Centre of Excellence Government College Sanjauli, Shimla-6

Bachelor of Science with Physics

Program Outcomes and Course Outcomes

Vision

To make the college a benchmark of quality education, applying innovative approaches of teaching and learning, empowering students to discover their full potential academically and socially.

Mission

To nurture intellectual excellence and social leadership amongst the educators and learners, in order to succeed in the increasingly competitive globalized world.

Aims of the Bachelor's Degree Program with Physics

- To provide students with a fundamental understanding of the principles and concepts of physics, as well as to develop their analytical, problem-solving, and critical thinking skills.
- The program also aims to prepare students for further education and research in physics or related fields, or for careers in industries that require a strong background in physics, such as technology, engineering, and finance or employability.
- To develop laboratory and research skills, as well as communication and teamwork skills through collaborative projects and presentations.
- To prepare students for life in general by equipping them with the information and skills necessary to take on societal challenges, succeed in a variety of professional fields, including entrepreneurship.

Graduate Attributes

Some of the characteristic attributes of a graduate in Physics are:

Disciplinary knowledge

(i)A thorough grasp and comprehension of fundamental principles, key concepts, and experimental discoveries across core domains of Physics.

(ii) Proficiency in utilizing physics laboratory techniques and contemporary instrumentation to develop and execute novel experiments in the field of physics.

Skilled communicator:

Ability to express complex and technical concepts orally in a simple, precise and straightforward language for better understanding.

Critical thinking:

The capacity to differentiate between pertinent and extraneous facts, discern between objective and biased information, employ logical

reasoning to reach conclusive outcomes, assess the adequacy of evidence supporting conclusions, obtain accurate quantitative results, make reasoned evaluations, and form qualitative judgments..

Sense of inquiry:

Capability for asking relevant/appropriate questions relating to the issues and problems in the field of Physics and beyond. Planning, executing and reporting the results of theoretical or experimental investigation.

Team player/worker:

Capable of working effectively in diverse teams in both classroom, laboratory, Physics workshop and in field-based situation.

Skilled project manager:

Proficient in identifying and utilizing necessary resources for a project, effectively managing the project until its successful completion, while adhering to responsible and ethical scientific practices, safety protocols, and laboratory hygiene regulations.

Digitally Efficient:

Capable of using computers for computational and simulation studies in Physics.

Ethical awareness/analytical reasoning: The graduates should be capable of demonstrating the ability to think and analyse rationally with modern and scientific outlook and adopt unbiased objectives and truthful actions in all aspects of work. They should be capable of identifying ethical issues related to their work. They should be ready to appropriately acknowledge direct and indirect contributions received from all sources, including from other personnel in the field of their work. Further, unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, or not adhering to intellectual property rights should be avoided.

Social, National and International perspective:

Graduates should cultivate an awareness of the importance of their knowledge and skills for the betterment of society and a strong sense of responsibility towards humanity and the environment. They should possess both a national and international outlook regarding their work and career in their chosen field of academic and research pursuits.

Lifelong learners:

Capable of self-paced and self-directed learning aimed at personal development and for improving knowledge/skill development and reskilling in all areas of Physics.

Qualification Descriptors for Graduates in B.Sc. with Physics

The qualification descriptor for B.Sc. with Physics graduates include the following:

They should be able to:

- Demonstrate

(i) a well-structured and comprehensive grasp of fundamental physics, encompassing concepts, theories, and applicable experimental techniques in key areas such as mechanics, electricity and magnetism, waves and optics, thermal physics, quantum mechanics, statistical mechanics, mathematical physics, and their broader applications across various fields of physics.

(ii) the ability to relate their understanding of physics to other sciences and hence orient their knowledge and work towards multi-disciplinary/inter-disciplinary contexts and problems;

(iii) procedural knowledge that creates different types of professionals related to different areas of study in Physics and multi/interdisciplinary domains, including research and development, teaching, technology professions, and government and public service;

(iv) skills in areas of specializations of their elective subfields so that they can continue with higher studies and can relate their knowledge to current developments in those subfields.

- Use knowledge, understanding and skills required for identifying problems and issues relating to Physics, and its interface with other subjects studied in the course; collect relevant quantitative and/or qualitative data from a wide range of sources including various research laboratories of the world, and do analysis and evaluation using appropriate methodologies.
- Communicate the results of studies undertaken accurately in a range of different contexts using the main concepts, constructs and

techniques of Physics and other subjects studied in the course. Develop communication abilities to present these results in technical as well as popular science meetings.

- Ability to meet their own learning needs, drawing on a range of pedagogic material available on the internet and books, current research and development work and professional materials, and in interaction with other science professionals.
- Demonstrate Physics-related technological skills that are relevant to Physics-related trades and employment opportunities.
- Apply their knowledge, understanding and skills to new/unfamiliar contexts beyond Physics to identify and analyze problems and issues, and to solve complex problems.

Programme Learning Outcomes in B.Sc. with Physics

Students graduating with the B.Sc. with Physics degree should be able to

- Acquire

(i) a fundamental/systematic and coherent understanding of the academic field of basic Physics in areas like Mechanics, Electricity and Magnetism, Waves and Optics, Thermal and Statistical Physics, Quantum Mechanics, Mathematical Physics and their applications to other core subjects in Physics.

(ii) a wide ranging and comprehensive experience in physics laboratory methods in experiments related to mechanics, optics, thermal physics, electricity, magnetism, digital electronics, solid state physics and modern physics. Students should acquire the ability for systematic observations, use of scientific research instruments, analysis of observational data, making suitable errorestimates and scientific report writing.

