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 • $\frac{1}{F} = \frac{1}{f1} + \frac{1}{f2} - \frac{d}{f1f2}$. • 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

Programme	**B.Sc. Physics Honours**				
Course Title	**ELECTROMAGNETISM AND NETWORK THEOREMS**				
Type of Course	**Minor (SET I: MATHEMATICS FOR PHYSICAL SYSTEMS)**				
Semester	**II**				
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 vector algebra, calculus and basic electronics				
Course Summary	This course explores different characteristics of electric and magnetic fields, application of network theorems for solving various electrical networks and behaviour of circuit components in ac circuits.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Revise the concept of charge, coulomb force, electric field, electric dipole and apply Gauss theorem for calculating electric field.	U & Ap	C & P	Instructor-created exams / Home Assignments
CO2	Identify the sources of magnetism, explain properties of magnetic forces, behaviour of charged particles in magnetic field and apply Amperes law for calculating magnetic field.	U & Ap	C & P	Instructor-created exams / Home Assignments
CO3	Analyse various network theorems and apply these	An & Ap	P	Instructor-created exams / Home

	theorems for solving complex electrical circuits.			Assignments
CO4	Analyse the behaviour of various electrical components like resistors, capacitors and inductors in pure ac circuit.	An	P	Instructor-created exams / Home Assignments
CO5	Design and analyse the behaviour of ac circuits with more than one electrical component.	An & Ap	P	Seminar Presentation / Group Tutorial Work
CO6	Develop skills to set up and perform experiments to analyse different properties of electric and magnetic field. Design and construct ac circuits consisting various circuit elements and analyse its properties.	Ap	M	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		**ELECTROSTATICS**	**12**	**19**
	1	Coulomb's law, superposition of forces, Electric field and electric forces	3	
	2	Electric field calculations, Electric field lines	2	
	3	Electric dipoles	2	
	4	Charge and electric flux,	1	
	5	Gauss's law	2	
	6	Applications of Gauss's law	2	
	Relevant topics of chapter 21, 22 of Book 1; sections 21.3 – 21.7 of chapter 21 and 22.1–- 22.4 of chapter 22 of Book 1			

II	**MAGNETISM**		**11**	**17**
	7	Magnetic field, magnetic flux, motion of charged particles in magnetic field.	3	
	8	Magnetic force on current carrying conductor, torque on a current loop.	2	
	9	Magnetic field of a moving charge, current element and a straight current carrying conductor.	2	
	10	Force between parallel conductors, Magnetic field of a circular current loop	2	
	11	Ampere's law, Applications ampere's law.	2	
	Sections 27.1- 27.4, 27.6, 27.7 (section 27.7 - till magnetic torque: loops and coils) of chapter 27 and sections 28.1 -28.7 of chapter 28 of Book 1			
III	**NETWORK THEOREMS**		**11**	**17**
	12	Electrical circuits, Kirchhoff's laws.	2	
	13	Solving simultaneous equations, solving equations with two and three unknowns.	2	
	14	Source conversion, Ideal constant voltage source, Ideal constant current source, Superposition theorem.	2	
	15	Thevenin theorem.	2	
	16	Norton's theorem.	2	
	17	Maximum power transfer theorem.	1	
	Sections 2.1 - 2.8, 2.14 – 2.20, 2.25 – 2.27 and 2.30 – 2.31 of chapter 2 of Book 2			
IV	**AC CIRCUITS**		**11**	**17**
	18	Generation of alternating voltage and current, equation of the alternating voltage and current, AC through pure resistance, pure inductance and pure capacitance alone.	3	

