

Name of the programme: B.Sc. PHYSICS (Honours) (CBCS)

Academic year of introduction: 2018 – 2019

Programme Outcome (PO):

The undergraduate (UG) course offered by the Department of Physics, St. Paul's cathedral Mission College strictly follows the CBCS syllabus prescribed by the University of Calcutta. The course is a combination of general and advanced education, simultaneously introducing the concepts of breadth and depth in learning. The course structure has been prepared in such a way so as the students learn and understand how the various physical phenomena take place based on their already acquired knowledge. Solving problems based on realistic situation make them understand how various physical systems in everyday life works.

It is further aimed to provide a firm foundation in every aspect of Physics and to explain a broad spectrum of modern trends in physics and to develop experimental, computational and mathematics skills of students. The mathematical skill and theoretical principles learnt during the three-year program, help them motivate and contribute to the society by actively participating in innovative research, teaching. Students are well prepared for cutting edge research activity for example, Nano Science, Astrophysics, Nuclear and Particle Physics, Condensed Matter Physics etc. The present curriculum will not only advance their knowledge and understanding of the subject, but will also increase the ability of critical thinking, development of scientific attitude, handling of problems and generating solution, improve practical skills, enhance communication skill, social interaction and increase awareness in environment related issues.

Programme Specific Outcomes (PSO):

The programme specific outcome includes:

- Imparting in students detailed knowledge in diverse premises of physics that includes classical mechanics, thermal physics, acoustics, wave optics, advanced mathematical physics, electricity & magnetism, quantum mechanics, statistical mechanics, electromagnetic theory, electronics, special theory of relativity and atomic physics, modern physics and modern communication electronics.
- Each of these theories are experimentally verified in a number of ways and found to be a sufficiently appropriate description of nature. Students get oriented along this line of thinking and earn enough proficiency to use Physical Principles/concepts to explain various phenomena.

- Developing proficiency in designing various electronic & electrical devices for domestic, engineering, medical and/or laboratory need
- Applying conceptual understanding of basic laws & principles of physics to analyze variety of physical phenomena of general real-world problems.
- Developing capabilities of oral and written scientific communication skill and scientific thinking to appreciate advancement of modern physics in diverse areas. Students learn the applications of computer programming language PYTHON in an elaborate manner.
- Knowledge gained through theoretical, computational and lab based experiments will generate technical personnel in various priority areas of research on basic, applied and interdisciplinary science.
- Physics uses mathematics as a medium to organize and formulate experimental results. Students gather handsome knowledge on mathematics required for formulating and solving problems.
- Students learn laboratory skills enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions.

Course Outcomes (CO)

Semester	Course Code	Course Name	Course Outcome (CO)
Semester I	PHS-A-- CC-1-1- TH	Mathematical Physics I (Theory)	<p>After completion of the course the students will learn some important mathematical tools required for pursuing higher study in Physics such as :</p> <ul style="list-style-type: none"> • To acquire knowledge of calculus which are integral part of any branch of Physics. • Understand divergence, gradient and curl and their physical interpretation which are very important for theories of electricity and magnetism to be taught later. • Understand basics of matrices and determinants i.e. inverses, adjoint, linear vector spaces, basis, basis transformations, how to calculate eigen values, eigenvectors. Solve simple problems with physics oriented application.
	PHS-A-- CC-1-1- PR	Mathematical Physics I (Practical)	<p>After completion of the course the students will learn:</p> <ul style="list-style-type: none"> • Basic concepts of data plotting with the help of GNUPLOT. • Understand how to write an algorithm, iteration techniques, and simple mathematical logic operations with the help of PYTHON. • Usage of the code as simple calculator • Various numerical methods to solve many problems

