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

S.Y.B.Sc. (Physics)

Choice Based Credit System Syllabus

To be implemented from Academic Year 2023-2024

Eligibility for **S.Y.B.Sc. Physics:** 50% credits from F.Y.B.Sc.

Structure of the Course: S.Y.B.Sc. Physics

Year	Semester	Course Type	Course Code	Course Title	Remark	Credit	No. of Lectures /Practical to be conducted
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

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	2
I/II/III	**Additional Credits**			4
			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 **Four** additional credits to get the **B.Sc. Physics** degree.

SEMESTER-III

Course Code and Title: USPH-231 Mathematical Methods in Physics - I

Lectures: 36 (Credits-02)

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

1. Understand the application of complex number.
2. Know the role of partial differential equations in Physics.
3. Solve the vector algebra and vector analysis useful in Mathematics and Physics.
4. Evaluate the degree, order, linearity and homogeneity of differential equation.
5. Understand the concept of singular points of differential equations.

1. Complex Numbers: 10 Lectures

1.1 Introduction to complex numbers
1.2 Rectangular, polar and exponential forms of complex numbers
1.3 Argand diagram
1.4 Algebra of complex numbers using Argand diagram
1.5 De-Moivre's Theorem (Statement only)
1.6 Power, root and log of complex numbers
1.7 Trigonometric, hyperbolic and exponential functions
1.8 Applications of complex number
1.9 Numerical

2. Partial Differentiation: 10 Lectures

2.1 Definition of partial differentiation
2.2 Successive differentiation
2.3 Total differentiation
2.4 Exact differential
2.5 Chain rule
2.6 Theorems of differentiation
2.7 Change of variables from Cartesian to polar co-ordinates
2.8 Conditions for maxima and minima (without proof)
2.9 Numerical

3. Vector Algebra: 6 Lectures

3.1 Introduction to scalars and vectors, dot product and cross product of two vectors and their physical significance. (Revision)
3.2 Scalar triple product and its geometrical interpretation
3.3 Vector triple product and its proof
3.4 Numerical

4. Vector Analysis: 10 Lectures

4.1 Scalar and vector fields

4.2 Differentiation of vectors with respect to scalar
4.3 Vector differential operator and Laplacian operator
4.4 Gradient of scalar field and its physical significance
4.5 Divergence of scalar field and its physical significance
4.6 Curl of vector field and its physical significance
4.7 Vector Identities
- 4.7.1 $\nabla \times (\nabla \Phi) = 0$
- 4.7.2 $\nabla . (\nabla \times V) = 0$
- 4.7.3 $\nabla . (\nabla \Phi) = \nabla^2 \Phi$
- 4.7.4 $\nabla . (\Phi A) = \nabla \Phi . A + \Phi (\nabla . A)$
- 4.7.5 $\nabla \times (\Phi A) = \Phi (\nabla \times A) + (\nabla \Phi) \times A$
- 4.7.6 $\nabla . (A \times B) = B . (\nabla \times A) - A (\nabla \times B)$

4.8 Numerical

Reference Books

1. Mathematical Physics: H.K. Dass and Rama Verma, S. Chand
2. Mathematical Physics: B.D. Gupta, Vikas Publishing House Ltd.
3. Mathematical Physics: B.S. Rajput, Pragati Prakashan
4. Mathematical Methods in Physical Science: M. L. Boas, Wiley
5. Vector analysis: M.R. Spiegel, Schaum's Outline Series
6. Mathematical Methods for Physicists: G.B. Arfken and H.J. Weber, Elsevier Academic Press
7. Fundamentals of Mathematical Physics: A.B. Gupta, Books and Allied Ltd.
8. Vector Analysis: M.R. Spiegel, S.L. Lipschutz and D.S. Spellman, Schaum's Outline Series

Course Code and Title: USPH-232(A) Electronics

Total Lectures: 36 (Credits-02)

N.B: This course is for students **who have not taken Electronic Science as one of the subjects at F. Y. B. Sc.**

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

1. Apply different theorems and laws to electrical circuits.
2. Understand the working of transistor, it's characteristics and applications.
3. Know the applications of operational amplifiers.
4. Design circuits using transistors and applications of operational amplifiers.
5. Study the different Number systems, Logic circuits and Boolean algebra.