	19	mathematical representation of vectors	1	
	20	AC through resistance and inductance.	2	
	21	A.C. through resistance and capacitance.	2	
	22	Resistance, inductance and capacitance in series.	3	
	Sections 11.1 – 11.2, 11.28 – 11.30, 11.32, 12.1 – 12.7, 13.1 – 13.19 of chapter 11, Chapter 12 and 13 of book 2			
V	**PRACTICALS**		**30**	
	Conduct any 6 experiments from the given list and 1 additional experiment, decided by the teacher-in-charge, related to the content of the course. The 7th 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.			
	1	**Mapping of the magnetic field lines of a bar magnet.** • Fix a paper on a drawing board kept on a table and place the bar magnet at the center along the magnetic meridian. • Using a small compass needle, map the magnetic field lines of the magnet placed with north pole pointing south • Mark the null points (where the horizontal component of Earth's magnetic field, Bh cancels the field due to magnet) along the axial/equatorial line and measure the distance, 2d, between them. • Calculate the moment of the magnet. $m = \frac{4\pi}{\mu_0}\frac{(d^2-l^2)^2}{2d}B_h$		
	2	**Study the variation of the magnetic field strength of a bar magnet using a smartphone magnetometer.** • Using a smartphone magnetometer, measure the strength of the magnetic field of a bar magnet, along the axial and equatorial lines and plot the data. • Magnetometer in the Phyphox app may be used to get the data after locating the approximate position of the magnetometer sensor.		

		https://phyphox.org/wiki/index.php?title=Sensor:_Magnetic_field • Fit the theoretical formulae to the data and obtain magnetic dipole moment. Along the axial line $B = \frac{\mu_0}{4\pi}\frac{2md}{(d^2-l^2)^2}$ and along the equatorial line $B = \frac{\mu_0}{4\pi}\frac{m}{(d^2+l^2)^{3/2}}$		
	3	**Determine the moment of a bar magnet and Bh using a deflection magnetometer and a box type vibration magnetometer.** • Determine m/Bh using deflection magnetometer in Tan A position and mBh using box type vibration magnetometer. Hence calculate the moment of the magnet and Bh. • If the same magnet was used, compare the dipole moment with that of experiment 2 and 3.		
	4	**Circular coil- Verification of Biot Savart's law and determination of Bh** • Move a compass through a platform along the axis of the coil carrying a study current. Note the deflection of the needle and plot magnetic flux density ($B = B_h tan\theta$) as a function of distance. • Optional: Smartphone magnetometer may be used to measure the strength of the magnetic field along the axial line and plot the data. https://phyphox.org/experiment/magnetic-field/ • Experiment 62 of Book 6 • By varying current and (or) distance of the compass box along the axial line of the coil, note the deflection and hence determine the value of Bh.		
	5	**Reduction factor of TG using potentiometer.** • Standardize the given potentiometer using a Danial cell or any other constant voltage source and use the standardized potentiometer to find the current through the TG. • By observing the deflection in the TG for different currents, calculate the reduction factor. • From the magnetic field at the center of a circular coil, deduce the value Bh.		

	6	**Verification of Kirchoff's laws/ Superposition theorem.** ● Verify Kirchoff's current law at a junction where a minimum of three branches meet. ● Verify Kirchoff's current law for a network with two loops. **OR** ● Verify the superposition theorem for a network with two sources, S1 and S2. ● First set particular voltage values in S1 and S2 and note down the ammeter reading. ● Set the same voltage in S1 and short circuit S2 and vise versa, note down the ammeter readings and verify the superposition theorem.		
	7	**Verification of Thevenin's theorem and maximum power transfer theorem** **Thevenin's theorem** ● Measure the current through the load resistance of the network. ● Estimate the values of R_{TH} and V_{TH}, construct the Thevenin's equivalent circuit and measure the current through load resistance and compare the two results with the theoretical values. **Maximum power transfer theorem** ● Measure the current through load resistance and estimate the power. Plot $R_L - P$ graph and find the R_L corresponding to the maximum power. ● Calculate the % of error with the theoretical value.		
	8	**AC three phase generator** ● Rotate a neodymium magnet about an axis perpendicular to its dipole axis and fix three coils displaced equally from each other, i.e., 120^o separated. ● Analyze the induced emf developed in the coils using CRO/ExpEYES and the phase relationship between the three induced voltages. ● https://expeyes.in/experiments/school-level/ac-generator.html		
	9	**RL and RC series AC circuits- Phase relationships of voltage across the elements.**		

