Department of Physics
B. C. College, Asansol-713304

Student graduating with B.Sc (Honours) in Physics

Programme Learning Outcomes (PLO) for Physics Under Graduates

➢ Undergraduate Learning Outcomes

❖ Students graduating with a B.Sc. in Physics should be able to:

PLO1: demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.
PLO2: demonstrate knowledge of classical mechanics, electromagnetism, quantum mechanics, and thermal physics, and be able to apply this knowledge to analyze a variety of physical phenomena.
PLO3: with learned laboratory skills, take measurements in a physics laboratory and analyze the measurements to draw valid conclusions.
PLO4: have proficient oral and written scientific communication, and think critically and work independently.
PLO5: understand basic physical fundamentals and the key vocabulary to describe them: kinematics, dynamics, work and energy, rotations, gravitation, heat and thermodynamics, fluids.
PLO6: with Intermediate Physics Labs, participate in complex experiments where the computer is interfaced to their environment, understand the challenges and advantages of using computers in science, recognize applications in computer interfacing to other disciplines such as engineering, chemistry, medicine, meteorology, analyze real physical problems and develop correct solutions to them, develop computer interfaced experiments, necessary electronic skills to produce a measurable signal from various sources for application of natural laws and computer logic.
PLO7: with Advanced Physics Labs, familiarize with the basics of vacuum systems and their role in physics research, analyze experimental data, error propagation and its role in making conclusions, realize usefulness and limitations of various optimization techniques.

❖ As a result of taking this course, students will be learning the following in general:

a) Understand how statistics of the microscopic world can be used to explain the thermal features of the macroscopic world.
b) Be able to use thermal and statistical principles in a wide range of applications.
c) Learn a variety of mathematical and computer techniques. Numerical Modeling in Physics
d) Break apart a problem into its component parts. Construct a workable model of a physical system.
e) Debug computer code that they write. Make comparisons between the computer model and the actual physical system.
f) Analyze physical problems and develop correct solutions using natural laws.
g) Express their knowledge and ideas through oral and written language.

h) Develop skills in observation, interpretation, reasoning, synthesis, generalizing, predicting, and questioning as a way to learn new knowledge.
i) Develop scientific problem-solving skills, including organization of given information, identification and application of pertinent principles, quantitative solutions, interpreting results, and evaluating the validity of results.
j) Develop interpersonal and communication skills including communicating in small groups, writing, working effectively with peers.
k) Apply conceptual understanding of the physics to general real-world situations.
l) Understand basic physical concepts and vocabulary used to describe them: electricity and magnetism, optics, atomic and nuclear physics.
m) Develop skills in observation, interpretation, reasoning, synthesis, generalizing, predicting, and questioning as a way to learn new knowledge.
n) Develop scientific problem-solving skills, including organization of given information, identification and application of pertinent principles, quantitative solutions, interpreting results, and evaluating the validity of results.
o) Develop interpersonal and communication skills including communicating in small groups, writing, working effectively with peers.
p) Apply conceptual understanding of the physics to general real-world situations.
q) Develop familiarity with interpersonal and communication in physics, facilitating informed decisions as students pursue research projects, internships, careers, and graduate study.
r) Learn about topics of interest independently, and subsequently organize and present information to each other and to a group, at an appropriate level for their target audience.
s) Employ conceptual understanding to make predictions, and then approach the problem mathematically.
t) Understand the important connections between theory and experiment.
u) Connect concepts and mathematical rigor in order to enhance understanding.
v) Learn a variety of advanced mathematical methods and computer techniques.
w) Solve numerical problems involving topics covered.
x) Use activities to give insights into some of the topics.
y) To develop problem solving methods that will include mathematical as well as numerical computations and solutions.
z) To build connections between mathematical development and conceptual understanding.

➢ Programme Specific Outcomes (PSO) for Physics Under Graduates

PSO01: The Physics under graduate students will gather the fundamental knowledge of physics, including basic concepts and principles of different branch of physics, like classical mechanics, electrodynamics, quantum mechanics, nuclear physics and thermodynamics. Throughout the program students are familiarized with different mathematical methods (analytic and numerical, c and fortran program language) and their applications in physics. Every steps of the whole course the knowledge of experimental methods for physics is introduced to them.