1. Network Theorem — 8 Lectures

1.1 Ohm's law and Kirchhoff's Laws
1.2 Voltage and Current Divider Circuit
1.3 Thevenin's Theorem
1.4 Norton's Theorem
1.5 Superposition Theorem
1.6 Maximum Power Transfer Theorem (with proof)
1.7 Numerical

2. Study of Transistor — 10 Lectures

2.1 Revision of Bipolar Junction Transistor, Types, Symbol and Basic action
2.2 Transistor Configuration (Common Base, Common Emitter and Common Collector)
2.3 Current Gain Factors (α and β) and their relations
2.4 Input and Output characteristics of CE Configuration
2.5 DC Load line (CE configuration), Operating Point (Q- point)
2.6 Transistor biasing, different biasing methods
2.7 Transistor as a switch
2.8 Numerical

3. Operational Amplifier and Oscillators — 10 Lectures

3.1 Introduction
3.2 Parameters of Op-Amp and characteristics of an Ideal Op-Amp
3.3 Operational Amplifier: IC-741- Block diagram and Pin diagram
3.4 Concept of Virtual Ground
3.5 Inverting and Non-inverting operational amplifiers and the concept of gain
3.6 Operational amplifier as an adder and subtractor
3.7 Concept of Positive and Negative Feedback
3.8 Barkhausen Criteria for an oscillator
3.9 Construction, working and application of Phase shift oscillator using IC-741

3.10 Numerical

4. Number System and Logic Gates **8 Lectures**

4.1 Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal
4.2 Addition and Subtraction of binary numbers and binary fractions using one's and two's complement.
4.3 Basic Logic gates (OR, AND, NOT)
4.4 Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table
4.5 Boolean Algebra
4.6 De Morgan's theorem and its verification
4.7 Numerical

Reference Books:

1. Electronic Principles: A.P. Malvino, Tata Mc-Graw Hills publication
2. Principles of Electronics: V.K. Mehta and R.V. Mehta, S. Chand and Co.
3. Op-amp and Linear Integrated Circuit: R.A. Gayakwad, Prentice-Hall of India Pvt. Ltd.
4. Integrated Circuit: K.R. Botkar, Khanna Publication, New Delhi
5. Digital Principles and Applications: D.P. Leach and A.P. Malvino, McGraw Hill Publication

Course Code and Title: USPH-232(B) Instrumentation

Total Lectures: 36 (Credits-02)

N.B: This course is for students **who have taken Electronic Science as one of the subjects at F. Y. B. Sc.**

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

1. Understand the concept of measurement.
2. Study the performance of measuring instruments.
3. Design the experiments using sensors.

1. Fundamentals of measurement — 8 Lectures

1.1 Aims of measurement
1.2 Functional elements of typical measurement system (Block diagram and its explanation)
1.3 Standards of measurement and its classification (International, primary or national, secondary and working standards)
1.4 Static characteristics: Accuracy, Precision, Sensitivity, Linearity, Resolution and Hysteresis
1.5 Dynamic characteristics concepts: First and Second order instruments, Example of first order: Resistance thermometer, Example of 2nd order: U–tube Manometer
1.6 Errors in measurement and its classifications
1.7 Numerical

2. Transducers — 12 Lectures

2.1 Classification of Transducers and its characteristics
2.2 Displacement Transducer
- 2.2.2 Resistive Type: Linear and Angular Potentiometer.
- 2.2.2 Inductive Type: Self inductive: Variable number of turns, Mutual Inductive: LVDT
- 2.2.3 Piezoelectric Type: Quartz Crystal

2.3 Force Transducer: Cantilever beam
2.4 Temperature Measurement
2.5 Temperature Measurement Techniques
- 2.5.1 Non-electrical: bimetallic thermometer
- 2.5.2 Electrical Methods
  - 2.5.2.1 Thermistor: PTC and NTC with characteristics
  - 2.5.2.2 Thermocouple: Seebeck effect and Peltier effect

3. Measurement of Pressure — 10 Lectures

3.1 Unit of pressure, Concept of vacuum, Absolute, gauge and differential pressure
3.2 Elastic Transducer- Bourdon Tube

3.3 Electric Type- Strain gauge
3.4 Pressure Transducer- Calibration by dead weight tester Method
3.5 Numerical

4. Signal Conditioning and Processing **6 Lectures**

4.1 Current to voltage, Voltage to current convertors
4.2 Buffer amplifier
4.3 Instrumentation Amplifier (Using 3 op-amp)

Reference Books

1. Instrumentation, Devices and Systems: C.S. Rangan, G.R. Mani and V.S. Sarma, Prentice Hall of India
2. Instrumentation, Measurement and System: B.C. Nakra and K.K. Chaudhary, McGraw Hill India
3. Sensors and Transducers, D. Patranabis, Pentice Hall of India Pvt. Ltd.
4. Op-Amps and Linear Integrated Circuits: R.A. Gayakwad, Prentice-Hall of India Pvt. Ltd.
5. Process Controlled Instrumentation: C.D. Johnson, Pearson Education Ltd.