		• Using a CRO/ ExpEYES, verify the phase relationship between voltage across the inductor/capacitor and the current. • Note the phase difference between the applied voltage and current and determine the value of inductance/capacitance. **OR** • Note the peak voltage and current and determine the value of inductance/capacitance. • https://expeyes.in/experiments/electrical/rcsteady.html • https://expeyes.in/experiments/electrical/rlsteady.html • https://expeyes.in/experiments/school-level/ac-rc.html • https://expeyes.in/experiments/school-level/ac-rl.html		
	10	**Series LCR circuits-Determination of resonance frequency, quality factor and bandwidth.** • The frequency of the signal generator is changed in steps and the corresponding voltage across the resistance is noted. • From the graph drawn for current against frequency, find the frequency corresponding to maximum voltage- resonant frequency. Also find the bandwidth and quality factor • CRO/Multimeter/ExpEYES can be used. https://expeyes.in/experiments/electrical/rlcsteady.html		
	11	**Thomson's e/m experiment - Determination of the specific charge of the electron.** • Measure the ratio of the electron charge-to-mass ratio (e/m) by studying the electron trajectories in a uniform magnetic field.		
	12	**Parallel plate capacitor. (a) verify the relationship between capacitance and the area of the plates (b) determination of dielectric constant of thin dielectric sheet** • Form a parallel plate capacitor with dielectric material filled between the plates. • Multimeter/ ExpEYES can be used to measure the capacitance. (For a significantly measurable value of the capacitance, use plates of dimension 10cmx10cm, or greater) • Change the area of the capacitor plates and verify the relationship of the capacitance on the area (Using the same set of plates, the area can be changed by varying the overlapping region of the plates)		

		• By measuring the capacitance for different areas of the capacitor plates and (or) thickness of the dielectric material,determine the dielectric constant of the given material/liquid. • https://www.youtube.com/watch?v=lKfIkUuFT-U		
	13	**Verification of Faraday's law and Lenz's law of electromagnetic induction** • Verify Faraday's law and Lenz's law by measuring the induced voltage across a coil subjected to the varying magnetic field. (section 7.2.1 of Book 1) • Galvanometer/ExpEYES can be used to measure the induced emf. • In the third experiment, for better coupling between the coils, use a high permeability material like iron or ferrite core, and observe the change in the induced emf. • https://expeyes.in/experiments/school-level/mutual-induction.html • Simulation: https://phet.colorado.edu/sims/html/faradays-law/latest/faradays-law_all.html		
	14	**Analysis of induced emf developed in a coil as a magnet dropping through it.** • Drop a neodymium magnet through a coil, guided through a vertical tube. • Repeat the experiment by dropping the magnet, through different heights from the coil and by changing the approaching pole. • Capture the induced emf as a function of time using ExpEYES, note the maximum value of the emf and verify Faraday's law and Lenz's law of induced emf and flux change. • Example 7.6 of Book 1 • https://expeyes.in/experiments/school-level/em-induction.html		
	15	**Demonstration of Eddy currents** • Mount aluminum/copper disk as a pendulum on a horizontal axis and observe the 'viscous drag' as it swings down and passes between the poles of a magnet (Can be realized using		

		two pieces of neodymium magnet. The demonstration illustrated in Fig. 7.16 of Book 3). • https://www.youtube.com/watch?v=qTkOpprVITM OR • Form a simple pendulum with a neodymium magnet and observe the 'viscous drag' as it swings down when an aluminium/copper sheet/block is placed under the pendulum. • https://www.youtube.com/watch?v=VK40utGgioI • https://www.youtube.com/watch?v=SF4xjO2RN1w OR • Drop a neodymium magnet through an aluminium/copper tube and observe the delay in the fall of the magnet. Tubes of different gauge may be used for the demonstration. • Keep the two probes at diametrically opposite points of the pipe and note the emf and current when a magnet is allowed to fall through the pipe. • https://www.youtube.com/watch?v=H31K9qcmeMU		