			<p>numerically. e.g. finding solution of a equation,</p> <ul style="list-style-type: none"> • Doing simple matrix operations using Python language. • Visualize physical problems and their solutions on a computer.
	PHSA-- CC-1-2- TH	Mechanics (Theory)	<p>The students attending the course will learn</p> <ul style="list-style-type: none"> • How to use different co-ordinates systems appropriately to solve equations of motion of particles in various situations. • The importance of inertial frames while applying Newtonian mechanics and learn about dynamics in rotating frame of reference. • Dynamics of system of particles and conservation laws. The topic of central force is introduced and gravitation is discussed as a classic example of it. • The dynamics of rotating rigid bodies using Euler's equation. • The concept of inertia tensor and the method of finding principal axes of rigid bodies in detail. • The dynamics of fluid motion using vector calculus.
	PHSA-- CC-1-2- PR	Mechanics (Practical)	<p>The students are made familiar with</p> <ul style="list-style-type: none"> • Basic laboratory instruments to measure length. • Possible systematic and random errors that are associated with such instruments. • The measurement of moment of inertia of different geometrical objects and different elastic constants of materials. • Use of compound pendulum to measure acceleration due to gravity. • Use of sextant to measure height of large structures.
Semester II	PHSA- CC-2-3- TH	Electricity and Magnetism (Theory)	<p>Students attending the course will learn</p> <ul style="list-style-type: none"> • Basic concepts of electric charges and currents and their properties • The concept of conductor dielectrics, inductance and capacitance. • About the nature of magnetic materials. • The concept of static and time varying fields. • About electromagnetic induction and Faraday's law and its applications • About EM waves and its propagation and solve Maxwell's equations
	PHSA- CC-2-3- PR	Electricity and Magnetism	<p>Students will get practical training on handling various electrical components such as resistors, ammeters, voltmeters, potentiometers, metre bridge, power supplies.</p>

		(Practical)	Students also learn the responses of resistors, inductors and capacitors in presence of ac signal.
	PHSA-CC-2-4-TH	Waves and Optics (Theory)	Students learn about <ul style="list-style-type: none"> • Various types of waves and their propagation. • Fundamentals of physical and geometrical optics • Various optical phenomena, for example interference, diffraction, polarization etc.
	PHSA-CC-2-4-PR	Waves and Optics (Practical)	Students get the first exposure to handle the spectrometer and understand its basic operation. They learn to measure <ul style="list-style-type: none"> • Fringe width, grating constants etc. • Radius of curvature of a plano-convex lens using Newton's ring, • Thickness of a paper by wedge shaped film. They learn to verify Cauchy's Relation experimentally. They are also exposed to experiments with bi-prism.
Semester III	PHSA-CC-3-5-TH	Mathematical Physics II (Theory)	Students attending the course learn <ul style="list-style-type: none"> • Expansion of a function in a Fourier series. • Solving differential equation using power law expansion (so called Frobenius method). • About various special functions i.e. Legendre, Bessel functions, generating functions and their properties. • About Fourier integral and its properties and application to signal analysis and also in quantum mechanics • Application of probability and various distribution functions in Physics. • Solving partial differential equation. • About beta and gamma functions and some special integrals. Integral transforms, introductory theory of probability.
	PHSA-CC-3-5-PR	Mathematical Physics II (Practical)	Students exposed to this course will learn <ul style="list-style-type: none"> • Basic concepts and syntax of the modules: numpy and scipy for scientific computing using Python. • Use of numpy array for matrix operations. • Use of numpy, scipy for different scientific applications such as interpolation ,numerical integration, solution of ODE and curve fitting • Use of matplotlib as a sub module of Python for drawing graphs.
	PHSA-CC-3-6-TH	Thermal Physics (Theory)	After getting exposure to this course, the students will <ul style="list-style-type: none"> • Understand the principle of calorimetry • Understand the basic principle and laws of Thermodynamics. • Understand the concepts of Entropy, various thermodynamic potentials and their applications in various systems

