

Department of Physics

PROGRAMME OUTCOMES (PO), PROGRAM SPECIFIC OUTCOMES (PSO) and COURSE OUTCOMES (CO) : PO-PSO-CO

Programme : B.Sc. (Hons.) (CBCS) under University of Calcutta

Program Outcomes (PO) :

B.Sc.(Hons.) (Bachelor of Science) Programme offers theoretical as well as practical knowledge about different subject areas of basic science and social science. These subject areas include Physics, Chemistry, Mathematics, Botany, Zoology, Computer Science, Statistics, Psychology and Economics depending on the Honours subject a student opts. This programme is most beneficial for students who have a strong interest and background in Science and Mathematics. The programme is also beneficial for students who wish to pursue multi and inter-disciplinary science careers in future. A well planned study programme is followed for holistic development of the students. Apart from imparting in-depth knowledge over the respective subject the aim of the programme is to make the students responsible citizens with good moral and ethical values.

Following are the various programme outcomes:

PO1. This programme helps to develop scientific aptitude among the students and thus can prove to be highly beneficial for the society and also for the development of the nation.

PO2. This programme helps to develop critical thinking, creativity, analytical and problem solving skills among the students.

PO3. The students will be able to learn necessary computational skill, use of technology and use of ICT required for an effective learning experience and further progress to higher studies.

PO4. After completion of this programme the students will be able to pursue higher studies in basic sciences or social sciences (M.Sc.) in different Universities, IIT's, IISER's, NIT's and other reputed institutes of higher learning in India and abroad, and then choose research career for the welfare of mankind and society. Students have also the option to enroll themselves for different applied science/ technical courses, B.Ed. and some other professional job oriented courses such as BCA, MCA, MBA, Marketing etc.

PO5. Students after completion of this programme have the eligibility to join jobs in Indian Civil Services as IAS, IFS, IPS etc., WBCS, UPSC, Banking Sector, Railways, Airlines, technical jobs at research institutes or as school teacher through SSC.

PO6. After completion of the B.Sc. degree there are various other options available for the science students. Often, they are recruited by big MNC's and different reputed companies in IT sector. Many students are directly recruited by some reputed companies through campus recruitment drive every year. They may even become entrepreneur and choose to start their own business or industrial units.

PO7. The students will be able to engage themselves in independent thinking and lifelong learning in the present context of scientific and technological advancement.

Program Specific Outcomes (PSO) :

B.Sc. Physics (Honours) (under CBCS curriculum of the University of Calcutta)

PSO1. The students will acquire a scientific knowledge of the fundamental principles of Physics through study of Classical Mechanics, Electromagnetic Theory, Optics, Heat and Thermodynamics, Statistical Mechanics, Solid State Physics, Nuclear Physics, Modern Physics, Quantum Mechanics and other areas of Physics.

PSO2. The students will learn use of appropriate level of technology for : a) experimental design and implementation, b) analysis of experimental data, and c) numerical and mathematical methods in problem solving, d) different computational techniques and apply them for experimental data analysis and solving theoretical problems.

PSO3. The students will acquire a fair amount of computational skill using open source software packages such as Gnuplot, Python, Numpy, Scipy, Matplotlib, Matlab, LaTeX , Arduino IDE etc. in both Linux and Windows platform. This will not only prepare them for higher studies or research in any branch of Physics but also make them ready for various kind of job in IT sector and other industries.

PSO4. The students will learn effective communication skill to present their knowledge of physics from basic concepts to specific advanced areas in the form of preparation of laboratory note book, project work, seminar presentation, poster presentation, wall magazines, models and other modes.

PSO4. The students will learn to work independently as well as a group during laboratory sessions, projects and student seminars.

PSO5. Students will get academic exposure through the various Internships offered by reputed National Research Institutes during their UG tenure. They will be able to utilize the small summer/winter recesses through their involvement in small projects under careful guidance of reputed faculties and may get the flavor of the current trend of research.

PSO6. The student will acquire a purposeful knowledge of scientific literature and ethical issues related to physics.

