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

BSc PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**MECHANICS AND OPTICS**				
Type of Course	**Minor (SET I: MATHEMATICS FOR PHYSICAL SYSTEMS)**				
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	Fundamentals of vectors, calculus and kinematics.				
Course Summary	This course explores Newton's Laws of Motion and how they can be applied to solve different mechanical systems, and also discusses various phenomena exhibited by light.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Apply Newton's Laws of Motion to solve different mechanical systems	Ap	P	Instructor-created exams / Home Assignments
CO2	Apply work-energy theorem to solve different mechanical systems	Ap	P	Instructor-created exams / Home Assignments
CO3	Analyse conservative systems and solve them using the conservation of mechanical energy.	An	P	Instructor-created exams / Home Assignments
CO4	Understand the basic nature and different phenomena exhibited by light.	U	C	Instructor-created exams / Home Assignments

CO5	Develop a skill to analyse the behaviour of light beams in devices consisting of mirrors and lenses.	Ap	P	Seminar Presentation / Group Tutorial Work
CO6	Develop skills to set up and perform experiments to test Newton's Laws of Motion, work energy theorem and different phenomenon exhibited by light.	Ap & C	P	Practical Assignment / Observation of Practical Skills / 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		**NEWTON'S LAWS OF MOTION AND APPLICATIONS**	**12**	**19**
	1	Newton's first laws: particles in equilibrium, Inertial frames of reference	3	
	2	Newton's Second law: Dynamics of particles	3	
	3	Frictional forces	3	
	4	Dynamics of circular motion	2	
	5	Fundamental forces of nature	1	
	Sections 4.2, 5.1 – 5.5 of Book1			
II		**WORK AND ENERGY**	**11**	**17**
	6	Work, Kinetic energy and work energy theorem	3	
	7	Work and energy with varying forces	3	
	8	Gravitational potential energy	2	
	9	Elastic potential energy	1	

	10	Conservative and non-conservative forces	1	
	11	Force and potential energy	1	
	Sections 6.1- 6.3, 7.1 - 7.4 of Book 1			
III	**GEOMETRICAL OPTICS**		**11**	**17**
	12	Nature of light, reflection, refraction	2	
	13	Total internal reflection, Dispersion	2	
	14	Reflection and refraction at a plane surface, reflection at spherical surface	3	
	15	Refraction at a spherical surface	2	
	16	Thin lenses, camera	2	
	Sections 33.1 - 33.4 of chapter 33 and sections 34.1 - 34.5 of chapter 34 of Book 1			
IV	**INTERFERENCE AND DIFFRACTION**		**11**	**17**
	17	Interference and coherent source	1	
	18	Two source interference of light, intensity of interference pattern	3	
	19	Interference in thin films, Newtons rings	1	
	20	Diffraction, Fresnel and Fraunhofer diffraction	1	
	21	Single slit diffraction	3	
	22	Two slits, Multiple slits	2	
	Sections 35.1 - 35.4 of chapter 35 and sections 36.1- 36.4 of chapter 36 of 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. Other experiments			

	listed here may be used as demonstrations of the concepts taught in the course. ● Plot the graphs using GeoGebra. FitLine function may be used to get the slope. ● Smartphones are exclusively intended for educational lab use. Necessary care should be taken to safeguard them during the experiments. ● Smartphone experiments primarily serve demonstration purposes, with result accuracy contingent upon the precision of phone sensors and experimental setups.			
	1	**Coefficient of Static Friction.** ● Determine the coefficient of static friction between a wooden block and a wooden plane. ● Measure the angle at which the wooden block just starts to slide down an inclined wooden plane and hence calculate the static friction coefficient. ● https://www.youtube.com/watch?v=gt8mr6pFSFE **OR** ● Place the wooden block on a wooden plane surface and add mass to the pan attached to the block using a string through a frictionless pulley. ● Find the mass required to initiate the sliding of the block. ● Different trials can be done by adding mass on the top of the block and hence determine the coefficient of static friction. ● Example 5.13 of Book 1. ● https://www.youtube.com/watch?v=MSV6VafiUF4&t=443s		
	2	**Verification of Newton's First Law: Equilibrium of a Particle** ● Analyze the two dimensional equilibrium problems using spring/digital force gauges. ● Hang a weight from a chain that is linked at the ring to two other chains, one fastened to the ceiling and the other to the wall. Example 5.3 of Book 1. ● Measure the angle between the chain from the ceiling and the horizontal and the tension in each of the three chains using		

		spring/digital force gauges and verify with the theoretical predictions. ● https://www.youtube.com/watch?v=XI7E32BROp0		
	3	**Acceleration of a Freely Falling Body** ● Use the smartphone acoustic stopwatch to determine the duration of a free fall. ● Measure the time of flight of a steel ball for different heights and plot a graph of distance vs. time squared (s vs. t^2). Determine g from the graph. ● Experiment 2 of Book 2. ● Phyphox app may be used. https://phyphox.org/experiment/free-fall-2/ **OR** ● Use ExpEyes kit, electromagnet, and contact sensor to determine the duration of a free fall. https://expeyes.in/experiments/mechanics/tof.html		
	4	**Verification of the Relation of Angular Velocity and Centrifugal Acceleration** ● Use the smartphone gyroscope and the accelerometer. ● Attach the smartphone to some rotating arrangements and record the data from the gyroscope and accelerometer. ● Plot angular velocity Vs acceleration and verify the relation. ● Experiment 18 of Book 2. ● https://doi.org/10.1119/1.4872422 ● Phyphox app may be used. https://phyphox.org/experiment/centrifugal-acceleration/		
	5	**Analysis of Air Resistance and Terminal Speed to Determine the Drag Coefficient.** ● Record the motion of a light weight paper cup and analyse it with Tracker tool (https://physlets.org/tracker/). ● Plot acceleration, velocity, and position with time. ● Repeat the experiment with different mass (by simply stacking the paper cups)		

