FOUR-YEAR UNDER
GRADUATE PROGRAMME (CU-FYUGP)

BSc PHYSICS HONOURS

Programme	**B.Sc. Physics Honours**				
Course Title	**ELECTRICITY AND MAGNETISM**				
Type of Course	**Minor (SET IV: OPTICAL 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	A strong foundation in introductory physics, including mechanics, thermodynamics, and basic concepts of electricity and magnetism. Proficiency in algebra, trigonometry				
Course Summary	This paper provides students with a solid foundation in the principles of electricity and magnetism, enabling them to apply theoretical concepts to practical scenarios and develop problem-solving skills in electromagnetism.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand and grasp the concept of electric charge, its properties, including quantization and conservation principles.	U	C	Instructor-created exams / Quiz
CO2	Students will analyze electric fields produced by various charge distributions, including point charges, electric dipoles, and charged infinite sheets. students will develop the ability	Ap	P	Practical Assignment / Observation of Practical Skills

	to visualize electric fields and understand their behavior in different spatial configurations.			
CO3	Understand the concept of electric dipoles, analyze the forces and torques acting on them in uniform electric fields, and relate these to practical applications.	Ap	P	Seminar Presentation / Group Tutorial Work
CO4	Apply Gauss's law to calculate electric flux through closed surfaces, understand its implications for charge distribution, and analyze the behavior of electric fields in various scenarios.	U	C	Instructor-created exams / Home Assignments
CO5	calculate electric potential due to point charges, charged conductors, and other charge distributions, and analyze the concept of electric potential energy.	Ap	P	One Minute Reflection Writing assignments
CO6	Through practical experiments and theoretical analysis, students will explore applications of Gauss's law, such as determining charges on conductors and understanding electric potential distributions.	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	**Electric charge and Electric field**		**10**	**16**
	1	Electric charge	3	
	2	Coulomb's law	2	
	3	Electric field and electric force, Electric field calculation- electric dipole and charged infinite sheet	2	
	4	Electric field lines	1	
	5	Electric dipole: upto force and torque on electric dipole	2	
	Sections 21.1, 21.3 - 21.7, Book 1			
II	**Gauss's law and Electric potential**		**16**	**25**

	6	Charge and electric flux	2	
	7	Calculating electric flux	3	
	8	Gauss's law	2	
	9	Application of Gauss's law	2	
	10	Charges on conductors-testing Gauss's law experimentally	1	
	11	Electric potential energy	3	
	12	Electric potential: upto electric potential of charged conducting sphere	3	
	Sections 22.1-22.5, 23.1- 23.3, Book 1			
III	**Current resistance and electromotive force**		**12**	**18**
	13	Current, resistivity and resistance	4	
	14	EMF and circuits	2	
	15	Energy and power in electric circuits: upto power input to a pure resistance	1	
	16	Theory of metallic conduction	1	
	17	Resistance in series and parallel	2	
	18	Kirchoff law and Power distribution system	2	
	Sections 25.1- 25.6, 26.1, 26.2, 26.5, Book 1			
IV	**Magnetic field and magnetic forces**		**7**	**11**
	19	Magnetism, Magnetic field	2	
	20	Magnetic field lines and magnetic flux	2	
	21	Motion of charged particle in a magnetic field	1	
	22	Magnetic force on a current carrying conductor-straight conductor	2	
	Sections 27.1-27.4, 27.6, 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.			

	Necessary theory of experiments can be given as Assignment/ Seminar.			
	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. (a) $m = \frac{4\pi}{\mu_0}\frac{(d^2-l^2)^2}{2d}B_h$		
	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 2		

		● 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.		
	7	**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.		
	8	**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		
	9	**Calibrate the ammeter using potentiometer** ● Standardize the potentiometer using a Danial cell or any other standard voltage source. ● Determine the current for at least 8 trials and draw the calibration graph.		
	10	**Conversion of Galvanometer to voltmeter and calibration using potentiometer**		

		• Determine the value of high resistance required to connect in series with the galvanometer so as it can read 0.1V or 0.2V per scale division. • Standardize the potentiometer using a Danial cell or any other standard voltage source. • Determine the voltage for at least 6 trials and draw the calibration graph.		
	11	**Determination of resistivity of a thin wire using Carey-Foster's Bridge** • Find the resistance per unit length of the bridge wire. • Determine resistance of the thin wire using the bridge, thickness of the wire using screw gauge and hence determine		
	12	**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		
	13	**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. • Phyphox app may be used. https://phyphox.org/experiment/centrifugal-acceleration/		
	14	**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		

		• Phyphox app may be used. https://phyphox.org/experiment/inelastic-collision/		
	15	**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		

Books and References:

1. University Physics with Modern Physics- Hugh D. Young, Roger A. Freedman,15th Edition (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. Introduction to Electrodynamics-David J Griffith, 5th Edition- Pearson

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO 6	PO 7
CO 1	2	1	1	0	1	1	1	1	1	1	2	1	1
CO 2	2	2	2	1	1	1	1	1	1	1	2	1	1
CO 3	2	2	2	0	1	1	1	1	1	1	2	1	1
CO 4	2	1	3	1	0	1	1	1	1	1	2	1	1
CO 5	2	1	1	0	2	1	1	1	1	1	3	1	1
CO 6	2	3	2	2	1	2	1	1	1	1	2	1	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		✓	✓	