Course Outcome (CO) – PHYSICS (Hons.) (CBCS)

- **The syllabus of this course has been framed by the University of Calcutta**

Name of the Programme	Year of Introduction	Course Code	Course Name	Course Outcome (CO)
B.Sc. PHYSICS (Honours) (CBCS)	2018	<u>Semester-I</u> PHSA-CC-1-1-TH	Mathematical Physics-I (Theory)	This course will acquaint the students with basic mathematical tools like vectors, matrices and calculus which are extremely essential to study theoretical and experimental physics.
		PHSA-CC-1-1-P	Mathematical Physics-I (Practical)	The students will learn basics of programming in Python, a universally accepted open source programming language. They will be familiar with

				open source advanced operating system Linux. They will also learn graph plotting in Gnuplot, also an open source graph plotting package. This course will be extremely beneficial as it will build the foundation of application of computational techniques in any branch of theoretical and experimental physics. It will also help in interdisciplinary research in future.
		PHSA-CC-1-2-TH	Mechanics (Theory)	This course in Classical Mechanics serves as the foundation for further progress towards study of physics at graduate or post-graduate level. Newtonian mechanics forms the basis of this course. The study of nature through different conservation principles are introduced with detailed treatment. The Physics of rotational motion of a rigid body and fluid motion are also introduced.
		PHSA-CC-1-2-P	Mechanics (Practical)	In this course the students will be familiar with some basic apparatus used in physics laboratory. They will learn how to make systematic experimental observation, data collection, recording of data and other basic laboratory practices in this course. They will learn how to plot graphs and determine different parameters from the graph. They will also learn how to estimate errors in experimental data. They will learn the importance of working as a group in any laboratory. They will perform some experiments to verify different laws and to determine different physical quantities related to the Theory portion of the course.
		PHS-G- CC-1-1-TH	Mechanics (Theory)	This course will be offered to students of Chemistry, Mathematics, Computer Science & Statistics Honours as per their choice. The students will learn the basic mathematical tools like vectors analysis, calculus of vectors,

				differential equations etc. to get an entry into Mechanics, Gravitation and the studies of General properties of Matter. These will help the students to carry on higher studies in interdisciplinary fields.
		PHS-G-CC-1-1-P	Mechanics (Practical)	In this laboratory course, the students will learn the verification of some known parameters like acceleration due to gravity, determination of moment of inertia of rotating objects and determination of some elastic constants of matter.
		Semester-II PHSA-CC-2-3-TH	Electricity & Magnetism (Theory)	The students will learn fundamental properties of charged particles and electric fields in this course. This course will also give students an understanding of the phenomena of electricity, magnetism, electromagnetic induction and electrical circuits which are extremely essential for higher studies in physics and also important for various engineering applications. This course builds the basis for studying more advanced topics in electromagnetic theory.
		PHSA-CC-2-3-P	Electricity & Magnetism (Practical)	The students will strengthen their skill of experimental work in this course. They will be familiar with various electrical components, power supply, multimeter and various other measuring instruments. They will be able to perform experiments on various topics of electricity and magnetism in this course. They will learn about precautions to be taken during performing an experiment and will be able to identify different sources of error. They will also learn how to analyze experimental data.
		PHSA-CC-2-4-TH	Waves and Optics (Theory)	The students will gain basic knowledge about vibration, wave motion and wave theory of light. Study of classical harmonic oscillator and wave propagation in vacuum and