Books and References:

1. University Physics with Modern Physics (Edn.15) by Young & Freedman (Book 1)
2. A Textbook of Electrical Technology, Volume – I (Revised 23rd Edition) by B. L. Thereja and A. K. Thereja (Book 2)
3. Introduction to Electrodynamics-David J Griffith, 4th Edition, Pearson (Book 3)
4. Electricity and Magnetism by R. Murugesan- S Chand and Company Limited (Book 4)
5. Basic electrical engineering by V. K. Mehta and Rohit Mehta - S Chand and Company Limited (Book 5)
6. Smartphones as Mobile Minilabs in Physics(Edn. 1) by Jochen Kuhn & Patrik Vogt, Springer, (Book 6)

Mapping of COs with PSOs and POs :

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	2	1	3	0	2	2	2	2	2	1	3	2	0
CO 2	2	1	2	0	2	2	2	2	2	1	3	2	0
CO 3	2	2	3	1	1	1	2	2	2	1	3	2	0
CO 4	0	0	2	3	1	1	2	2	2	1	3	2	0
CO 5	0	0	2	1	2	2	2	2	2	1	3	2	0
CO 6	2	3	2	2	1	1	2	2	2	1	3	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	**MATHEMATICAL METHODS FOR PHYSICS**				
Type of Course	**Minor (SET I: MATHEMATICS FOR PHYSICAL SYSTEMS)**				
Semester	**III**				
Academic Level	**200 –299**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Fundamentals of vectors, linear algebra, differential equations coordinate systems and familiarity with basic concepts in physics.				
Course Summary	This course explores fundamental principles and applications of vector analysis, complex functions, differential equations and curvilinear coordinates in electromagnetism and engineering contexts.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Students will attain a strong foundational understanding about vector calculus, complex numbers, differential equations and curvilinear coordinates	U	C	Instructor-created exams / Quiz

CO2	Students will develop analytical proficiency which enables them to analyse and interpret complex physical phenomena through the application of mathematical principles.	Ap	P & M	Practical Assignment / Observation of Practical Skills
CO3	Students will cultivate advanced problem-solving skills.	Ap	P	Practical Assignment / Observation of Practical Skills
CO4	Students will enhance their ability to model and represent physical systems mathematically for describing and understanding complex phenomena.	Ap	P M	Practical Assignment / Observation of Practical Skills / Home Assignments
CO5	Students will recognize and appreciate the interdisciplinary applications of mathematical methods.	Ap	C & M	Seminar Presentation / Group Discussion
CO6	Students will refine their critical thinking which encourages independent inquiry and problem-solving approaches in tackling challenging problems and scenarios.	Ap	P & M	Group Discussion/ Viva Voce
* - Remember (R), Understand (U), Apply (Ap), Analyse (An), Evalu ate (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	**VECTOR CALCULUS**		**12**	**20**
	1	Scalar and Vector Point Functions, Gradient of a Scalar Function Geometrical Meaning of Gradient	4	
	2	Normal and Directional Derivative, Divergence of a Vector Function, Physical Interpretation of Divergence, Divergence and Curl of Electrostatic Fields	4	
	3	Curl, Physical Meaning of Curl, The Divergence and Curl of B	4	
	Sections 2.4, to 2.11 of book 2, Sections 2.2.1 – 2.2.4 of chapter 2 and Section 5.3.1 – 5.3.3 of chapter 5 of book 1			
II	**COMPLEX NUMBERS AND COMPLEX FUNCTIONS**		**11**	**15**
	4	Introduction, Complex Numbers	1	
	5	Geometrical Representation of Imaginary Numbers Argand Diagram	1	
	6	Equal Complex Numbers, Addition, Addition of Complex Numbers by Geometry	1	
	7	Subtraction, Powers of *i*, Multiplication, *i* (Iota) as an Operator, Conjugate of a Complex Number	1	
	8	Division, Division of Complex numbers by Geometry	1	
	9	Modulus and Argument, Polar form, Types of Complex Numbers	1	
	10	Resistance and Reactance	2	
	11	The L-R-C series Circuit	3	
	Sections 20.1 to 20.17 of book2, Sections 31.2 and 31.3 of book 3			
III	**ORDINARY DIFFERENTIAL EQUATIONS**		**12**	**20**
	12	Definition, order and Degree of a Differential Equation	1	
	13	Formation of Differential Equations, Solution of a Differential Equation	1	