(iii) procedural knowledge that creates different types of professionals related to the disciplinary/subject area of Physics, including professionals engaged in research and development, teaching and government/public service.

(iv) Knowledge and skills in areas related to their specialization area corresponding to elective subjects within the disciplinary/subject area of Physics and current and emerging developments in the field of Physics.

- Demonstrate the ability to use skills in Physics and its related areas of technology for formulating and tackling Physics-related problems and identifying and applying appropriate physical principles and methodologies to solve a wide range of problems associated with Physics.
- Recognize the importance of mathematical modelling, simulation and computational methods, and the role of approximation and mathematical approaches to describing the physical world and beyond.
- Plan and execute Physics-related experiments or investigations, analyze and interpret data/information collected using appropriate methods, including the use of appropriate software such as programming languages and purpose-written packages, and report accurately the findings of the experiment/investigations while relating the conclusions/findings to relevant theories of Physics.
- Demonstrate relevant generic skills and global competencies such as:

(i) problem-solving skills that are required to solve different types of Physics- related problems with well-defined solutions, and tackle open-ended problems that belong to the disciplinary area boundaries.

(ii) investigative skills, including skills of independent investigation of Physics- related issues and problems.

(iii) communication skills involving the ability to listen carefully, to read texts and research papers analytically and to present complex information in a concise manner to different groups/audiences of technical or popular nature.

(iv) analytical skills involving paying attention to detail and ability to construct logical arguments using correct technical language related to Physics and ability to translate them with popular language when needed;

(v) ICT skills.

(vi) personal skills such as the ability to work both independently and in a group.

- Demonstrate professional behavior such as:

(i) being objective, unbiased and truthful in all aspects of work and avoiding unethical, irrational behavior such as fabricating, falsifying or misrepresenting data or committing plagiarism.

(ii) the ability to identify the potential ethical issues in work-related situations.

(iii) be committed to the free development of scientific knowledge and appreciate its universal appeal for the entire humanity.

(iv) appreciation of intellectual property, environmental and sustainability issues.

(v) promoting safe learning and working environment.

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION FOR B.Sc. WITH PHYSICS

Year	Course Type	Course Code	Title of paper	*Credits
I	CORE COURSE-I	PHYS101TH PHYS101IA	MECHANICS Theory	4
		PHYS101PR	MECHANICS Lab	2
	CORE COURSE-II	CHEM101TH CHEM101IA CHEM101PR	ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS	6
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	6
	A.E.C. COURSE-I		ENVIRONMENTAL SCIENCE	4
	CORE COURSE-IV	PHYS102TH PHYS102IA	ELECTRICITY, MAGNETISIM AND EMT Theory	4
		PHYS102PR	ELECTRICITY, MAGNETISIM AND EMT Lab	2
	CORE COURSE-V	CHEM102TH CHEM102IA CHEM102PR	STATES OF MATTER, CHEMICAL KINETICS & FUNCTIONAL ORGANIC CHEMISTRY	6
	CORE COURSE-VI	MATH102TH MATH102IA	DIFFERENTIAL EQUATIONS	6
	A.E.C.COURSE-II		ENGLISH/MIL COMMUNICATION	4
II	**CORE COURSE-VII**	**PHYS201TH PHYS201IA**	**STATISTICAL AND THERMAL PHYSICS Theory**	4
		PHYS201PR	**STATISTICAL AND THERMAL PHYSICS Lab**	2
	CORE COURSE-VIII	CHEM201TH CHEM201IA CHEM201PR	SOLUTIONS, PHASE EQUILIBRIUM, CONDUCTANCE ELECTROCHEMISTRY & ORGANIC CHEMISTRY	6
	CORE COURSE-IX	MATH201TH MATH201IA	REAL ANALYSIS	6
	CORE COURSE-X	PHYS202TH PHYS202IA	WAVES AND OPTICS Theory	4
		PHYS202PR	WAVES AND OPTICS Lab	2
	CORE COURSE-XI	CHEM202TH CHEM202IA CHEM202PR	CHEMISTRY OF MAIN GROUP ELEMENTS, CHEMICAL ENERGETICS AND EQUILIBRIA	6
	CORE COURSE-XII	MATH202TH MATH202IA	ALGEBRA	6
	SEC 1	**PHYS203TH PHYS203IA**	**PHYSICS WORKSHOP SKILLS Theory**	**3+1**
		PHYS203SE	**PHYSICS WORKSHOP SKILLS Skill Exam**	

