St. Albert's College (Autonomous)

An initiative of Archdiocese of Verapoly

Affiliated to Mahatma Gandhi University, Kottayam

(Accredited with "A" Grade by NAAC)

Programme Outcomes
Programme Specific Outcomes
Course Outcomes

Department of Physics

Undergraduate Programme in Physics

2017 Onwards

Programme Objectives

Within a few years of earning an undergraduate degree in science, graduates are expected to achieve one or more of the following program educational objectives:

1. **Deep Knowledge in the Discipline**: To develop thorough knowledge about the subject and its allied realms by a conscious and continuous process of learning and get informed about the cutting-edge research in the frontier areas of the subject.

2. **Critical Thinking and Problem-Solving Skills**: To develop an informed and analytical approach to learning and demonstrate an in-depth knowledge of the subject and to give his/her opinion supported by logical reasoning and problem-solving skills.

3. **Self-Awareness and Emotional Intelligence**: To develop a proper idea about one's own capabilities and potentials and to nurture those attributes towards holistic personality development.

4. **Teamwork and Effective Communication**: To demonstrate proficiency in communicating competently in groups and organizations, competence in interpersonal communication and to possess skills to effectively deliver formal and informal presentations to a variety of audiences in multiple contexts.

5. **Leadership Qualities**: To build essential features of a true leader and to cultivate the character and courage to shoulder responsibilities.

6. **Social Interaction and Ethical Standards**: To foster the social skills and developing peer interaction and enabling them to make all people feel valued and to respect their differences by being responsible citizens for creating a socially inclusive society. To recognize values such as justice, trust, equity, fairness, kindness and develop a commitment to meeting and upholding standards of ethical behaviour in all walks of life and comprehending the moral dimensions of decisions and actions.

7. **Environmental Consciousness**: To discern the issues of environmental contexts and engages in promoting values and attitudes that claim coexistence and sustainable living with reduced, minimal, or no harm upon ecosystems.

8. **Lifelong Learning**: To develop a passion to be an independent lifelong learner by imbibing real-time changes in the socio-technological context, promoting continuous development and improvement of the knowledge and skills needed for employment and personal fulfilment.

Programme Specific Objectives

The syllabi are framed in such a way that it bridges the gap between the plus two and post graduate levels of Physics by providing a completer and more logical framework in almost all areas of basic Physics. By the end of the first year (2nd semester), the students should have attained a common level in basic mechanics, a secure foundation in mathematics, Chemistry (otherwise specified), Languages and other relevant subjects to complement the core for their future courses and developed their experimental and data analysis skills through experiments at laboratories. By the end of the second year (4th semester), the students should have been introduced to powerful tools for tackling a wide range of topics in Optics, Laser, Fiber optics, Semiconductor devices and circuits. Along with Languages, they should have been familiar with additional relevant techniques in mathematics, Chemistry or Electronics/Computer application and developed their experimental and data analysis skills through a wide range of experiments through practical at laboratories. By the end of the third year (6th semester), the students should have developed their understanding of core Physics by covering a range of topics in almost all areas of physics including Classical and Quantum Mechanics, Electricity and Electrodynamics, Relativity and spectroscopy, Thermal and Statistical Physics, Nuclear and Particle physics, Solid State Physics, Digital Electronics etc. along with one choice based courses, Open course and had experience of independent work such as projects; seminars etc. and thereby developing their experimental skills through a series of experiments which also illustrate major themes of the lecture courses.

Course Outcome – CORE COURSES

PHY1CRT0117: METHODOLOGY AND PERSPECTIVES OF PHYSICS

Module I (8 Hrs.)

1. Introduced with the pursuit of physics, its history and methodology.

Module II (18 Hrs.)

1. Illustrate different number systems and their significance in Physics.
2. Realize the role of vectors and coordinate systems in Physics.

Module III (10 Hrs.)

1. Understand the Importance of measurements and error analysis which is central to Physics.

PHY2CRT0117: MECHANICS AND PROPERTIES OF MATTER

Module I (12 Hrs.)

1. Express wave motion mathematically and define different terms related to wave motion.
2. Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.

Module II (7 Hrs.)

1. Explain the conservation of energy, momentum, angular momentum and apply them to basic problems.
2. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

Module III (17 Hrs.)

