Savitribai Phule Pune University

(Formerly University of Pune)

Three Year B.Sc. Degree Program in Physics

(Faculty of Science & Technology)

F.Y.B.Sc. (Physics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2019-2020

Title of the Course: B.Sc. (Physics)

Preamble:

The curriculum for the B. Sc. (Physics) programme is designed to cater to the requirement of Choice Based Credit System following the University Grants Commission (UGC) guidelines. In the proposed structure, due consideration is given to Core and Elective Courses (Discipline specific - Physics), along with Ability Enhancement (Compulsory and Skill based) Courses. Furthermore, continuous assessment is an integral part of the CBCS, which will facilitate systematic and thorough learning towards better understanding of the subject. The systematic and planned curricula from first year to the third year (comprised of six semesters) shall motivate the student for pursuing higher studies in Physics and inculcate enough skills for becoming an entrepreneur.

Objectives:

- To foster scientific attitude, provide in-depth knowledge of scientific and technological concepts of Physics.
- To enrich knowledge through problem solving, minor/major projects, seminars, tutorials, review of research articles/papers, participation in scientific events, study visits, etc.
- To familiarize with recent scientific and technological developments.
- To create foundation for research and development in Physics.
- To help students to learn various experimental and computational tools thereby developing analytical abilities to address real world problems.
- To train studentsin skills related to research, education, industry, and market.
- To help students to build-up a progressive and successful career in Physics.

Structure of the Course:

Subject Name	Year	Semester	Course Type	Course Code	Course Name	Credit
Physics	1	I	Compulsory Course	PHY-111	Mechanics and Properties of Matter	2
				PHY-112	Physics Principles and Applications	2
				PHY-113	Physics Laboratory-IA	1.5
		II	Compulsory Course	PHY-121	Heat and Thermodynamics	2
				PHY-122	Electricity and Magnetism	2
				PHY-123	Physics Laboratory-IB	1.5
	2	III	Compulsory Course	PHY-231	Mathematical Methods in Physics I	2
				PHY-232	Electronics I /Instrumentation	2
				PHY-233	Physics Laboratory-2A	2
			Ability Enhancement Compulsory Course	PHY-2310	Environment -I	2
				PHY-2311	Language-I	2
		IV	Compulsory Course	PHY-241	Oscillations, Waves and Sound	2
				PHY-242	Optics	2
				PHY-243	Physics Laboratory-2B	2
			Ability Enhancement Compulsory Course	PHY-2410	Environment –II	2
				PHY-2411	Language-II	2
	3	V	Discipline Specific Elective Course	PHY- 351	Mathematical Methods in Physics II	2
				PHY- 352	Electrodynamics	2
				PHY- 353	Classical Mechanics	2
				PHY- 354	Atomic and Molecular Physics	2
				PHY- 355	Computational Physics	2
				PHY- 356	Elective I (Select any One)	2
				PHY- 357	Physics Laboratory-3A	2
				PHY- 358	Physics Laboratory-3B	2
				PHY- 359	Physics Laboratory-3C	2
			Skill Enhancement Course	PHY-3510	Maintenance and Repairing of Laboratory equipment – I	2
				PHY- 3511	Household Electrification, Maintenance and repairing - I	2

		VI	Discipline Specific Elective Course	PHY- 361	Solid State Physics	2
				PHY- 362	Quantum Mechanics	2
				PHY- 363	Thermodynamics and Statistical Physics	2
				PHY- 364	Nuclear Physics	2
				PHY- 365	Electronics II /Advanced Electronics	2
				PHY- 366	Elective II (Select any One)	2
				PHY- 367	Physics Laboratory-4A	2
				PHY- 368	Physics Laboratory-4B	2
				PHY- 369	Project	2
			Skill Enhancement Course	PHY-3610	Maintenance and Repairing of Laboratory Equipment – II	2
				PHY- 3611	Household Electrification, Maintenance and Repairing- II	2

SEMISTER-I

Course code and title: PHY-111 Mechanics and Properties of Matter

Lectures: 36 **(Credits-02)**

1. Motion: **(9 Lectures)**

Introduction to motion, Types of motion, Displacement, Velocity, Acceleration, Inertia, Newton's laws of motion with their explanations, Various types of forces in nature, Frames of reference (Inertial and Non inertial), Laws of motion and it's real life applications, Problems.

