St. Xavier's College (Autonomous), Mumbai
Department of Physics

Programme: B.Sc. Physics

Programme Specific Outcomes (PSOs) for B.Sc. Physics

Sr. No.	On completing B.Sc. Physics, the student will be able to:
PSO 1	Comprehend physics principles and their applications in the problems of everyday life.
PSO 2	Possess industry-specific skills for the existing industrial jobs, and for developing new technologies.
PSO 3	Understand the advanced methods of scientific inquiry and develop skills for extensive research.
PSO 4	Know mathematical methods and computer programming so as to model the advanced theories and provide deductions.
PSO 5	Develop skills for understanding scientific literature and creating scientific communication in the written, audio and video forms.
PSO 6	Not only stitch a fragmented problem into a complete one, but also create alternate solutions in diverse fields of physical, biological and social sciences.

Course Outcomes (COs): B.Sc. Physics

Semester I

Course Title: Classical Mechanics – I
Course Code: SPHY0101

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Apply Newton's laws to any physical situation, and deduce its kinematical behaviour.	1, 3, 4, 5	U, R, Ap
CO 2	Understand the concepts of work, power and energy, and apply them to industrial and day-to-day life situations.	1, 3, 4, 5, 6	U, R, Ap, An
CO 3	Understand and apply the concepts of momentum and its conservation to evaluate performance of machines.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E
CO 4	Understand and apply the concept of rotation and locomotives, and other revolving systems.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E
CO 5	Understand and apply the concept of fluid mechanics to systems involving gases and liquids.	1, 2, 3, 4, 5, 6	U, Ap, An, E
CO 6	Understand the concept of gravitation and analyse its many consequences in the universe.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C

Course Title: Waves and Thermodynamics
Course Code: SPHY0102

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the conditions for static equilibrium and solve rigid-body equilibrium problems.	1, 2, 3, 5	U, R, Ap, An, E
CO 2	Understand simple harmonic oscillation and damped oscillations in various mechanical systems and their applications.	1, 2, 3, 4, 5, 6	U, R, Ap, An,
CO 3	Understand the properties of materials and heat transfer mechanisms.	1, 2, 3, 5	U, R, Ap, An,
CO 4	Understand the basic concepts of thermodynamics such as state variables, state of a system, work done and internal energy.	1, 3, 4, 5	U, R, Ap, E
CO 5	Apply the laws of thermodynamics in various processes / systems (in day-to-day phenomena) to calculate the work done/ internal energy.	1, 2, 3, 4, 6	U, R, Ap, An, E, C
CO 6	Analyse the performance of heat engines, steam power plants and refrigerators, and their components using the first law of thermodynamics.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C

Course Title: Physics Practicals – I
Course Code: SPHY01PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Know video analysis technique for mechanics experiments, new software tools and error analysis techniques for the experimental data.	1, 2
CO 2	Design and implement experimental projects in mechanics and thermodynamics.	3, 5

Semester II

Course Title: Electricity and Magnetism
Course Code: SPHY0201

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Explain the concepts of electrical charge, field and force, and applications of Coulomb's law.	1, 3, 5	U, R, Ap, An, E
CO 2	Analyse the concepts of capacitor and explain the working principle of capacitors.	1, 3, 6	U, R, Ap, An, E, C
CO 3	Discuss the concepts of magnetism; apply the principles of electromagnetic induction.	1, 3, 5, 6	U, R, Ap, An, E, C
CO 4	Apply Gauss's law and determine electric flux and charge.	1, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 5	Apply Kirchoff's laws and analyse the electrical circuits.	1, 3, 4, 5, 6	U, R, Ap, An, E
CO 6	Recall and explain the concept of EMF; gain employment by applying knowledge of basic principles of electricity and magnetism.	1, 2, 3, 4, 5	U, R, Ap, An, E, C

Course Title: Optics and Electromagnetic Waves
Course Code: SPHY0202

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Discuss the nature and propagation of light.	1, 2, 3	U, R, Ap
CO 2	Explain the working of different optical instruments such as camera, telescope, microscope etc.	1, 2, 3	U, R, Ap, An, E
CO 3	Explain the optical phenomena of interference and diffraction.	1, 2, 3	U, R, Ap
CO 4	Explain the domains of particle nature and wave nature of light.	1, 2, 3, 5	U, R, Ap
CO 5	Discuss fundamentals of electromagnetic induction.	1, 2, 3	U, R, Ap, An, E
CO 6	Describe generation and properties of electromagnetic waves.	1, 2, 3, 5, 6	U, R, An, E