	(CHOOSE ANY ONE FROM GIVEN TWO)			**(TH+IA = 3 SE = 1)**
		PHYS204TH PHYS204IA	**COMPUTATIONAL PHYSICS Theory**	
		PHYS204SE	**COMPUTATIONAL PHYSICS Lab**	
	SEC 2 (CHOOSE ANY ONE FROM GIVEN TWO)	**PHYS205TH PHYS205IA**	**ELECTRICAL CIRCUITS AND NETWORK SKILLS Theory**	**3+1 (TH+IA = 3 SE = 1)**
		PHYS205SE	**ELECTRICAL CIRCUITS AND NETWORK SKILLS Skill Exam**	
		PHYS206TH PHYS206IA	**BASIC INSTRUMENTATION SKILLS Theory**	
		PHYS206SE	**BASIC INSTRUMENTATION SKILLS Skill Exam**	
III	**DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN THREE)**	**PHYS301TH PHYS301IA**	**ELEMENTS OF MODERN PHYSICS Theory**	**4+2 (TH+IA = 4 PR = 2) OR 5+1 (TH+IA = 5 TU = 1)**
		PHYS301PR	**ELEMENTS OF MODERN PHYSICS Lab**	
		PHYS302TH PHYS302IA	**SOLID STATE PHYSICS AND ELECTRONICS Theory**	
		PHYS302PR	**SOLID STATE PHYSICS AND ELECTRONICS Lab**	
		PHYS303TH PHYS303IA	**ASTRONOMY AND ASTROPHYSICS Theory**	
		PHYS303TU	**ASTRONOMY AND ASTROPHYSICS Tutorials**	
	DISCIPLINE SPECIFIC ELECTIVES DSE:2A (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM301TH CHEM301IA CHEM301PR	POLYNUCLEAR HYDROCARBONS, DYES, HETEROCYCLIC COMPOUNDS AND SPECTROSCOPY (UV, IR ,NMR)	**6**
		CHEM302TH CHEM302IA CHEM302PR	INDUSTRIAL CHEMICALS AND ENVIRONMENT	
		CHEM303TH CHEM303IA CHEM303PR	QUANTUM CHEMISTRY, SPECTROSCOPY & PHOTOCHEMISTRY	
	DISCIPLINE SPECIFIC ELECTIVES DSE:3A (CHOOSE ANY ONE FROM GIVEN THREE)	MATH301TH MATH301IA	MATRICES	**6**
		MATH302TH MATH302IA	MECHANICS	
		MATH303TH MATH303IA	LINEAR ALGEBRA	
	DISCIPLINE SPECIFIC ELECTIVES	**PHYS304TH PHYS304IA**	**NUCLEAR AND PARTICLE PHYSICS Theory**	**5+1 (TH+IA = 5 TU = 1) OR**
		PHYS304TU	**NUCLEAR AND PARTICLE PHYSICS Tutorials**	
		PHYS305TH	**QUANTUM MECHANICS Theory**	

	DSE:1B (CHOOSE ANY ONE FROM GIVEN THREE)	**PHYS305IA**		**4+2 (TH+IA = 4 PR = 2)**
		PHYS305PR	**QUANTUM MECHANICS Lab**	
		PHYS306TH PHYS306IA	**PHYSICS OF DEVICES AND INSTRUMENTS Theory**	
		PHYS306PR	**PHYSICS OF DEVICES AND INSTRUMENTS Lab**	
	DISCIPLINE SPECIFIC ELECTIVES DSE:2B (CHOOSE ANY ONE FROM GIVEN THREE)	CHEM304TH CHEM304IA CHEM304PR	CHEMISTRY OF TRANSITION AND INNER TRANSITION ELEMENTS, COORDINATION CHEMISTRY, ORGANOMETTALICS, ACIDS & BASES	**6**
		CHEM305TH CHEM305IA CHEM305PR	POLYMER CHEMISTRY	
		CHEM306TH CHEM306IA CHEM306PR	MOLECULES OF LIFE	
	DISCIPLINE SPECIFIC ELECTIVES DSE:3B (CHOOSE ANY ONE FROM GIVEN THREE)	MATH304TH MATH304IA	NUMERICAL METHOD	**6**
		MATH305TH MATH305IA	COMPLEX ANALYSIS	
		MATH306TH MATH306IA	LINEAR PROGRAMMING	
	SEC 3 (CHOOSE ANY ONE FROM GIVEN TWO)	**PHYS307TH PHYS307IA**	**RADIATION SAFETY Theory**	**3+1 (TH+IA = 3 SE = 1)**
		PHYS307SE	**RADIATION SAFETY Skill Exam**	
		PHYS308TH PHYS308IA	**APPLIED OPTICS Theory**	
		PHYS308SE	**APPLIED OPTICS Skill Exam**	
	SEC 4 (CHOOSE ANY ONE FROM GIVEN TWO)	**PHYS309TH PHYS309IA**	**WEATHER FORECASTING Theory**	**3+1 (TH+IA = 3 SE = 1)**
		PHYS309SE	**WEATHER FORECASTING Skill Exam**	
		PHYS310TH PHYS310IA	**RENEWABLE ENERGY AND ENERGY HARVESTING Theory**	
		PHYS310SE	**RENEWABLE ENERGY AND ENERGY HARVESTING Skill Exam**	

***TH = Theory, IA = Internal Assessment, PR = Practical, TU = Tutorials and SE = Skill Exam**

Comprehensive Continuous Assessment (CCA) and yearly Scheme in BSc with Physics of Three years

Scheme of Examination English shall be the medium of instructions and Examinations. Examinations shall be conducted at the end of each year as per the academic calendar notified by H.P. University Shimla-5. Each course of 6 credits will carry 100 marks (theory + practical) and will have following components:

I. Theory 50 marks
Yearly Examination

II. Comprehensive Continuous Assessment 30 marks

a) Assignment/Quiz/Seminar/model/ Mid-Term Examination 15 marks

b) Attendance 05 marks

c) Lab Seminar /Lab CCA 10 marks

II. Practical 20 marks

Practical examination will have following components:

i) Performing the two practical exercises assigned by the examiner in terms of requirement of chemicals/apparatus/ theory/ reaction (if any) involved, procedure/ scheme/ observations/calculations and results. 10 marks

ii) ii) viva-voce examination 5 marks

iii) iii) Practical note book and regularity during practical classes 5 Marks

Theory Paper (CCA + yearly Examination) +Practical [30 +50 +20] =100 marks

Each Skill Enhancement course will be of 4 credits and scheme of examination for these courses is as under: {CCA+ Project + yearly Examination [30 +20+ 50] =100 marks}

Criterion for marks on the basis of Class-room attendance (0 - 5 marks) under component CCA/ IA be defined as follows:

a) Attendance 75 -- 80% = 3 marks

b) Attendance 81 – 90 % = 4 marks

c) Attendance 91% and above = 5 marks

d) Candidates securing 75% Attendance after condonation will not be entitled to get any mark.