1. Infer the principles of elasticity through the study of Young Modulus and modulus of rigidity.
2. Learn simple principles of fluid flow and the equations governing fluid dynamics.
3. Understand basic principles of surface tension and its application in real life situations.

PHY3CRT0117: OPTICS, LASER AND FIBER OPTICS

Module 1 (13 Hrs.)

1. Explain several phenomena we can observe in everyday life that can be explained as wave phenomena.
2. Inspect interference in thin films and its applications in daily life/Science.

Module II (10 Hrs.)

1. Use the principles of wave motion and superposition to explain the Physics of distraction.
2. Understand the working of selected optical instruments like distraction grating.

Module III (12 Hrs.)

1. Use the principles of wave motion and superposition to explain the Physics of polarisation.
2. Illustrate the production of polarized light.

Module IV (10 Hrs.)

1. Understand the 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.

Module V (9 Hrs.)

1. Describe structure and principle of optic fibers.

PHY4CRT0117: SEMICONDUCTOR PHYSICS

Module I (14 Hrs.)

1. Recall N- and P- type semiconductors, Illustrate the fabrication of P-N junctions;
2. Compare forward and reverse biased junctions.
3. Build different types of rectifiers and voltage regulators using P-N junction diodes.

Module II (24 Hrs.)

1. Classify NPN and PNP transistors and basic configurations namely common base, common emitter and common collector; Define current and voltage gain.
2. Illustrate the biasing and feedback in amplifiers and oscillators.
3. Describe Field effect transistors and MOSFET

Module III (16 Hrs.)

1. Recognize Operational amplifiers and knowledge about different configurations namely inverting and non-inverting; applications of operational amplifiers.
2. Outline basic ideas of Amplitude, Frequency, Pulse, and Phase modulation.

PHY5CRT0117: ELECTRICITY AND ELECTRODYNAMICS

Module I (15 Hrs.)

1. Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
2. Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis.

Module II (8 Hrs.)

1. Explain different thermoelectric effects.

Module III (20 Hrs.)

1. Apply Gauss's law of electrostatics to solve a variety of problems.
2. Explain different laws in electrostatics.

Module IV (11 Hrs.)

1. Derive Maxwell's equation and apply boundary conditions for free space.

2. Apply Maxwell's equations to deduce wave equation and electromagnetic field energy.

PHY5CRT0217: CLASSICAL AND QUANTUM MECHANICS

Module I (15 Hrs.)

1. Distinguish various types of constraints in a mechanical problem.
2. Understand Lagrangian and Hamiltonian methods and apply them to solve simple practical problems.

Module II (24 Hrs.)

1. Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter.
2. Understanding about general formalism of Quantum Mechanics such as linear vector space, operators etc.

Module III (15 Hrs.)

1. Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g. one dimensional rigid box, tunnelling through potential barrier, rectangular barrier.

PHY5CRT0317: DIGITAL ELECTRONICS AND PROGRAMMING

Module I (9 Hrs.)

1. Differentiate Fundamental logic gates and Universal logic gates.
2. Synthesis of Boolean functions, simplification and construction of digital circuits by employing Boolean algebra.

Module II (19 Hrs.)

1. Construct sequential systems by choosing FlipFlop as a building block-construct multivibrators, counters to provide a basic idea about memory.

Module III (26 Hrs.)

1. Understand different commands of C++ language and write simple programs in C++.

PHY5CRT0417: ENVIRONMENTAL PHYSICS AND HUMAN RIGHTS

Module I (18 Hrs.)

1. Research, investigate how and why things happen, and make their own decisions about complex environmental issues by developing and enhancing critical and creative thinking skills. It helps to foster a new generation of informed consumers, workers, as well as policy or decision makers.

Module II (26 Hrs.)

1. Understand how their decisions and actions affect the environment, build knowledge and skills necessary to address complex environmental issues, as well as ways we can take action to keep our environment healthy and sustainable for the future. It encourages character building, and develops positive attitudes and values.

Module III (10 Hrs.)

1. Differentiate between renewable and Non-renewable energy sources and their merits and demerits.

Module IV (10 Hrs.)

1. Explain the advantages of solar energy over other energy sources and different methods for harvesting solar energy.

Module V (8 Hrs.)

1. Identify issues and problems relating to the realisation of human rights, and provides the ability to understand the human right issues related to environment. It also develops investigative and analytical skills.

Field Study (5 Hrs.)