				material media, and phenomena of interference and diffraction of light are important for further progress to more advanced topics of Physics.
		PHSA-CC-2-4-P	Waves and Optics (Practical)	In this laboratory course the students will be acquainted with spectrometer, a very important optical instrument and some other optical instruments like Fresnel's biprism and Newton's ring experiment. They will learn how to level a spectrometer and how to take readings from it. They will also be familiar with various light sources used in physics laboratory. They will be able to determine some well known physical quantities like refractive index etc. by performing laboratory work.
		PHS-G-CC-2-2-TH	Electricity and Magnetism (Theory)	This course will repeat the necessary parts of vector treatments at the beginning and is meaningful for the students who didn't opt for Physics as GE subject in Semester 1. From the rest part, the students will learn the topics Electrostatics, Magnetism and Electrodynamics. This course is very important for students of Chemistry, Computer Sc Honours if they opt to carry on higher studies in interdisciplinary fields.
		PHS-G-CC-2-2-P	Electricity and Magnetism (Practical)	The students will get familiar with basic instruments like Carey Foster Bridge, Potentiometer, Ammeter, Voltmeter, Magnetometer etc. and their uses. The student will learn how to measure some basic physical quantities like resistance, current, magnetic field components etc.
		<u>Semester-III</u> PHSA-CC-3-5-TH	Mathematical Physics-II (Theory)	In this course the students will learn more advanced topics of mathematical physics like Fourier series, some special functions, special integrals, integral transforms, partial differential equations and probability. All these topics are very important for studying theoretical aspects of various branches

				of physics
		PHSA-CC-3-5-P	Mathematical Physics-II (Practical)	In this course the students will learn more advanced computational techniques using different packages of Python like numpy, scipy, matplotlib etc. They will learn various numerical analysis techniques like use of array, numerical solution of problems of matrix algebra, numerical integration, interpolation, solution of differential equation and curve fitting. This course will immensely benefit the students for higher studies and research career in Physics.
		PHSA-CC-3-6-TH	Thermal Physics (Theory)	<p>Thermodynamics is introduced in this course and this covers fundamental laws of nature. Problems related to conversion of heat into work or the vice versa give rise to thermodynamics. Students will learn the principle of operation of engines and refrigerators in this course.</p> <p>The students learn the basic distribution laws which are obeyed by the molecules in the Thermal Physics part and the application to explain the basic laws of ideal gas. The limitation to explain different observed phenomena with ideal gas prescription leads the study of real gas and also conduction of heat in this course. This part covers other very important aspects related to academic importance and also to industrial applications.</p>
		PHSA-CC-3-6-P	Thermal Physics (Practical)	In this course the student will perform different experiments on heat and thermodynamics. This laboratory course will further enrich their experimental skill learned so far.
		PHSA-CC-3-7-TH	Modern Physics (Theory)	The students will be introduced to the fascinating world of quantum physics in this course. One cannot have any other tool except this branch to probe the physics in the micro world. The students will become familiar with the

				<p>mathematical tools and their physical implications and have a good practice in solving problems using those tools. The students will learn basics of nuclear structure, radioactivity, nuclear fission & fusion. They will also learn fundamental principle of Laser and its applications in this course. This course is extremely important from theoretical as well as application point of view.</p>
		PHSA-CC-3-7-P	Modern Physics (Practical)	<p>This laboratory course will introduce the students to some advanced level experiments. The students will learn to determine value of Planck's constant, study of photoelectric effect, verification of Stefan's law of radiation, determination of e/m of electron and behaviour of tunnel diode</p>
		PHSA-SEC-A1-TH (Technical Skill)	Scientific Writing (Theory)	<p>This course is a project type technical skill enhancement course. The students will learn how to prepare a scientific article containing figures, tables and mathematical equations in a presentable form through open source scientific writing software LaTeX. This course will be beneficial for the students in the job market.</p>
		PHSA-SEC-A1-PR (Technical Skill)	Scientific Writing (Project)	<p>In this course the students will learn how to prepare different kind of projects in real world using the knowledge acquired in the theory portion of this paper.</p>
		PHS-G- CC-3-3-TH	Thermal Physics and Statistical Mechanics (Theory)	<p>A very important course particularly for the students of Chemistry Honours. This will pave the way to understand the basic laws of nature which are inbuilt in the laws of Thermodynamics. The other aspects like kinetic theory of gas, the distribution of radiation energy are also covered in this course. The course is further extended to understand Statistical Mechanics which is relevant to study Thermodynamics analytically.</p>