Assessment methods

In the undergraduate education of Physics leading to the B.Sc. with Physics degree, the assessment and evaluation methods focus on testing the conceptual understanding of basic concepts and theories, experimental techniques and the ability to apply the knowledge acquired to solve new problems and communicate the results and findings effectively. The courses offered in the undergraduate Physics by Himachal Pradesh University are assessed for monitoring the progress towards achieving the learning objectives is an important assessment component, which provides both teachers and students feedback on progress towards learning goals. University of Himachal Pradesh University examination system has 30 percent internal assessment for theory component, and 20 percent for physics laboratory components. These marks should be distributed in periodic assessments in different modes to serve the intended purpose.

Assessment Methods for the Theory component of Core courses

The evaluation scheme of the Himachal Pradesh University allots 30 percent marks for internal assessment of theory papers and 50 percent marks for Substantive Summative Assessment at the end of the year. Teachers may use a judicious combination of the following methods to assess students for CCA marks: i) Mid term examination(compulsory) ii) regular problem based assignments, iii) periodic class tests, iv) individual seminar presentations

Assessment Methods for the Physics Laboratory component of Core courses

The 20 percent internal assessment for the evaluation scheme for laboratory courses is best used in continuous evaluation of students' performance in the lab. Annual laboratory examination include these components: i) evaluation of experiments through i) written report of

each experiment(Practical file) and ii) Viva-Voce on any experiment, iii) skill test, iv) written test on experiments done in the lab and data analysis, to test the comprehension and analysis of the experiment done by the students

ASSESSMENT METHODS FOR SKILL ENHANCEMENT COURSES

Learning in skill enhancement courses is largely experience based. Student performance in these courses is best assessed under continuous evaluation. Students could be assigned a specific task or project individually or in group and they could be assessed for their success by demonstrating their project by presentation along with showing the working model of the task for which 20 percent of the marks are assigned. The evaluation scheme of SEC courses also include 30 percent CCA and 50 percent theory of SEC courses.

DETAILED COURSES FOR PROGRAMME IN B.Sc. PHYSICS, INCLUDING COURSE OBJECTIVES & LEARNING OUTCOMES

B.Sc. Ist year	
Name of the Course	**PHYSICS-DSC 1A: MECHANICS (Credits: Theory-04) Theory**
Code	PHYS101TH

Course Objective

This course reviews the concepts of mechanics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with Newton's Laws of Motion and ends with the Fictitious Forces and Special Theory of Relativity. Students will also appreciate the Collisions in CM Frame, Gravitation, Rotational Motion and Oscillations. The students will be able to apply the concepts learnt to several real world problems.

Course Outcomes

Students will be able to articulate and describe:

1 Relative motion and the concept of Ordinary Differential Equations Coordinate systems and motion of a particle, Space Time Symmetry and Conservation Laws,Frames of Reference

2 Parameters defining the motion of mechanical systems and Gravitation and Inverse Square Force Law

3 Study of the interaction of forces between solids in mechanical systems.

4 Rotational Motion and Kinematics of Elastic and Inelastic Collisions

5 Special Theory of Relativity and Effects of Relativity

6 Introduction to analytical mechanics as a systematic tool for problem solving.

Unit-I

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

Coordinate systems and motion of a particle: Volume, velocity and acceleration in Cartesian and Spherical co-ordinate systems, Solid angle.

Space Time Symmetry and Conservation Laws: Relationship of conservation laws and symmetries of space and time.

Frames of Reference: Inertial frames of reference, Galilean transformation and Galilean invariance. Non-inertial frames, Coriolis force and its applications; Foucault's pendulum.

Unit-II

Gravitation and Inverse Square Force Law: Newton's Law of Gravitation, Various forces in nature (qualitative). Central and non-central forces, Inverse square force, Centre of mass. Equivalent one body problem. Reduced mass, angular momentum in central force field.Equation of motion under a force law**.** Equation of orbit and turning points. relationship between eccentricity and energy, Kepler's laws., Basic idea of global positioning system (GPS).

Unit-III

Rotational Motion and Kinematics of Elastic and Inelastic Collisions : Angular velocity, angular momentum, Torque, Conservation of angular momentum,: Elastic and inelastic collisions, coefficient of restitution, Elastic collisions in laboratory and C.M. systems, Velocities, angle and energies in elastic collisions in C.M. and lab. Systems, Classical Scattering: Cross- section for elastic scattering, Rutherford scattering (with derivation).

Unit IV

Special Theory of Relativity: Concept of stationary universal frame of reference and search for ether. Michelson-Morley experiment, postulates of special theory of relativity. Lorentz transformations. Observer in relativity. Relativity of simultaneity.

Effects of Relativity: Length contraction. Time dilation. Relativistic addition of velocities. Relativistic Doppler effect. Variation of mass with velocity and mass energy equivalence. Increase of mass in an inelastic collision, Relativistic momentum and energies. Transformation of momentum, energy. Minkowsky space.