1. Develop the sense of awareness about the environment and its various problems and to help the students in realizing the inter-relationship between man and environment and help to protect nature and natural resources.

PHY5COT0117: PHYSICS IN DAILY LIFE

Module I (20 Hrs.)

1. Understand the ideas regarding sensible units and measurements which is the counter stone of physics.
2. Identify the optical phenomenon observed in daily life and understand the scientific reason behind them. Able to distinguish the common medical problems of the eye.

Module II (22 Hrs.)

1. Identify and distinguish the daily life phenomena related to linear and rotational motion and explain them scientifically.
2. Do a basic service of electrical appliances.

Module III (30 Hrs.)

1. Distinguish various forms of energy.
2. Acquire basic knowledge of solar system, galaxies, and GPS.

PHY6CRT0117: THERMAL AND STATISTICAL PHYSICS

Module I (21 Hrs.)

1. Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the

thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.

2. Understand systems such as gases, heat engines and refrigerators etc.

Module II (17 Hrs.)

1. Define Entropy and explain its relation with other thermodynamic quantities.
2. Able to arrive at Maxwell's thermodynamic relations.
3. Understand different methods of Heat transfer and explain different laws associated with thermal radiation.

Module III (16 Hrs.)

1. Use the statistical physics methods, such as Boltzmann distribution and Gibbs distribution.
2. Apply Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.
3. Apply the concepts and laws of thermodynamics to solve basic problems in thermodynamics.

PHY6CRT0217: RELATIVITY AND SPECTROSCOPY

Module I (18 Hrs.)

1. Understand Special Theory of Relativity.
2. Analyze Lorentz transformation equations.
3. Apply relativistic variations in mass, length and time.

Module II (21 Hrs.)

1. Describe various atom models.
2. Explain the spectra of one electron system on the basis of the vector atom model.

Module III (33 Hrs.)

1. Explain rotational, vibrational, electronic and Raman spectra of molecules.
2. Describe electron spin and nuclear magnetic resonance spectroscopy and their applications.

PHY6CRT0317: NUCLEAR, PARTICLE PHYSICS AND ASTROPHYSICS

Module I (18 Hrs.)

1. Understand the properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
2. Learn about the detectors of nuclear radiations- the Geiger-Mueller counter, the scintillation counter, the photo-multiplier tube, the solid state and semiconductor detectors.

Module II (19 Hrs.)

1. Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays and the mechanisms of the emissions of these rays, outlines of tunnel theory of alpha decay and nuclear reactors.

Module III (17 Hrs.)

1. Gain knowledge on the basic aspects of particle Physics as the fundamental interactions, elementary and composite particles, the classifications of particles: leptons, hadrons (baryons and mesons), quarks, gauge bosons. The students should know about the quantum numbers of particles.
2. Understand the Physics of stars and sun.
3. Introductory knowledge about Neutron stars, Black holes and Supernova explosion.

PHY6CRT0417: SOLID STATE PHYSICS

Module I (18 Hrs.)

1. A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, the concept of Brillouin zones and diffraction of X-rays by crystalline materials.

Module II (31 Hrs.)

1. Secured an understanding about the bonding in solids.
2. Describe the free electron theory and band theory of solids and must be able to differentiate insulators, conductors and semiconductors.
3. Distinguish intrinsic and extrinsic semiconductors and their Fermi levels.

Module III (22 Hrs.)

1. Secured an understanding about the dielectric properties of materials.
2. A knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
3. Understand the basic idea about superconductors and their classifications.
4. Review the basic theory of superconductors; Distinguish Type I and II superconductors, their properties and physical concept of BCS theory.

PHY6CBT0117: COMPUTATIONAL PHYSICS

Module I (18 Hrs.)

1. Discuss and compare the methods to solve algebraic and transcendental equations.
2. Solve nonlinear problems using numerical methods.

Module II (18 Hrs.)

1. Explain curve fitting and interpolation.

Module III (18 Hrs.)

1. Discuss various numerical integration and differentiation methods.

Course Outcomes - PRACTICAL COURSES

There is one lab course in every year (two semesters) up to the second year (fourth semester) and two lab courses each in fifth and sixth semesters. In this course, students will be able to apply the theory that they have learned in the theory class to gain hands-on experience. The student shall perform experiments related to mechanics (cantilever, compound pendulum), Fluid dynamics, electricity, magnetism, etc. By the end of these six courses, students should be able to

- Decide which data to collect.
- Decide how to measure data.
- Make predictions about expected measurements, data, and results.
- Evaluate the process and outcomes of an experiment quantitatively and qualitatively.
- Communicate the process and outcomes of an experiment.
- Conduct an experiment collaboratively and ethically.