		PHS-G- CC-3-3-P	Thermal Physics and Statistical Mechanics (Practical)	The students will get hands on training of the methods of determination of different physical quantities of thermal physics like coefficients of expansion, pressure coefficients, thermal coefficients of resistance, thermal conductivity etc and also the verification of very important Stefan's law of radiation.
		<u>Semester-IV</u> PHSA-CC-4-8-TH	Mathematical Physics-III (Theory)	The students will learn the mathematical tools required for study of some advanced topics of theoretical physics. They will learn complex analysis, variational calculus and its application which results in the famous Lagrangian and Hamiltonian formulation of classical mechanics. The students will also be acquainted with the revolutionary concept of special theory of relativity which is extremely essential for understanding the physical world beyond Newtonian mechanics. This is one of the fundamental concepts of physics which every student of physics should learn.
		PHSA-CC-4-8-P	Mathematical Physics-III (Practical)	The students will learn some advanced level programming with Python in this course. They will learn to handle Gaussian integration, delta function, numerical solution of first and second order differential equation, some special functions, solution of some basic partial differential equations and evaluation of Fourier coefficients. This course will prepare the students for higher studies and research in theoretical and computational physics.
		PHSA-CC-4-9-TH	Analog Electronics (Theory)	This course forms the basis of electronics which is undoubtedly at the heart of most of the technological advances of the present era. The students will understand the basic concepts of semiconductor physics and its application. They will learn about the operation, characteristics and

				various applications of different type of diodes, transistors, field effect transistors, OPAMP and oscillators. They will also have an idea about working of amplifier and regulated power supply.
		PHSA-CC-4-9-P	Analog Electronics (Practical)	This laboratory course will provide the student with adequate exposure to some essential laboratory equipments like CRO, function generator, regulated power supply etc. The students will design, fabricate and perform experiments with zener diode, transistor, OPAMP and Wein Bridge oscillator. The students will acquire basic skill required for higher studies or research in experimental Physics.
		PHSA-CC-4-10-TH	Quantum Mechanics (Theory)	The already introduced Quantum Mechanics finds application in this course and hence this is the appropriate course to introduce Atomic Physics so that the students get continuity in their progress. Student will also learn the behaviour of atoms in magnetic and electric field. This course is essential for progress to higher studies and research career in physics.
		PHSA-CC-4-10-P	Quantum Mechanics (Practical)	The student will learn some advanced computational techniques and applying them to solve various problems related to quantum mechanics using Python in this course.
		PHSA-SEC-B1-TH (Technical Skill)	Arduino (Theory)	This course is a technical skill enhancement course. The students will learn about microprocessors and hardware software interfacing techniques through open source software package Arduino IDE.
		PHSA-SEC-B1-PR (Technical Skill)	Arduino (Project)	The students will be able to demonstrate real life applications using Arduino IDE and Arduino UNO R3 Board. This course will help the students to gain hands on training on

				software-hardware interfacing techniques. The students will get better opportunity in job market after completion of this course.
		PHS-G- CC-4-4-TH	Waves and Optics (Theory)	This course will introduce another important branch of Classical Physics. The students will get refreshed through the recapitulation of the basic preliminary aspects of vibration. The basic mathematical tools for analysis of vibration & wave motion will be introduced. The aspects of Interference, Diffraction and Polarization will be studied extensively using the wave concept of light.
		PHS-G- CC-4-4-P	Waves and Optics (Practical)	This laboratory course will give the students the methodologies of determination of optical parameters like focal length, radius of curvature of a lens. The students will also study other optical phenomena like the interference patterns, rotation of plane of polarization by active substance.
		Semester-V PHSA-CC-5-11-TH	Electromagnetic Theory (Theory)	The students will go through a very important training in Electromagnetic Theory which is one of the fundamental components of classical physics. The important set of relations of Electrostatics, Magnetostatics, Electro-magnetic Induction, taught in earlier Semesters find application in this topic. The electromagnetic wave is generated naturally from the Maxwell's relations and the students will get the explanation of polarization and related optical and other aspects from this theory.
		PHSA-CC-5-11-P	Electromagnetic Theory (Practical)	The students will get hands on training on the topics covered in CC 11 (theory). The behavior of electromagnetic wave after refraction as established through well known laws can be verified in the laboratory. Also the theoretical predictions on