Name of the Course	**PHYSICS-DSC 1A LAB: MECHANICS (Credits: -02)**
Code	PHYS 101PR

Course objectives

Aims on the writing of scientific laboratory reports, which may include theoretical and practical significance of the experiment performed, apparatus description, relevant theory, necessary precautions to be taken during the experiment, proper recording of observations, data analysis, estimation of the error and explanation of its sources, correct recording of the result of the experiment, and proper referencing of the material taken from other sources (books, websites, research papers, etc.)

Course Outcomes

1. To develop ability to model and analysis of mechanics using vector representation of forces and moments.
2. To be able to draw the free body diagrams of mechanical components and systems.
3. To understand the phenomenon of friction and ability to solve problem related to the same. Ability to apply the principles of virtual work.
4. To develop the understandings of fundamental principles of Mechanics

PHYSICS-DSC 1A LAB: MECHANICS

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To determine the Height of a Building using a Sextant.
3. To determine the Moment of Inertia of a Flywheel.
4. To determine the Young's Modulus of a Wire by Optical Lever Method.
5. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
6. To determine the Elastic Constants of a Wire by Searle's method.
7. To determine g by Bar Pendulum.
8. To determine g by Kater's Pendulum.
9. To determine g and velocity for a freely falling body using Digital Timing Technique
10. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

11. To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.
12. To compare the moment of inertia of a solid sphere and hollow sphere or solid disc of same mass with the torsional pendulum.
13. To verify (a) the law of conservation of linear momentum and (b) law conservation of kinetic energy on case of elastic collision.

ELECTRICITY, MAGNETISM AND EMT

Name of the Course	**PHYSICS-DSC 1B: ELECTRICITY, MAGNETISM AND EMT (Credits: Theory-04)Theory**
Code	PHYS102TH

Course objectives

This course reviews the concepts of electromagnetism learnt at school from a more advanced perspective and goes on to build new concepts. The course covers static and dynamic electric and magnetic fields, and the principles of electromagnetic induction. It also includes analysis of electrical circuits and introduction of network theorems. The students will be able to apply the concepts learnt to several real world problems.

Course Outcomes

At the end of this course the student will be able to

1, Demonstrate the application of Coulomb's law for the electric field, and also apply it to systems of point charges as well as line, surface, and volume distributions of charges.

2. Demonstrate an understanding of the relation between electric field and potential, exploit the potential to solve a variety of problems, and relate it to the potential energy of a charge distribution.

3. Apply Gauss's law of electrostatics to solve a variety of problems.

4.Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere laws)

5. Understand the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws.

6. Understand the basics of electrical circuits and analyze circuits using Network Theorems.

Unit-I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem, Stokes's theorem, Green's theorem. **(5 Lectures)**

Electrostatics: Significance of electrostatic force, Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor, electrostatic potential, electrostatic potential energy. Electric potential due to a dipole and quadrupole, long uniformly changed wire, charged disc. Electric potential energy. Electric field as a gradient of a scalar potential. Calculation of electric field due to a point charge and a dipole from potential. Method of Electrical Images. Poisson and Laplace equations. **(7 Lectures)**

Electric Current and Fields of Moving charges: Current and current density. Continuity equation; $\nabla J + \partial\rho/\partial t = 0$. Microscopic form of Ohm's law ($J \alpha E$) and conductivity. Failure of Ohms law and its explanation. Invariance of charge. **(3 Lectures)**

Unit-II

Magnetism: Ampere circuital law and its applications. Hall Effect, Expression for Hall constant and its significance. Divergence and curl of magnetic field **B**. Vector potential: Definition of vector potential **A** and derivation.

Field of Moving Charges: E in different frames of reference. Field of a point charge moving with constant velocity. Field of charge that starts or stops (qualitative). Interaction between moving charge and force between parallel currents.

Surface current density: Definition. and its use in calculation of change in magnetic field at a current sheet. Transformation equations of E and B from one frame of reference to another. Dielectrics, parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector **D**, molecular interpretation of Claussius - Mossotti equation, boundary conditions satisfied by **E** and **D** at the interface between two homogenous dielectrics, illustration through a simple example**.**

Unit-III

Electrostatic Fields in Dielectrics: Polarization of matter. Atomic and molecular dipoles, induced. Dipole moment and atomic polarizability. Electric susceptibility and polarization vector Capacity of a capacitor filled with Dielectrics. Dielectrics and Gauss's law Displacement vector-Establishment of relation $\nabla . D = \rho_{free}$. Energy stored in a dielectric medium.

Magnetic Fields in Matter: Behavior of various substances in magnetic fields. Definition of M and H and their relation to free and bound currents. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites.

Unit-IV

Maxwell`s equations and Electromagnetic wave propagation: Displacement current, Maxwell's equations and its physical interpretation, EM waves and wave equation in a medium having finite permeability and permittivity but with conductivity $\sigma = 0$. Poynting vector, Poynting theorem, Impedence of a dielectric to EM waves, EM waves in conducting medium and skin depth. EM waves velocity in a conductor and anomalous dispersion. Reflection and Transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence of reflection of EM waves from the surface of a conductor at normal incidence.

ELECTRICITY, MAGNETISM AND EMT LAB

Name of the Course	**PHYSICS-DSC 1B LAB: ELECTRICITY, MAGNETISM AND EMT (Credits: -02)**
Code	PHYS 102PR

Course objectives

In the laboratory course the student will get an opportunity to verify network theorems and study different circuits such as RC circuit, LCR circuit. Also, different methods to measure low and high resistance, capacitance, self-inductance, mutual inductance, strength of a magnetic field and its variation in space will be learnt.

