03
Course Code	**22UME311C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	**2:2:0:0**	SEE Marks	50
Total Hours of Pedagogy	**40**	Total Marks	100
Credits	**03**	Exam Hours	3 hrs
Examination type (SEE)	**Theory**		

Brief description of the course:

Mechanics of Materials is a branch of solid mechanics that focuses on the behavior of solid objects subject to stresses and strains. It is concerned with how materials deform and behave under various types of loads and environmental conditions. The goal is to predict the material's response to forces, which is critical for designing safe and efficient structures and mechanical components.

Key Concepts in Mechanics of Materials:

1. Stress
2. Strain
3. Elasticity
4. Modulus of Elasticity (Young's Modulus)
5. Poisson's Ratio
6. Yield Strength and Ultimate Strength
7. Failure Criteria
8. Bending
9. Torsion
10. Deflections
11. Buckling

Applications:

- Structural Engineering
- Mechanical Engineering
- Aerospace Engineering
- Materials Science

Key industries of Mechanics of materials

Mechanics of materials is fundamental in ensuring that products and structures across a wide variety of industries can withstand the forces they will encounter throughout their lifecycles. From aerospace to medical devices, automotive to defense, and energy to manufacturing, it is essential for designing reliable, efficient, and safe systems. By understanding how materials behave under stress and strain, engineers can optimize performance, reduce failure risks, and extend the lifespan of components and structures.

1. Aerospace Industry
2. Automotive Industry
3. Construction and Civil Engineering
4. Energy Industry (Oil, Gas, Nuclear, Renewable)
5. Manufacturing and Heavy Industry
6. Defense and Military
7. Medical Devices and Biomedical Engineering
8. Railway and Transportation

9. Shipbuilding and Marine Engineering

Course objectives:

- To provide the basic concepts and principles of strength of materials.
- To give an ability to calculate stresses and deformations of objects under external loadings.
- To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.

Module-1

Simple stress and strain: Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram for brittle and ductile materials - Poisson's ratio & volumetric strain – Elastic constants – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Deformation of simple and compound bars, Resilience, Gradual, sudden, impact and shock loadings – thermal stresses.

Module-2

Bi-axial Stress system: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, graphical method - Mohr's circle for plane stress.

Thick and Thin cylinders: Stresses in thin cylinders, Lame's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), simple numerical.

Module-3

Bending moment and Shear forces in beams: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads – Point of contra flexure.

Module-4

Theory of simple bending – Assumptions – Derivation of bending equation - Neutral axis – Determination of bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections – Design of simple beam sections, Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, and T sections.

Module-5

Torsion of circular shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts.

Theory of columns – Long column and short column - Euler's formula – Rankine's formula.

Course outcome (Course Skill Set)

At the end of the course, the student will be able to:

CO1: Apply the concepts of stress and strain in simple and compound bars.

CO2: Explain the importance of principal stresses and principal planes & Analyse cylindrical pressure vessels under various loadings

CO3: Apply the knowledge to understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.

CO4: Evaluate stresses induced in different cross-sectional members subjected to shear loads.

CO5: Apply basic equation of simple torsion in designing of circular shafts & Columns

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours).**

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored shall be proportionally reduced to 50 marks.

Suggested Learning Resources:

Books

1. Mechanics of Materials, S.I. Units, Ferdinand Beer & Russell Johnstan, 7th Ed, TATA McGrawHill-2014
2. Mechanics of Materials, K.V.Rao, G.C.Raju, Subhash Stores, First Edition, 2007
3. Strength of Materials by R.K. Bansal ,Laxmi Publications 2010.

Web links and Video Lectures (e-Resources):

1. Statics and Strength of Materials, Shehata, 2nd edition, 1994. (http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J. htm)
2. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGE S/JTE12637J.htm
3. 3. http://www.freeengineeringbooks.com/Civil/Strength-of-MaterialBooks.php

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	1							1		1	1			
CO2	2	2	1							1		1	1			
CO3	1	2	1							1		1	1			
CO4	1	1	2							1		1	1			
CO5	1	2	1							2		1	1			

22UME312C			Manufacturing Process	Credits : 04		
L:T:P	:	3:0:2		CIEMarks	:	50
Total Hours	:	40 Hrs		SEEMarks	:	50

Brief description of the course:

Manufacturing is the process of turning raw materials or parts into finished goods through the use of tools, human labor and machinery. Most products were handmade using human labor and basic tools before the Industrial Revolution. The Industrial Revolution led to mass production, assembly line manufacturing, and the use of mechanization to manufacture larger quantities of goods at a lower cost. The main stages of the manufacturing process include:

1. **Design and Planning**: Conceptualizing the product and planning the production process, including material selection, design specifications, and manufacturing methods.
2. **Material Sourcing**: Procuring raw materials or components needed for the product.
3. **Processing**: This is the core of manufacturing and involves transforming raw materials into finished products. It can include various techniques such as:
    - **Casting**: Pouring liquid material into molds.
    - **Machining**: Cutting or shaping materials using tools like lathes, drills, and CNC machines.
    - **Forming**: Changing the shape of materials through processes like forging, stamping, or extrusion.
    - **Joining**: Assembling components through welding, riveting, or adhesives.

Course Objectives:

- To provide knowledge of various casting process in manufacturing.
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes.
- To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes.
- To impart knowledge of various joining process used in manufacturing.
- To impart knowledge about behaviour of materials during welding, and the effect of process parameters in welding

Module-1	12 Hrs.

Introduction & basic materials used in foundry: Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved – (Brief Introduction)- Not for SEE

Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.

Sand moulding: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; preparation of sand moulds. Molding machines- Jolt type, squeeze type and Sand slinger.

Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO2mould, shell mould, investment mould, plaster mould, cement bonded mould.

Cores: Definition, need, types. Method of making cores

Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions andtypes.

Module-2	06Hrs.

Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.

Casting using metal moulds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies.

Module-3	06 Hrs.

METAL FORMING PROCESSES

Introduction of metal forming process: Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, train rate and temperature in metal working; Hot deformation, Cold working and annealing.

Metal Working Processes: Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method

Other sheet metal processes: Sheet metal forming processes (Die and punch assembly, Blanking, piercing, bending etc., Compound and Progressive die), High Energy rate forming processes.

Module-4	**08 Hrs.**

JOINING PROCESSES

Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding

Module-5	**08 Hrs.**

Weldability and thermal aspects: Concept of weldability of materials; Thermal Effects in Welding (Distortion, shrinkage and residual stresses in welded structures); Welding defects and remedies.

Allied processes: Soldering, Brazing and adhesive bonding

Advance welding processes: Resistance welding processes, friction stir welding (FSW).

Practical Module

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	**Experiments**
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
5	Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
6	Foundry Practice: 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: 1. Using two molding boxes (hand cut molds). 2. Using patterns (Single piece pattern and Split pattern).
7	Preparation of green sand molds kept ready for pouring in the following cases: 1. Incorporating core in the mold.(Core boxes).
8	Forging Operations: Use of forging tools and other forging equipment. Preparing minimum three forged models involving upsetting, drawing and bending operations.
Demo experiments for CIE	
9	Demonstration of forging model using Power Hammer.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
11	Mould preparation of varieties of patterns, including demonstration

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks).

student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Demonstrate a clear understanding of the fundamental concepts in manufacturing processes, including the types of processes and their classifications

CO2: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings.

CO3: Apply critical thinking and problem-solving techniques to real-world manufacturing problems and case studies, offering viable solutions.

CO4: Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing.

CO5: Describe the methods of different joining processes and thermal effects in joining process

Course Outcomes (COs)	Programme Outcomes (POs)												Program Specific Outcomes(PSOs)			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	1	2	3	4
1	3	2	1	-	-	1	1	-	-	-	-	-	1	-	-	-
2	2	3	1	-	-	1	1	-	-	-	-	-	-	1	-	-
3	3	1	2	1	-	1	-	-	-	-	-	-	-	-	-	1
4	2	2	2	2	-	1	1	-	-	-	-	-	-	-	1	-

22UME313C	MATERIAL SCIENCE AND ENGINEERING	**Credits: 04**
3-0-2		CIE Marks: 50
Total Hours: 40		SEE Marks: 50

Brief description of the course:

Materials Science and Engineering (MSE) is an interdisciplinary field that focuses on understanding and manipulating the properties of materials to meet specific engineering needs. It combines principles from physics, chemistry, and engineering to design, test, and optimize materials used in a wide range of applications, from electronics to construction to aerospace. Key areas of study in MSE include:

1. **Structure**: Investigating the atomic, molecular, and microstructural arrangement of materials.
2. **Properties**: Understanding how materials respond to various forces and environmental conditions (mechanical, thermal, electrical, magnetic, etc.).
3. **Processing**: Exploring techniques for shaping, forming, and manufacturing materials (e.g., casting, welding, 3D printing).
4. **Performance**: Evaluating how materials perform in real-world conditions and ensuring their reliability, sustainability, and safety.