		<ul style="list-style-type: none"> • Gain knowledge about microscopic behavior of systems and understand various transport phenomena • Understand the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems. • Gain knowledge in kinetic theory of gas. • Learn behaviour of real gases, Joule-Thomson effect.
PHSA-CC-3-6-PR	Thermal Physics (Practical)	<p>The students will learn how</p> <ul style="list-style-type: none"> • to determine different physical quantities of thermal physics like coefficients of expansion, • thermal coefficients of resistance, thermal conductivity of bad conductors, • pressure coefficients • to verify Stefan's law of radiation experimentally.
PHSA-CC-3-7-TH	Modern Physics (Theory)	<p>Exposure to this course will lead to understanding of the</p> <ul style="list-style-type: none"> • Main aspects of the inadequacies of classical mechanics like Blackbody Radiation which leads to historical and fascinating development of Planck's quantum hypothesis. • Systematic development of quantum mechanics, laying the foundation of modern physics. • Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions. • Application of Schrodinger equation to one dimensional system, Quantum Mechanical tunnelling, Quantum Dot. • Properties of nuclei like density, size, binding energy, nuclear force and structure of atomic nucleus, different nuclear models • Decay rates and lifetime of Radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay. • Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars. • Spontaneous and stimulated emission of radiation, optical pumping and population inversion, Three level and four level lasers, Ruby laser and He-Ne laser in details, Basic lasing action.
PHSA-CC-3-7-PR	Modern Physics (Practical)	<p>In the laboratory course, the students will get opportunity to measure Planck's constant using LED, study photoelectric effect, verify Stefan's law of radiation and determine e/m of electron by using bar magnet. They will also study the tunnelling effect in tunnel diode using I-V characteristics.</p> <p>The practical component includes</p> <ul style="list-style-type: none"> • Sessions on the construction and use of specific

			<p>measurement instruments and experimental apparatuses used in the modern physics lab, including necessary precautions.</p> <ul style="list-style-type: none"> • Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors. • Application to the specific experiments done in the laboratory.
	PHSA-SEC-A1-TH (Technical Skill)	Scientific Writing(Theory)	<p>The students learn</p> <ul style="list-style-type: none"> • How to write scientific documents using the software LATEX. • To create LATEX files and compile them using the software. • To create different chapters, sections, subsections, paragraph inside a document. • To write all kinds of mathematical equations using LATEX. • To create lists, use different kinds and sizes of fonts and put figures and tables at appropriate places. <p>Arguably the most important lesson are the use of citation from bibliography and referring equations, figures, tables etc. inside a document without worrying about their numbering.</p>
	PHSA-SEC-A1-PR (Technical Skill)	Scientific Writing (Project)	<ul style="list-style-type: none"> • Each student is asked to create two LATEX files; one is a resume and the other a scientific document. • The creation of resume challenges their skills of organising records and its artistic representation. • It also shows their ability to include photograph and tables in a LATEX file. • Creation of a scientific document mainly shows their ability to organise the document in different chapters and sections. It also shows their ability to write mathematical equations and citing references of those equations inside the document. Citing the items in the bibliography inside the document is also a major feature that the students are expected to show in their projects.

Semester	Course Code	Course Name	Course Outcome (CO)
	PHSA-CC-4-8-	Mathematical	The course introduces three different topics, Complex analysis, Classical mechanics and Special theory of

TH	Physics III (Theory)	<p>relativity.</p> <ul style="list-style-type: none"> • In the first topic, Complex numbers are recapitulated in details before function of complex variables is introduced. The analyticity of such functions is discussed in the light of Cauchy-Riemann conditions. Singular functions are discussed introducing definition of pole and branch points. Cauchy's integral formula is taught. Students learn to apply Residue theorem to solve definite integrals with simple poles on and off the real axis. • In Classical mechanics the concept of functional in variational calculus is taught and Lagrangian mechanics is formulated by extremizing the action. The relation between existence of symmetries and conservation laws are taught by introducing the idea of cyclic coordinates. Students also learn about Hamiltonian formulation of mechanics and apply Canonical equations of motion in simple cases. • In the last topic, the importance of Michelson-Morley experiment and the postulates of special theory of relativity are taught. The phenomenon of length contraction, time dilation, variation of mass with velocity and mass-energy equivalence are discussed. Tensors and their transformation properties are introduced. Concept of four-vectors is used to find invariant quantities under Lorentz transformation in 4-dimensional space-time.
PHSA- CC-4-8- PR	Mathemati cal Physics III (Practical)	<p>In this course the students learn to</p> <ul style="list-style-type: none"> • Handle improper integrals using Python programs. • Solve first and second order differential equations using Scipy module in Python. Special functions and their properties are demonstrated. As a first step towards solving Partial Differential Equations (PDE) the boundary value problem and initial value problem are discussed in detail. • Solve simple PDEs of different kinds like Laplace equation, Wave equation and Heat equation, by Python programming using finite discrete methods with fixed step sizes. The Fourier coefficients of different periodic functions are evaluated using Python programming.
PHSA- CC-4-9- TH	Analog Systems and Applicatio ns (Theory)	<p>In this course, students will be able to achieve the following learning outcomes.</p> <ul style="list-style-type: none"> • Understand the concept of voltage and current sources, Network theorems, Mesh Analysis and application of different Network Theorems for simplifying complicated electronics circuits. • Understand and use the concepts of semiconductors to describe different Semiconductor devices such as diode, transistors, BJT, FET etc with their classifications and explain their characteristics, operations and various