Course Outcomes

1. Analyze electric circuits to compute currents and voltage drops, both in stationary and time-dependent situations-
2. Solve Maxwells equations for simple systems- Have a rudimentary grasp on how experimental equipment related to electricity and magnetism can be used (this is achieved via lab-exercises)
3. Account for the importance of electricity and magnetism in society, especially with regard to technological applications.

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:
   (i) Measurement of charge and current sensitivity
   (ii) Measurement of CDR
   (iii) Determine a high resistance by Leakage Method
   (iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and
   (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem
10. To verify the Superposition, and Maximum Power Transfer Theorem
11. To determine unknown capacitance by flashing and quenching method
12. To find frequency of ac supply using an electrical viberator.
13. To study the induced emf as a function of the velocity of the magnet (simple method).

B.Sc. 2nd Year

Name of the Course	**PHYSICS-STATISTICAL AND THERMAL PHYSICS (Credits: -04)**
Code	PHYS 201TH

Course Objectives: This course deals with the relationship between the macroscopic properties of physical systems in equilibrium. It reviews the concepts of thermodynamics learnt at school from a more advanced perspective and develops them further. The primary goal is to understand the fundamental laws of thermodynamics and their applications to various systems and processes. In addition, it will also give exposure to students about the Kinetic theory of gases, transport phenomena involved in ideal gases, phase transitions and behavior of real gases.

Course Outcomes : Students will have the Practical knowledge about:

1. How to apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc
2. Analyze phase equilibrium condition and identify types of phase transitions of physical systems.
3. Make connections between applications of general statistical theory in various branches of physics.
4. Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, Free energies, and partition functions.

Unit-I

Basic Ideas of Statistical Physics: Scope of statistical physics, basic ideas about probability, distribution of four distinguishable particles in two compartments of equal sizes. Concept of macro-states, micro-states, thermodynamic probability, effect of constraints on the system.

Distribution of Particles in Compartments: Distribution of n particles in two compartments, Deviation from the state of maximum probability. Equilibrium state of a dynamic system, distribution of n distinguishable particles in k compartments of unequal sizes.

Unit-II

Types of Statistics in Physics: Phase space and division into elementary cells. Three kinds of statistics. The basic approach in the three statistics. M-B. Statistics applied to an ideal gas in equilibrium, experimental verification of the Maxwell Boltzmann's law of distribution of molecular speeds. Need for quantum statistics, h as a natural constant and its implications, indistinguishability of particles and its implications. B-E statistics,

Bose Einstein and Fermi Dirac Statistics: Derivation of Planck's law of radiation, deduction of Wien's distribution law and Stefan's law from plank's law. Fermi-Dirac statistics. Applications to liquid helium, free electrons gas (Fermi level and Fermi Energy), Comparison of M-B, B-E, F-D statistics

Unit-III

Entropy and Laws of Thermodynamics: Application of thermodynamics to the thermoelectric effect, change of entropy along a reversible path in a p-v diagram, entropy of a perfect gas, equation of state of ideal gas from simple statistical considerations, heat death of the universe.

Statistical Interpretation of entropy: Statistical definition of entropy, change of entropy of system, additive nature of entropy, law of increase of entropy. Reversible and irreversible processes, example of reversible and irreversible processes. Work done in a reversible process, example of entropy in natural process, entropy and disorder.

Unit-IV

Maxwell's Thermodynamic Relations and Their Applications: Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Derivation of Maxwell's thermodynamic relations.

Applications of thermodynamics relations. Cooling produced by adiabatic stretching, adiabatic compression, adiabatic Stretching of a wire, stretching of thin films, change of internal energy with volume. Clausius-Clapeyron Equation, Thermo dynamical treatment of Joule-Thomson effect for liquification of Helium. Production of very low temperatures by adiabatic demagnetization, TdS equations.

STATISTICAL AND THERMAL PHYSICS LAB

Name of the Course	**PHYSICS-DSC 1C LAB: STATISTICAL AND THERMAL PHYSICS (Credits: -02)**
Code	PHYS 201PR

Course Objectives: Sessions on the construction and use of specific measurement instruments and experimental apparatuses used in the thermal physics lab, including necessary precautions. Sessions on the review of experimental data analysis, sources of error and their estimation in detail, writing of scientific laboratory reports including proper reporting of errors.

Course Outcomes : Students will have the Practical knowledge about:

1. How to apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc
2. Analyze phase equilibrium condition and identify types of phase transitions of physical systems.
3. Make connections between applications of general statistical theory in various branches of physics.

PHYSICS LAB-DSC 1C LAB: STATISTICAL AND THERMAL PHYSICS

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge
11. To prove the law of probability by using one coin, two coins and 10 or more coins.
12. To determine the coefficient of increase of volume of air at constant pressure.
13. To determine the coefficient of increase of pressure of air at constant volume.
14. To study the spectral characteristics of a photo-voltaic cell.
15. To study the current voltage, power load, areal, azimuthal and spectral characteristics of a photo voltaic cell.
16. To verify inverse square law of radiation using a photoelectric cell.

WAVES AND OPTICS

Name of the Course	PHYSICS-DSC 1D: WAVES AND OPTICS (Credits: Theory-04) Theory
Code	PHYS202TH

Course Objective

This course reviews the concepts of waves and optics learnt at school from a more advanced perspective and goes on to build new concepts. It begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. The course also provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.