PSO02: Students should acquire the skills to deal with physics problems and situations at the UG level. They will able to identifying the key factors and applying appropriate principles and assumptions in the formulation of physics problems. Develop general experimental and measurement skills with prescribed procedures. They should acquire also the skill of analyzing the experimental data and their level of uncertainty and relating the experimental results with theoretical expectations.

PSO03: The Physics under graduate students should have acquired some generic skills in their study like skill of self-study and work independently, working effectively in a team and presenting information in a clear, concise and logical manner.

PSO04: The Physics under graduate students should have developed some positive attitudes and values. They have been appreciated by the principles and theories, and the beauties of physics. They should build the willingness to take up responsibility in study and work and also get confidence in his/her capabilities.

PSO05: Students are expected to develop their written and oral communication skills in communicating physics-related topics. Students should learn how to design and conduct series of experiments. Not only the design and conduct but they are expected to be able to interpret and analyze the results and draw conclusions as supported by their data. Students will develop the proficiency in the acquisition of data using a variety of laboratory instruments.

PSO05: Students will learn the method of applications of computer programming in solving different physics related problems and mathematical methods.

PSO06: Apply conceptual understanding of the physics to general real-world situations.

PSO07: Analyze physical problems and develop correct solutions using natural laws.

- **Course Outcomes (COs):**

1. *Mathematical Methods of Physics-I (Semester-I) and Mathematical Methods of Physics-II (Semester-II)*
   - To acquire knowledge and apply it to various physical problems.
   - To develop the problem-solving ability.
   - To motivate the students to apply matrices in solving physics problems.
   - To apply vectors in solving physics problems regarding dynamics.
   - To use methods for solving various differential equations.
   - To learn and apply the various special functions in solving the problems in physics.

2. *Mechanics (Semester-I)*
   - Learn motion of bodies and preliminaries of oscillations.
   - Acquire basic knowledge of mechanics, properties of matter and gravitation.
   - Know about the basic of central force and rotational motion of rigid bodies.

3. *Electricity and Magnetism (Semester-II) and Electromagnetic Theory (Semester-IV)*
   - Know the vocabulary and concepts of physics as it applies to: Principles of Electric Fields, Gauss's Law, Electric Potential, Capacitance and Dielectrics, Current and Resistance, Direct Current Circuits, Magnetic Fields, Sources of Magnetic Fields, Faraday's Law, Inductance, Alternating Current Circuits, and Electromagnetic Waves.
   - Understand the relationship between electrical charge, electrical field, electrical potential, and magnetism.
   - Be able to use electromagnetic theory and principles in a wide range of applications.
   - Solve mathematical problems involving electric and magnetic forces, fields, and various electro-magnetic devices and electric circuits.
   - Gain confidence in their ability to apply mathematical methods to understand electromagnetic problems to real-life situations.
   - To gain knowledge about the electrical energies in order to learn motion of charges.
   - Acquire basic knowledge of magnetic properties.
   - Know about the alternating current and its circuits.
   - Get in depth knowledge about electricity and magnetism.

4. *Classical Mechanics and Special Theory of Relativity (Semester-III) and Classical Dynamics (Semester-VI)*
   - Limitations of Newtonian mechanics.
   - Necessity of the introduction of the concept of Lagrangian and Hamiltonian in mechanics.
   - Necessity of the introduction of the concept of classical field.
   - Learn about the different operator symmetry relation and their significance in motion of bodies.
   - Learn about the basic of special theory of relativity.

5. *Thermal Physics- I (Semester-III) and Thermal Physics-II (Semester-V)*
    - To understand the fundamental theories of heat and calorimetry.
    - Understand the basic principle and laws of Thermodynamics.
    - Understand the concepts of Entropy.
    - Understand the concept of low temperature physics.

6. *Analog Systems and Applications (Semester-III),Digital Systems and Applications (Semester-IV) and Physics of Devices and Instruments (Semester-VI)*
    - To acquire knowledge of various electronic devices like diode, transistor, opamp, amplifier, oscillator, Phase locked loop etc. and their operation or functions.
    - To motivate the students to apply the principles of electronics in their daily life.
    - Learn the logic gates
    - Acquire basic knowledge of number system and binary arithmetic.
    - Understand the action and application of different digital device.
    - Get in knowledge of various memories used in computers and their mapping.
    - Learn the basic of different method of communication.
    - Learn the IC technology and their fabrication.