2. Work and Energy: **(7 Lectures)**

Kinetic energy, Work Energy Theorem, Work done with constant force, Work done with varying force (spring force), Conservative and Non conservative forces, Potential energy, Law of energy conservation, Gravitational potential energy, Problems.

3. Fluid Mechanics: **(8 Lectures)**

Concept of viscous force and viscosity, Coefficient of viscosity, Steady and Turbulent flow, Reynolds number, Equation of continuity, Bernoulli's Principle, Applications of Bernoulli's Principle (Ventury Meter, PitotTube), Applications of viscous fluids, Problems.

4. Properties of Matter: **(12 Lectures)**

Surface tension, Angle of contact, Factors affecting surface tension, Jaeger's method for determination of surface tension, Applications of surface tension.

Stress and Strain, Hook's law and Coefficient of elasticity, Young's modulus, Bulk modulus, Modulus of rigidity, Work done during longitudinal strain, Volume strain, Shearing strain, Poisson's ratio, Relation between three elastic moduli, (Y, η, K), Applications of elasticity, Problems.

Reference Books

1. Physics: Resnick, Halliday& Walker 9/e, Wiley.
2. University Physics : Sears and Zeemansky, XIth/XIIth Edition, Pearson Education.
3. Mechanics: D. S. Mathur, S. Chand and Company, New Delhi.
4. Elements of Properties of Matter : D. S. Mathur, S. Chand, New Delhi.
5. Concepts of Physics: H. C. Verma, BharatiBhavan Publisher.
6. Problems in Physics: P. K. Srivastava, Wiley Eastern Ltd.
7. Applied Fluid Mechanics: Mott Robert, Pearson Benjamin Cummir VI Edition. Pearson Education/Prentice Hall International, New Delhi.
8. Fundamentals of Mechanics: J C Upadhyaya, Himalaya Publishing House.
9. Mechanics: D. S. Mathur, Revised by P. S. Hemne, S. Chand and Company, New Delhi.
10.

Course code and title: PHY-112 Physics Principles and Applications

Lectures: 36 **(Credits-02)**

Learning Outcomes:

On successful completion of this course students will be able to do the following:

1. To understand the general structure of atom, spectrum of hydrogen atom.
2. To understand the atomic excitation and LASER principles.
3. To understand the bonding mechanism and its different types.
4. To demonstrate an understanding of electromagnetic waves and its spectrum.
5. Understand the types and sources of electromagnetic waves and applications.
6. To demonstrate quantitative problem solving skills in all the topics covered.

1. Physics of Atoms **(08-Lectures)**

1.1 Introduction to Atom
1.2 Atomic Models:
- 1.2.1 Thomson's Atomic Model
- 1.2.2 Rutherford's Atomic Model
- 1.2.3 Bohr's Atomic Model

1.3 Atomic Spectra:
- 1.3.1 Emission line Spectrum
- 1.3.2 Absorption line spectrum
- 1.3.3 Uses of Atomic Spectra

1.4 Classical planetary model of Hydrogen Atom
1.5 The Bohr Theory of the Hydrogen Atom
1.6 The Hydrogen Spectrum
1.7 Frank-Hertz experiment
Problems

2. LASERS and Its Applications **(07-Lectures)**

2.1 Introduction to LASERS
2.2 Basic Principle of Lasers: Three Processes
2.3 Characteristics of Lasers: brief explanation
2.4 Boltzmann Distribution Law
2.5 Population Inversion and Pumping
2.6 Types of Lasers:
- 2.5.1 He-Ne Laser
- 2.5.2 Ruby Laser

2.7 Applications of Lasers
Problems

3. Physics of Molecules **(08-Lectures)**

3.1 Introduction to Bonding Mechanisms
3.2 Forces between Atoms
3.3 Types of Bonding:
- 3.3.1 Ionic Bonds
- 3.3.2 Covalent Bonds
- 3.3.3 van der Waal's Bonds
- 3.3.4 Hydrogen Bond
- 3.3.5 Metallic Bond

3.4 Rotation energy levels of a diatomic molecule
3.5 Vibration energy levels of a diatomic molecule
Problems

4. Sources of Electromagnetic Waves (06-Lectures)

4.1 Introduction to Electromagnetic Waves: Historical Perspective
4.2 General properties of Electromagnetic radiations
4.3 Electromagnetic spectrums and its sources
4.4 Production of electromagnetic waves: Hertz experiment
4.5 Plank's hypothesis of Photons
4.6 Applications of various waves in electromagnetic spectrum

