PHY1CJ 101 - FUNDAMENTALS OF PHYSICS

BSc PHYSICS HONOURS

Core in Major PHY1CJ101/PHY1MN100 FUNDAMENTALS OF PHYSICS

Programme	B.Sc. Physics Honours				
Course Title	FUNDAMENTALS OF PHYSICS				
Type of Course	Core in Major				
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.				

FYUGP Physics	
PO1	Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.
PO4	Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.

PO6	Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.

PSO1	Understand concepts and applications in the field of Physics viz. Mechanics, Electrodynamics, Thermodynamics, Optics, Quantum Mechanics, Electronics etc.
PSO2	Develop the skills for experimentation to measure, analyse and interpret empirical data, and present the results in a methodical and accessible way.
PSO3	Evaluate complex real-world problems by applying principles of theoretical and applied physics, and mathematical and computational models.
PSO4	Design and execute a Project to solve real-world problems in accordance to the need of the industry and academic research, in a stipulated time frame.
PSO5	Develop understanding of the fundamental concepts of Physics needed for a deeper study of related fields of knowledge viz. Mathematics, Chemistry, Electronics, Computer Science, Geology etc.
PSO6	Develop the experimental and analytical skills in Physics that can be of useful applications in allied areas of knowledge.

CO's	CO Description	Tax	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Summarize the concepts of Newton's Laws of Motion	Un	3	0	2	0	2	1	3	3	1	1	2	2	1
CO2	Apply Newton's Laws of Motion to solve different mechanical systems	Ap	3	2	2	0	1	2	3	3	3	1	3	3	3
CO3	Apply work-energy theorem to solve different mechanical systems	Ap	3	2	2	0	1	2	3	3	3	1	3	3	3
CO4	Analyse conservative systems and solve them using the conservation	An	3	2	2	3	1	2	3	3	3	1	3	3	3

	of mechanical energy.														
CO5	Demonstrate critical thinking and problem-solving skills by applying the concepts and techniques learned to solve an extended set of real-world problems.	Un	3	2	3	0	3	3	3	3	3	1	3	3	3
CO6	Demonstrate skills to set up and perform experiments to test Newton's Laws of Motion and related concepts.	Un	3	3	3	3	1	3	3	3	3	1	3	3	3

Detailed Syllabus:

Module	Unit	Content	Hrs (45 +30)	Marks (70)
I		NEWTON'S LAWS OF MOTION	12	18
	1	Review of units, physical quantities and vectors	3	
	2	Force and Interactions	2	
	3	Newton's First Law	2	

	4	Newton's Second Law	2	
	5	Mass and Weight	1	
	6	Newton's Third Law	1	
	7	Free-Body Diagrams	1	
	Relevant topics of chapter 1 of Book 1 ; sections $4.1 - 4.6$ of chapter 4 of Book 1 Self-Study: Chapters $1 - 3$ of Book 1			

II		APPLYING NEWTON'S LAWS	14	20
	8	Using Newton's First Law: Particles in Equilibrium	3	
	9	Using Newton's Second Law: Dynamics of Particles	3	
	10	Apparent Weight and Apparent Weightlessness	1	
	11	Friction Forces	2	
	12	Fluid Resistance and Terminal Speed	1	
	13	Dynamics of Circular Motion	3	
	14	The Fundamental Forces of Nature	1	
	Sections 5.1 - 5.5 of chapter 5 of Book 1			
III		WORK AND KINETIC ENERGY	8	14
	15	Work	1	
	16	Kinetic Energy and the Work - Energy Theorem	3	

	17	Work and Energy with Varying Forces	3	
	18	Power	1	
	Sections $6.1 - 6.4$ of chapter 6 of Book 1			
IV	POTENTIAL ENERGY AND ENERGY CONSERVATION		11	18
	19	Gravitational Potential Energy	3	
	20	Elastic Potential Energy	2	
	21	Conservative and Nonconservative Forces	2	
	22	Force and Potential Energy	2	
	23	Energy Diagrams	2	

	Sections $7.1 - 7.5$ of chapter 7 of Book 1			
V		PRACTICALS	30	
	Con deci 6^{th} expc liste cours	uct any 5 experiments from the given list and 1 additional experiment, ed by the teacher-in-charge, related to the content of the course. The periment may also be selected from the given list. Other experiments here may be used as demonstrations of the concepts taught in the		

		Error Analysis: Lecture/ Tutorial/ Seminar: 2 hrs. Theory of experiments 1 and 2 can be given as Assignment/ Seminar. 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	Young's Modulus of the Material of a Given Bar: Uniform Bending - Use an optic lever and telescope. Take measurements for a minimum of 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 the error formulae.		
	2	Young's Modulus of the Material of a Given Bar: Non-Uniform Bending - Use a pin and a microscope. Take measurements for a minimum of 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 the error formulae.		

