Maharashtra Education Society's

Abasaheb Garware College

(Autonomous)

(Affiliated to Savitribai Phule Pune University)

Three Year B.Sc. Degree Program in Physics

(Faculty of Science and Technology)

Syllabi under Autonomy

F.Y.B.Sc. (Physics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2022-2023

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

Preamble

MES Abasaheb Garware College, Pune affiliated to Savitribai Phule Pune University is awarded academic autonomy by the University Grants Commission (UGC), New Delhi and Savitribai Phule Pune University (SPPU), Pune in 2021 for a period of ten years. The Choice Based Credit System (CBCS) will be implemented for UG and PG programs from 2022-23 as per the guidelines of UGC. The under graduate programme in Physics is of three years with two semesters every year. 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. Continuous assessment is an integral part of the CBCS system which will facilitate systematic and thorough learning towards better understanding of the subject. This syllabus is planned to improve the students' understanding of fundamental concepts of Physics along with practical skill required to achieve excellence in recent advances of Physics and its applications to society. This course shall motivate students for higher studies in Physics and build-up successful career in various branches of science and technology.

Program Outcomes

1. To develop the various skills among the students to learn the basic concepts and principles of Physics.
2. To acquire deep knowledge of fundamental aspects of Physics and basic knowledge in the specialized thrust areas like Materials Science and Nanophysics.
3. To improve the students' logical thinking using computational programming.
4. To develop analytical ability through problem solving.
5. To inculcate research aptitude through minor projects, participation in scientific events, study tours etc.
6. To acquaint the students with recent scientific developments in Physics.
7. To encourage students to explore applications of physics through projects at final year of the course.
8. The overall objective is to familiarize the Physics among students by providing information and knowledge in the relevant fields and to motivate them for innovation; and also, empowering students to pursue Physics at higher studies and to generate keen interest about the subject among them to attract outstanding students from all walks of society.

Eligibility for B.Sc. Physics: Higher Secondary School Certificate (10+2) or its equivalent Examination

Structure of the Course: B.Sc. Physics

Total credits to be completed to award the B.Sc. degree: 132 + 8 Additional credits

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
FYBSc	I	Compulsory	USPH-111	Mechanics and Properties of Matter	Theory	2	36
			USPH-112	Physics: Principles with Applications	Theory	2	36
			USPHP-113	Physics Laboratory-IA	Practical	1.5	8
	II		USPH-121	Heat and Thermodynamics	Theory	2	36
			USPH-122	Electricity and Magnetism	Theory	2	36
			USPHP-123	Physics Laboratory-IB	Practical	1.5	8
SYBSc	III	Compulsory	USPH-231	Mathematical Methods in Physics I	Theory	2	36
			USPH-232A OR	Electronics-I	Theory	2	36
			USPH-232B	Instrumentation	Theory (For students opting Electronics at FYBSc)	2	36
		Ability Enhancement Compulsory Course	UEVS-231	Environment Awareness - I	Theory	2	36
			USLG-231	Language-I	Theory	2	36
		Compulsory	USPHP-233	Physics Laboratory-2A	Practical	2	10
	IV	Compulsory	USPH-241	Oscillations, Waves and Sound	Theory	2	36
			USPH-242	Optics	Theory	2	36
			USPHP-243	Physics Laboratory-2B	Practical	2	10
		Ability Enhancement Compulsory Course	UEVS-232	Environment Awareness - II	Theory	2	36
			USLG-232	Language-II	Theory	2	36