5. Applications of Electromagnetic Waves (07-Lectures)

5.1 Microwave oven
5.2 RADAR
5.3 Pyroelectric thermometer
5.4 X-ray radiography
5.5 CT Scan
5.6 Solar cell and its types
Problems

Books/References

1. Concepts of Modern Physics: A Beiser (6th ed., McGraw Hill, 2003

2. Modern Physics: Raymond A. Serway, Clement J. Moses, Curt A. Moyer

3. Sears and Zemansky's University Physics: H.D. Young R. A. Freedman, Sandin (11th Ed. Pearson Education)

4. LASERS: M. N. Avdhanulu, S. Chand Publications.

Course code and title: PHY-113 Physics Laboratory 1A

Practical: 10 (Credits-1.5)

Section I- Mechanics and Properties of Matter

Sr. No	Title of the experiment
1	Study and use of various measuring Instruments. 1. Vernier caliper 2. Micrometer Screw Gauge 3. Travelling Microscope
2	Study of Modulus of Rigidity of wire using Torsional Oscillations
3	Determination of coefficient of Viscosity by Poiseuille's method
4	Determination of "Y" and "η" by flat spiral spring
5	Determination of "Y" by bending method.
6	Study of surface tension by Jaeger's method
7	Study of Poisson's ratio of rubber using rubber tube /rubber chord
8	Study of surface tension of liquid using Fergusson Method

Section II-Physics Principles and Applications

Sr. No	Title of the experiment
1	Study of Spectrometer and determination of angle of prism
2	Study of Spectrometer calibration and determination of refractive indices of different colors
3	Study of divergence of LASER beam
4	Study of total internal reflection using LASER
5	Determination of Plank's constant
6	Determination of wavelength of LASER light by plane diffraction grating
7	Study of I-V characteristics of solar cell

Note: Any four experiments from each section be conducted during the semester, with a total of 10 experiments.

SEMISTER-II

Course code and title: PHY-121 Heat and Thermodynamics

Lectures: 36 **(Credits-02)**

1. Fundamentals of Thermodynamics **(10 Lectures)**

Concept of thermodynamic state, Equation of state, Van der Waal's equation of state, Thermal equilibrium, Zeroth law of thermodynamics, Thermodynamic processes: Adiabatic, Isothermal, Isobaric and Isochoric changes, Indicator diagram, Work done during isothermal change, Adiabatic relations, Work done during adiabatic change, Internal energy, Internal energy as state function, First law of thermodynamics, Reversible and Irreversible changes, Problems.

2. Applied Thermodynamics: **(9 Lectures)**

Conversion of heat into work and it's converse, Second law of thermodynamics, Concept of entropy, Temperature - entropy diagram, T-dS equations, Clausius - Clapeyron latent heat equations, Problems.

3. Heat Transfer Mechanisms **(9 Lectures)**

Carnot's cycle and Carnot's heat engine and its efficiency, Heat Engines: Otto cycle & its efficiency, Diesel cycle & its efficiency, Refrigerators: General principle and coefficient of performance of refrigerator, Simple structure of Vapour compression refrigerator, Air Conditioning: Principle and it's applications, Problems.

4. Thermometry: **(8 Lectures)**

Concept of heat & temperature, Principle of thermometry, Temperature scales & inter-conversions, Principle, Construction and Working: (Liquid thermometers, Liquid filled thermometers, Gas filled thermometers, Bimetallic thermometers, Platinum resistance thermometer, Thermocouple), Problems.

Reference Books:

1. Concept of Physics: H. C. Verma, BharatiBhavan Publisher.
2. Heat and Thermodynamics: Brijlal, N. Subrahmanyam, S. Chand and Company Ltd.
3. Heat and Thermodynamics: Mark W. Zemansky, Richard H. Dittman, 7th Edition, Mc-Graw Hill International Edition.
4. Thermodynamics and Statistical Physics: J. K. Sharma, K. K. Sarkar, Himalaya Publishing House.
5. Thermal Physics (Heat and Thermodynamics): A. B. Gupta, H. P. Roy books and Allied (P) Ltd. Calcutta.
6. Instrumentation:Devices & Systems, Rangan, Mani, and Sarma.