MSE plays a vital role in developing advanced materials, such as nanomaterials, biomaterials, composites, and semiconductors, which drive technological innovations across many industries.

Materials Science and Engineering drives technological advancements across virtually every industry by developing new materials and improving existing ones to meet evolving demands. Its influence is pivotal in innovation, whether through creating stronger, lighter, more efficient materials or solving complex global challenges such as sustainability and energy storage. Some key industries where MSE plays a crucial role include:

- Aerospace and Defense
- Automotive
- Electronics and Semiconductor
- Energy
- Construction and Civil Engineering
- Biotechnology and Healthcare
- Consumer Products
- Nanotechnology
- Textiles and Apparel
- Food Packaging
- Mining and Metallurgy
- Telecommunications
- Environmental and Sustainability

Course objectives:

1. Explain the basic concepts of geometrical crystallography, crystal structure and imperfections in Solids.
2. Construct the phase diagrams to know the phase transformations and concept of diffusion in solids.
3. Identify the heat treatment, cooling method for controlling the microstructure and plastic deformation to modify their properties.
4. Explain the powder metallurgy process, types and surface modifications.
5. Apply the method of materials selection, material data, properties and knowledge sources for computer-aided selection of materials.

Module-I	08 Hrs.

Structure of Materials

Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding.

Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexa Close Packed structure. Classification and Coordination of voids.

Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids. Slip, Twinning.

Module –II	08 Hrs.

Physical Metallurgy

Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules

Diffusion: Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion.

Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibrium and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions: Eutectic reaction, Eutectoid reaction and Peritectic reaction, Lever Rule, Iron-Carbon Diagram. Effect of common alloying elements in steel. Numerical on Lever rule.

Module –III	08 Hrs.

Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation.

Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, Recovery-Recrystallization-Grain Growth. Strengthening mechanisms: Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.

Module –IV	08 Hrs.

Surface coating technologies: Introduction, coating materials, coating technologies, types of coating: Electro-plating, Chemical Vapor Deposition (CVD), Physical Vapor Deposition(PVD), High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating.

Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method.

Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy.

Module –V	08 Hrs.

Engineering Materials and Their Properties: Classification, **Ferrous materials:** Properties, Compositions and uses of Grey cast iron and steel. **Non-Ferrous materials:** Properties, Compositions and uses of Copper, Brass, Bronze.

Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Applications of composite materials.

Mechanical and functional properties of Engineering Materials

Corrosion and its prevention: Galvanic cell, the electrode potentials, polarization, passivation General methods of corrosion prevention by alloying, stress corrosion cracking.

PRACTICAL COMPONENT OF IPCC	10 hours

1. Specimen preparation for macro and micro structural examinations and study the macrostructure and microstructure of a sample metal/ alloys.
2. Study the heat treatment processes (Hardening and tempering) of steel/Aluminium specimens.
3. To determine the hardness values of Mild Steel/ Aluminium by Rockwell hardness/Vickers Hardness.
4. To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine.
5. To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminium and to observe the necking.
6. To conduct a wear test on Mild steel/ Cast Iron/Aluminium/ Copper to find the volumetric wear rate and coefficient of friction.
7. To determine the Impact strength of the mild steel using Izod test and Charpy test.
8. Study the chemical corrosion and its protection. ***Demonstration.***
9. Study the properties of various types of plastics. ***Demonstration.***
10. Computer Aided Selection of Materials: Application of GRANTA Edupack for material selection: Case studies based on material properties. ***Demonstration***

Reference Books *

1. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An \ Introduction, 10th Edition, Hoboken, NJ: Wiley.
2. Jones, D.R.H., and Ashby,M.F., (2011), Engineering Materials 1: An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
3. Jones, D.R.H., and Ashby,M.F., (2012), Engineering Materials 2: An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
4. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), Physical Metallurgy Principles, 4th Edition, Cengate Learning.
5. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI,New Delhi,2008.
6. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth-Heinemann.
7. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.
8. Avner, S.H., (2017), Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education

Course Outcomes**

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters.
2. Understand the importance of phase diagrams and the phase transformations.
3. Explain various heat treatment methods for controlling the microstructure.
4. Correlate between material properties with component design and identify various kinds of defects.
5. Apply the knowledge of properties of materials for better material selection and knowledge of corrosion and its prevention.

Assessment Details (both CIE and SEE)

Continuous and Comprehensive Evaluation (CCE), Theory Course
Five module Integrated course
(Maximum marks 20 and Minimum for Eligibility is 08 marks)

Component-I: Assignment
Two assignments of five marks each must be collected one week prior to 1st and 2nd CIE tests, totalling to 10 marks

Component-II: Quiz/project/simulation etc., except assignment
At least one Quiz or seminar, or simulation, or project, or design etc of 10 marks must be conducted between 1st and 2nd CIE tests, totalling to 10 marks

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC
Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module

(with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Question Paper Pattern for theory SEE

Answer any 1 full question from each module for 100 Marks.

Course Outcomes (COs)	Programme Outcomes (POs)/ Programme Specific Outcomes (Pso)															
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3	PSO 4
1	1	3	2	2	-	-	-	-	-	-	-	-	3	2	1	3
2	2	3	2	3	-	-	-	-	-	-	-	-	1	2	1	1
3	2	3	3	3	-	-	-	-	-	-	-	-	2	3	2	1
4	2	3	3	2	-	-	-	-	-	-	-	-	3	1	2	1

22UME314C	**BASIC THERMODYNAMICS**	**Credits : 03**
Hours/Week (L:T:P) :		**CIE Marks : 50**
Total Hours of Pedagogy		**SEE Marks : 50**

Course Objectives:

- Learn about thermodynamic system and its equilibrium, basic law of zeroth law of thermodynamics.
- Understand various forms of energy - heat transfer and work, Study the first law of thermodynamics.
- Study the second law of thermodynamics.
- Interpret the behaviour of pure substances and its application in practical problems.
- Study of Ideal and real gases and evaluation of thermodynamic properties.

Module-1 — 12 Hrs.

Introduction and Review of fundamental concepts: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium ***(The topics are Only for Self-study and not to be asked in SEE. However, may be asked for CIE)***

Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical.

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems.

Module-2 — 06Hrs.

First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems.

Extension of the First law to control volume; steady flow energy equation (SFEE), Problems.

Module-3 — 06 Hrs.

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems

Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems

Module-4 — 08 Hrs.

Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Problems

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams.

Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. Problems.

Module-5	**08 Hrs.**

Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties (Processes are not to be asked for SEE).

Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.

Thermodynamic relations: Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Course Outcomes:

At the end of the course, the student will be able to:

CO1: Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.
CO2: Apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers.
CO3: Evaluate the feasibility of cyclic and non-cyclic processes using 2nd law of thermodynamics
CO4: Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and Interpret the behaviour of pure substances and its application in practical problems.
CO5: Recognize differences between ideal and real gases and evaluate thermodynamic properties of ideal and real gas mixtures using various relations.

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	3	2	-	2	2	-	-	-	-	-	-	**1**	**1**	**1**	--
CO2	3	2	3	-	2	1	-	-	-	-	-	-	**0**	**1**	**1**	--
CO3	3	2	3	-	3	-	-	-	1	-	-	-	**0**	**1**	**1**	--
CO4	2	1	1	-	2	1	-	-	1	-	-	**1**	**0**	**1**	**1**	--
CO5	2	1	1	-	2	1	-	-	-	**1**	-	-	**0**	**0**	**0**	--

Introduction to Modelling and Design for Manufacturing		Semester	3
Course Code	**22UME315L**	CIE Marks	50
Teaching Hours/Week (L: T:P)	**0:0:2**	SEE Marks	50
Credits	**01**	Total Marks	100
		Exam Hours	3
Examination nature (SEE)	**Practical**		

***One hour per week can be taken additionally**

Course objectives:

1. To improve the visualisation skills and understand the conventions used in engineering drawing.
2. To inculcate understanding of the theory of projection and make drawings using orthographic projections and sectional views.
3. To impart fundamental knowledge of drawing of different machine parts.
4. To enable the students with concepts of dimensioning and standards related to drawings.
5. To enable the students to draw the assembly of various machine components.
6. To enable the students on limits, tolerance and fits and indicate them on machine drawings.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt online sharable playlist for students
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modeling, Assembly creation and product rendering.

Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. ***(Above topics to be studied as a review*)**

01 Session

Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry. The basics of sketching and modelling:

Create a basic sketch - Profile Tools, Curve Tools, Editing Tools, Operation Tools, Constraints, construction geometries and adding dimensions. Part- Solid from sketches, Solid from surfaces, modify Tools, Operation Tools.

02 Sessions

Module-2 **02 Sessions**

Exploring design tools for production:

Create draft during a feature - Create draft as a feature - Add ribs and plastic supports - Analyze draft on a design - Create holes and threads - Use a coil feature - Mirrors and patterns - Surface creation for complex geometry - Use surfaces to replace faces - Use surfaces to split bodies and faces - Practice exercise.

Module-3	**03 Sessions**
The Basics of Assemblies The different ways to create components - Use scripts to create gears - Component color swatch and color cycling - Use McMaster-Carr parts in a design - Copy, paste, and paste new. - Distributed designs - Create as-built joints - Create joints - Joint origins and midplane joints - Drive joints and motion studies - Interference detection and contact sets - Isolation and opacity control - Create groups and organize a timeline - Practice exercise.	
Module-4	**06 Sessions**
Assembly Drawings: (Part drawings shall be given) Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing, Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats. 1. **Reciprocating saw mechanical assembly,** 2. **Innovated bottle design for sustainability** 3. **Engine Piston** 4. **Cylinder Flange** 5. **Engine Case** 6. **Design for Injection Molding**	
Course outcome (Course Skill Set) At the end of the course the student will be able to: 1. Demonstrate their visualization skills. 2. Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies. Make component drawings. 3. Produce the assembly drawings using part drawings. 4. Engage in lifelong learning using sketching and drawing as communication tool.	
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.	

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course is 50 Marks.
- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
  - Continuous evaluation of Drawing work of students as and when the Modules are covered.
  - At least one closed book Test covering all the modules on the basis of below detailed weightage.
  - *Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators*.

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module-1	15	10	05
Module-2	15	10	05
Module-3	20	15	05
Module-4	50	40	10
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours. Questions shall be set worth of 3 hours
- SEE shall be conducted jointly by the two examiners (one internal and one external) appointed by the University.
- SEE shall be conducted and evaluated for maximum of 100 marks. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule.
- Questions are to be set preferably from Text Books.
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.
- One full question shall be set from each Modules as per the below tabled weightage details.

However, the student may be awarded full marks, if he/she completes solution on computer display without sketch.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation (CIE):

- CIE marks for the practical course is 50 Marks.
- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
  - Continuous evaluation of Drawing work of students as and when the Modules are covered.
  - At least one closed book Test covering all the modules on the basis of below detailed weightage.
  - *Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators*.

Module	**Max. Marks weightage**	**Evaluation Weightage in marks**	
		Computer display & printout	**Preparatory sketching**
Module-1	15	10	05
Module-2	15	10	05
Module-3	20	15	05
Module-4	50	40	10
Total	**100**	**80**	**20**

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours. Questions shall be set worth of 3 hours
- SEE shall be conducted jointly by the two examiners (one internal and one external) appointed by the University.
- SEE shall be conducted and evaluated for maximum of 100 marks. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule.
- Questions are to be set preferably from Text Books.
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.
- One full question shall be set from each Modules as per the below tabled weightage details. ***However, the student may be awarded full marks, if he/she completes solution on computer display without sketch***.

Module	Max. Marks Weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module-1 OR Module-2	20	15	05
Module-3	20	15	05
Module-4	60	50	10
Total	**100**	**80**	**20**

Suggested Learning Resources:

Books

Text Books:

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999.
3. 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

Reference Book:

1. "A Text Book of Computer Aided Machine Drawing", S. Trymbakaa Murthy, CBS Publishers, New Delhi, 2007.
2. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastri, published by Tata Mc.Grawhill, 2006.
3. K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
4. Ajeet Singh, "MACHINE DRAWING", Tata McGraw-Hill Education, , ISBN: 9781259084607, 2012

Web links and Video Lectures (e-Resources):

- . https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes
- Introduction to Modelling and Design for Manufacturing
- https://www.autodesk.com/certification/learn/course/fusion360-intro-modeling-design-professional

Table: Mapping of COs with Pos/PSOs,

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	2	1		1					1			1			
CO2	1	2	1		1					1			1			
CO3	1	2	1		1					1			1			
CO4	1	2	1		1					1			1			

22UME321C			INTRODUCTION TO VIRTUAL REALITY	3 Credits (3:0:0)	
L: T:P	:	0:2:0		CIE Marks	50
Total Hours	:	30		SEE Marks	50

Brief description of the course:

Virtual Reality (VR) refers to a computer-generated simulation or recreation of a 3D environment that users can interact with in a seemingly real or physical way, typically through special electronic devices such as VR headsets, gloves, and sensors. These systems immerse users in a virtual world that can be similar to the real world or entirely imaginative, offering experiences that may not be possible or practical in reality.

Unlike traditional interfaces such as a computer screen or smartphone, VR allows users to experience an environment as if they are actually present within it. The technology uses a combination of hardware such as headsets and motion-tracking sensors and software such as 3D rendering to create an immersive and interactive environment.

Applications of Virtual Reality

1. **Entertainment and Gaming**: One of the most popular uses of VR is in the entertainment industry, especially video games. VR gaming offers an unparalleled level of immersion, enabling players to experience games from a first-person perspective in a fully interactive environment.
2. **Healthcare**: In medicine, VR is used for surgical training, rehabilitation, and patient treatment. Surgeons can practice procedures in a risk-free virtual environment, and patients can undergo therapy for conditions like PTSD or phobias using VR simulations.
3. **Education and Training**: VR is transforming education by offering interactive and immersive learning experiences. For example, students can explore historical sites, conduct science experiments, or practice skills in virtual simulations. In the military and aviation industries, VR is used for training pilots, soldiers, and emergency responders.
4. **Architecture and Design**: Architects and designers use VR to visualize buildings, homes, or public spaces in 3D before they are built. Clients can virtually walk through designs, make changes, and get a real sense of how a structure will look and feel in reality.
5. **Social Interaction**: Social VR platforms, such as VRChat, allow users to interact with others in virtual spaces, whether for meetings, gaming, or socializing. This has become especially important in the era of remote work and virtual events.

The Future of Virtual Reality

The future of VR is exciting, with potential breakthroughs in several areas:

- **Improved hardware**: Lighter, more comfortable headsets with higher resolutions and wider fields of view.
- **Expanded content**: More immersive and diverse VR content across various industries, from games and entertainment to healthcare and education.
- **Mixed Reality (MR)**: A combination of VR and augmented reality (AR), where virtual objects are overlaid onto the real world. This is often referred to as "augmented VR" and could have applications in industries like medicine, manufacturing, and design.
- **Social and Collaborative VR**: As technology advances, VR is likely to become a major platform for social interaction and collaborative work, potentially replacing traditional video conferencing or in-person meetings.

Virtual reality is a rapidly evolving technology that is reshaping how we interact with digital content. Whether for gaming, education, professional training, or entertainment, VR's immersive experience has vast potential to enhance various aspects of our lives.

Module-1
Introduction to Virtual Reality: Defining Virtual Reality, History of Virtual Reality, Key Elements of Virtual

Reality Experience, Hardware systems for Virtual Reality, Software systems for Virtual Reality, Human Physiology and Perception, Virtual Reality System

Module-2

Interface to the Virtual World-Input: Position Tracking:Electromagentic, Mechanical, Optical, Videometric, Ultrasonic, Inertial and Neural Tracking, Body Tracking: Tracking the Head, Hand & fingers, Eyes, Feet & other body parts

Interface to the Virtual World-output: Visual Displays, Visual presentation properties of visual displays, Aural Displays, Aural presentation properties, Haptic displays, Haptic presentation properties

Module-3

Visual Perception: Perception of depth, Perception of motion, Perception of colour

Visual Rendering: Visual rendering systems, Rendering complex visual scenes, Visual rendering latency

Module-4

Interacting with the Virtual World: Manipulating a Virtual Reality, Manipulating methods, Properties of Manipulation, Navigating in a Virtual World

Module-5

The Future of Virtual Reality: The state of Virtual Reality, The field of Virtual Reality research, The Trends of Virtual Reality, Technology Futures, Software

Reference Books:

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2020
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.
4. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
5. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
6. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Meging Real and Virtual Worlds", 2005.
7. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Course outcomes

At the end of the course the student will be able to:

- CO1: Assimilate the fundamental concepts of Virtual Reality (VR), including its history, key elements, hardware & software systems, and the role of human perception in designing immersive VR experiences.
- CO2: Apply various input and output interface technologies, including position and body tracking methods, principles of visual perception, including depth, motion, and color, and evaluate visual rendering techniques
- CO3: Articulate effective methods for interaction, manipulation, and navigation within VR environments, considering key properties and techniques to enhance user engagement and immersion.
- CO4: Analyze the current state, emerging trends, and future directions of Virtual Reality technology, including advancements in research, hardware, and software development.

