Course code	Course name	Course credit
PHSPCOR01T	Mathematical Methods of Physics	4
PHSPCOR02T	Classical Mechanics	4
PHSPCOR03T	Introductory Quantum Mechanics	4
PHSPCOR04T	Statistical Mechanics	4
PHSPCOR05P	General and Computational Lab I	4
PHSPAEC01M	Computational Ability Development	2
PHSPCOR06T	Classical Theory of Fields & Electrodynamics	4

PHSPCOR07T	Condensed Matter Physics	4
PHSPCOR08T	Applications of Quantum Mechanics	4
PHSPCOR09T	Nuclear and Particle Physics	4
PHSPCOR10P	General and Computational Lab II	4
PHSPSEC01M	Physics Problem Solving and Teaching Skill	2
PHSPCOR11T	Advanced Statistical Mechanics and Molecular Spectroscopy	4
PHSPCOR12T	Advanced Quantum Mechanics	4

PHSPCOR13T	General and Computational Lab III	4
PHSPDSE01T	(a) Advanced Condensed Matter Physics I OR (b) Astrophysics I	4
PHSPCOR14M	Seminar and Colloquia	4
PHSPGEC01T	Elements of Modern Physics	4
PHSPCOR15M	Grand Viva	4
PHSPDSE02T	(a) Quantum Field Theory OR (b) Non-linear Dynamics	4
PHSPDSE03T	(a) Advanced Condensed Matter Physics II OR (b) Astrophysics II	4
PHSPDSE04P	(a) Advanced Condensed Matter Physics Lab OR (b) Astrophysics Lab	4

Course Outcome

Every branch of physics depends heavily on mathematical methods. Objective of this course is to enable to students (i) to understand and apply the concept of discrete groups; (ii) to understand and apply techniques of solving of second order linear ordinary differential equation; (iii) to understand and apply the theory of functions of complex variable and to perform contour integration; (iv) to understand various properties of special functions to be applied in most of the following courses of this program.

To enable the student to grasp the fundamental principles of Mechanics and to apply those principles in different branches of Physics. Further, to learn the alternate formulations of Mechanics which can be applied beyond the regime of Classical Physics, namely, the Variational principle and Action formalism, Lagrangian and Hamiltonian formulation etc.

Students will know and understand the concept of vector space and will be able to apply immediately in formulation of Quantum Mechanics (this can also find application in many other fields of quantitative science). Students will be exposed to the postulatory approach of quantum mechanics. Students will be able to deal with the angular momentum operator and its wave-function. Students will be able to solve bound state problems in three dimension in central field potential. Students will be able solve problems in stationary and time dependent perturbation techniques.

To enable the student to grasp the fundamental principles of Statistical Mechanics and to apply those principles in solving various problems related to different branches of Physics. Also to develop the ability to formulate and solve problems involving many degrees of freedom that draw recent research interest in the area of Statistical Mechanics.

Student gets trained i) in performing experiments and recording data on reasonably state of the art equipment, ii) in analyzing data to draw the final conclusions. The experiments are so chosen so as to give them maximum exposure to fascinating field of experimental physics based on the theoretical knowledge acquired by the student. To encourage students in critically reviewing the results, experimental set-up and procedure, rather than merely performing standard experiments

Since familiarity at the fundamental level with the logical structure and grammar and syntax of any computer language can enable the student to quickly change, if necessary, to any other, we shall generally concentrate on one such language. Target is to inculcate the ability to write programs by the students themselves for understanding different concepts and solving different problems of physics. Each year problem sets need to be different.

To familiarize the learner with the techniques of field theoretic study that forms the core of many advanced topics in Physics, e.g., Quantum field theory, Nuclear Physics, Condensed Matter Physics, General Relativity and so on. The student should be able to understand and apply the concepts of Electrodynamics. The student should develop an understanding of the basics of electromagnetic (EM) radiation and relativistic nature of EM-field.

To familiarize the learner with the basic facts and underlying principles that form the back-bone of Condensed Matter Physics. To develope the skill of formulating and systematically solving problems in Condensed Matter Physics that will find applications in Material Physics as well as in other related branches of Physics.
The objective of this course is to enable the students (i) to apply quantum mechanics in studying atomic physics of increasing complexities; (ii) to learn WKB approximation, an important tool to be applied in many application of atomic, molecular and nuclear physics; (iii) to learn the techniques of scattering problems in quantum mechanics: to be applied in various branches of modern nuclear and subatomic physics.

To familiarize the student with the basic facts and experiments of Nuclear Physics. To demonstrate how the basic principles of physics are applied to the understanding of the properties of the atomic nucleus and nuclear reactions. To introduce the student with the basic phenomenology in particle physics. To promote student's interest in the area of high energy physics.