			<p>applications.</p> <ul style="list-style-type: none"> • Become familiar with the load-line analysis as well as hybrid parameter analysis of the BJT amplifier • Study and construction of Regulated Power Supply with a comprehensive understanding of different types of Rectifiers, Filters and Voltage Regulator. • Study of feedback in amplifiers along with their advantages and disadvantages. • Explain the functioning of OP-AMPS and use them as the building blocks for different applications. • Study of different types of oscillators like Wien Bridge Oscillator, Hartley Oscillator etc.. • To be able to perform detailed analysis of astable, monostable and bistable multivibrator.
PHSA-CC-4-9-PR	Analog Systems and Applications (Practical)		<p>In the laboratory course, the students will get opportunity</p> <ul style="list-style-type: none"> • To study characteristics of Zener diode, to design and study static characteristics and frequency response of BJT in CE configuration, • To construct and design a series regulated power supply. • They will also study the OPAMP and its different applications like inverting amplifier, non inverting amplifier, adder, subtractor, comparator, Schmitt trigger, Integrator, differentiator, relaxation oscillator. • The students are encouraged to design, fabricate and study a Wien bridge oscillator for given frequency using an op-amp. Thus, the students will acquire basic skill required for higher studies or research in experimental Physics.
PHSA-CC-4-10-TH	Quantum Mechanics (Theory)		<p>After completion of the course the students will learn:</p> <ul style="list-style-type: none"> • Wavepacket description of particles and general discussions of bound states in arbitrary potentials. • Solution of Schrodinger equation for harmonic oscillator and hydrogen like atom problems. • Important concepts of generalized angular momenta and spin. • Atomic spectra of hydrogen atom and its fine structure. • Behaviour of atoms in electric and magnetic field • Symmetric and anti-symmetric wave-function for identical particles. • L-S and J-J coupling and fine structure splitting of spectra of many electron atoms
PHSA-CC-4-10-PR	Quantum Mechanics (Practical)		<p>The student will learn some advanced computational techniques and applying them to solve various problems related to quantum mechanics using Python in this course.</p>

	PHSA-SEC-B1-TH (Technical Skill)	Arduino (Theory)	The students will learn some basic idea on open source microprocessor and hardware applications, basic principles of different sensors and their interfacing techniques with the software package Arduino IDE.
	PHSA-SEC-B1-PR (Technical Skill)	Arduino (Practical)	<ul style="list-style-type: none"> • The students will have hand-on experience with the applications of Arduino IDE and Arduino UNO R3 Board. • Skill will be developed on the measurement of temperature, distance, voltage, display techniques and other modern-age electronic applications in the field of advanced research job.

