CALICUT UNIVERSITY – FOUR-YEAR UNDER GRADUATE PROGRAMME (CU-FYUGP)

BSc PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**PROPERTIES OF MATTER & THERMODYNAMICS**				
Type of Course	**Minor (SET II: MATERIALS PHYSICS)**				
Semester	**I**				
Academic Level	**100 - 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	1. Awareness of Newton's first law, Hooke's law and static friction				
Course Summary	understanding of fundamental concepts of Equilibrium and Elasticity and their applications				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the concept of the center of gravity and its significance in determining stability. Solve problems involving the equilibrium of rigid bodies subjected to various forces and torques. Apply principles of equilibrium to analyze real world scenarios. Get the concept of elastic moduli and their significance in characterizing material properties.	U	C	Instructor-created exams / Quiz
CO2	Understand density and pressure in a fluid and their effects in fluid behaviour. Explain the principle of buoyancy and its application in determining the behavior of floating and submerged objects.	Ap	P	Practical Assignment / Observation of Practical Skills

	Understand Bernoulli's principle and its significance in describing the behaviour of fluids in motion. Analyse viscosity and turbulence.			
CO3	Get the concepts of temperature and thermal equilibrium. Demonstrate a clear understanding of the first law of thermodynamics, including the principles of conservation of energy and the relationships between heat, work, and internal energy. analyze various thermodynamic processes, including the work done during volume changes and the paths between thermodynamic states.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Calculate and interpret the internal energy of ideal gases, understanding the heat capacities and behavior of ideal gases under different conditions, including adiabatic processes.	U	C	Instructor-created exams / Home Assignments
CO5	Grasp the significance of the second law of thermodynamics in determining the direction of thermodynamic processes. Analyze heat engines and refrigerators, applying the principles of the second law to evaluate their efficiency.	Ap	P	One Minute Reflection Writing assignments
CO6	understand fundamental concepts in thermodynamics and apply them in practical situations.	Ap	P	Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evaluate (E), Create (C) # - Factual Knowledge(F) Conceptual Knowledge (C) Procedural Knowledge (P) Metacognitive Knowledge (M)				

Detailed Syllabus:

Module	**Unit**	**Content**	**Hrs (45 +30)**	**Marks (70)**
I	**Equilibrium and Elasticity**		**10**	**15**
	1	Conditions of Equilibrium, Center of Gravity	2	
	2	Solving Rigid body Equilibrium Problems	3	
	3	Stress, Strain and Elastic moduli	4	
	4	Elasticity and Plasticity	1	

	Sections from References: 11.1, 11.2, 11.3, 11.4, 11.5, Book 1			
II	**Fluid Mechanics**		**10**	**15**
	5	Gases, liquids and Density, Pressure in a Fluid	2	
	6	Buoyancy, Fluid flow	3	
	7	Bernoulli's Equation	3	
	8	Viscosity and Turbulence	2	
	Sections from References:12.1, 12.2, 12.3, 12.4, 12.5, 12.6, Book 1			
III	**Temperature, Heat and First Law of Thermodynamics**		**15**	**25**
	9	Temperature and Thermal Equilibrium	1	
	10	Thermodynamic systems	1	
	11	Work done during volume changes	2	
	12	Paths between Thermodynamic states	1	
	13	Internal Energy and First law of Thermodynamics	2	
	14	Kinds of Thermodynamic processes	2	
	15	Internal Energy of an ideal gas,	2	
	16	Heat capacities of an ideal gas	1	
	17	Adiabatic process for an ideal gas	3	
	Sections from References:17.1, 19.1, 19.2, 19.3, 19.4, 19.5, 19.6, 19.7, 19.8, Book 1			
IV	**The Second law of thermodynamics**		**10**	**15**
	18	Directions of thermodynamic processes	1	
	19	Heat Engines, Refrigerators	2	
	20	Second law of thermodynamics	2	
	21	The Carnot Cycle	3	
	22	Entropy	2	
	Sections from References:20.1, 20.2, 20.4, 20.5, 20.6, 20.7, Book 1			
V	**PRACTICALS**		**30**	