7. *Waves and Optics (Semester-IV) and Applied Optics (Semester-VI)*
    - Understand the basic concepts of wave optics and an ability to compute basic quantities in optics.
    - Experience the diverse applications of the wave equation.
    - To develop an understanding of the principles of optics.
    - To build connections between mathematical development and conceptual understanding.
    - Application of matrix method in ray optics.
    - Acquire the knowledge about different optical instruments.
    - Understand the basic of modern technology like fibre optics and holography.

8. *Quantum Mechanics (Semester-V)*
    - Learn the fundamental concepts and idea of quantum mechanics.
    - Learn the mathematical tools needed to solve quantum mechanics problems. This will include complex functions and Hilbert spaces, and the theory of operator algebra. Solutions of ordinary and partial differential equations that arise in quantum mechanics will also be studied.
    - Develop problem solving methods that will include mathematical as well as numerical computations and solutions.
    - To apply Schrodinger equation or solving problems in Wave mechanics, Nuclear physics etc.

9. *Nuclear and Particle Physics (Semester-V)*
   - Acquire knowledge in the content areas of nuclear and particle physics, focusing on concepts that are commonly used in this area.
   - Develop and communicate analytical skills in subatomic physics.
   - Develop familiarity with the vast areas of nuclear and particle physics as well as develop an interest in these subjects.
   - To acquire knowledge and apply it to study the structure of nucleus.
   - Know the formation of nucleus and their binding energy
   - To motivate the students and analyze the energy released by the nucleus during the fission and fusion process

10. *Atomic Physics & Spectroscopy (Semester-V)*
   - Apply the mathematical tools developed to various quantum mechanics problems.
   - Develop problem solving methods that will include mathematical solutions.
   - To provide a detailed study of atom.
   - To learn the impact of magnetic fields in spectra.
   - To learn the behavior of atom in various states.
   - To provide a knowledge of the application of observed theories.

11. *Statistical Mechanics (Semester-VI)*
   - Understand how probabilistic approach and statistics of the microscopic world can be used to explain the features of the macroscopic world involving various of physics.
   - Be able to use thermal and statistical principles in a wide range of applications.

12. *Condensed Matter Physics (Semester-VI)*
   - Understand basic concepts and mathematical methods of solid state physics.
   - Practice problem solving by using selected problems in solid state physics.
   - Explore important connections between theory, experiment, and current applications.
   - Develop a basis for future learning and work experience.

❖ **Ability Enhancement Compulsory Courses (AECC):**

English/Modern Indian Language/EVS

"AECC" courses are the courses based upon the content that leads to Knowledge enhancement in Environmental Science and in English/MIL Communication.

❖ **Skill Enhancement Courses:**

SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

❖ **Semester III**

I. *Electrical Circuit Network Skills*

- Learn about basic circuit components and their properties with application.
- Learn to design some hands-on project.

II. *Technical Drawing Skills*

- Learn the necessity of using updated computer software in technical drawing.
- Learn about the CAD software and its application.

❖ **Semester IV**

III. *Basic Instrumentation Skills*

- Learn about different measuring instruments and their applications.
- Learn to design some hands-on project.

IV. *Computational Physics*

- Learn "what is computational physics".
- Get familiar with LINUX system.
- Learn about the FORTRAN software and its application to write program to solve different problems.
- Learn to write text in LATEX.

❖ **Physics Laboratory Course:**

- Experience simple computer programming in C and FORTRAN programming language.
- Learn to recognize the limitations of equipment.
- Describe the methodology of physics and the relationship between observation and theory.
- Participate in the methodology by performing laboratory exercises.
- Analyze physical problems and develop correct solutions using natural laws.
- Express their knowledge and ideas through oral and written language.
- Teach students how to analyze experimental data.
- Teach error analysis.

Student graduating with B.Sc (Program) in Physics

- **Program Outcomes (POs):**

PO1: Students will gather the fundamental knowledge of physics, including basic concepts and principles of different branch of physics, like mechanics, electricity magnetism, thermal physics, optics and modern physics. They also gather the knowledge of experimental methods for physics.
PO2: Students should acquire the skills to deal with physics problems. They will able to apply appropriate principles and assumptions in the formulation of physics problems.
PO3: Develop general experimental and measurement skills with prescribed procedures.
PO4: They should have acquired some skills in their study like self-study and work independently.
PO5: They should have developed some positive attitudes and values. They have been appreciated by the principles and theories, and the beauties of physics.