	14	Geometrical Meaning of the Differential Equation of the First order and First Degree, Differential Equations of the First order and First Degree	2	
	15	Variables Separable, Homogeneous Differential Equations, Equations Reducible to Homogeneous form, Linear Differential Equations, Equations Reducible to the Linear form (Bernoulli Equation)	4	
	16	Non-Linear Differential Equations, Linear Differential Equations of Second order with Constant Coefficients	2	
	17	Periodic Motion- Simple Harmonic motion. Applications of simple Harmonic motion, Damped oscillations	2	
	Sections 12.1 to 12.11, 13.2, 13.3 of book 2, Sections 14.2, 14.4, 14.7 of Book 3			
IV	**CURVILINEAR COORDINATES**		**10**	**15**
	18	Curvilinear Coordinates	1	
	19	Cylindrical (Polar) Co-ordinates	2	
	20	Spherical Polar Co-ordinates	2	
	21	Relation Between Cylindrical and Spherical Co-ordinates	2	
	22	Applications of Gauss's Law in polar, cylindrical and spherical problems	3	
	Sections 4.1, 4.8, 4.9, 4.12 of book 2, Section 2.2.3 Application of Gauss's law of Book 1			
V	**PRACTICALS**		**30**	
	1	**Flywheel- Determination of the Moment of Inertia.** ● This experiment aims to help students grasp the concept of energy conservation and the dynamics of rotation. ● Do at least 9 trials for different masses and number of turns wound on the axil.		
	2	**Torsion Pendulum- Determination of the Moment of Inertia.** ● Using identical masses on the disc, determine the moment of inertia of the disc. ● Verify the moment of inertia by direct method, $I = \frac{1}{2}MR^2$		

	3	**Compound Pendulum- Acceleration Due to Gravity and Moment of Inertia and Verification of Parallel Axis Theorem.** ● Plot a graph of distance of knife edge from one end Vs period of oscillations. Using the measurement from the graph, calculate g. ● Calculate the radius of gyration and hence the moment of inertia about CM. Compare the result obtained by the direct calculation $I_{CM} = \frac{ML^2}{12}$		
	4	**Kater's Pendulum- Determination of Earth's Gravity.** ● To determine g and discuss the relative merits of both cases by estimation of error in the two cases.		
	5	**Sonometer - Determine the Frequency of AC.** ● Estimate the linear mass density of the wire. ● Draw $L^2 - m$ graph and from the slope calculate the frequency.		
	6	**Determination of the Velocity of Sound in Air.** ● Sound wave of known frequency is generated using a wave generator(WG) and piezo buzzer and are recorded using a microphone(MIC). ● Phase differences between the WG and MIC waveforms were analyzed in a CRO and the distance between them were adjusted to make both of them in phase and hence calculate velocity of sound. ● Phase difference can be analyzed from the Lissajous figure obtained by X-Y plotting of WG and MIC waves. ● ExpEYES may be used. ● https://expeyes.in/experiments/sound/velocity.html ● https://expeyes.in/experiments/electrical/xyplot.html		