	Conduct any 5 experiments from the given list and 1 additional experiment, decided by the teacher-in-charge, related to the content of the course. The 6th experiment may also be selected from the given list. ● Necessary theory of experiments can be given as Assignment/ Seminar.			
	1	**Young's Modulus of the Material of a Given Bar: Uniform Bending** ● Use optic lever and telescope. Take measurements for minimum two lengths. Obtain the elevation (e) from the shift (s) in the telescope reading and calculate Y from it. ● For each length of the bar, plot the load-elevation graph (using GeoGebra) and obtain m/e, and then calculate Y from it. ● Estimate the random error in the measurements and the error of the result using propagation of error formulae.		
	2	**Young's Modulus of the Material of a Given Bar: Nonuniform Bending** ● Use pin and microscope. Take measurements for minimum two lengths. Obtain the depression (e) from the shift in the microscope reading and calculate Y from it. ● For each length of the bar, plot the load-depression graph (using GeoGebra) and obtain m/e, and then calculate Y from it. ● Estimate the random error in the measurements and the error of the result using propagation of error formulae.		
	3	**Torsion Pendulum- Determination of the Moment of Inertia and Rigidity Modulus.** ● Using identical masses on the disc, determine the moment of inertia of the disc. ● Verify the moment of inertia by direct method, $I = \frac{1}{2}MR^2$ ● Using I, calculate rigidity modulus of the material of the wire, $n = \frac{8\pi I}{r^4}\frac{L}{T^2}$		
	4	**Static torsion - Rigidity modulus** ● Using Searle's static torsion apparatus, determine the rigidity modulus of the material of the rod.		
	5	**Viscosity of a liquid - Poiseuille's Method** ● Fill the liquid in a vertically fixed burette with its lower end attached to a capillary tube, placed in horizontal position using a rubber tube.		

		• Note the time taken to reach each 10cc of water and the height of the corresponding marking. • Also measure the radius of the capillary tube using the traveling microscope and estimate the viscosity of the liquid.		
	6	**Viscosity of a liquid - Falling Ball Viscometer** • Drop a polished steel ball into a glass tube of a somewhat larger diameter containing the liquid. • Record the time required for the ball to fall at constant velocity through a specified distance between reference marks. • Use the Stoke's law for the sphere falling in a fluid under effect of gravity, to estimate the viscosity of the liquid.		
	7	**Surface tension of liquid - Capillary rise method** • Clamp a clean capillary tube by dipping its lower end into the liquid in the beaker. • Measure the rise of water in the tube using a traveling microscope. • Also measure the radius of the capillary tube using the traveling microscope and estimate the surface tension of the liquid. • Density of the liquid can be determined using Hare's apparatus of can be given		
	8	**Density of the liquid using manometer** • Fill a manometer tube partially with water. Pour the given oil (or any liquid which does not mix with water) into the left arm of the tube until the oil–water interface is at the midpoint. Both arms of the tube are open to the air. • Measure the heights of the oil and water using a traveling microscope and hence estimate the density of the oil assuming that of water. • Example 12.4 of book 1		
	9	**Verification of Boyle's law and Charle's law** • Boyle's law (PV= a constant) states that at a constant temperature, volume of a gas is inversely proportional to pressure. • Determine the volume - pressure relation at constant temperature using the water column. • Plot the pressure versus volume graph and verify Boyle's law. • Verify the law at minimum two different temperatures. • Charle's law (V/T = a constant) states that at constant pressure, volume is directly proportional to temperature. • In this experiment determine the temperature - volume relation at constant pressure using the water column. • Plot the temperature versus volume graph and verify the Charle's law.		