Table: Revised Bloom Vincenti (RBV) Taxonomy Table

Cognitive Processes	Knowledge Categories							
	Factual	Conceptual	Procedural	Metacognitive	Fundamental Design Principles	Criteria and specifications	Practical Constraints	Design Instrumentalities
Remember	--	--	--	--	--	--	--	--
Understand	AI1, AI2,	--	--	--	--	--	--	--

	AI3, AI4							
Apply	CO1, IA1, AI1, CO2, IA2, AI2	CO1, IA1, AI1	CO2, IA2, AI2, CO3, IA3, AI3, CO4, IA4, AI4	CO3, IA3, AI3, CO4, IA4, AI4	--	--	--	--
Analyze	--	--	--	--	--	--	--	--
Evaluate	--	--	--	--	--	--	--	--
Create	--	--	CO4, IA4, AI4	--	--	--	--	--

Procedure followed to frame RBV Taxonomy table:

1. Course Outcome (CO) and Instructional Activities (IA) are in complete alignment (located in the same cells). While some assessment items (AI) in cells represent lower cognitive level than that of CO, significant percentage of Assessment items (AI) are in the same cell as that of CO.
2. Courses in Science, Mathematics, Humanities, Social Sciences and Management in Engineering programs are concerned with **only first four categories of knowledge** (Factual, Conceptual, Procedural and Metacognitive).
3. In case of engineering courses, there are **additional four categories of engineering knowledge** (Fundamental Design Principles, Criteria and specifications, Practical Constraints and Design Instrumentalities)
4. Majority of the engineering science courses as offered at present (Fluid Mechanics, Thermodynamics, etc.) may or may not address the four categories of engineering knowledge. However, a teacher may choose to address (if not addressed previously) some categories of engineering knowledge in his/her engineering science course so that 6x8 RBV taxonomy table can be made applicable to the engineering science courses.

Table: Mapping of COs with POs and PSOs

Course Outcomes (COs)	Program Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	-	-	-	-	1	2	-	-	1	-	1	1	-	-	1
CO2	2	-	-	-	-	-	-	1	-	1	-	1	1	-	-	1
CO3	1	-	-	-	-	-	1	-	-	1	-	1	1	-	-	1
CO4	-	-	-	-	-	-	1	-	-	2	-	2	1	-	-	1

Table: Mapping of COs with Pos/PSOs, Cognitive Level, Knowledge Level and Classroom Sessions

Course Outcomes		**POs/ PSOs**	**Cognitive Level**	**Knowledge Level**	**Class Sessions (Hrs)**	**Open Ended Experiments**
CO1	Assimilate the fundamental concepts of Virtual Reality (VR), including its history, key elements, hardware & software systems, and the role of human perception in designing immersive VR experiences.	PO6, PO10, PO12	Remember Understand	Fundamental Knowledge, Basic concepts	06	---
CO2	Apply various input and output interface technologies, including position and body tracking methods, principles of visual perception, including depth, motion, and color, and evaluate visual rendering techniques	PO6, PO10, PO12	Remember Understand	Fundamental Knowledge, Tracking Constraints	12	---
CO3	Articulate effective methods for interaction, manipulation, and navigation within VR environments, considering key properties and techniques to enhance user engagement and immersion.	PO6, PO10, PO12	Remember Understand	Fundamental Knowledge, VW Design Specifications	06	---

CO4	Analyze the current state, emerging trends, and future directions of Virtual Reality technology, including advancements in research, hardware, and software development.	PO6, PO10, PO12	Remember Understand	Research Knowledge	06	---
				Total (Hours)	**30**	---

Program Outcomes as defined by NBA (PO)

PO-1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

PO-2 **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

PO-3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

PO-4 **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

PO-5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

PO-6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

PO-7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO-8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO-9 **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

PO-10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

PO-11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

PO-12 **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Educational Objectives (PEO)

PEO-1 The Mechanical Engineering students should be able to engage in the design and to develop the components and equipments in the field of mechanical engineering industries and other allied industries.

PEO-2 The graduates should be able to apply the knowledge of mechanical engineering to solve problems of social relevance and pursue higher education studies and research in the field of materials science, machine design, manufacturing and thermal/fluid engineering.

PEO-3 The graduates will work effectively as individuals and as team members in interdisciplinary projects

PEO- The graduates should be able to engage in lifelong learning, to become an entrepreneur, apply

4	ethics and adapt to changing professional and societal requirements.

Program Specific Outcomes (PSO)

PSO-1	The students should be able to identify, analyze and solve mechanical engineering problems in the area of manufacturing technology, machine design, thermal/fluid engineering and interdisciplinary courses.
PSO-2	The students should be able to pursue higher studies and research in the area of material science, manufacturing, machine design, industrial management and thermal/fluid engineering .
PSO-3	The students should be apply ethics and professional values in addressing social issues
PSO-4	The students should be able to become technocrats and entrepreneurs and to solve community problems related to mechanical systems by imparting technological inputs and managerial skills

22UME322C	Internet of Things	Credits: 03
L:T:P - 3 : 0: 0		CIEMarks:50
Total Hours/Week: 3		SEEMarks:50

About the Course

The Internet of Things (IoT) course covers the fundamentals of connecting and managing devices through the internet to collect, exchange, and analyze data. Key topics include IoT architecture, hardware and software components, communication protocols, and data processing. The course also explores practical applications, security challenges, and emerging trends in IoT. IoT applications are transforming a wide range of sectors, including:

- **Healthcare**
- **Manufacturing**
- **Transportation and Logistics**
- **Agriculture**
- **Smart Cities**
- **Energy**
- **Retail**
- **Home Automation**

Module – I	08 Hrs.

IOT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.

Module – II	08 Hrs.

Basics of Networking: Introduction, Network Types, Layered network models
Emergence of IoT: Introduction, Evolution of IoT, Enabling IoT and the Complex Interdependence of Technologies, IoT Networking Components

Module – III	10 Hrs.

IOT ARCHITECTURE - IoT Open source architecture (OIC)- OIC Architecture & Design principles-IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.

Module – IV	7 Hrs.

WEB OF THINGS - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture –WoT Portals and Business Intelligence.

Module – V	07Hrs

IOT APPLICATIONS - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.

Reference Books

Text Books

1. "The Internet of Things in the Cloud: A Middleware Perspective", Honbo Zhou, CRC Press, 2012.
2. "Architecting the Internet of Things", Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), Springer, 2011.
3. "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. "The Internet of Things – Key applications and Protocols", Olivier Hersent, David Boswarthick, Omar Elloumi, Wiley, 2012.

References Books:

1. "Internet of Things (A Hands-on-Approach)", Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014
2. "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", Francis da Costa, 1st Edition, Apress Publications, 2013
3. "Getting Started with the Internet of Things, CunoPfister, O Reilly Media, 2011, ISBN: 978-1-4493-

9357-1

Course Outcomes**

After completion of the course student will be able to

CO 1. Describe the meaning and application of the term "Internet of Things" across various contexts.
CO 2. Know the key components of Emergence of IoT and Networking
CO 3. Utilize the knowledge and skills gained in the course to design, develop, and evaluate a functional IoT system, including prototyping.
CO 4. Analyze the distinctions between the Web of Things (WoT) and Internet of Things (IoT), examining WoT architecture, standardization, middleware, and evaluate industry applications of IoT.