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
TYBSc	V	Discipline Specific Elective Course	USPH-351	Mathematical Methods in Physics - II	Theory	2	36
			USPH-352	Solid State Physics	Theory	2	36
			USPH-353	Classical Mechanics	Theory	2	36
			USPH-354	Atomic and Molecular Physics	Theory	2	36
			USPH-355	Computational Physics	Theory	2	36
			USPHELE-356A	Astronomy and Astrophysics-I	Theory - Elective Course (Select any one)	2	36
			USPHELE-356B	Elements of Materials Science		2	36
			USPHP-357	Physics Laboratory-3A	Practical	2	10
			USPHP-358	Physics Laboratory-3B	Practical	2	10
			USPHP-359	Project-I	Project	2	
		Skill Enhancement Courses	USPHSEC-3510	Choose any one from **Group I**	Theory	2	36
			USPHSEC-3511	Choose any one from **Group I**	Theory	2	36
	VI	Discipline Specific Elective Course	USPH-361	Electrodynamics	Theory	2	36
			USPH-362	Quantum Mechanics	Theory	2	36
			USPH-363	Thermodynamics and Statistical Physics	Theory	2	36
			USPH-364	Nuclear Physics	Theory	2	36
			USPH-365A OR	Electronics-II	Theory	2	36
			USPH-365B	Applied Electronics	Theory (For students opting Electronics at SYBSc)	2	36
			USPHELE-366A	Physics of Nanomaterials	Theory - Elective Course (Select any one)	2	36
			USPHELE-366B	Lasers		2	36
			USPHP-367	Physics Laboratory-4A	Practical	2	10
			USPHP-368	Physics Laboratory-4B	Practical	2	10
			USPHP-369	Project-II	Project	2	
		Skill Enhancement Courses	USPHSEC-3610	Choose any one from **Group I**	Theory	2	36
			USPHSEC-3611	Choose any one from **Group I**	Theory	2	36

Courses in Group I (SEC): The course in this group shall be conducted only once during the program.

Sr. No.	Course Name
1	Energy Studies
2	Physics Workshop Skills
3	Calibration Techniques
4	Radiation Physics
5	Scientific Data Plotting and Analysis using Excel
6	Introduction to Arduino
7	Introduction to Python Programming
8	Scientific Data Analysis using Python
9	Basic Electrical Engineering

Additional Credits Courses are as follows:

Year	Semester	Course Code	Mandatory Add-On Credit Course	Credits
I	I	UPE1-11	Physical Education	1
	II	UPE2-12	Physical Education	1
		UDEG-12	Democracy, Election and Governance	
I/II/III	Additional Credits (Pl. refer UG and PG_AGC_Autonomous Rules and Regulations (Science Faculty) manual)			6
			Total Credits	**8**

Note: Only Grade will be given for add-on courses and this will not be counted for SGPA or CGPA calculations. Student must pass in all add-on courses and earn **six** additional credits to get the **B.Sc. Physics** degree.

For all the courses **Continuous Assessment (CA)** is of **15 marks and Semester End Evaluation (SEE)** is of **35 marks**. For more details refer **UG and PG Autonomous Rules and Regulations (Science Faculty)** manual.

SEMESTER-I

Course Code and Title: USPH-111 Mechanics and Properties of Matter

Lectures: 36 (Credits-02)

Course Outcomes: After completion of the course, students would be able to:

1. Study vectors, laws of motion, momentum, energy, gravitation, fluids and elasticity.
2. Learn about the motion of objects in different frame of references
3. Provide the basic concepts related to the motion of all the objects around us in our daily life.
4. Build a foundation about work and energy.
5. Understand the tortional oscillations, surface tension of a liquid and elastic moduli.

1. Motion, Work and Energy **9 Lectures**

1.1 Revision of motion, Laws of kinematics, Newton's laws of motion
1.2 Fundamental forces
1.3 Frame of references (Inertial and Non inertial)
1.4 Kinetic energy, Potential Energy
1.5 Work Energy Theorem
1.6 Work done with constant and varying force
1.7 Conservative and Non-conservative forces
1.8 Law of conservation of energy
Problems

2. Elasticity **12 Lectures**

2.1 Stress and Strain
2.2 Hook's law and Coefficient of elasticity
2.3 Types of Elastic moduli: Young's modulus, Bulk modulus, Modulus of rigidity
2.4 Work done during longitudinal, volume and shearing strain
2.5 Poisson's ratio
2.6 Relation between three elastic moduli, (Y, η, K)
2.7 Torsional oscillations
2.8 Torsional pendulum
Problems