		• Determine the Drag Coefficient • Experiment 27 of Book 2. • https://www.youtube.com/watch?v=iujzK3uH1Yc		
	6	**Projectile Motion: Energy Conservation** • Analyse the motion of the tossing ball/ projectile in the Tracker tool. • Plot time vs the x-and y-components of velocity and acceleration. • Also plot the kinetic energy, potential energy (build data using define tool) and total energy. • https://www.youtube.com/watch?v=x0AWRLvgB28 • https://www.youtube.com/watch?v=i07HeUWo8xc		
	7	**Analysis of Bouncing Balls to Determine Gravitational Acceleration and Coefficient of Restitution.** • After doing the experiment, the student should be able to understand the concept of inelastic collision. • Measure the time interval between successive bounces using a digital acoustic stopwatch and hence calculate g and coefficient of restitution • Experiment 12 of Book 2 and section 3.3 of Book 1 • Phyphox app may be used. https://phyphox.org/experiment/inelastic-collision/		
	8	**The Nearly Parabolic Trajectories of a Bouncing Ball** • Perform Experiment 7 using Tracker tool. • Track the ball and plot the time vs position graph. • Measure the time interval between successive bounces and hence calculate g and coefficient of restitution. • Experiment 12 of Book 2 and section 3.3 of Book 1 • https://www.youtube.com/watch?v=ocLQFMMLIGw		
	9	**Determine the refractive index of (a) given liquid and (b)the material of a lens, by forming a liquid lens.**		

		• Through this experiment the students are expected to get the concepts of image formation, combination of lenses and radius of curvature of the surface of lens. • Determine the radius of curvature of the lens by Boy's method and hence calculate the refractive indices.		
	10	**Determine the focal length of the combination of two lenses separated by a distance.** • Determine the focal lengths, f1 and f2 of the two lenses using an illuminated cross-slit screen holder, nodal slide(for placing the lenses) and plane mirror arrangement. • Place the two lenses separated by a distance d, determine the focal length, F of the combination and verify the relation • $\frac{1}{F} = \frac{1}{f1} + \frac{1}{f2} - \frac{d}{f1 f2}$. • The combination of the lenses in the eyepiece of the spectrometer/ travelling microscope may be used for the study. • https://www.youtube.com/watch?v=IOlEEtyNPBg • https://www.youtube.com/watch?v=tNo4Ipk74SU		
	11	**Determination of the refractive index of the material of the prism** • Familiarize the initial adjustments and measurements in the spectrometer. • Find the angle of the prism and the angle of minimum deviation using the yellow line of a sodium lamp and calculate the refractive index.		
	12	**Determination of the dispersive power of a solid prism using a spectrometer.** • Find the angle of the prism and the angle of minimum deviation for prominent lines of the mercury spectrum using a spectrometer. • Calculate the refractive indices corresponding to the colors and find the dispersive power of the material of the prism for two pairs of wavelengths.		
	13	**Determination of wavelengths of mercury spectrum using diffraction grating and spectrometer.** • Arrange the grating at normal incidence.		

		• Standardize the grating using the green line of mercury and then find the wavelengths of other prominent lines of the spectrum.		
	14	**Newton's rings-determination of the wavelength of sodium light** • Form of Newton's rings in the air-film in between a plano-convex lens and a glass plate using sodium-source. • Determine the radius of curvature by Boy's method and determine the wavelength of the source.		
	15	**Air wedge-determination of the radius of a thin wire/human hair//thin foil.** • Form interference fringes using sodium-source, in the air-film in between wedge formed by placing the given sample between the glass plates. • Measure the positions of the successive dark bands using a travelling microscope and determine the angle of the wedge and thickness of the sample given.		
	16	**Single slit diffraction using laser - Determination of slit width.** • The laser light diffracted from the narrow slit is allowed to fall on a screen and record the maxima or minima points in a paper. • From the width of the central maxima or the position of minimum intensity points, calculate the slit width. • Wavelength of laser can be found using diffraction grating of known N.		

Books and References:

1. University Physics with Modern Physics (Edn.15) by Young & Freedman (Book 1)
2. Smartphones as Mobile Minilabs in Physics(Edn. 1) by Jochen Kuhn & Patrik Vogt, Springer, (Book 2)
3. https://phyphox.org/
4. https://physlets.org/tracker/
5. Berkeley Physics Course : Vol.1 : Mechanics, 2ndEdn. – Kittelet al. – McGraw-Hill
6. Optics by Ajoy Ghatak – 4th edition
7. A textbook of Optics by Subramaniam, Brijlal & Avadhanulu, 25th Edition- S Chand and Company Limited

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO 4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	2	1	2	0	2	2	2	0	0	2	2	0
CO 2	2	2	1	2	0	2	2	2	0	0	2	2	0
CO 3	2	2	2	2	0	2	2	2	0	0	2	2	0
CO 4	0	1	0	1	2	1	2	2	0	0	2	2	0
CO 5	0	0	0	0	2	0	2	2	0	0	2	2	0
CO 6	2	2	2	2	0	2	2	2	0	0	2	2	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	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	

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 6^{th} 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	PSO5	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	Assignment /Viva	Practical Skill Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6		✓	✓	