Course Outcomes

Students will have the knowledge and skills to:

1. Appreciate the efficacy of Fourier transforms and their application to physical systems.
2. Understand linear, time-invariant systems.
3. Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems
4. Understand dispersion in waves and model dispersion using Fourier theory.
5. Understand diffraction and imaging in terms of Fourier optics and gain physical and intuitive insight in a range of physics via the spatial Fourier Transform.
6. Understand optical phenomena such as polarisation, birefringence, interference and diffraction in terms of the wave model.

Unit-I

Simple harmonic motion: characteristics, graphical representation of SHM, phase relation between displacement, velocity and acceleration of a particle, executing SHM, SHM oscillator (mass attached to a spring placed on horizontal frictionless surface). energy of a simple harmonic oscillator. solution of the differential equation of SHM. Average kinetic energy, average potential energy and total energy.

Damped SHM: Damped oscillations. differential equation of motion of one dimensional damped harmonic mechanical oscillator. Types of damping. damped harmonic electric oscillator (differential equation and its solutions). Determination of the damping constants. Logarithmic decrement. Relaxation time. The quality factor, power dissipation in a damped harmonic oscillator when damping is weak. Relation between power dissipation energy and relaxation time of damped harmonic oscillator.

Unit-II

The Forced Oscillator: Transient and steady behaviour of forced oscillator. Displacement and velocity variation with driving force frequency. Variation of phase with frequency. Power supplied to an oscillator and its variation with frequency. Q- value and band width. Q-value as an amplification factor (Phasor treatment to be followed)

Coupled Oscillators: Stiffness coupled pendulums. Normal co-ordinates and normal modes of vibration. Inductance coupling of electrical oscillators.

Wave Motion: The type of waves. The wave equation and its solution. Characteristic impedance of a string. Impedance matching. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on a string of fixed length. Energy of a vibrating string. Wave velocity and group velocity.

Unit-III

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Interference: Division of wavefront and division of amplitude. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer.

Unit-IV

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating, Dispersive power of diffraction grating, Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Polarization: Transverse nature of light waves. Unpolarized and plane polarized light, production of polarized light, Wire grid polarizer, Polaroid, Effect of intensity of light passing through Polaroid, Malus' law, double refraction; ordinary ray and extraordinary ray, positive and negative crystals, birefringence, Nicol Prism, quarter wave plate and half wave plate, Polarization by reflection (Brewster law), polarization by scattering,. Circular and elliptical polarization, production of elliptically polarized and circularly polarized light.

WAVES AND OPTICS LAB

Name of the Course	**PHYSICS-DSC 1D LAB: WAVES AND OPTICS (Credits: -02)**
Code	PHYS 202PR
Course Outcomes Through the lab course, understand the principles of measurement and error analysis and develop skills in experimental design.	

1. To investigate the motion of coupled oscillators
2. Familiarization with Schuster`s focussing; determination of angle of prism.
3. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
4. To determine Dispersive Power and Resolving power of the Material of a given Prism using Mercury Light
5. To determine the value of Cauchy Constants of a material of a prism.
6. To determine the Resolving Power of a Prism.
7. To determine wavelength of sodium light using Fresnel Bi prism.
8. To determine wavelength of sodium light using Newton's Rings.
9. To determine the wavelength of Laser light using Diffraction of Single Slit.
10. To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating
11. To determine the Resolving Power of a Plane Diffraction Grating.
12. To measure the intensity using photo sensor and laser in diffraction patterns of single and double slits.
13. To find the refractive index of glass slab using travelling microscope
14. To find the refractive index of water using travelling microscope
15. To determine the magnifying power of a telescope.
16. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.
17. Plot a graph between the concentration and rotation for various strengths of sugar solution and hence find (a) the specific rotation and (b) the concentration of the given sugar solution.

SKILL ENHANCEMENT COURSE (Any four) (Credit: 04 each)- SEC1 to SEC4

B.SC. 2nd Year(SEC)

PHYSICS WORKSHOP SKILL - SEC1

Name of the Course	**PHYSICS – SEC1: PHYSICS WORKSHOP SKILL(Credits: Theory-03)+(Credits: -01Project)**
Code	PHYS203TH
Course Outcomes 1. Aim of this course is to create awareness among the students about the mechanical, electrical and electronic tools through hands-on activities. 2. This course introduces the students to the workshop skills like cutting, drilling, filing, different types of AC and DC generators, soldering- desoldering of electrical and electronics components, constructing regulated power supplies, etc., 3. After completing this course students will gain skills of using various workshop tools and also to find faults and general troubleshoots and wiring faults.	

ELECTRICAL CIRCUITS AND NETWORK SKILLS – SEC2

Name of the Course	**PHYSICS-SEC1/ SEC2: ELECTRICAL CIRCUITS AND NETWORK SKILLS (Credits: Theory-03)+(Credits: -01Project)**
Code	PHYS205TH
Course Outcomes 1. To know the concept of study of measurement. 2. To gain the knowledge of electrical and electronic skill. 3. To study of introduction of prime mover(machine). 4. To study of use bread board for designing the basic	

B.Sc. IIIrd Year

ELEMENTS OF MODERN PHYSICS

Name of the Course	**PHYSICS-DSE 1A: ELEMENTS OF MODERN PHYSICS (Credits: Theory-04)Theory**
Code	PHYS301TH
Course Outcomes **1.** To know the concept and study of Quantum theory and its importance. **2.** To study the Schrodinger's wave equations for nonrelativistic particles and physical significance. **3.** To study the application's Schrodinger's equations **4.** To know the concept and study of Nucleus Stability. **5.** To study of radioactivity and emission of α, β and γray.	