	3	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		
	4	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		

		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 versus. time squared (s vs. $t^\wedge 2$). 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		
	6	**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 versus acceleration and verify the relation. ● Experiment 18 of Book 2. ● Phyphox app may be used. https://phyphox.org/experiment/centrifugal-acceleration/		
	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 versus 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	**Verification of Newton's Second Law: Atwood's Machine** ● Determine the relationship between the vertical acceleration and the mass difference, using a smartphone accelerometer. ● The vertical acceleration is registered using the built-in accelerometer of the smartphone. ● By redistributing the masses of the supports, a linear relationship between the mass difference and the vertical acceleration is obtained. ● Experiment 8 of Book 2.		

		- https://phyphox.org/experiment/acceleration-without-g/	

	10	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	
	11	Projectile Motion: Kinematics - Analyse projectile motion as a combination of horizontal motion with constant velocity and vertical motion with constant acceleration. - Drop two balls from a height, one from rest, and other simultaneously projected horizontally. - Analyse the motion of both in the Tracker tool. - Section 3.3 of Book 1 - https://www.youtube.com/watch?v=zMF4CD7i3hg - https://www.youtube.com/watch?v=Mi01anodoDE - https://www.youtube.com/watch?v=5I0NLNthJGc	
	12	Projectile Motion: Energy Conservation - Analyse the motion of the tossing ball / projectile in the Tracker tool. - Plot time versus 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 Reference			

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. B.Sc Practical Physics by C L Arora

6. Practical Physics by S L Gupta & V Kumar

7. Fundamentals of Physics by David Halliday, Robert Resnick and Jearl Walker

8. Physics for Scientists and Engineers by Paul A. Tipler and Gene Mosca
9. Fundamentals of Physics by J. Richard Christman and William J. Francis
10. NPTEL video lectures: https://nptel.ac.in/courses/115106090

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	0	2	0	2	1	3	3	1	1	2	2	1
CO 2	3	2	2	0	1	2	3	3	3	1	3	3	3
CO 3	3	2	2	0	1	2	3	3	3	1	3	3	3
CO 4	3	2	2	3	1	2	3	3	3	1	3	3	3

CO5	3	2	3	0	3	3	3	3	3	1	3	3	3
CO6	3	3	3	3	1	3	3	3	3	1	3	3	3

Correlation Levels:

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

Assessment Rubrics:

- Quiz / Discussion / Seminar
- Internal Theory / 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		✓	✓	

Core in Major PHY1CJ102 (ELEMENTS OF MODERN PHYSICS

IMPORTANT: This course is for the Double Major pathway only. It should not be offered for the other four pathways.

Programme	**B. Sc. PhysicsHonours**				
Course Title	**ELEMENTS OF MODERN PHYSICS**				
Type of Course	**Core in Major**				
Semester	**I or II (depending upon the batch in the Double Major)**				
Academic Level	**100 – 199**				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	4	3	-	2	75
Pre-requisites	Higher secondary Physics				
Course Summary	The course integrates key principles of modern physics, including the Special Theory of Relativity, wave-particle duality, and the Bohr Atom Model, to provide students with a comprehensive understanding of fundamental concepts and their applications in diverse scientific fields.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Understand the principles of special theory of relativity and apply relative stick principles to solve problems	Ap	C	Written exams, quizzes
CO2	Analyse the particle like properties of electromagnetic radiation	An	C	Problem sets, essays

CO3	Analyse the Wave like properties of particles	An	C	Instructor-created exams / Home Assignments
CO4	Describe Rutherford-Bohr model of the atom	U	C	Problem-solving exams, simulations
CO5	Analyse experimental evidence supporting wave- particle duality (Practical)	An	Seminar Presentation / Group Tutorial Work	
CO6	Compare and contrast classical and quantum mechanical models (Project, viva)	Ap	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	**THE SPECIAL THEORY OF RELATIVITY**		**16**	**22**
	1	Classical Relativity	1	
	2	The Michelson – Morley Experiment	1	
	3	Einstein's Postulates and Its Consequences– Relativity of Time, Relativity of Length, Relativistic Velocity Addition	4	
	4	The Lorentz Transformation and Derivations of Relativistic Effects from Lorentz Transformations	2	
	5	Length Contraction, Velocity Transformation, Time Dilation, Simultaneity and Clock Synchronization	2	
	6	The Twin Paradox	1	
	7	Relativistic Dynamics – Relativistic Momentum	2	
	8	Relativistic Kinetic Energy, Total Energy and Rest Energy	2	
	9	Experimental Tests of Special Relativity	1	
	Sections 2.1 –2.7, 2.9 of chapter 2 of Book 1			
II	**THE PARTICLE – LIKE PROPERTIES OF ELECTROMAGNETIC RADIATION**		**10**	**16**
	10	Review of Electromagnetic Waves, Interference and Diffraction, Crystal Diffraction of X-Rays	2	
	11	The Photoelectric Effect	2	
	12	Thermal Radiation	2	
	13	The Compton Effect	2	
	14	Other Photon processes	1	
	15	Particles or Waves	1	
	Sections 3.1 – 3.6 of chapter 3 of Book 1.			