General Lab II: To introduce experiments in modern physics which are related to the domain of theoretical knowledge of the student. To give exposure to techniques of determination of fundamental constants and basic measurement techniques in modern physics. Emphasis to be given on critically reviewing the results, experimental set-up and procedure, rather than merely performing standard experiments. Student is to be encouraged to think of alternative experimental design of their own.
Computational Lab II : A good knowledge in numerical methods and the skill to implement them in program code is necessary for computational physics. Students will be able (i) to develope codes for a given numerical method; (ii) to compare the efficiency of different alternative methods; (iii) to use the python scipy and numpy numerical library for numerical calculation.

To develop skill of solving innovative problems in core areas of Physics as well as problems of inter-disciplinary nature. To train the learner develop teaching skill in Physics. The course intends to help the learner specifically prepare for taking up a professional career in Physics.

To take the student beyond the scope of equilibrium statistical mechanics and introduce the basic elements of non-equilibrium statistical mechanics. To introduce the modern theory of phase transition.
The student at the end of the course should be able to (i) explain the principle and instrumentation of microwave, vibration-rotation Raman and infra-red spectroscopy and interpret microwave, vibration-rotation Raman and infra-red spectra for chemical analysis, and (ii) explain the principle and instrumentation of electronic spectroscopy and analyze the electronic spectra of different species.

To impress upon the learners how symmetry and group theory works in subatomic world and how Lorentz symmetry restricts and thereby ensures the very structure of relativistic quantum mechanics. Also to demonstrate the real necessity of an action principle in the quantum domain through the introduction of path-integral techniques. To familiarize the learner with the basic facts and underlying principles that work in the relativistic regime of a sub-atomic world.

To perform and analyze results of some standard experiments. To give the students exposure to basic measurement techniques and ample scope of analyzing the experimental data. To motivate students in innovative designing of experimental techniques.
Students will be able (i) to model a physical problem in terms of mathematical formulation and subsequent code development and explore the properties of the model by simulation; (ii) to generate random numbers of different probability distribution; (iii) to carry out Monte Carlo simulation.

To extend the learner's training in the core course on Condensed Matter Physics. To familiarize the learner with some areas of recent interest in Consed Matter Physics. To prepare the learner for taking a further advanced course in Condensed Matter Physics.
To extend applicability of the learner's training in various core courses of Physics to the arena of Astrophysics. To familiarize the learner with various facets of theoretical
Astrophysics and also to introduce the learner to the current status of observational Astronomy. To prepare the learner for taking a further advanced course in Astronomy and Astrophysics.

To train the learner to systematically review a scientific topic and present the finding in the form of a written report. To familiarize the learner to defend the work in the form of a general seminar lecture.
To introduce somewhat advanced topics that are generally not included in the PG curriculum.
To familiarize the students from non-Physics programme with the outline of
recent developments of modern physics. To promote the perspective of inter-disciplinary study that involves knowledge of quantum physics and relativity.

To learn the basic principles of field quantization and to equip the student for taking an advanced course in Quantum Field Theory. To develop understanding of QED. To develop the idea of spontaneous symmetry breaking. To introduce Path integral quantization.
To enable the students (i) to analyze the fixed points, phase portrait and the
bifurcation of 1-dimensional and 2-dimensional continuous dynamical systems; (ii) to xplore the possibility of limit cycle and to analyze relaxation and weakly nonlinear oscillators; (iii) to study the characteristics of chaos in three dimension. Students will be able to analyze iterative maps and the consequent bifurcation and learn about different routes to chaos. They learn about fractals, Poincare maps, strange attractor and non-linearity in Hamiltonian systems.
a) To introduce some of the advanced areas of Condensed Matter Physics that remain at the focus of recent research interest. To enable the learner to identify and solve toy problems that gives the flavour of hands-on experience of research in these areas.
To equip the learner with the tools and techniques for studying advanced areas of theoretical Astrophysics and Cosmology. To prepare the learner for taking a further advanced course in Astrophysics and Cosmology.
To introduce some experiments in condensed matter physics closely related to the
Advanced Condensed Matter Special Paper courses. To train the students in handling relatively more sophisticated instruments. To encourage innovative extension of experimental techniques. To analyze experimental data.
To train the learner's to operate astronomical telescopes to collect data and further
introduce them to the the hands-on techniques for using Astronomical data.

To train the learner to investigate an open problem that requires ability of working out problems independently. To give a flavour of hands-on experience in reserach work. To enable the learner to prepare the finding in the form of a dissertation. Also to enable the learner to present and defend the work carried out in the Major Project.