3. Surface Tension **7 Lectures**

3.1 Explanation of Surface tension
3.2 Relation between surface tension and surface energy
3.3 Angle of contact
3.4 Factors affecting surface tension
3.5 Jaeger's method for determination of surface tension
3.6 Applications of surface tension
Problems

4. Viscosity **8 Lectures**

4.1 Concept of viscous force and viscosity
  4.1.1 Coefficient of viscosity
4.2 Newton's Law of Viscosity
4.3 Steady and Turbulent flow - Critical Velocity, Reynolds number
4.4 Equation of continuity
4.5 Flow of liquid through a capillary tube – Poiseuille's equation (Proof)
4.6 Bernoulli's Principle
4.7 Applications of Bernoulli's Principle (Venturimeter, Pitot Tube)
4.8 Magnus effect
4.9 Applications of viscous fluids
  Problems

Reference Books

1. Fundamentals of Physics: D. Halliday and R. Resnick and J. Walker, Wiley Publications
2. University Physics: F. Sears and M. 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, Bharati Bhavan Publisher
6. Problems in Physics: P.K. Srivastava, Wiley Eastern Ltd.
7. Fundamentals of Mechanics: J.C. Upadhyaya, Himalaya Publishing House

Course Code and Title: USPH-112 Physics: Principles with Applications

Lectures: 36 (Credits-02)

Course Outcomes: After completion of the course, students would be able to:

1. Understand the general structure of atom and different types of spectra.
2. Understand the LASER principles, characteristics and types.
3. Know about electromagnetic spectrum.
4. Study the sources of electromagnetic waves and their applications.
5. Demonstrate quantitative problem- solving skills in all the topics covered.

1. Physics of Atoms **9 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 The Hydrogen Spectrum
1.5 Frank-Hertz experiment
  Problems

2. Introduction to LASERS **9 Lectures**

2.1 Introduction to LASERS
2.2 Basic Principle of Lasers: Three Processes
2.3 Characteristics of Lasers
2.4 Boltzmann Distribution Law
2.5 Population Inversion, Pumping and Metastable state
2.6 Energy Level Systems for LASER Action
  2.6.1 Two energy level system
  2.6.2 Three energy level system
  2.6.3 Four energy level System
2.7 Uses of Lasers
  Problems

3. Introduction to Solar Cell **11 Lectures**

3.1 Conductors and Semiconductors
3.2 Intrinsic and Extrinsic Semiconductor (p- and n- type)
3.3 p-n Junction
3.4 Diode Biasing
  3.4.1 I – V Characteristics in Forward Bias

3.4.2 I – V Characteristics in Reverse Bias
3.5 Photo-voltaic Principle
3.6 Introduction to Solar Cell
3.7 I – V Characteristics of Solar Cell
3.8 Fill factor, Efficiency of solar cell
3.9 Applications
Problems

4. Electromagnetic Radiations and Applications **7 Lectures**

4.1 Electromagnetic Wave Properties
4.2 Electromagnetic spectrum and its sources
4.3 Plank's hypothesis of Photons
5.1 Applications of electromagnetic waves: Microwave oven and RADAR
Problems

Reference Books

1. Concepts of Modern Physics: A. Beiser, 6th ed., McGraw Hill
2. Modern Physics: R.A. Serway, C.J. Moses, Curt A. Moyer, Cengage Learning
3. University Physics: F. Sears and M. Zeemansky, XIth/XIIth Edition, Pearson Education
4. An Introduction to LASERS- Theory and Applications: M.N. Avdhanulu, S. Chand Publications
5. Electronic Principle– A. Malvino and D.J. Bates, Tata McGraw Hill Publication
6. Solar Energy – S.P. Sukatme, Tata McGraw Hill Publication

Course Code and Title: USPHP-113 Physics Laboratory 1A

(Credits-1.5)

Course Outcomes: After completion of the course, students would be able to:

1. Acquire skills in use of laboratory equipment like Screw gauge, DMM, spectrometer, travelling microscope.
2. Apply scientific procedures for performing experiments based on basic concepts in mechanics and optics.
3. Analyse the experimental data through graph plotting and numerical calculations.
4. Compare the experimental results with theoretical predictions.
5. Develop an ability to understand the fundamental Physics concepts through experiments and its applications in science and technology.