Table: Revised Bloom Vincenti (RBV) Taxonomy Table

Cognitive Processes	Knowledge Categories							
	Factual	Conceptual	Procedural	Metacognitive	Fundamental Design Principles	Criteria and specifications	Practical Constraints	Design Instrumentalities
Remember	IA1,AI1,*CO1,CO2*	IA1, AI1, *CO1, CO2*						
Understand		AI1, *AI2,AI3, AI4,CO3,CO4*						
Apply			*CO4, IA4,AI4*					
Analyse								
Evaluate								
Create								

CO-Course Outcome AI-Assessment Items IA-Instructional Activities

Table: Mapping of COs with Pos/PSOs,

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1				2			1				1	1			
CO2	1				2			1				1	1			
CO3	1		1		2			1				1	1			
CO4	1		1		2			1				1	1			

Table: Mapping of COs with Pos/PSOs, Cognitive Level, Knowledge Level and Classroom Sessions.

Course Outcomes		POs/PSOs	Cognitive Level	Knowledge level	Class sessions
CO1	Describe the meaning and application of the term "Internet of Things" across various contexts	PO1, PO5, PO8, PO12, PSO1	Comprehension	Procedural Knowledge, Fundamental Principles	8
CO2	Know the key components of Emergence of IoT and Networking	PO1, PO5, PO8, PO12, PSO1	Comprehension	Procedural Knowledge, Fundamental Principles	10
CO3	Utilize the knowledge and skills gained in the course to design, develop, and evaluate a functional IoT system,	PO1, PO5, PO8, PO12, PSO1	Comprehension, Apply,	Procedural Knowledge, Fundamental Principles	10

	including prototyping				
CO4	Analyze the distinctions between the Web of Things (WoT) and Internet of Things (IoT), examining WoT architecture, standardization, middleware, and evaluate industry applications of IoT.	PO1, PO5, PO8, PO12, PSO1	Knowledge, Understand, Analyse	Procedural Knowledge, Fundamental Principles	12

22UME332C	**Spreadsheets for Engineers**		
Course Code		CIE Marks	50
Teaching Hour/Week (L:T:P:S)	1:0:2:0	SEE Marks	50
Total hours per week :	03	Total Marks	100
Credits	02	Exam Hours	03

PART – A (Theory)

1. **Introduction to Excel**

About Excel & Microsoft, Uses of Excel, Excel software, Spreadsheet window pane, Title Bar, Menu Bar, Standard Toolbar, Formatting Toolbar, the Ribbon, File Tab and Backstage View, Formula Bar, Workbook Window, Status Bar, Task Pane, Workbook & sheets

2. **Columns & Rows**

Selecting Columns & Rows, Changing Column Width & Row Height, Autofitting Columns & Rows, Hiding/Unhiding Columns & Rows, Inserting & Deleting Columns & Rows, Cell, Address of a cell, Components of a cell – Format, value, formula, Use of paste and paste special

3. **Functionality Using Ranges**

Using Ranges, Selecting Ranges, Entering Information Into a Range, Using AutoFill

4. **Creating Formulas**

Using Formulas, Formula Functions – Sum, Average, if, Count, max, min, Proper, Upper, Lower, Using AutoSum,

5. **Advance Formulas**

Concatenate, Vlookup, Hlookup, Match, Countif, Text, Trim

6. **Spreadsheet Charts**

Creating Charts, Different types of chart, Formatting Chart Objects, Changing the Chart Type, Showing and Hiding the Legend, Showing and Hiding the Data Table

7. **Data Analysis**

Sorting, Filter, Text to Column, Data Validation

8. **PivotTables**

Creating PivotTables, Manipulating a PivotTable, Using the PivotTable Toolbar, Changing Data Field, Properties, Displaying a PivotChart, Setting PivotTable Options, . Adding Subtotals to PivotTables

9. **Spreadsheet Tools**

Moving between Spreadsheets, Selecting Multiple Spreadsheets, Inserting and Deleting Spreadsheets, Renaming Spreadsheets, Splitting the Screen, Freezing Panes, Copying and Pasting Data between Spreadsheets, Hiding , Protecting worksheets

PART – B (Practical)

1 Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart

2 Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units

3 Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.

4 Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis Tool Pack.

5 Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, Non Linear Regression Analysis.

6 Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.

Reference Books
Mc Fedries Paul "Microsoft Excel 2019 Formulas and Functions" Microsoft Press, U.S, 2019 Edition

Course Outcomes

After completion of the course student will be able to

CO 5. Create formulas using basic arithmetic operations, as well as the SUM, AVERAGE, IF, COUNT, MAX, MIN, PROPER, UPPER, and LOWER functions

CO 6. Create different types of charts, such as XY scatter graphs, charts with two Y-axes, charts with error bars, and combination charts.

CO 7. Perform data analysis tasks, including sorting and filtering data, converting text to columns, and using data validation.

CO 8. Perform advanced formula operations using functions like CONCATENATE, VLOOKUP, HLOOKUP, MATCH, COUNTIF, TEXT, and TRIM.

Table: Mapping of COs with POs/PSOs,

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	1				2			**1**				**1**	**1**			
CO2	1				2			**1**				**1**	**1**			
CO3	1				2			**1**				**1**	**1**			
CO4	1				2			**1**				**1**	**1**			

Table: Mapping of COs with POs/PSOs, Cognitive Level, Knowledge Level and Classroom Sessions.

Course Outcomes		POs/PSOs	Cognitive Level	Knowledge level	Class sessions
CO1	Create formulas using basic arithmetic operations, as well as the SUM, AVERAGE, IF, COUNT, MAX, MIN, PROPER, UPPER, and LOWER functions	PO1, PO5, PO8, PO12, PSO1	Comprehension	Procedural Knowledge, Fundamental Principles	4
CO2	Create different types of charts, such as XY scatter graphs, charts with two Y-axes, charts with error bars, and combination charts.	PO1, PO5, PO8, PO12, PSO1	Comprehension	Procedural Knowledge, Fundamental Principles	4
CO3	Perform data analysis tasks, including sorting and filtering data, converting text to	PO1, PO5, PO8, PO12, PSO1	Comprehension, Apply,	Procedural Knowledge, Fundamental Principles	4

	columns, and using data validation.				
CO4	Perform advanced formula operations using functions like CONCATENATE, VLOOKUP, HLOOKUP, MATCH, COUNTIF, TEXT, and TRIM.	PO1, PO5, PO8, PO12, PSO1	Knowledge, Understand, Analyse	Procedural Knowledge, Fundamental Principles	4

Course Code: 22UME411C	APPLIED THERMODYNAMICS	Credits: 03
Hours/Week (L:T:P) :		CIE Marks : 50
Total Hours of Pedagogy		SEE Marks : 50

CourseObjectives:

- Explain the air standard cycle and combustion in I. C. Engines.
- Describe the gas power cycle and vapour power cycles.
- Explain the performance of compressor.
- Explain the concepts of Refrigeration and Air conditioning.

Module-1	12 Hrs.

Air standard cycles: Carnot cycle. Otto, Diesel, Dual and cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.
I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, Heat balance, Morse test

Module-2	06Hrs.

Gas power Cycles: Gas turbine (Brayton) cycle; description and analysis. Regenerative, Intercooling and reheating in gas turbine cycles.
Jet Propulsion cycles: Turbojet, Turboprop, Turbofan, Ram Jet, Rocket, Pulse Jet, Ram Rocket.

Module-3	06 Hrs.

Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.
Actual vapour power cycles: Actual vapour power cycles, regenerative vapour power cycle with open and closed feed water heaters. Reheat Rankine cycle.

Module-4	08 Hrs.

Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system.
Pscychrometrics and Air-conditioning Systems: Psychometric properties of Air (only for review), Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.

Module-5	08 Hrs.

Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.
Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Super saturated flow.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for theSEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall bedeemed to have satisfied the academic requirements and earned the credits allotted to each subject/course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE(ContinuousInternalEvaluation)and SEE(SemesterEnd Examination)takentogether.

Course Outcomes:

Attheendofthecourse,thestudentwillbeableto:

1. Analyse air standard cycle to evaluate the performance of I C engines.
2. Analyze the gas power cycles to evaluate the overall efficiency of gas turbine plant.
3. Apply thermodynamic concepts to analyze the performance of vapour power cycles.
4. Analyze the vapour compression and vapour absorption systems to improve refrigeration.
5. Determination of various parameters of air compressors and steam nozzles.