Course Code and Title: USPHP-233 Physics Laboratory 2A

(Credits-02)

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

1. Use various instruments and equipment.
2. Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
3. Investigate the theoretical background of an experiment.
4. Enhance an experimental approach.
5. Analyze the data, plot appropriate graphs and reach conclusions from data analysis.
6. Work in a group to plan, implement and report on a project/experiment.
7. Keep a well-maintained and instructive laboratory logbook.

Note: Total Experiments: (A) 10 OR (B) 8 + Two Activities

(A) 5 experiments from Section-I and 5 experiments from Section-II

(B) 4 experiments from Section-I and 4 experiments from Section-II + Any Two Activities

Section-I: Electronics-I / Instrumentation (Any four)

1. Circuit Theorems (Thevenin's, Norton's and Maximum Power Transfer Theorems)
2. Transistor Characteristics (Input and Output characteristics of CE Configuration)
3. Transistor Amplifier
4. Zener as a Regulator (Line and Load Regulation)
5. Op-amp as inverting and non-inverting amplifier
6. Op-amp as an adder and subtractor
7. Study of logic gates and verification of de Morgan's theorems
8. Use of CRO (AC/DC Voltage measurement, Frequency measurement)
9. To measure force using load cell
10. To measure pressure using elastic diaphragm (In Variable Capacitor / Bourdon Tube)
11. To measure magnetic field using Hall Probe for a system of ring magnets

Section-II: Mathematical Methods of Physics based

1. Use of Computer: Plotting of various trigonometric functions using spread sheet/any graphic software viz. Microsoft Excel, Origin: sinx, cosx, tanx, e^{x}, e^{-x}, logx, lnx, x^{n}
2. Use of Computer: Plotting of conic sections using spreadsheet /any graphic software viz. Microsoft Excel, Origin: circle, ellipse, parabola, hyperbola
3. I Use of Computer: Inverse, determinant of matrix, solution of linear equations using Microsoft Excel or Origin software
4. Vector additions (PHET Animation)
5. Complex Numbers

Additional Activities (Any two)

1. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student)
2. Any two computer aided demonstrations (Using computer simulations or animations)
3. Demonstrations –Any two demonstrations
4. Study tour with report
5. Mini project

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.

Course Code and Title: USPH-241 Oscillations, Waves and Sound

Lectures: 36 (Credits-02)

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

1. To study underlying principles of oscillations and its scope in development.
2. To understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves.
3. To explain oscillations in terms of energy exchange with various practical applications.
4. To solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations.
5. To study characteristics of sound, decibel scales and applications.

1. Undamped Free Oscillations: **8 Lectures**

1.1 Different types of equilibria (static, dynamic, stable, unstable, and metastable equilibrium)
1.2 definitions only with examples
1.3 Linear Simple Harmonic Motion (S.H.M) and angular S.H.M.
1.4 Differential equation for linear S.H.M. and its solution
1.5 Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1 (analytical method)
1.6 Lissajous figures
1.7 Numerical

2. Damped Oscillations: **8 Lectures**

2.1 Introduction
2.2 Differential equation for damped harmonic oscillator and its solution, discussion of different cases
2.3 Logarithmic decrement
2.4 Average energy of damped harmonic oscillator
2.5 Quality factor
2.6 Application: LCR series circuit
2.7 Numerical

3. Forced Oscillations: **10 Lectures**

3.1 Introduction
3.2 Differential equation for forced oscillations and its solution
3.3 Resonance: Mechanical and Electrical
3.4 Velocity and Amplitude resonance
3.5 Sharpness of resonance and half width
3.6 Average energy of forced oscillator
3.7 Quality factor of forced oscillator

3.8 Relation between quality factor and bandwidth
3.9 Application of forced oscillations- LCR series circuit
3.10 Numerical

4. Wave Motion, Sound and Doppler Effect: 10 Lectures

4.1 Introduction
4.2 Revision of longitudinal and transverse waves
4.3 Seismic and gravitational waves (Qualitative discussion)
4.4 Definition of sound Intensity, Loudness, Pitch, Quality and Timbre
4.5 Reverberation time and reverberation of hall
4.6 Sabine's formula (without derivation)
4.7 Doppler Effect in sound, Expression for apparent frequency in different cases
4.8 Asymmetric nature of Doppler Effect in sound
4.9 Doppler Effect in light, Symmetric nature of Doppler Effect in light
4.10 Applications: Radar, Speed of distant star, Rotational speed of binary star, Red Shift and Width of spectral line
4.11 Numerical