Course Title: Physics Practicals – II
Course Code: SPHY02PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Know video analysis technique for optics experiments, new software tools and error analysis techniques for the experimental data of electrical and optics experiments.	1, 2
CO 2	Design and implement experimental projects in electricity and magnetism, and in optics.	3, 5

Semester III

Course Title: Waves and Quantum Optics
Course Code: SPHY0301

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the concept of Fresnel's class of diffraction.	1, 2, 3, 5, 6	U, R, Ap, An, E, C
CO 2	Understand the working of Fabry-Perot and Michleson's interferometer and their applications.	1, 2, 3, 5, 6	U, R, Ap, An, E, C
CO 3	Understand the basic principles of polarized light.	1, 2, 3	U, R, Ap, An, E, C
CO 4	Explain the polarization-based phenomena such as optical activity, photoelasticity, etc.	1, 2, 3, 5, 6	U, R, Ap, An, E, C
CO 5	Be familiar with the working principle of lasers.	1, 2, 3	U, R, Ap, An, E
CO 6	Understand holography and its applications.	1, 2, 3, 5, 6	U, R, Ap, An, E

Course Title: Mathematical Physics
Course Code: SPHY0302

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Undersatnd conics: ellipse, parabola and hyperbola, polar coordinates.	1, 3, 6	U, R, Ap, C
CO 2	Understand basic and advanced topics in matrices.	1, 3, 4, 6	U, R, Ap, An, E
CO 3	Understand and apply the concepts of vector calculus, and understand and apply orthogonal curvilinear coordinate systems.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E
CO 4	Understand the concept of one- and three-dimensional Dirac Delta function.	1, 3, 4	U, R, Ap, An, E
CO 5	Understand the 1st and 2nd order ordinary linear differential equations, and solve these equations using different methods.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 6	Understand and apply the concept of Fourier series, Fourier transform and Laplace transform.	1, 2, 3, 4, 5	U, R, Ap, An, C

Course Title: Electronics – I
Course Code: SPHY0303

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the working, characteristics and applications of semiconductor diodes.	1, 2, 3, 5, 6	U, Ap, E, C
CO 2	Analyse the configuration of transistor (CE and CB) and transistor as an amplifier.	1, 2, 3, 5, 6	An, E, C
CO 3	Recollect different types of biasing methods for transistor.	2, 3	U, R, E
CO 4	Understand the working, characteristics and applications of SCR.	1, 2, 3, 5, 6	An, Ap, E, C
CO 5	Understand the conversions of numbers in different base systems, and explain the working of digital electronic circuits using flip-flop logic.	1, 2, 3, 4, 5, 6	U, R, An, Ap, E, C
CO 6	Know the basic principles of electronics.	1, 2, 3, 4, 5, 6	An, Ap, E, C

Course Title: Physics Practicals – III
Course Code: SPHY03PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Write programs in Python/ Octave; perform laser-based experiments; design electronic circuits, and express results using scientific communication methods.	1, 2, 4
CO 2	Design and implement experimental/ computational projects in mathematical physics, wave optics and electronics.	3, 4, 5

Semester IV

Course Title: Thermodynamics
Course Code: SPHY0401

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Know the properties of real gases and ideal gases, the basic concepts of thermodynamics, and various parameters, viz; temperature, pressure, system, properties, process, state, cycles and equilibrium.	1, 2, 3, 4, 5	U, R, Ap, An, E,
CO 2	Understand substances with the help of P-V diagram and T-S diagrams, and energy transfer through mass, heat and work for closed and control volume systems.	1, 2, 5, 6	An, Ap, E, C
CO 3	Apply of first law and second law of thermodynamics and entropy concepts in analysing the thermal efficiencies of heat engines such as Carnot cycle, and the coefficients of performance for refrigerators.	3, 4, 5, 6	U, R, Ap, An, E
CO 4	Apply the inequality of Clausius and establish the property entropy of a system; apply the principle of increase of entropy to evaluate the feasibility of a thermodynamic process.	1, 2, 3, 4, 5	U, R, Ap, An, E,
CO 5	Understand different methods of liquefaction of various gases, Seebeck and Peltier effects and their potential industrial applications.	1, 2, 3, 4, 5	U, R, Ap, An, E,
CO 6	Understand concepts in thermometry, and different theories of heat capacity of solids.	1, 2, 3, 5	U, R, Ap, An