III	**THE WAVE – LIKE PROPERTIES OF PARTICLES**		**10**	**16**
	16	De Broglie's Hypothesis	1	
	17	Experimental Evidences for De Broglie waves	3	
	18	Uncertainty Relationships for Classical waves	1	
	19	Heisenberg Uncertainty Relationships	2	
	20	Wave Packets and the Motion of a Wave Packet	2	
	21	Probability and Randomness, and the Probability Amplitude	1	
	Sections 4.1 – 4.7 of chapter 4 of Book 1			
IV	**THE RUTHERFORD – BOHR MODEL OF THE ATOM**		**9**	**16**
	22	Basic Properties of Atoms ,The Rutherford Nuclear Atom – Rutherford Scattering Formula and Its Experimental Verification – The Closest Approach of a Projectile to the Nucleus	2	
	23	Line Spectra	1	
	24	The Bohr Model	3	
	25	The Franck – Hertz Experiment	1	
	26	The Correspondence Principle	1	
	27	The Failure of the Bohr Model	1	
	Sections 5.1 – 5.8 of chapter 5 of Book1. Excluded: sections 5.2.1, 5.3.1, derivation of Rutherford scattering formula			
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.			

	1	**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.		
	2	**Continuous and line spectra- Determination of the wavelengths and photon energy.** ● Familiarize the initial adjustments and measurements in the spectrometer. ● Mount the grating at normal incidence on the spectrometer. ● Determine the wavelengths of the sodium vapor lamp and calculate the associated photon energy. ● Determine the approximate range of the wavelengths of the continuous spectrum of incandescent/white LED lamp or any one coloured LED and calculate the associated photon energy. ● The readings of the first order spectrum will be enough. Number of lines/m of the grating can be given.		
	3	**Mercury spectrum- Determination of wavelength and photon energy.** ● Determine wavelength of any four prominent lines and associated photon energy of the mercury spectrum using a spectrometer with grating at normal incidence. ● The readings of the first order spectrum will be enough. Number of lines/m of the grating may be given.		
	4	**Hydrogen spectrum - Determination of wavelengths and calculation of the Rydberg's constant.** ● Determine the wavelengths and photon energy in eV of the prominent lines of the Balmer series of the Hydrogen spectrum using a spectrometer with grating at normal incidence. ● Calculate the Rydberg's constant and estimate the % error. ● The readings of the first order spectrum will be enough. Number of lines/m of the grating may be given.		
	5	**Wave Packets - Analysis of beats in sound.** ● The experiment is intended to understand the concept of wave packet, phase and group velocities. ● Generate sounds waves of two near frequencies using smartphone/ExpEYES/Function generator and the		

		superimposed wave can be recorded and analysed using smartphone/ExpEYES/CRO ● Change the separation between the frequencies and compare the results with the theoretical values. ● https://expeyes.in/experiments/sound/beats.html ● Multi Tone generator and Audio scope tools of Phyphox may be used https://phyphox.org/experiment/tone-generator/		
	6	**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		
	7	**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.		
	8	**Verification of Wein's displacement law and Stefan's law using incandescent bulb.** ● Calibrate the video of the spectra of the incandescent bulb in the Tracker tool using two laser wavelengths/lines of mercury spectra. ● Plot wavelength vs intensity and note λ_{max}. ● Repeat the experiment by increasing the operating voltage of the incandescent bulb(hence increasing the temperature of the source) ● From the plots, verify the Wein's displacement law and Stefan's law.		
	9	**Black body radiation- total energy output.** ● Plot Planck's radiation formula. ● Evaluate the area under the curve and x- axis(total radiance over all wavelengths) by numerical integration and hence verify Stephan's law		

Books and References:

1. Modern Physics (Fourth Edition, an Indian Adaptation) by Kenneth S. Krane (Book 1)
2. https://phyphox.org/
3. https://physlets.org/tracker/

- https://expeyes.in/
- Modern Physics for Scientists and Engineers" by John Morrison
- Concepts Of Modern Physics By Arthur Beiser
- Modern Physics by Raymond A. Serway
- Modern physics by Randy Harris

Mapping of COs with PSOs and POs :

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

PHY1MN 104 Electricity and Magnetism

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.				