				polarization of electromagnetic waves find verification through the experiments referred in this course.
		PHSA-CC-5-12-TH	Statistical Physics (Theory)	In Statistical Mechanics, the students will get an entry into the world of mechanics comprising of a collection of particles and will understand how to study the gross behavior of a system. This approach also establishes the laws of thermodynamics which are the fundamental rules of nature. The Quantum Statistical Mechanics gives the approaches to treat identical elementary particles which are frequently involved in theoretical and experimental research.
		PHSA-CC-5-12-P	Statistical Physics (Practical)	The students will use Python programming to study aspects of statistics like Random numbers and Time scale, application of Random numbers including Monte Carlo integration. The approach is extended also to the study of different distributions in statistical mechanics.
		PHSA-DSE-A1(b)-TH	Laser and Fiber Optics (Theory+ Tutorial)	The students will learn this topic which finds many applications in different spheres starting from industry to medical fields. The study of many well known devices for the generation of LASER and their controlling tools are covered. The topic of Fiber Optics is now a well known terminology in the world of Internet and other connections and Telecommunication.
		PHSA-DSA-B1(b)-TH	Nuclear and Particle Physics (Theory+ Tutorial)	The students of UG level will get the first lesson of Nuclear Physics in this topic. The contents are very important from the viewpoints of both theory and applications. Since it is very difficult to set up Nuclear Physics Laboratory at the UG level, the students are taught very carefully so that they may get the necessary inputs to carry on the study in Masters and in the Research level in reputed national and International

				Laboratories.
		<u>Semester- VI</u> PHSA-CC- 6-13-TH	Digital Electronics (Theory)	This topic intends to make the students familiar with the digital world. Starting from the introductory ideas of ICs, fundamental Gates and different number systems, the topic in steps is extended to implementation of different logic circuits. The students will be familiar with the basics of hardware; learn Counters, Registers, Flip-Flops, Data Processing Circuits and Computer Organization.
		PHSA-CC- 6-13-P	Digital Electronics (Practical)	This course will give the students hand on training of fabrication of the basic electronic components like different Gates, Flip-Flops, Shift Registers, Multiplexers using standard ICs.
		PHSA-CC- 6-14-TH	Solid State Physics (Theory)	The study of the solid state encompasses the understanding of the organizational, mechanical, magnetic and electrical properties of the substance as well as the forces that bind the units into the solid state. By far the most important subfield of solid state physics in the 20th century is the study of semiconductors and solid state electronics. The syllabus also covers Superconductivity, the ability of certain materials to conduct electric current with practically zero resistance. Superconductors have been employed in, or proposed for use in, an enormous variety of applications.
		PHSA-CC- 6-14-P	Solid State Physics (Practical)	All the Experiments of this course are related to investigation of fundamental and electrical and magnetic properties of solids. The determinations of BH loop area of ferromagnetic substance, dielectric constant of a material, study and verification of temperature dependence of resistance of semiconductor etc by experiments (topics which are included in CC 14 Theory) will boost up the interest of

				the students.
		PHSA-DSE-A2(a)-TH	Nano Materials and Applications (Theory+ Tutorial)	This course will offer the entry into the Nano World. The basic physics of nano particles and their synthesis following different methodology will be taught. The important characteristic features like optical properties, electron transport phenomena in nanostructures will be studied. The students will be familiar in both the theoretical prospects of development and application of nano science in different fields.
		PHSA-DSE-B2(b)-TH	Advanced Statistical Mechanics (Theory+ Tutorial)	This course may be viewed as an extension of CC 12 (Theory) with the incorporation of two specialized topics which will be helpful in their trend of research in future. These are the Ising Model and the introduction of non equilibrium statistical mechanics.