CO PO Mapping

Course Outcomes	**Programme Outcomes (POs)**												**Program Specific Outcomes (PSOs)**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	3	3	2	-	2	2	-	-	-	-	-	-	**1**	**1**	**1**	--
CO2	3	2	3	-	2	1	-	-	-	-	-	-	**0**	**1**	**1**	--
CO3	3	2	3	-	3	-	-	-	1	-	-	-	**0**	**1**	**1**	--
CO4	2	1	1	-	2	1	-	-	1	-	-	**1**	**0**	**1**	**1**	--
CO5	2	1	1	-	2	1	-	-	-	**1**	-	-	**0**	**0**	**0**	--

22UME412C	**Machining Science and Metrology**	**Credits: 04**
3-0-2		CIE Marks: 50
Total Hours: 40		SEE Marks: 50

Brief description of the course:

Machining Science and Metrology are two closely related fields that focus on the processes and techniques used to shape, measure, and ensure the quality of materials and manufactured products. Here's a brief overview of each:

Machining Science

Machining Science is the study and application of processes used to remove material from a workpiece to achieve the desired shape, size, and surface finish. It involves the understanding of various machining operations such as turning, milling, drilling, grinding, and advanced techniques like electrical discharge machining (EDM) and laser cutting. Key aspects include:

1. **Cutting Mechanics**: Understanding how cutting tools interact with the material, including forces, temperature, and chip formation.
2. **Tool Materials and Wear**: Studying the performance and longevity of cutting tools, including the effects of material hardness and coating technologies.
3. **Machining Processes**: Developing methods to optimize processes for speed, accuracy, and cost-effectiveness.
4. **Surface Finish**: Ensuring that the surface quality of the workpiece meets required standards, which affects its performance in final applications.
5. **Manufacturing Systems**: Involves automation, CNC (computer numerical control) machines, and integrating modern technologies to improve productivity.

Metrology

Metrology is the science of measurement and the study of techniques to ensure precision, accuracy, and reliability in the measurement of physical quantities, especially in manufacturing. It plays a critical role in verifying that parts meet specified dimensions and tolerances. Key components include:

1. **Dimensional Metrology**: Measurement of physical dimensions such as length, diameter, angles, and surface profiles using tools like calipers, micrometers, and coordinate measuring machines (CMM).
2. **Geometrical Dimensioning and Tolerancing (GD&T)**: A system for defining and communicating engineering tolerances and geometric features of parts.
3. **Calibration**: Ensuring that measuring instruments are accurate by comparing them to known standards or traceable reference points.
4. **Surface Measurement**: Quantifying surface roughness, flatness, and texture using specialized equipment like profilometers.
5. **3D and Optical Metrology**: Advanced techniques like laser scanning and optical measuring systems for precise and non-contact measurement, particularly in complex geometries.

Interconnection of Machining Science and Metrology

- **Quality Control**: Machining science focuses on the efficient production of parts, while

metrology ensures that those parts meet precise specifications. The two fields work together to improve manufacturing processes and produce high-quality, functional components.

- **Precision Manufacturing**: In advanced manufacturing, where high precision and tight tolerances are crucial (e.g., aerospace, medical devices, and electronics), machining science and metrology are essential to ensure products meet performance standards.

Together, machining science and metrology enable the effective production of high-quality, dimensionally accurate parts in various industries, contributing to the efficiency, reliability, and consistency of manufactured products.

Machining Science and Metrology are vital in ensuring the precision, functionality, and quality of components across a diverse range of industries. From high-performance aerospace parts to everyday consumer electronics, these fields enable manufacturers to meet exacting standards, optimize production processes, and ensure product reliability. Both industries are integral to the modern economy and drive technological innovation across sectors.

1. Aerospace Industry
2. Automotive Industry
3. Medical Device Industry
4. Energy Industry
5. Electronics and Semiconductor Industry
6. Tooling and Mold Making
7. Manufacturing of Precision Components
8. Defense and Military
9. Consumer Goods Industry
10. Railway and Transportation Industry

Course objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To understand the basic principles of measurements
- To enrich the knowledge pertaining to gauge , comparator and angular measurement.

Module-I	**08 Hrs.**

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications.

Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, accessories of lathe Machine and various operations carried out on lathe. Turret and Capstan lathe.

Module–II	**08 Hrs.**

Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations.

Indexing: Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing.

Shaping, Slotting and Planning Machines Tools: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter. Difference between shaping and planning operations.

Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time.

Grinding: Grinding operation, classification of grinding processes: cylindrical, surface & centerless grinding

Module–III	**08 Hrs.**

Thermal aspects, Tool wear, and Machinability

Temperature in Metal Cutting: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures Tool life and tool Wear: progressive tool wear;

Forms of wear in metal cutting: crater wear, flank wear, tool-life criteria, cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability

Cutting fluids: Action of coolants and application of cutting fluids.

Module–IV	**08 Hrs.**

Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration.

Line & End Standards: Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges.

Systems of Limits, Fits & Tolerance: Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation.

UNIT–V	**08 Hrs.**

Gauges: Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems.

Comparators: Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT.

Angular Measurements: Bevel protractor, sine bar, angular gauges, numerical on building of angles.

PRACTICAL COMPONENT OF IPCC	**10 hours**

1. Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning.
2. Preparation of One model on lathe involving - Plain turning, Facing , Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
3. One Job, Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4. Cutting of Gear Teeth using Milling Machine.
5. Simple operations and One Job on the drilling and grinding machine.
6. Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.
7. Demonstration/Experimentation of simple programming of CNC machine operations.
8. To study the tool geometry of a single point turning tool (SPTT) in the American Standards

Association (ASA) system.
9. Calibration of LVDT.
10. Calibration of Load cell
11. Calibration of micrometer screw gauge.

Reference Books *

1. Workshop Technology Vol-II by Hazara Choudhry, Media Promoters andPublishers Pvt. Ltd. 14, 2014 .
2. Production Technology by R.K.Jain Khanna Publications, 2003.
3. Productiontechnology by HMT Tata MacGraw Hill, 2001.
4. ManufacturingScience by Amitabha Ghosh and Mallik, Affiliated East West Press, 2003.
5. Production Technology by P. C. Sharma, S. Chand & Company Pvt.Ltd., 8, 2014.
6. Fundamentals ofMachining and Machine Tools by G. Boothroyd,Winston A. Knight, Marcel Dekker, INC, 2, 2005.
7. Production Engineering by P. C. Pandey, Standard PublishersDistributors, 10, 2016.
8. Engineering Metrology by R. K. Jain, Khanna Publishers, 1994.
9. Measurement Systems Applications and Design, by Ernest O, Doeblin, McGraw Hill Book Co.
10. Engineering Metrology by R. K. Jain Khanna Publishers, 1994.

Course Outcomes**

Course outcomes (Course Skill Set):

At the end of the course, the student will be able to:

CO1: Analyze various cutting parameters in metal cutting.

CO2: Understand the construction of machines & machine tools and compute the machining time of various operations.

CO3: Understand the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids

CO4: Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design

CO5: Understand the working principle of different types of comparators, gauges, angular Measurements.

Assessment Details (both CIE and SEE)

Continuous and Comprehensive Evaluation (CCE), Theory Course
Five module Integrated course
(Maximum marks 20 and Minimum for Eligibility is 08 marks)

Component-I: Assignment
Two assignments of five marks each must be collected one week prior to 1st and 2nd CIE tests, totalling to 10 marks

Component-II: Quiz/project/simulation etc., except assignment
At least one Quiz or seminar, or simulation, or project, or design etc of 10 marks must be conducted between 1st and 2nd CIE tests, totalling to 10 marks

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total

of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scoredby the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Question Paper Pattern for theory SEE
Answer any 1 full question from each module for 100 Marks.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12				
CO1	2	1								1		1				
CO2	2	2								1		1				
CO3										1		1				
CO4		1								1		1				
CO5	1	2			1					2		1				

Table: Revised Bloom Vincenti (RBV) Taxonomy Table

Cognitive Processes	Knowledge Categories							
	Factual	Conceptual	Procedural	Metacognitive	Fundamental Design Principles	Criteria and specifications	Practical Constraints	Design Instrumentalities
Remember								
Understand			AI1, *AI2, AI3, AI4*					
Apply			CO1, IA1, AI1, *CO2, IA2, AI2*		CO1, IA1, AI1	*CO2, IA2, AI2, CO3, IA3, IA3, CO4, IA4, AI4*	*CO3, IA3, IA3, CO4, IA4, AI4*	
Analyse								
Evaluate								
Create								

CO-Course Outcome AI-Assessment Items IA-Instructional Activities

Table: Mapping of COs with Pos/PSOs, Cognitive Level, Knowledge Level and Classroom Sessions.