FYUGP Physics	
PO1	Demonstrate a profound understanding of knowledge trends and their impact on the chosen discipline of study.
PO2	Become a team player who drives positive change through effective communication, collaborative acumen, transformative leadership, and a dedication to inclusivity.
PO3	Demonstrate professional skills to navigate diverse career paths with confidence and adaptability.

PO4	Demonstrate proficiency in varied digital and technological tools to understand and interact with the digital world, thus effectively processing complex information.
PO5	Emerge as an innovative problem-solver and impactful mediator, applying scientific understanding and critical thinking to address challenges and advance sustainable solutions.
PO6	Become a responsible leader, characterized by an unwavering commitment to human values, ethical conduct, and a fervent dedication to the well-being of society and the environment.
PO7	Emerge as a researcher and entrepreneurial leader, forging collaborative partnerships with industry, academia, and communities to contribute enduring solutions for local, regional, and global development.
PSO1	Understand concepts and applications in the field of Physics viz. Mechanics, Electrodynamics, Thermodynamics, Optics, Quantum Mechanics, Electronics etc.
PSO2	Develop the skills for experimentation to measure, analyse and interpret empirical data, and present the results in a methodical and accessible way.
PSO3	Evaluate complex real-world problems by applying principles of theoretical and applied physics, and mathematical and computational models.
PSO4	Design and execute a Project to solve real-world problems in accordance to the need of the industry and academic research, in a stipulated time frame.
PSO5	Develop understanding of the fundamental concepts of Physics needed for a deeper study of related fields of knowledge viz. Mathematics, Chemistry, Electronics, Computer Science, Geology etc.
PSO6	Develop the experimental and analytical skills in Physics that can be of useful applications in allied areas of knowledge.

			PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	Understand electric charge properties, develop ability to visualize electric fields for various charge distributions, and explore the behaviour of electric dipoles.	Understand	3	0	2	1	2	2	3	3	2	2	3	2	2
CO2	Students will apply Gauss's law to calculate electric flux and analyse electric fields, as well as determine electric potential and potential energy for various charge systems.	Analyze	3	2	3	0	1	3	3	3	3	2	3	3	3
CO3	Analyze current, resistance, and EMF in circuits, calculate energy and power in resistive elements, and apply Kirchhoff's laws to electrical systems.	Analyze	3	3	2	1	2	3	2	3	3	1	3	3	3
CO4	Understand the principles magnetism, including magnetic fields, magnetic flux, and the behaviour of	Apply	3	3	3	2	2	2	3	3	3	1	3	3	3

	charged particles and current-carrying conductors in magnetic fields.														
CO5	Understand the concept of electric dipoles, analyze the forces and torques acting on them in uniform electric fields, and relate these to practical applications	Analyze	3	2	3	0	3	3	3	3	3	1	3	3	3
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.	Analyze	3	3	3	3	1	3	3	3	3	1	3	3	3

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	
	Condur □ deci expe liste cou	act any 5 experiments from the given list and 1 additional experiment, ed by the teacher-in-charge, related to the content of the course. The 6th iment may also be selected from the given list. Other experiments here may be used as demonstrations of the concepts taught in the		

	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 :

1 2	PSO PSO PSO 4	PSO PSO5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO	PO			
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		✓	✓	

CHRIST
COLLEGE (AUTONOMOUS)
IRINJALAKUDA, KERALA

BSc PHYSICS HONOURS- **Multi-Disciplinary Course 1**

PHY1FM105 PHYSICS IN DAILY LIFE

Programme	B.Sc. Physics Honours				
Course Title	PHYSICS IN DAILY LIFE				
Type of Course	Multi-Disciplinary Course 1				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours
	3	3	-	-	45
Pre-requisites	High school level science				
Course Summary	This course explores the use of physics in daily life. Working of the daily use devices, physical principles coming to play in the kitchen and in sports are explored.				