Course Title: Quantum Mechanics
Course Code: SPHY0402

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand physical situations where classical physics fails, and how quantum concepts explain it.	1, 3, 5, 6	U, Ap, An
CO 2	Understand the mathematical basis of quantum theory and concept of probabilistic approach.	1, 4, 5, 6	U, R, Ap, An
CO 3	Understand the concept of quantisation and discrete energy states.	1, 3, 4, 5, 6	U, Ap, An
CO 4	Apply the quantum theory to many idealistic situations and solve problems.	1, 3, 4, 5, 6	U, R, Ap, An, E
CO 5	Apply quantum theory and perform mathematical analysis of more complicated systems.	1, 3, 4, 5, 6	U, Ap, An, E
CO 6	Apply quantum theory to a real world example of hydrogen atom and look at limitations of the quantum theory.	1, 3, 4, 5, 6	U, Ap, An, E, C

Course Title: Acoustics
Course Code: SPHY0403

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the aural response of humans.	1, 3, 6	U, Ap
CO2	Understand the quantification of sound and working of relevant instruments.	1, 2, 3, 6	U, Ap, An, E, C
CO 3	Possess knowledge of various musical instruments.	1, 2, 3, 4	U, R, Ap, An, E, C
CO 4	Understand the working of human vocal cord.	1, 2, 3, 6	U, R, Ap, An, E, C
CO 5	Understand the workings of microphone, loudspeaker and sound processing system.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 6	Analyse the acoustics of a room, large or small; presence of noise and its elimination.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C

Course Title: Physics Practicals – IV
Course Code: SPHY04PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Interpret acoustic clues; use computer-based acoustic tools, numerical simulations for quantum mechanics problems and experimentation in the subject of thermodynamics.	1, 2, 4
CO 2	Design and implement experimental/ computational projects in acoustics, quantum mechanics and thermodynamics.	3, 4, 5

Semester V

Course Title: Classical Mechanics – II
Course Code: SPHY0501

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Apply the concepts of special theory of relativity to the various physical phenomena, and understand its significance.	1, 2, 3, 5	U, R, Ap
CO 2	Understand fundamental concepts of Newtonian mechanics and its applications to various physical systems, natural and man-made.	1, 2, 3, 4	U, R, Ap
CO 3	Apply Lagrange's formulation to understand complex mechanical systems and solve quantitative problems in applied physics.	1, 3, 5, 6	U, R, Ap
CO 4	Understand the fundamental concept of moment of inertia and inertia tensor of a rigid body.	1, 2, 3	U, R,
CO 5	Apply critical thinking skills to describe the motion of the rigid body about its principal axis.	1, 2, 4, 5	U, Ap, E, C
CO 6	Apply the theories learnt and the skills acquired to solve real time problems, both analytically and computationally.	1, 3, 4, 5, 6	U, Ap, An, E, C

Course Title: Statistical Mechanics
Course Code: SPHY0502

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.	1, 2, 3, 5, 6	U, R, An, Ap
CO 2	Remember and describe micro and macro states.	1, 2, 5, 6	U, R, An
CO 3	Analyse the differences in micro-canonical, macro-canonical and grand canonical ensembles.	1, 2, 5, 6	U, R, An
CO 4	Analyse the phase transition of different systems.	1, 2, 5, 6	U, An, Ap, E, C
CO 5	Distinguish between different types of particles, and understand particle statistics.	1, 2, 5, 6	An, Ap, E, C
CO 6	Distribute classical particles, bosons and fermions among energy levels.	1, 2, 5, 6	U, An, Ap, E, C