		● Verify the law at minimum two different pressures.		
	10	**Verification of Gay-Lussac's law** ● Gay-Lussac's law (P/T = a constant) states that at constant volume, pressure is directly proportional to temperature. ● In this experiment determine the temperature - pressure relation at constant pressure using metallic bulb and water column or pressure gauge or using Jolly's bulb apparatus. ● Plot the temperature versus volume graph and verify the Charle's law.		
	11	**Thermal conductivity by Searle's method** ● Determine the thermal conductivity of copper or any other metal using Searle's method / apparatus.		
	12	**Temperature coefficient of resistance of a metal** ● Resistance of metals increases with increase in temperature. ● Measure the resistance of the metal coil, using Carey Foster's bridge or Potentiometer or any other suitable method, as a function of temperature from 100 degree Celsius to room temperature. ● Plot graph and find the temperature coefficient of resistance.		
	13	**Thermo emf of a Thermocouple** ● Study the variation of thermo emf of a thermocouple as a function of temperature of the hot junction while maintaining the cold junction at 0 degree Celsius.		
	14	**Newton's law of cooling** ● According to Newton's law of cooling, the rate of heat loss of a hot body is proportional to the difference in temperature between the body and the surroundings. ● The calorimeter is filled with hot water and the variation in temperature is noted as a function of time. ● Cooling rate graph is plotted and law is verified. ● Emissivity of the surface of the calorimeter can also be determined. ● ExpEYES with PT1000 sensor may be used to record the temperature. https://expeyes.in/experiments/thermal/cooling.html		
	15	**Characteristics of NTC thermistor**		

		● Resistance of Negative Temperature Coefficient (NTC) thermistors decreases with increase in temperature. ● Measure the resistance of the thermistor, using Carey Foster's bridge or Potentiometer or ExpEYES or any other suitable method, as a function of temperature from 100 degree Celsius to room temperature. ● Plot the graph and study the characteristics.		
	16	**Melting point of wax** ● Fill a test tube with wax until half and use a thermometer inside the wax / test tube to measure wax temperature. Avoid the thermometer touching the test tube. ● Immerse the test tube in a water bath with the help of a stand, in such a way that the wax is below the water level. ● Use a suitable flame / heating rate and measure the wax temperature as a function of time at a suitable time interval. ● Plot temperature versus time graph. ExpEYES and PT1000 sensor may be used to record the temperature. https://expeyes.in/experiments/thermal/cooling.html ● The temperature increases initially and remains constant until the wax melts completely. The flat temperature gives the melting point of wax (The melting point depends on the type of wax used)		

Books and References:

1.University Physics with Modern Physics- Hugh D. Young, Roger A. Freedman,15th Edition (Book 1)

2.Intermediate Dynamics (Edn.2) by Patrick Hamill

3.An Introduction to Mechanics" by Daniel Kleppner and Robert J. Kolenkow

4.Mechanics" by Keith R. Symon

5.Concepts in Thermal Physics by Stephen J Blundell and Katherine M. Blundell

6.Thermal Physics by Charles Kittel and Herbert Kroemer

7.An Introduction to Thermal Physics by Daniel V. Schroeder

8.Heat and Thermodynamics by Mark Zemansky, Richard Dittman.

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	2	2	3	2	2	3	2	2	1	2	2	0
CO 2	1	3	2	1	2	1	2	3	2	1	2	2	0
CO 3	1	1	3	3	3	1	2	2	3	2	3	2	0
CO 4	3	1	2	1	1	2	3	2	2	2	2	2	0
CO 5	1	2	1	1	2	2	2	1	2	2	3	2	0
CO 6	2	2	1	1	1	3	2	2	2	2	2	3	0

Correlation Levels:

Level	**Correlation**
0	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Discussion / Seminar
- InternalTheory/Practical Exam
- Assignments /Viva
- End Semester Exam (70%)

Mapping of COs to Assessment Rubrics

	Internal Theory/ Practical Exam	Assignmen t /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	