Course Outcomes (CO):

CO	CO Statement	Cognitive Level*	Knowledge Category#	Evaluation Tools used
CO1	Apply the principles of physics to understand the functioning of common kitchen appliances and the properties of various kitchen materials in everyday cooking scenarios	Ap	F	Instructor-create d exams / Quiz
CO 2	Analyse the principles of physics to the sport of cricket.	U	F	Instructor-create d exams / Quiz
CO3	Analyze the principles of physics to the sport of football.	Ap	F	Instructor-create d exams / Quiz
CO 4	Understand the connection between resonance and sound phenomena and analyse the working of photocopier.	Ap	F	Instructor-create d exams / Quiz
CO5	Understand the working principles of bicycles, air conditioners, sound, and music.	U	F	Instructor-create d exams / Quiz

* - 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 (**36** +9)	Marks (**50**)
I		Physics in the Kitchen (Thermodynamics)	10	15
	1	Advantages and disadvantages of using LPG and electricity as energy sources in the kitchen - physics of induction cooktop physics of microwave oven	2	
		Smoke detectors - the fresh air fan: things to look out for. Purpose and use of different metals as kitchen utensils	2	

	3	Why do cold objects (plastic, metal) break easily – Working of refrigerator.	3	
	4	Noise in the kitchen, Dishwasher, Energy waste in the kitchen and solutions, Modern gas lighters, weighing scales	3	
Pages 154 - 159, 161-170, 179-186 of Chapter 5, 192-202 of Chapter 6, Book 1				
	The Physics of Sports: Cricket (Mechanics)		**10**	
	5	Physics of pace bowling – use of seam of the ball	3	
	6	Difference between hard & soft pitches on the pace bowling.	1	
	7	Spin bowling – reason for ball to spin during later the day.	2	
II	8	Magnus effect and its importance.		**13**
	9	The cricket bat: reasons for choosing willow wood, sweet spot of the bat.	2	
	10	Physics of *Hawkeye, Hotspot, Snicko* and *Super SloMo*, no need of Rutherford scattering, no need of elaborating equation of Planck's Law.	2	
Pages 86-89 of Chapter 5, 187 - 200 of Chapter 10, 114 - 116, 123-125 of Chapter 7, 164-181 of Chapter 9, Book 2				
	The Physics of Sports: Football (Mechanics)		**9**	
	11	The kick	2	
	12	Forces on the foot, power, the curled kick.	2	
III	13	The throw-in, goalkeeper's throw, heading, punching, catching, receiving, trapping the football.	1	**12**
	14	Airflow around the ball – the boundary layer	1	
	15	The Bernoulli effect, separation of the flow, the turbulent wake, the critical speed, what happens at the critical speed, speed and range, effect of a wind, the banana kick.	2	

	3	Why do cold objects (plastic, metal) break easily – Working of refrigerator.	3	
	4	Noise in the kitchen, Dishwasher, Energy waste in the kitchen and solutions, Modern gas lighters, weighing scales	3	
Pages 154 - 159, 161-170, 179-186 of Chapter 5, 192-202 of Chapter 6, Book 1				

Pages 19 - 25 of Chapter 2, 33-41 of Chapter 3, 49 - 68 of Chapter 4, Book 3				
IV		**Physics Every day**	**7**	**10**
	16	Sound in air – natural resonances	1	
	17	Pendulums and harmonic oscillators, pendulum clock	2	
	18	Quartz/electronic clocks	2	
	19	Working of photocopier/ Xerograph	2	
Pages 232-237, 239-240 of Chapters 9, 276-280 of Chapter 10, Book 4				
V		**Open Ended Module (suggestions only)**	**9**	
	1	Bicycles: Stability, leaning, pedaling		
	2	Working of air conditioner: laws of thermodynamics & entropy.		
	3	Working of air conditioner: mechanism		
	4	Sound and music (basic ideas only, scale used in western music not needed)		
Pages 97-104 of Chapter 4, 209-219 of Chapter 8, 241-242 of Chapter 9, Book 4				

Books and References:

1. *Physics in the Kitchen*, George Vekinis, Springer Nature Switzerland, 2023. (Book 1)
2. *The Physics of Cricket*, Mark Kidger, Nottingham University Press, 2011. (Book 2)
3 *The Science of Soccer*, John Wesson, Institute of Physics Publishing, 2002. (Book 3)
4. *How Things Work* 6th Ed, Louis A Bloomfield, John Wiley & Sons, 2016. (Book 4)

Mapping of COs with PSOs and POs :

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	1	1	1	1	0	0	0	0	0	0	0	0	0
CO 2	2	1	1	1	0	0	0	0	0	0	0	0	0
CO 3	2	1	1	1	0	0	0	0	0	0	0	0	0
CO4	2	1	1	1	0	0	0	0	0	0	0	0	0
CO5	2	1	1	1	0	0	0	0	0	0	0	0	0

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CO 3	✓	✓	✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