Course Title: Electronics – II
Course Code: SPHY0503

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the construction, working and industrial applications of FETs, UJTs, DIACs, TRIACs, TTL devices and MOSFET devices.	1, 2, 3, 4, 5	U, R, Ap, An, E
CO 2	Understand transistorized differential amplifiers with DC - AC analysis, Op-Amps and Timer integrated circuits such as IC–555 timer and its applications.	1, 2, 3, 5, 6	U, R, An, Ap
CO 3	Design amplifiers using various solid state devices.	4, 5, 6	Ap, An, E
CO 4	Understand fundamentals of TTL and CMOS logic devices.	1, 2, 3, 4	U, R, Ap
CO 5	Understand different types of feedback oscillators and their industrial applications; design regulated power supplies.	1, 2, 3, 4, 5	U, R, Ap, An, E
CO 6	Understand the fundamentals of microprocessors and their architecture.	1, 2, 3, 4, 5	U, R, Ap, An, E

Course Title: Atomic and Molecular Physics
Course Code: SPHY0504

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand general formalism and Dirac notation in quantum mechanics.	1, 3, 4, 5	R, U, Ap
CO 2	Master the application of quantum mechanics to one-electron and two-electron atoms.	1, 3, 4, 5	R, U, Ap, An, E
CO 3	Explain the details of perturbation theory and its applications to fine structure splitting, Zeeman effect, Stark effect and Paschen-Back effect.	1, 2, 3, 4, 5, 6	R, U, Ap, An, E, C
CO 4	Understand the spectra of one-electron atom.	1, 2, 3	R, U, Ap, An, E, C
CO 5	Analyse vibrational, rotational and electronic spectra of diatomic molecules.	1, 2, 3, 4, 5, 6	R, U, Ap, An, E, C
CO 6	Understand Raman spectra of different types of molecules, concepts of nuclear magnetic resonance and electron spin resonance and their applications.	1, 2, 3, 4, 5, 6	R, U, Ap, An, E, C

Course Title: Physics Practicals – V
Course Code: SPHY05PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Carry out computations and numerical simulations; use advanced video analysis techniques, carry out analysis of data obtained online from research laboratories; design advanced electronic circuits for studying classical and statistical mechanics, atomic and molecular physics, and electronics.	1, 2, 4
CO 2	Design and implement experimental/computational projects for some branches of physics such as, classical and statistical mechanics, atomic and molecular physics and electronics.	3, 4, 5

Course Title: Digital Image Processing
Course Code: SPHY05AC

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the fundamental concepts of digital image processing.	1, 2, 3, 4	U, R, Ap
CO 2	Analyse images in spatial domain using various transforms.	1, 2, 3, 4	U, R, Ap, An, E
CO 3	Analyse images in frequency domain using different transforms.	1, 2, 3, 4	U, R, Ap, An, E
CO 4	Evaluate the techniques for image enhancement.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 5	Know the concepts of various image restoration techniques.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 6	Describe the fundamentals of colour imaging and its applications.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C

Course Title: Applied Component Practicals – I
Course Code: SPHY05ACPR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Understand and process digital imaging using computational tools; learn image enhancement and analysis techniques.	2, 4
CO 2	Design and implement a computational project for digital image processing.	3, 4, 5

Semester VI

Course Title: Modern Astrophysics
Course Code: SPHY0601

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Apply knowledge of physics to understand celestial bodies and their physical properties.	1, 3	R, U, Ap
CO 2	Understand working of instruments and analyse nature of electromagnetic radiation coming from celestial bodies.	1, 3, 4	R, U, Ap
CO 3	Understand the solar system, structure of stars and the nature of the interstellar medium.	1, 2, 3, 4, 5	R, U, Ap, An
CO 4	Understand the life cycles of stars; formation and energy production in stars.	2, 3, 4, 5, 6	U, Ap, An, E
CO 5	Analyse and explain the end states of stars: white dwarfs, neutron stars and black holes.	1, 3, 4, 5, 6	U, Ap, An, E, C
CO 6	Understand the nature of galaxies and the large scale structure of the universe through study of cosmology.	1, 3, 4, 5, 6	U, Ap, An, E, C