- **Program Specific Outcomes (PSOs):**

PSO1: Students are expected to develop their written and oral communication skills in communicating physics-related topics.
PSO2: Develop hands on project to presents various physical properties.
PSO3: Analyze physical problems and develop correct solutions using natural laws.

- **Course Outcomes (COs):**

1. *Mechanics (Semester-I)*
   - Learn motion of bodies and preliminaries of oscillations.
   - Acquire basic knowledge of kinematics, gravitation and GPS.
   - Know about the basic of central force and rotational motion of rigid bodies.
   - Learn about the basic of special theory of relativity.

2. *Electricity and Magnetism (Semester-II)*
   - Know the vocabulary and concepts of physics as it applies to: Principles of Electric Fields, Gauss's Law, Electric Potential, Capacitance and Dielectrics, Current and Resistance, Magnetic Fields, Sources of Magnetic Fields, Faraday's Law, Inductance, Alternating Current Circuits, and Electromagnetic Waves.
   - Understand the relationship between electrical charge, electrical field, electrical potential, and magnetism.
   - Solve mathematical problems involving electric and magnetic forces, fields, and various electro-magnetic devices and electric circuits.
   - Acquire basic knowledge of magnetic properties.
   - Know about the alternating current and its circuits.
   - Get in depth knowledge about electricity and magnetism.

3. *Thermal Physicsand Staistical Mechanics (Semester-III)*
    - To understand the fundamental theories of heat and calorimetry.
    - Understand the basic principle and laws of Thermodynamics.
    - Understand the concepts of Entropy.
    - Understand how probabilistic approach and statistics of the microscopic world can be used to explain the features of the macroscopic world involving various of physics.
    - Be able to use thermal and statistical principles in a wide range of applications.

4. *Waves and Optics (Semester-IV)*
    - Understand the basic concepts of wave optics and an ability to compute basic quantities in optics.
    - Experience the diverse applications of the wave equation.
    - To develop an understanding of the principles of optics.
    - To build connections between mathematical development and conceptual understanding.

5. *Modern Physics (Semester-V)*
    - Learn the fundamental concepts and idea of quantum mechanics.
    - Develop problem solving methods that will include mathematical as well as numerical computations and solutions.
    - Acquire knowledge in the content areas of nuclear physics, focusing on concepts that are commonly used in this area.
    - To acquire knowledge and apply it to study the structure of nucleus.
    - Know the formation of nucleus and their binding energy
    - To motivate the students and analyze the energy released by the nucleus during the fission and fusion process

6. *Basic Electronics (Semester-V)*
    - To acquire knowledge of various electronic devices like diode, transistor, opamp, amplifier, oscillator etc. and their operation or functions.
    - Learn the logic gates
    - Acquire basic knowledge of number system and binary arithmetic.
    - Learn function of few digital devices like adder, multiplexer etc.

- **Ability Enhancement Compulsory Courses (AECC) :** *English/Modern Indian Language/EVS*

  "AECC" courses are the courses based upon the content that leads to Knowledge enhancement in Environmental Science and in English/MIL Communication.
- **Skill Enhancement Courses:**

  SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Semester III

1. *Electrical Circuit Network Skills*
    - Learn about basic circuit components and their properties with application.
    - Learn to design some hands-on project.

Semester IV

2. *Basic Instrumentation Skills*
    - Learn about different measuring instruments and their applications.
    - Learn to design some hands-on project.

Semester V

3. *Technical Drawing Skills*
    - Learn the necessity of using updated computer software in technical drawing.
    - Learn about the CAD software and its application.

Semester VI

4. *Computational Physics*
    - Learn "what is computational physics".
    - Get familiar with LINUX system.
    - Learn about the FORTRAN software and its application to write simple programs to solve different problems.
    - Learn to write text in LATEX.

❖ *Physics Laboratory Course:*

- Experience simple computer programming FORTRAN programming language.
- Describe the methodology of physics and the relationship between observation and theory.
- Participate in the methodology by performing laboratory exercises.