Course Outcomes		POs/ PSOs	Cognitive Level	Knowledge Level	Class Sessions (Hrs)	Open Ended Experiments
CO1	Analyze various cutting parameters in metal cutting	PO1, PO2, PO3, PO10, PO12, PSO1	Apply, Understand	Procedural Knowledge, Fundamental Design Principles	08	02 Experiments (02 Hours each)
CO2	Understand the construction of machines & machine tools and compute the machining time of various operations	PO1, PO2, PO3, PO10, PO12, PSO1	Apply, Understand	Procedural Knowledge, Criteria and Specifications	08	
CO3	Understand the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids	PO1, PO2, PO4, PO5, PO9, PO10, PO12, PSO1	Apply, Understand	Criteria and Specifications, Practical Constraints	08	
CO4	Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain	PO1, PO2, PO3, PO10, PO12, PSO1	Apply, Understand	Criteria and Specifications, Practical Constraints	08	

	tolerance, limits of size, fits, geometric and position tolerances, gauges and their design					
CO5	Understand the working principle of different types of comparators, gauges, angular Measurements	PO1, PO2, PO3, PO10, PO12, PSO1	Apply, Understand	Procedural Knowledge, Criteria and Specifications	08	
Total Hours of Instruction					40+4=44	

Course Code: 22UME413C	**Course Title: Fluid Mechanics**	**Credits :** (3 : 0 : 0)
Hours/Week (L:T:P) : 03		**CIE Marks :** 50
Total Hours of Pedagogy (Theory + Lab): 40		**SEE Marks :** 50
Course Type: Integrated		

Brief Description of the Subject:

1. Introduces the fundamental properties of fluids, including mass density, viscosity, surface tension, and compressibility, providing an understanding of fluid behavior in different conditions. It covers the concept of the continuum, types of fluids, and the pressure at a point in a static fluid mass. Students will also explore how pressure varies within a fluid, along with Pascal's law and different types of pressure measurements, such as absolute, gauge, and atmospheric pressures. Fluid statics is further discussed, focusing on total pressure and the center of pressure for different submerged surfaces, including horizontal, vertical, and inclined plane surfaces.
2. Focuses on fluid kinematics, including types of flow like steady, unsteady, laminar, turbulent, and compressible versus incompressible flow. Key concepts such as streamlines, pathlines, and streaklines are introduced, along with velocity components, convective and local acceleration, and continuity equations. Students will also learn about laminar and turbulent flow through pipes and between parallel plates, and understand the Poiseuille equation that governs viscous flow. Further analysis of fluid behavior in different flow regimes, including rotation, vorticity, and circulation, is provided.
3. Delves into fluid dynamics, covering the momentum equation, jet impacts, and forces on fixed and moving vanes. Students will explore Euler's equation and the derivation of Bernoulli's equation, along with its applications in devices such as venturemeters, orifice meters, and pitot tubes. The module also examines head losses due to friction in pipes, both major and minor losses, and the flow of fluids through pipes arranged in series and parallel. Numerical problems are included to reinforce concepts.
4. Students will study the development of the boundary layer around bodies, including the concepts of lift and drag, and the effects of streamlined versus bluff bodies. Flow around various shapes like cylinders, spheres, and aerofoils is explored, along with boundary layer separation and its control. Dimensional analysis is introduced, covering topics such as derived quantities, dimensional homogeneity, the Rayleigh method, and Buckingham Pi-theorem. The module also covers dimensionless numbers and similitude, important for understanding fluid dynamics in scaled models.
5. Focuses on compressible fluid flow, covering the speed of sound, isentropic and adiabatic flow, and how flow properties change with area variation. Students will learn about normal and oblique shocks, and flow through nozzles, with emphasis on stagnation and sonic properties. The introduction to Computational Fluid Dynamics (CFD) explains its necessity, philosophy, limitations, and applications in fluid analysis and design, providing students with an overview of modern computational techniques

used in fluid mechanics.

Course Objectives:

1. To have a working knowledge of the basic properties of fluids and understand the continuum approximation.
2. To calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.
3. To understand the flow characteristic and dynamics of flow field for various Engineering applications.
4. To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.
5. To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.
6. Understand the concept of dynamic similarity and how to apply it to experimental modelling.
7. To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.

Module-1	**8 Hrs.**

Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc, pressure at a point in the static mass of fluid, variation of pressure, Pascal's law, Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges.

Fluid Statics: Total pressure and center of pressure for horizontal plane, vertical plane surface and Inclined plane surface submerged in static fluid.

Module-2	**8 Hrs.**

Fluid Kinematics: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems.

Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation.

Module-3	**8 Hrs.**

Fluid Dynamics: Momentum equation, Impacts of jets-force on fixed and moving vanes, flat and curved. Numericals. Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation, Bernoulli's theorem, Application of Bernoulli's theorem such as venturemeter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals.

Loss of head due to friction in pipes, Major and minor losses, pipes in series and parallel.

Module-4	**8 Hrs.**

Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control.

Dimensional Analysis: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types

of similitude

Module-5	8 Hrs.

Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, and flow through nozzles.
Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications

Practical Module

1. Determination of Coefficient of discharge of Venturimeter.
2. Determination of Coefficient of discharge of Orifice meter
3. Determination of head loss due to friction (Major losses)
4. Determination of head due to sudden contraction, sudden enlargement, bend and elbow (Minor losses)
5. Determination of Coefficient of discharge of V- Notch
6. Determination of Coefficient of impact of jet.
7. Determine the viscosity of oil using Redwood viscometer and Say-bolt viscometer.

Suggested Learning resources

1. Fox, R. W., Pitchard, P.J. and McDonald, A. T., (2010), Introduction to Fluid Mechanics, 7thEdition, John Wiley & Sons Inc.
2. A text book of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
3. Fundamentals of Fluid Mechanics, Munson,Young, Okiishi & Hebsch, John Wiley Publicationss,7th Edition
4. Fluid Mechanics (SI Units), Yunus A. Cingel John M. Oimbala. Tata McGraw-Hill, 2006
5. Fluid Mechanics and hydraulics, Dr. Jagadishlal: Metropolitan Book Co-Ltd., 1997.
6. Fluid Mechanics by Oijush K. Kundu, Iram Cochen, Elsevier 3rd Edition. 2005.
7. Fluid Mechanics by John F. Douglas, Janul and M.Gasiosek and John A. Swaffield, Pearson Education Asia, 5th edition., 2006.
8. Fluid Mechanics and Fluid Power Engineering," Kumar.D.S Kataria and Sons.,2004.
9. Essential Computational Fluid Dynamics by Oleg ZiaanovPub: Jhon Wiley.

Course Outcomes:

CO1: Classify the types of fluids and calculate shear stress, pressure intensity, total pressure and centre of pressure.

CO2: Differentiate between the types of fluid flow, similitude and calculate the velocity and acceleration aspects in a fluid flow applying continuity equation and dimensional analysis.

CO3: Evaluate the velocity as well as theoretical discharge using flow meters and losses in a pipes and conduits by applying Bernoulli's, Euler's, Darcy-Weisbach and Chezy's equations.

CO4: Apply the concept of boundary layer to fluid flow and dimensional analysis to form dimensionless numbers in terms of input output variables.

CO5: Understand the basic concept of compressible flow and CFD and Conduct basic experiments of fluid mechanics and understand the experimental uncertainties.

CO and PO Mapping Matrix

Course Outcomes	Programme Outcomes												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	2	1	-	-	-	-	-	-	1	-	-	1	1	-	-	-
CO2	2	1	-	-	-	-	-	-	1	-	-	1	1	-	-	-
CO3	2	1	-	-	-	-	-	-	1	-	-	1	1	-	-	-
CO4	2	1	-	-	1	-	-	-	1	-	-	1	1	-	-	-
CO5	2	1	-	-	1	-	-	-	1	-	-	1	1	-	-	-

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks**

  for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

1. The question paper will have ten questions. Each question is set for 20 marks.
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students have to answer 5 full questions, selecting one full question from each module.
4. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Question Paper Pattern for theory SEE

Answer any 5 full questions choosing at least one from each module for 100 Marks.

22UME414L	MECHANICAL MEASUREMENTS AND METROLOGY LAB	Credits: 01
0-0-2		CIE Marks: 50
Total Hours: 40		SEE Marks: 50

Course objectives:

1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.
2. To illustrate the use of various measuring tools measuring techniques.
3. To understand calibration techniques of various measuring devices.

Experiments

MECHANICAL MEASUREMENTS:

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

METROLOGY:

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set

Demonstration Experiments (For CIE)

1. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.
2. Measurements of Screw thread Parameters using two wire or Three-wire methods.
3. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
4. Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

1. To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.
2. To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
3. To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
4. To measure cutting tool forces using Lathe/Drill tool dynamometer.
5. To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.
6. To measure surface roughness using Tally Surf/ Mechanical Comparator.