Course Title: Electrodynamics
Course Code: SPHY0602

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand the concepts of divergence and curl of electrostatic fields, electric potential and boundary conditions, and uniqueness theorems and their applications.	1, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 2	Understand multipole expansion of a dipole, and the electric field in matter.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C
CO 3	Understand divergence and curl of magnetic field, magnetic potential and its multipole expansion, and properties of magnetic field in matter.	1, 3, 4	U, R, Ap, An, E, C
CO 4	Apply Maxwell's correction to Ampere's law, understand Newton's third law in electrodynamics; conservation of momentum.	1, 3, 4, 5, 6	U, R, Ap, An, E
CO 5	Grasp the concepts of wave equation for e and b; propagation, reflection and transmission of electromagnetic waves in linear medium and a conductor and wave guides.	1, 2, 3, 5, 6	U, R, Ap, An, E, C
CO 6	Understand potentials and fields; the fields of a moving point charge, electric and magnetic dipole radiation, relativity and electrodynamics.	1, 2, 3, 4, 5, 6	U, R, Ap, An, E, C

Course Title: Nuclear Physics
Course Code: SPHY0603

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand different properties of the nucleus, binding energy, and the measurements of the size of the nucleus.	1, 2, 3, 4, 5	R, U, An, Ap
CO 2	Analyse the concept of Q-equation in different nuclear reactions, and understand the radioactive decay of alpha, beta and gamma rays, and their fine structure spectra.	1, 2, 3, 4, 5, 6	R, U, An, Ap, E
CO 3	Analyse different nuclear models, viz., liquid drop model and shell model, and their applications.	1, 2, 3, 4, 5, 6	R, U, An, Ap, E, C
CO 4	Understand generation of nuclear energy by nuclear fission and nuclear fusion processes; designing different types of fission and fusion reactors.	1, 2, 3, 4, 5, 6	R, U, An, Ap, E, C
CO 5	Design and analyse various nuclear detectors and their applications.	1, 2, 3, 4, 5, 6	R, U, An, Ap, E, C
CO 6	Understand the concept of nuclear force, design different types of accelerators for production of elementary particles, and analyse different properties of elementary particles based on the Quark Model.	1, 2, 3, 4, 5, 6	R, U, An, Ap, E, C

Course Title: Solid State Physics
Course Code: SPHY0604

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Understand crystal structures, crystal planes and directions, and Miller indices.	1, 2, 5	U, R, Ap, An
CO 2	Understand Bragg's law and methods of crystal structure determination.	1, 2, 3, 4, 6	U, R, Ap, An, E, C
CO 3	Understand free electron gas model and band model (Kronig-Penney model).	1, 3, 4	U, R, Ap, E, C
CO 4	Apply the band theory to understand the motion of charge carriers in solids.	1, 2, 3, 4, 6	U, Ap, An
CO 5	Understand the concepts of magnetization and origin of magnetism in an atom, and differentiate between dia, para and ferromagnetic materials.	1, 2, 5	U, R, Ap, An
CO 6	Understand the quantum theory of dia, para and ferromagnetic materials.	1, 2, 3, 4, 5	U, Ap, An, E, C

Course Title: Physics Practicals – VI
Course Code: SPHY06PR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Use astronomical databases for basic level research; carry out advanced experimentation in electrodynamics and solid state physics; carry out numerical simulations and data analysis in nuclear physics.	1, 2, 4
CO 2	Design and implement experimental/ computational projects for some branches of physics such as, astrophysics, electrodynamics, solid state physics and nuclear physics.	3, 4, 5

Course Title: Applied Physics
Course Code: SPHY06AC

Sr. No.	On completing the course, the student will be able to:	PSOs addressed	Cognitive levels
CO 1	Write a research problem statement.	1, 2, 3, 5	An, U
CO 2	Conduct Literature review.	1, 2, 3	An, U, E
CO 3	Write a synopsis of the project proposal.	1, 2, 3, 5	C, Ap, An
CO 4	Create and construct a large project work.	1, 2, 3, 6	U, R, Ap, An
CO 5	Write interim (experimental) report.	1, 2, 3	U, Ap, An, E, C
CO 6	Organise and write a thesis report.	1, 2, 3, 5, 6	R, U, An, Ap, E, C

Course Title: Applied Component Practicals – II
Course Code: SPHY06ACPR

Sr. No.	On completing the course, the student will be able to:	PSOs addressed
CO 1	Design, execute and analyse projects that are industry oriented as well as related to environment sustainability.	1, 2, 4, 6
CO 2	Write a thesis for dissertation work and defend it through an oral examination.	3, 4, 5, 6