Note: Any four experiments from each section be conducted during the semester, with a total of **8** experiments.

Section I- Mechanics and Properties of Matter

1. Study and use of various measuring Instruments:
   a. Vernier caliper b. Micrometer Screw Gauge c. 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

1. Study of Spectrometer and determination of angle of prism
2. Study of Spectrometer calibration and determination of refractive indices of different colours
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

Reference Books

1. Advanced Practical Physics for Students: B.L. Worsnop and H.T. Flint, Littlehampton Book Services Ltd.
2. Practical Physics: R.K. Shukla, A. Srivastava, New Age International (P) Ltd.

SEMESTER-II

Course Code and Title: USPH-121 Heat and Thermodynamics

Lectures: 36 (Credits-02)

Course Outcomes: After completion of the course, students would be able to:

1. Understand the thermodynamic laws and explore the fundamental concepts of physics.
2. Ability to evaluate entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
3. Study of various heat cycles and principle of refrigerator and air conditioner.
4. Study of principle and construction of various types of thermometers.
5. Understand the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems.

1. Fundamentals of Thermodynamics — 10 Lectures

1.1 Concept of thermodynamic state
1.2 Equation of state
1.3 van der Waal's equation of state
1.4 Thermal equilibrium
1.5 Zeroth law of thermodynamics
1.6 Thermodynamic processes: Adiabatic, Isothermal, Isobaric and Isochoric changes
1.7 Indicator diagram
1.8 Work done during isothermal change
1.9 Adiabatic relations
1.10 Work done during adiabatic change
1.11 Internal energy
1.11.1 Internal energy as state function
1.12 First law of thermodynamics
1.13 Reversible and Irreversible changes
Problems

2. Applied Thermodynamics — 9 Lectures

2.1 Conversion of heat into work and it's converse
2.2 Carnot's Cycle and Carnot's heat engine and it's efficiency
2.3 Second law of thermodynamics
2.4 Concept of entropy
2.4.1 Temperature - entropy (T-S) diagram
2.5 Free energy
2.6 Maxwell's Equations (with derivation)
2.7 TdS equations
2.8 Clausius - Clapeyron latent heat equations and its applications
Problems

3. Heat Transfer Mechanisms **9 Lectures**

3.1 Heat Engines
3.2 Otto cycle, Otto engine and its efficiency
3.3 Diesel cycle, diesel engine and its efficiency
3.4 Refrigerators: Principle, Cycle and coefficient of performance of refrigerator
3.5 Simple structure of Vapour compression refrigerator
3.6 Methods used to achieve low temperature
3.7 Criteria for refrigerants
3.8 Air Conditioning: Principle, working, factors affecting and its applications
Problems

4. Thermometry **8 Lectures**

4.1 Concept of heat and temperature
4.2 Concept of absolute zero
4.3 Principle of thermometry
4.4 Temperature scales and inter-conversions
4.5 Principle, Construction and Working: Liquid and Gas filled thermometers, Bimetallic thermometers, Platinum resistance thermometer, Thermocouple, Radiation Pyrometer)
Problems

Reference Books

1. Concept of Physics: H.C. Verma, Bharati Bhavan Publisher
2. Heat, Thermodynamics and Statistical Physics: Brij Lal, N. Subrahmanyam, S. Chand and Co. Ltd.
3. Heat and Thermodynamics: M.W. Zemansky, R.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 Pvt. Ltd., Calcutta
6. Instrumentation - Devices and Systems: C.S. Rangan, G.R. Mani and V.S. Sharma, Mc-Graw Hill