PHY2CRP0117 - Mechanics and Properties of Matter

In the laboratory course, the student shall perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity) and fluid dynamics (verification of Stokes law, Capillary rise method, Searle method) etc.

PHY4CRP0117 - Optics and Semiconductor Physics

In the laboratory course, students will gain hands-on experience of using various optical instruments and making finer measurements of the wavelength of light using the Newton Rings experiment, Fresnel Biprism, etc. Resolving power of optical equipment can be learned first-hand. They will also learn to plot the V-I characteristics of different semiconductor devices such as ordinary diodes, Zener diodes, transistors, etc. and will be able to construct and verify different circuits employing the above components.

PHY6CRP0117 - Electricity, Magnetism and Laser

In the laboratory course, the students will get the opportunity to perform experiments related to Electricity (Potentiometer, Conversion of Galvanometer, etc), Magnetism: (Filed along the axis of coil, vibration and deflection magnetometer) Laser (Characterization, determination of wavelength, determination of slit width, etc.)

PHY6CRP0217 - Digital Electronics

In this course, students will be able to apply the theory that they have learned in the theory class to gain hands-on experience in building logic gates, half adder, Full adder, Multivibrators, D/A and A/D converters, Flip Flops, multivibrators, counters and verify their results.)

PHY6CRP03117 - Thermal Physics, Spectroscopy and C++ Programming

In this laboratory course, the students will get the opportunity to perform experiments related to Thermodynamics (Thermal conductivity, thermoelectric effects) Spectroscopy (Spectrometer experiments) and C++ programming.

PHY6CRP0417 - Acoustics, Photonics, and Advanced Semiconductor Physics

In this laboratory course, the students will get the opportunity to perform experiments related to Acoustics (Melde's string, sonometer, Kundus tube) Photonics (LED characteristics, solar cell characteristics) and semiconductor physics (wave shaping circuits, pulse width modulation))

Course Outcome – PROJECT

PHY6CPR0117 - PROJECT

At the end of the project the students are expected to have:

1. The capability to complete projects within the stipulated period and cost.
2. The capability to manage and use scientific knowledge to carry out projects.
3. The capability to think objectively, analytically, and critically in identifying and solving problems in a systematic manner.
4. The capability to deliver or present the project findings in oral and written form.

Course Outcome - Complementary Courses

COMPLEMENTARY PHYSICS FOR MATHEMATICS

PHY1CMT0117: PROPERTIES OF MATTER & ERROR ANALYSIS

Module I (13 Hrs.)

1. Understand the principles of elasticity through the study of Young Modulus and modulus of rigidity.

Module II (10 Hrs.)

1. Understand simple principles of fluid flow and the equations governing fluid dynamics.

Module III (13 Hrs.)

1. Know about the basic theory of errors, their analysis, estimation with examples of simple experiments in Physics.

PHY2CMT0117: MECHANICS AND ASTROPHYSICS

Module I (15 Hrs.)

1. Recall the basic ideas of gravity and illustrate the experiments related to gravity.
2. Explain the conservation of energy, momentum, angular momentum and apply them to basic problems.
3. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

Module II (13 Hrs.)

1. Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.
2. Use the principles of wave motion and superposition to explain the phenomena of Beats.

Module III (8 Hrs.)

1. Understand basic parameters of stars like brightness, radiant flux, luminosity,
2. magnitude, orbits, spectral classification. H-R diagram.

PHY3CMT0117: MODERN PHYSICS AND ELECTRONICS

Module I (18 Hrs.)

1. Understand the differences between Bohr atom model and vector atom model and explain various quantum numbers associated with orbital electrons.
2. Explain the properties of nuclear charge, mass, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
3. Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays, the mechanisms of the emissions of these rays and applications.

Module II (18 Hrs.)

1. Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret Schrodinger equations and applications.
2. Summarise the basics of electronic and molecular spectra.

Module III (18 Hrs.)

1. Understand the characteristics of P-N junction diodes, Transistors and their applications.
2. Differentiate between number systems, their interconversions, basic logic gates, Boolean algebra, and combinational circuits to construct half adders and full adders.