Reference Books

1. Wave Physics – Ocsillations, Solutions, Chaos: Stephen Nettel, Springer
2. The Physics of Waves and Oscillations: N.K. Bajaj, Tata McGraw Hill
3. Fundamentals of Vibrations and Waves: S.P. Puri, Tata McGraw Hill
4. A Text Book of Sound: Brij Lal and N. Subramanyam, Vikas Publishing House
5. Light and Sound: M. Nelkon, Heinemann Edition, London
6. Waves and Oscillations: R.N. Chaudhari, New Age International Pvt. Ltd.
7. A Textbook on Oscillations, Waves and Acoustics: M. Ghosh and D. Bhattacharya, S. Chand

Course Code and Title: USPH-242 Optics

Lectures: 36 (Credits-02)

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

1. Acquire the basic concept of Ray and Wave optics.
2. Understand various types of aberrations and their minimization techniques.
3. Study the operation of many modern optical instruments.
4. Know optical phenomenon such Polarization, Diffraction and Interference in terms of the wave model and learn to analyse it.

1. Geometrical Optics and Lens Aberration — 10 Lectures

1.1 Thin lenses: Lens equation, Lens maker equation for convex lens
1.2 Concept of magnification, deviation and power of thin lens
1.3 Equivalent focal length of two thin lenses
1.4 Cardinal points
1.5 Types of aberration: Monochromatic and chromatic
1.6 Types of monochromatic aberrations and their reductions
1.7 Types of chromatic aberrations
1.8 Achromatism: lenses in contact and separated by finite distance
1.9 Numerical

2. Optical Instruments — 6 Lectures

2.1 Introduction
2.2 Terrestrial telescope, Magnifying Power of Terrestrial telescope
2.3 Ramsden's eye piece
2.4 Huygens eye piece
2.5 Numerical

3. Polarization — 8 Lectures

3.1 Introduction
3.2 Brewster's law
3.3 Law of Malus
3.4 Polarization by double refraction.
3.5 Huygen's Explanation of double Refraction
3.6 Nicol Prism
3.7 Numerical

4. Interference and Diffraction — 12 Lectures

4.1 Introduction to Interference
4.2 Phase change on reflection. (Stokes treatment)
4.3 Interference due to reflected light
4.4 Interference due to refracted light

4.5 Newton's ring
4.6 Introduction to Diffraction
4.7 Fresnel's and Fraunhofer's diffraction
4.8 Fraunhofer's diffraction at single slit
4.9 Fraunhofer's diffraction at double slit
4.10 Plane diffraction grating
4.11 Rayleigh criterion for resolution
4.12 Numerical

Reference Books

1. Optics: E. Hecht and A.R. Ganesan, Pearson
2. A Textbook of Optics: N Subhramanyam, Brij Lal and M.N. Avadhanulu, S. Chand Publication
3. Physical Optics: A.K. Ghatak, McMillan Publication Pvt, Ltd., New Delhi
4. Fundamental of Optics: F.A. Jenkins, H.E. White McGraw Hill Publication
5. Principles of Optics: D.K. Mathur, Gopal Press, Kanpur

Course Code and Title: USPHP-243 Physics Laboratory 2B

(Credits-02)

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

1. Use various instruments and equipment.
2. Design experiments to test a hypothesis and/or determine the value of an unknown quantity.
3. Investigate the theoretical background of an experiment.
4. Enhance an experimental approach.
5. Analyze the data, plot appropriate graphs and reach conclusions from data analysis.
6. Work in a group to plan, implement and report on a project/experiment.
7. Keep a well-maintained and instructive laboratory logbook.

Note: Total Experiments: (A) 10 OR (B) 8 + Two Activities

(A) 5 experiments from Section-I and 5 experiments from Section-II

(B) 4 experiments from Section-I and 4 experiments from Section-II + Any Two Activities

Section I: Oscillations, Waves and Sound

1. Logarithmic decrement (in air and water)
2. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient
3. 'g' by bar pendulum
4. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.)
5. Study of Lissajous's figures and determination of unknown frequency
6. Directional characteristics of Microphone
7. Velocity of sound by Phase shift method
8. To determine the velocity of sound in air at room temperature with Kundt's Tube

Section II: Optics

1. Newton's Ring: Determination of wavelength of monochromatic light source (λ)
2. Dispersive power of glass prism
3. Total internal reflection using LASER beam and glass prism
4. Diffraction at the edge of a razor blade
5. Optical activity of sugar solution using Polarimeter
6. To determine temperature of sodium flame
7. Double refracting prism
8. Determination of Cauchy's constant

Additional Activities (Any two)

1. Plotting of any two graphs using spreadsheets (of data obtained from various experiments performed by the student)

2. Any two computer aided demonstrations (Using computer simulations or animations)
3. Demonstrations –Any two demonstrations
4. Study tour with report
5. Mini project

Reference Books

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