Course Code and Title: USPH-122 Electricity and Magnetism

Lectures: 36 (Credits-02)

Course Outcomes: After completion of the course, students would be able to:

1. Understand the basic concepts of electric and magnetic fields.
2. Understand the concept of conductors, dielectrics, inductance and capacitance.
3. Gain knowledge on the nature of magnetic materials.
4. Gain knowledge on electromagnetic induction and its applications.

1. Electrostatics **9 Lectures**

1.1 Concept of charge, Electric potential, Electric Field, Electrostatic energy, Electrostatic force
- 1.1.1 Coulomb's law
- 1.1.2 Energy of system of charges

1.2 Superposition principle
- 1.2.1 Statement
- 1.2.2 Explanation with illustration

1.3 Concept of electric flux

1.4 Gauss's law in electrostatics

Problems

2. Dielectrics **9 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 Capacitor and capacitance

2.8 Charging and discharging of capacitor

Problems

3. Transient Current **9 Lectures**

3.1 AC voltage applied to Resistor

3.2 AC voltage applied to Capacitor

3.3 AC voltage applied to Inductor

3.4 LR Circuit

3.5 LCR Series Circuit - Resonance and Q-factor

Problem

4. Magnetostatics and Magnetism **9 Lectures**

4.1 Biot-Savart's law

4.1.1 Long straight conductor
4.1.2 Circular Coil
4.2 Ampere's circuital law
4.4.1 Field of Solenoid
4.4.2 Field of Toroid
4.3 Gauss law for magnetism
4.4 Introduction to magnetization
4.5 Definitions
4.5.1 Magnetization (M)
4.5.2 Magnetic Intensity (H)
4.5.3 Magnetic Induction (B)
4.5.4 Magnetic Susceptibility (χ)
4.5.5 Magnetic Permeability (μ)
4.6 Types of Magnetic Materials
4.6.1 Diamagnetic materials
4.6.2 Paramagnetic materials
4.6.3 Ferromagnetic materials
4.6.4 Antiferromagnetic materials
Problems

References Books

1. Fundamentals of Physics: D. Halliday and R. Resnick and J. Walker, Wiley Publications
2. Electromagnetics: B.B. Laud, New Age International (P) Ltd.
3. Foundations of Electromagnetic Theory: J.R. Reitz, F.J. Milford and R.W. Christy, Prentice Hall
4. Electricity and Electronics: D.C. Tayal, Himalaya Publishing House, Mumbai
5. Introduction to Electrodynamics: D.G. Griffith, Pearson Publications
6. Electricity and Magnetism: Brij Lal, N. Subramanyan, Ratan Prakashan
7. Electricity and Magnetism: N.S. Khare and S.S. Shrivastav, Atmaram and Sons
8. Classical Electromagnetism: H.C. Verma, Bharati Bhavan Publishers

Course Code and Title: USPHP-123 Physics Laboratory 1B

(Credits-1.5)

Course Outcomes: After completion of the course, students would be able to:

1. Acquire skills in recognition and use of electronic components like resistor, capacitor.
2. Apply scientific procedures for performing experiments based on basic concepts of heat, electricity and magnetism.
3. Gain the knowledge about heat and radiation, thermodynamics, RTD etc.
4. Study of Carnot's cycle through graph plotting.

Note: Any four experiments from each section be conducted during the semester, with a total of **8** experiments.

Section I- Heat and Thermodynamics

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
8. Study of phase change of a given material

Section II- Electricity and Magnetism

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

Reference Books

1. Advanced Practical Physics for Students: B.L. Worsnop and H.T. Flint, Littlehampton Book Services Ltd.
2. Practical Physics: R.K. Shukla, A. Srivastava, New Age International (P) Ltd.