PHY4CMT0117: OPTICS & ELECTRICITY

Module I (22 Hrs.)

1. Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.

Module II (10 Hrs.)

1. Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in detail.
2. Understand the fundamentals of propagation of electromagnetic waves through optical fibres and differentiate step and graded index fibre.

Module III (10 Hrs.)

1. Secured an understanding about the dielectric and ferroelectric properties of materials.

Module IV (12 Hrs.)

1. Describe RC, LC, LR and LCR Series Circuits at resonance.

COMPLEMENTARY PHYSICS FOR CHEMISTRY

PHY1CMT0217: PROPERTIES OF MATTER AND THERMODYNAMICS

Module I (13 Hrs.)

1. Understand the principles of elasticity through the study of Young Modulus and modulus of rigidity.

Module II (10 Hrs.)

1. Understand simple principles of fluid flow and the equations governing fluid dynamics.

Module III (13 Hrs.)

1. Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.

PHY2CMT0117: PHY2CMT0219: MECHANICS AND SUPERCONDUCTIVITY

Module I (15 Hrs.)

1. Recall the basic ideas of gravity and illustrate the experiments related to gravity.
2. Explain the conservation of energy, momentum, angular momentum and apply them to basic problems.
3. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.

Module II (13 Hrs.)

1. Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.
2. Use the principles of wave motion and superposition to explain the phenomena of Beats.

Module III (8 Hrs.)

1. Understand the basic idea about superconductors and their classifications.
2. Explain the basic theory of superconductors. Type I and II superconductors, their properties and physical concept of BCS theory.

PHY3CMT0217: MODERN PHYSICS AND MAGNETISM

Module I (18 Hrs.)

1. Understand the differences between Bohr atom model and vector atom model and explain various quantum numbers associated with orbital electrons.
2. Explain the properties of nuclear charge, mass, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
3. Learn about the process of radioactivity, the radioactive decay law, the emission of alpha, beta and gamma rays, the properties of the constituents of these rays, the mechanisms of the emissions of these rays and applications.

Module II (26 Hrs.)

1. Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret Schrodinger equations and applications.
2. Summarise the basics of electronic and molecular spectra.

Module III (10 Hrs.)

1. Knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.
2. Able to explain the origin of Earth's magnetism and define related terms.

PHY4CMT0217: OPTICS AND SOLID-STATE PHYSICS

Module I (22 Hrs.)

1. Use the principles of wave motion and superposition to explain the Physics of polarisation, interference and diffraction.

Module II (10 Hrs.)

1. Understand the spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in detail. Understand the fundamentals of propagation of electromagnetic waves through optical fibres and differentiate step and graded index fibre.

Module III (10 Hrs.)

1. Secured an understanding about the dielectric and ferroelectric properties of materials.

Module IV (12 Hrs.)

1. A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials.

Course Outcome - Complementary Practical Courses

There is one lab course in every year (two semesters) up to the second year (fourth semester). In this course, students will be able to apply the theory that they have learned in the theory class to gain hands-on experience. The student shall perform experiments related to mechanics (cantilever, compound pendulum), Fluid dynamics, electricity, magnetism, etc. By the end of these two courses, students should be able to

- Decide which data to collect.
- Decide how to measure data.
- Make predictions about expected measurements, data, and results.
- Evaluate the process and outcomes of an experiment quantitatively and qualitatively.
- Communicate the process and outcomes of an experiment.
- Conduct an experiment collaboratively and ethically.

PHY2CMP0117: Complementary Physics Practical 1

In the laboratory course, students will gain hands-on experience of using various instruments and making finer measurements of the length, mass, etc. The student shall perform experiments related to basic measurements (Vernier Callipers, Screw Gauge, Beam Balance), mechanics (compound pendulum), rotational dynamics (Flywheel), elastic

properties (Young Modulus and Modulus of Rigidity) and Optics (Liquid lens, Spectrometer and Laser) etc.

PHY4CMP0217: Complementary Physics Practical 2

In the laboratory course, the students will get the opportunity to perform experiments related to Elasticity (Cantilever, Uniform and Non-uniform Bending etc), Optics (Newtons rings, Spectrometer) Electricity (Tangent galvanometer, Potentiometer, conversion of galvanometer to ammeter and voltmeter, etc.)