Course code and title: PHY-122 Electricity and Magnetism

Lectures: 36 **(Credits-02)**

Learning Outcomes:

On successful completion of this course students will be able to do the following:

1) To understand the concept of the electric force, electric field and electric potential for stationary charges.
2) Able to calculate electrostatic field and potential of charge distributions using Coulomb's law and Gauss's law.
3) To understand the dielectric phenomenon and effect of electric field on dielectric.
4) To Study magnetic field for steady currents using Biot-Savart and Ampere's Circuital laws.
5) To study magnetic materials and its properties.
6) Demonstrate quantitative problem solving skills in all the topics covered.

1. Electrostatics **(08-Lectures)**

1.1 Revision of Coulomb's law:
- 1.1.1 Statement
- 1.1.2 Variation of forces with distances

1.2 Superposition principle:
- 1.2.1 Statement
- 1.2.2 Explanation with illustration

1.3 Energy of system of charges

1.4 Concept of electric field
- 1.4.1 Due to point charge
- 1.4.2 Due to group charges

1.5 Concept of electric flex

1.6 Gauss's law in electrostatics

Problems

2. Dielectrics **(08-Lectures)**

2.1 Introduction to dielectric materials

2.2 Electric Dipole
- 2.2.1 Electric dipole
- 2.2.2 Dipole moment

2.3 Electric potential and intensity at any point due to dipole

2.4 Torque on a dipole placed in an electric field

2.5 Polar and non-polar molecules

2.6 Electric polarization of dielectric material

2.7 Gauss' law in dielectric

2.8 Electric vectors and its relation

Problems

3. Magnetization **(07-Lectures)**

3.1 Introduction to Magnetization

3.2 Magnetic materials

3.3 Types of Magnetic Materials
- 3.3.1 Diamagnetic materials
- 3.3.2 Paramgnetic materials
- 3.3.3 Ferromagnetic materials
- 3.3.4 Antiferromagnetic materials

3.4 Bohr magnetron
Problems

4. Magnetostatics (07-Lectures)

4.1 Introduction to magnetization,
4.2 Magnetic Induction and Intensity of magnetization
4.3 Biot-Savart's law:
4.3.1 Statement
4.3.2 Long straight conductor
4.3.3 Circular Coil
4.4 Ampere's circuital law:
4.4.1 Statement
4.4.2 Field of Solenoid
4.4.3 Field of Toroid
4.5 Gauss law for magnetism
Problems

5. Magnetic Properties of Materials (06-Lectures)

5.1 Definition
5.1.1 Magnetization (M),
5.1.2 Magnetic Intensity (H),
5.1.3 Magnetic Induction (B),
5.1.4 Magnetic Susceptibility
5.1.5 Magnetic Permeability
5.2 Relation between B, M and H
5.3 Hysteresis and Hysteresis Curve
5.4 Ferrite materials and its Applications
Problems

References:

1. Fundamentals of Physics: HallidayResnik and Walkar, 8th Edition.

2. Electromagnetics: B. B. Laud.

3. Foundations of Electromagnetic theory: Reitz,Milford, Christey.

4. Electricity and Electronics: D.C.Tayal, Himalaya Publishing House, Mumbai.

5. Introduction to Electrodynamics: D.G. Griffith.

6. Electricity and Magnetism: BrijLal, Subramanyan, RatanPrakashan (Revised edition, 1997).

7. Electricity and Magnetism: Khare, Shrivastav (Revised edition, 1997).

Course code and title: PHY-123 Physics Laboratory 1B

Practical: 08 **(Credits-1.5)**

Section I- Heat and Thermodynamics

Sr No	Title of the experiment
1	Interpretation of Isothermal and Adiabatic curve on P-V diagram and theoretical study of Carnot's cycle by drawing graphs of Isothermal and Adiabatic curves
2	Study of temperature coefficient of Thermistor.
3	Study of Thermocouple and determination of inversion temperature
4	Study of thermal conductivity by Lee's method
5	Study of specific heat of Graphite
6	Study of Solar constant
7	Determination of calorific values of different fuels

Section II- Electricity and Magnetism

Sr No	Title of the experiment
1	Study of charging and discharging of capacitor
2	Study of LR circuit
3	Study of LCR circuit
4	Study of Kirchhoff's Laws
5	Study of Diode characteristics
6	Study of Voltmeter, Ammeter and Multimeter (AC, DC, ranges and least count)
7	Determination of frequency of AC mains
8	Comparison of capacitor using DeSauty's method

Note: Any four experiments from each section be conducted during the semester.