ELEMENTS OF MODERN PHYSICS LAB

Name of the Course	**PHYSICS-DSE 1A LAB: ELEMENTS OF MODERN PHYSICS (Credits: -02)**
Code	PHYS301PR
Course Objective The objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern physics which are crucial for understanding atoms, molecules, photons, nuclei	

and elementary particles. These concepts are also important to understand phenomena in laser physics, condensed matter physics and astrophysics.

Course Outcomes

1. Main aspects of the inadequacies of classical mechanics as well as understanding of the historical development of quantum mechanics.
2. Formulation of Schrodinger equation and the idea of probability interpretation associated with wave-functions.
3. 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.
4. 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.
5. Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino, its properties and its role in theory of beta decay.
6. Fission and fusion: Nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.

Unit-I

Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment.

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.

Unit-II

Heisenberg uncertainty principle- impossibility trajectory; estimating minimum energy of a confined principle; Energy-time uncertainty principle. Wave-particle duality.

Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Unit-III

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of
nuclear force, NZ graph, semi-empirical mass formula and binding energy.

Unit-IV

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission.

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions.

NUCLEAR AND PARTICLE PHYSICS

Name of the Course	**PHYSICS-DSE 1B: NUCLEAR AND PARTICLE PHYSICS (Credits: Theory-05, Tutorials-01)**
Code	PHYS304TH

Course Objective

The objective of the course is to impart the understanding of the sub atomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in

different branches Physics and societal application. The course will focus on the developments of problem based skills.

Course Outcomes

1. To be able to understand the basic properties of nuclei as well as knowledge of experimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance.
2. To appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support.
3. Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays.
4. Familiarization with different types of nuclear reactions, Q- values, compound and direct reactions.
5. To know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter. Through the section on accelerators students will acquire knowledge about Accelerator facilities in India along with a comparative study of a range of detectors and accelerators which are building blocks of modern day science.
6. It will acquaint students with the nature and magnitude of different forces, particle interactions, families of sub- atomic particles with the different conservation laws, concept of quark model.
7. The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

Unit-I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Unit-II

Radioactivity decay:(a) Alphaα decay: basics of -decay processes, theory of α-emission, Gamowα factor, Geiger Nuttall law, -decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Unit-III

Nuclear Detectors and Accelerators: Interaction of nuclear radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Detector for Nuclear Radiations: Gas detectors, estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility). Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Unit-IV

Particle Physics: Particle interactions; basic features. Classification of elementary particles and its families. Conservation Laws: energy and momentum, angular momentum, parity, Baryon number, Lepton number, Isospin, Strangeness, Gell-Mann-Nishijima Scheme, CPT theorem, parity violation in weak interactions. Particle Symmetries. Quarks Model, quantum number of quarks and gluons. Quark Model of Hadrons: Quark structure of

non strange and strange hadrons, Mesons and baryons containing charm and bottom quarks, explanation of their quantum numbers in terms of their constituents quarks, Quark wave function of Mesons and nucleons, need of color quantum number. Cosmic Rays; origin of cosmic rays. primary and secondary cosmic rays, hard component and soft component, the altitude effect, the latitude effect, East–west asymmetry, cosmic rays showers.

B.Sc.3rd Year (SEC)

RADIATION SAFETY – SEC - 3

Name of the Course	**PHYSICS-SEC3: RADIATION SAFETY** **(Credits: Theory-03)+(Credits: -01Project)**
Code	PHYS307TH

Course Outcomes

Upon completion, successful students will be able to:

1. Obtain basic information of radiation safety including understanding basic principles of ionizing radiation, the risks of working with radioactive materials/radiation producing machines etc.
2. Obtain relevant information to work safely and confidently with radiation sources while maintaining the professional standard of ALARA.
3. Understand typical everyday radiation safety topics, how radiation safety programs are implemented in a university, research, and or hospital setting.
4. Obtain an in-depth understanding of a student-selected radiation protection topic through an independent study project

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission.

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, **Interaction of Photons** - Photo- electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons**- Collision, slowing down and Moderation.

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management.

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses*:* Tracing, Gauging, Material Modification, Sterization, Food

RENEWABLE ENERGY AND ENERGY HARVESTING - SEC4

Name of the Course	**PHYSICS-SEC4: RENEWABLE ENERGY AND ENERGY HARVESTING (Credits: Theory-03)+(Credits: -01Project)**
Code	PHYS310TH

Course Outcomes

1. To understand the different kinds of Energy sources.
2. To study the basis of solar energy and solar radiation measurement.
3. To learn the fundamental principles and theory of wind energy conversion system.
4. Student will acquire enough knowledge enough knowledge about the renewable energy resources.
5. This course helps the student to understand the concepts of energy sources and their technologies.
6. To learn the environmental pollution and climate change.
7. To understand the basic need of carbon free energy .and student will acquire enough knowledge about the renewable energy sources.

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.

Add On/Bridge Courses Offered by the Department

Class	Name of Course	Description	Agency
All Students of the Department	**Avogadro**	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	UCSF Chimera	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Biopython	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	CellDesigner	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Inkscape	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Arduino	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Linux	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	JAVA	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Digital Divide	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Latex	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	Libre Office	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
	HTML	Skill Development Value Added Course	IIT Bombay Spoken Tutorials
BSc 1st Year	**Standard Operating Procedure (SOP)**	Bridge Course Guidelines, Procedures and Rules	Department of Physics, Government College Sanjauli,