	7	**Pendulum- Limits on Angular Displacement and Study of Damped Oscillations.** ● Estimate limits on angular displacement for SHM by measuring the time period at different angular displacements and compare it with the expected value of time period for SHM. ● Study damped oscillations. Plot amplitude as a function of time and determine the damping coefficient and Q factor. ● Digitized data can be used for the study. ● https://www.youtube.com/watch?v=jcpvm95bhXw ● https://expeyes.in/experiments/school-level/sr04.html ● https://phyphox.org/experiment/pendulum/		
	8	**Black body spectrum of Sun -Estimation of surface temperature using the Tracker Video Analysis tool.** ● Calibrate the video of the solar spectra in the Tracker tool using two laser wavelengths/lines of mercury spectra. ● Plot wavelength vs intensity, get λ_{max} and using Wein's law calculate the surface temperature. ● Pre recorded video of the solar spectra can be used.		
	9	**Analysis of Hydrogen spectra using the Tracker Video Analysis tool**. ● Calibrate the video of the Hydrogen spectra in the Tracker tool using two laser wavelengths/lines of mercury spectra. ● Plot the intensity profile, find the prominent wavelengths of the Balmer series and calculate the Rydberg's constant. ● Estimate the %error. ● Pre recorded video of the Hydrogen spectra can be used. ● https://physlets.org/tracker/. ● https://www.youtube.com/watch?v=UCCPkJpUQEw		

	10	**RC and RL transients - determination of capacitance and inductance.** ● Apply a voltage step to a series RC/RL circuit and record the resulting voltage variation across the capacitor/inductor. ● Get the value of time constant by an exponential fit to the data. ● Repeat the experiment for different resistances. ● https://expeyes.in/experiments/electrical/rctransient.html ● https://expeyes.in/experiments/electrical/rltransient.html		
	11	**Determination of Plank's constant using LEDs** ● Observe the turn-on voltage, ● V_0 of LEDs and calculate the value of h. Use at least 4 different colors of LED (with transparent casing) ● Plot $\frac{1}{\lambda} - V_0$ graph using Python, fit a straight line to get the slope and estimate the value of h. ● Calculate the %error. ● Programmable voltage source of ExpEYES may be used to find the turn-on voltage.		
	12	**Construction of the center tapped full wave rectifiers and regulated power supply** ● Construct a center tapped full wave rectifier without filter and with a filter. ● Measure the AC and DC voltages using a multimeter and calculate the ripple factor without and with a filter. ● Observe the variation of the ripple factor with load resistance, when filter is used. ● Construct 5V/12V regulated power supply using 78XX IC.		
	13	**Construct Half adder using universal gates and study the operation.** ● Implement half adder using NAND/NOR gates and verify the truth table for each input/output combination.		

	14	**Verification of De-Morgan's Theorems using basic gates.** ● Realize the either side of the De-Morgan's Theorems using gates from appropriate ICs and verify the truth table for each input/output combination.		
	15	**Construction of the center tapped full wave rectifiers and regulated power supply.** ● Construct a center tapped full wave rectifier without filter and with a filter. ● Measure the AC and DC voltages using a multimeter and calculate the ripple factor without and with a filter. ● Observe the variation of the ripple factor with load resistance, when filter is used. ● Construct 5V/12V regulated power supply using 78XX IC.		

Books and References:

1. Introduction to Electrodynamics by David J Griffiths, 5th Edition (Book 1)
2. Mathematical Physics by H K Das and Rama Verma, 7th Edition (Book 2)
3. University Physics With Modern Physics by Hugh D Young and Roger A Freedman 14th edition (Book 3)
4. Mathematical Physics by Satya Prakash - S Chand and Sons

Mapping of COs with PSOs and POs:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	1	2	0	2	2	3	2	2	1	3	2	1
CO 2	2	3	2	1	1	1	2	2	2	1	3	2	0
CO 3	1	2	3	1	2	1	2	2	2	1	3	2	1
CO 4	2	1	1	3	2	1	2	2	2	1	3	2	0
CO 5	2	2	2	1	3	1	2	2	2	1	3	2	1
CO 6	2	1	3	0	2	3	2	2	2	1	3	2	1

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		✓	✓	