Assessment Details (both CIE and SEE)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

CIE marks for the practical course are **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment is to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments are designed by the faculty who is handling the laboratory session and are made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled down to **30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct a test of 100 marks after the completion of all the experiments listed in the syllabus.
- In a test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- The marks scored shall be scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and marks of a test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero. The minimum duration of SEE is 02 hours

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12				
CO1	2	1								1		1				
CO2	2	2								1		1				
CO3										1		1				
CO4		1								1		1				
CO5	1	2			1					2		1				

22UME419C	INTRODUCTION TO DATA ANALYTICS	Credits: 01
L:T:P - 0 : 0: 2		CIEMarks:50
Total Hours/Week: 1		SEEMarks:50

About the Course

The **Data Analytics** course in the **Mechanical Engineering** domain is designed to empower students with the knowledge and skills to analyze and interpret complex datasets related to mechanical systems, processes, and applications. The course combines fundamental principles of mechanical engineering with modern data-driven techniques to solve real-world engineering problems.

Applications of Data Analytics course

1. Predictive Maintenance
2. Quality Control in Manufacturing
3. Process Optimization
4. Design and Simulation Enhancement
5. Thermal Systems Monitoring
6. Vibration Analysis
7. Automotive Industry Applications
8. Robotics and Automation
9. Energy Management
10. Smart Manufacturing (Industry 4.0)
11. Aerospace Industry Applications
12. Supply Chain and Inventory Management
13. Renewable Energy Systems
14. Building Systems and Infrastructure
15. Safety and Risk Management

Syllabus

Experiments	
1. Determine frequency distributions, variability, average, and standard deviation using Python 2. Determine probability, sampling and sampling distribution using Python 3. Draw normal curves, correlation, correlation coefficient and scatter plots using Python 4. Experiments 5. Implement and analyze Decision tree algorithm in Python 6. Implement and analyze Linear regression in Python (Single variable & Multivariable) 7. Implement and analyze Logistic regression in Python 8. Implement and analyze Random Forest algorithm in Python 9. Implementation of one-way and two-way ANOVA in excel. 10. Implementation of two samples T-test and paired two-sample T-test in excel. 11. Use matplot library to plot graph for data visualization using Python 12. Use Numpy to create single and multi-dimensional array and perform various operations using Python. 13. Use Pandas to access dataset, cleaning, manipulate data and analyze using Python	
Resources:	
Learning Resources: • McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc.".	

- Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
- Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. "John Wiley & Sons, Inc"
- https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python
- https://www.youtube.com/watch?v=GPVsHOlRBBI&ab_channel=freeCodeCamp.org

Course Outcomes**

After completion of the course student will be able to

CO1: Analyze data using tools and represent for visualization

CO2: Implement various statistical methods.

CO3: Understand and use decision tree and random forest algorithm

CO4: Understand and Implement T test and Anova

Table: Revised Bloom Vincenti (RBV) Taxonomy Table

Cognitive Processes	Knowledge Categories							
	Factual	Conceptual	Procedural	Metacognitive	Fundamental Design Principles	Criteria and specifications	Practical Constraints	Design Instrumentalities
Remember	IA1, AI1, *CO1,CO2*	IA1,AI1 *,CO1, CO2*	IA1, AI1 *, CO1, CO2*					
Understand	IA1, AI1 *,CO1,CO2*		AI1, *AI2,AI3, AI4,CO3,CO4*					
Apply			*CO4, IA4, AI4*					
Analyse								
Evaluate								
Create								

CO-Course Outcome AI-Assessment Items IA-Instructional Activities

Table: Mapping of COs with Pos/PSOs,

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1			1								1			
CO2	1	1			1								1			
CO3	1		1		1								1			
CO4	1	1			1								1			

Table: Mapping of COs with Pos/PSOs, Cognitive Level, Knowledge Level and Classroom Sessions.

Course Outcomes		POs/PSOs	Cognitive Level	Knowledge level	Class sessions
CO1	Analyze data using tools and represent for visualization	PO1, PO2, PO5, PSO1	Apply	Procedural Knowledge	6
CO2	Implement various statistical methods.	PO1, PO2, PO5, PSO1	Apply	Procedural Knowledge	6
CO3	Understand and use decision tree and random forest algorithm	PO1, PO3, PO5, PSO1	Understand	Conceptual Knowledge	6
CO4	Understand and Implement T test and Anova	PO1, PO2, PO5, PSO1	Understand	Conceptual Knowledge	6

Course Code:22UME421C	**Course Title: Non Traditional Machining**	**Credits :** (3 : 0 : 0)
Hours/Week (L:T:P) : 03		**CIE Marks :** 50
Total Hours of Pedagogy (Theory + Lab): 40		**SEE Marks :** 50
Course Type: Theory		

Brief Description of Subject:

Introduces the history, classification, and comparison between conventional and non-conventional machining processes, emphasizing the growing need for non-traditional methods in modern manufacturing. It explores various process selection criteria, highlighting the advantages of non-conventional machining when precision, complexity, or material hardness exceed the capabilities of conventional methods. The modules includes(USM), AJM,EDM,EBM,PAM,LBM, IBM, ECM & Chemical machining focusing on its equipment, principles of material removal, and process elements such as tool feed mechanism, process parameters, and the cutting theory of Miller. Applications, advantages, and limitations of USM are also discussed, providing students with a comprehensive understanding of its capabilities and constraints.

Course Objectives:

1. To introduce students to the history, classification, and selection criteria of conventional and non-conventional machining processes, with a focus on understanding the need for non-traditional methods.
2. To provide in-depth knowledge of various non-traditional machining processes, including Ultrasonic Machining, Abrasive Jet Machining, and Thermal Metal Removal processes like Electric Discharge Machining, focusing on their principles, applications, advantages, and limitations.
3. To explore advanced machining technologies such as Electron Beam Machining, Plasma Arc Machining, and Laser Beam Machining, emphasizing process mechanisms, equipment, and capabilities.
4. To familiarize students with Electrochemical and Chemical machining processes, including Electrochemical Machining and Chemical Machining, covering their principles, applications, and design considerations.

Module-1	**8 Hrs.**

Introduction to Non-traditional machining

Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.

Module-2	**8 Hrs.**

Ultrasonic Machining (USM):

Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.

Abrasive Jet Machining (AJM):

Introduction, Equipment and process of material removal, process variables: Carrier gases, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate,

Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.

Module-3	**8 Hrs.**

Electrochemical machining (ECM):

Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.

Chemical Machining (CHM):

Elements of the process, Resists (maskants), Etchants. Types of chemical machining Process -chemical blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Module-4	**8 Hrs.**

Electrical Discharge Machining (EDM):

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.

Plasma Arc Machining (PAM):

Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.

Module-5	**8 Hrs.**

Laser Beam Machining (LBM):

Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.

Electron Beam Machining (EBM):

Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.

Practical Module

Suggested Learning resources

1. Modern Machining Processes, P.C Pandey & H.S. Shan Tata McGraw Hill 2017
2. Hassan Abdel, Advanced Machining Processes, Mc Graw Hill, Mechanical Engineering Series.
3. HMT, Production technology, Tata Mc Graw Hill.
4. ASME, Metals hand book, Vol-3.
5. F.M Wilson, High velocity forming of metals, ASTME Prentice Hall.

Course Outcomes:

CO1: Determine a particular unconventional machining process for a particular material with respect to type of energy, mechanism of material removal and process capability and able to distinguish between conventional and unconventional machining processes.

CO2: Apply the knowledge of thermal metal removal processes for electric discharge machining and plasma arc machining and also the effect of various parameters on the material removal rate.

CO3: Apply the knowledge of mechanism of material removal and effect of parameters on material removal rate for ultra sonic machining, abrasive jet machining, electron beam machining, and laser beam machining processes.

CO4: Apply the knowledge of chemistry to electro chemical machining and chemical machining processes.

CO and PO Mapping Matrix

Course Outcomes	Programme Outcomes												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	1	1							1	1		1	1			
CO2	1	1							1			1	1			
CO3	1	1							1	1		1	1			
CO4	2	1							1			1	1			

Assessment Details (both CIE and SEE)

The weight age of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks**
  for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored by the student shall be proportionally scaled down to 50 Marks

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper may include questions from the practical component.

Question Paper Pattern for theory SEE

Answer any 5 full questions choosing at least one from each unit for 100 Marks.