Semester	Course Code	Course Name	Course Outcome (CO)
Semester V	PHSA-CC-5-11-TH	Electromagnetic Theory (Theory)	<p>This course introduces the knowledge about</p> <ul style="list-style-type: none"> • Electromagnetic laws, Maxwell's equations, wave phenomena, their

			<p>characteristics and propagation through media.</p> <ul style="list-style-type: none"> • The polarization of em waves.
PHSA-CC-5-11-PR	Electromagnetic Theory (Practical)		<p>Student will learn</p> <ul style="list-style-type: none"> • how to verify some of the well known phenomena and laws of polarization as well as electromagnetic waves in the laboratory such as Brewster's law, Malus law, Fresnel's law. • To find specific rotation of an optically active solution and dispersive power, resolving power of a plane diffraction grating.
PHSA-CC-5-12-TH	Statistical Physics (Theory)		<p>After completion of the course the students will be able to learn :</p> <ul style="list-style-type: none"> • Basic concepts of classical statistical mechanics. • Ideas of micro canonical, canonical and grand canonical ensembles, partition function and their application in simple systems. • Concepts of quantum statistics, behaviour of system of identical particles bosons and fermions. • Bose-Einstein and Fermi-Dirac statistics. • Classical and quantum aspects of black body radiation. • Electron gas and electronic specific heat of metal by FD statistics.
PHSA-CC-5-12-PR	Statistical Physics(Practical)		<p>The students will use Python programming to study aspects of statistics like Random numbers and Timescale, application of Random numbers including Monte Carlo integration. The approach is extended also to the study of different distributions in statistical mechanics.</p>
PHSA-DSE-B1(b)-TH	Nuclear and Particle Physics (Theory+ Tutorial)		<p>The students of Physics Honours get introduced to the course on Nuclear Physics at Semester 3. In Semester 5, Nuclear and Particle Physics is Discipline Specific Course (DSC) and taught at advanced level. The course provides necessary inputs to the students to carry on the study in Masters and in the Research level in the relevant topics.</p>

	PHSA-DSE-A1(b)-TH	Laser and Fibre Optics	<p>Student attending the course will learn about</p> <ul style="list-style-type: none"> • Theory of laser and its basic properties • Resonators, transient effect, Different types of lasers • The practical use of laser • Basics of Nonlinear Optics and its applications
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Semester	Course Code	Course Name	Course Outcome (CO)
Semester VI	PHSA-CC-6-13-TH	Digital Systems and Applications (Theory)	<p>At the end of this course, students will be able to achieve the following learning outcomes.</p> <ul style="list-style-type: none"> • Understand to Differentiate the Analog and Digital circuits • Understand the concept of Integrated Chips (IC): its classification, advantages, drawbacks and uses. • Become familiar with the concepts of various number systems like Binary,

			<p>BCD, Octal and hexadecimal's complement and 2's complement method of subtraction in addition with other binary arithmetic are developed to elaborate and focus on the digital systems.</p> <ul style="list-style-type: none"> • Become familiar with the concepts of Boolean algebra. • Study of construction of basic, universal as well as other important logic gates using different logics like DDL, TTL, MOS logic and their applications. • Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits. • Understand the minimization techniques for designing a simplified logic circuit using SOP, POS and Karnaugh map. • Design a half adder, full adder, half-subtractor, and full-subtractor. • Understand the working of data processing circuits, multiplexers, demultiplexers, decoders and encoders. • Become familiar with the working of flip-flop circuits, its working and applications. • Become familiar with other Sequential Circuits like shift registers and 4-bits counters leading to the concept of RAM, ROM and memory organization. • Study of A/D (Ladder and weighted resistance) and D/A conversion circuit.
	PHSA-CC-6-13-PR	Digital Systems and Applications (Practical)	<ul style="list-style-type: none"> • In the laboratory students will learn to fabricate and study fundamental logic gates OR & AND logic with diode and resistor as well as both of them and NOT logic with Transistors and verify the logics by universal gates like NAND/ NOR gate. • They will construct by employing NAND as building blocks and demonstrate Half Adder, Full Adder, Flip Flops like SR, D & JK. • They will also construct of 4 bit shift registers (serial & parallel) using D

			<p>type FF IC 7476.</p> <ul style="list-style-type: none"> • Student will design and fabricate 4×1 Multiplexer using basic gates and IC 74151.
	PHSA-CC-6-14-TH	Solid State Physics (Theory)	<ul style="list-style-type: none"> • Study of this course builds an understanding on the structural morphology of the solid materials. • Students will learn electrical, magnetic, thermal properties of the solids. • They will be acquainted with the band structures of solids. • The students will also be introduced with emerging field of superconductivity.
	PHSA-CC-6-14-PR	Solid State Physics (Practical)	<ul style="list-style-type: none"> • Student will perform experiments in the laboratory and learn about the electrical and magnetic properties of solids like measurements of dielectric constant, band gap, magnetic susceptibility, Hall coefficient. • They also get practical training on tracing of BH Hysteresis loop, construction of temperature controller using relay.
	PHS-A-DSE-A2-TH	Nano Materials and Applications	<p>Outcome of this course will be</p> <ul style="list-style-type: none"> • To learn about nanoscale systems, their band structures, their different properties • To know how nano materials are synthesised • To learn about different characterization techniques • To know various properties of nano materials, e.g. optical and electrical (transport) properties • To know applications of nano-materials in new age
	PHS-A-DSE-B2-TH	Communication Electronics (Theory)	<p>Outcome of this course will be</p> <ul style="list-style-type: none"> • To introduce students to basics of electronic communication • To learn analog modulations and to modulate analog pulse • To learn how to modulate digital pulse • To introduce communication and navigation system, which has many modern day applications.

Name of the programme: B.Sc. PHYSICS (General) (CBCS)

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Semester	Course Code	Course Name	Course Outcome (CO)
Semester I	PHS-G-CC-1-1-TH	Mechanics (Theory)	This is a Generic Elective (GE) course offered to students of Mathematics and Chemistry Honours . The students will learn the basic mathematical tools like vectors analysis, calculus of vectors, differential equations etc. as prerequisites to the

			course on Mechanics, Gravitation and the studies of General properties of Matter.
	PHS-G-CC-1-1-PR	Mechanics (Practical)	In this laboratory course, the students will measure and verify values of some known parameters like acceleration due to gravity, moment of inertia of rigid bodies, elastic moduli of matter.
Semester II	PHS-G-CC-2-2-TH	Electricity and Magnetism (Theory)	The first part of this course gives the necessary idea of vector treatments which is important to carry out the analysis of the rest part of this course. The next part of the course gives an idea on the electrostatic phenomena, magnetism and electrodynamics. This course offers an opportunity to learn the different physical laws and properties of matter.
	PHS-G-CC-2-2-PR	Electricity and Magnetism (Practical)	It encompasses the practical training on electrical circuits and components. Students learn how to handle potentiometers, Carey Foster Bridges. They also learn to use voltmeters and ammeters. Students learn about the measurement of Earth's magnetic field.
Semester III	PHS-G-CC-3-3-TH	Thermal Physics and Statistical Mechanics (Theory)	The student will acquire knowledge on the physical properties of thermodynamics and kinetic theory of gases. They also learn about the radiation process. A very important idea of statistical mechanics will be introduced here. This course will be helpful for the students who will work in interdisciplinary field.
	PHS-G-CC-3-3-PR	Thermal Physics and Statistical Mechanics (Practical)	The students will learn how to determine different physical quantities of thermal physics like coefficients of expansion, thermal coefficients of resistance, thermal conductivity of bad conductors, pressure coefficients and also the verification of Stefan's law of radiation.

Semester	Course Code	Course Name	Course Outcome (CO)
Semester IV	PHS-G-CC-4-4-TH	Waves and Optics(Theory)	After completion of the course the students will have knowledge on the following topics: SHM, Wave Equation in stretched string and its solution Wave optics, Huygens' principle, interference of waves. Interference of waves. Young's double slit, Lloyd's mirror, Fresnel's bi-prism and Newton's ring experiment to

			<p>demonstrate interference of waves. Diffraction of waves, Fraunhofer diffraction of single slit, double slit & grating, Fresnel diffraction, half period zone & zone plates. Transverse nature of light, Polarization: Plane, Circular & Elliptical polarized light.</p>
	PHS-G-CC-4-4-PR	Waves and Optics (Practical)	<p>After completion of the course the students will learn to measure:</p> <ul style="list-style-type: none"> • Frequency of a Tuning fork by sonometer • Focal length of concave lens. • Radius of curvature of a plano-convex lens using Newton's ring, • Thickness of a paper by wedge shaped film. • Optical rotation of an active solution using polarimeter.