M.C.E. Society's
Abeda Inamdar Senior College of Arts, Science and Commerce, Pune (Autonomous)

Three Year B. Sc. Degree Program in Physics

(Faculty of Science & Technology)

Syllabus under Autonomy for S. Y. B. Sc. (Physics)

Choice Based Credit System

Academic Year: 2022-2023

Structure of the course

Year	SEM	Course Type	Course Code	Course Name	Credit
2	III	Compulsory Course	21SBPH231	Mathematical Methods in Physics-I	2
	III	Compulsory Course	21SBPH232	Electronics	2
	III	Compulsory Course	21SBPH233	Physics Laboratory	2
	IV	Compulsory Course	21SBPH241	Oscillations, Waves, and Sound	2
	IV	Compulsory Course	21SBPH242	Optics	2
	IV	Compulsory Course	21SBPH243	Physics Laboratory	2

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Syllabus under Autonomy S. Y. B. Sc. (Physics)

Choice Based Credit System (Academic Year: 2022-2023)

SEMISTER-III

Course code and title: 21SBPH231: Mathematical Methods in Physics-I

Total Lectures: 36 (Credits-02)

Learning Outcomes: After the completion of this course students will be able to

- Understand the complex algebra useful in Physics courses.
- Understand the concept of partial differentiation.
- Understand the role of partial differential equations in Physics.
- Understand vector algebra useful in Mathematics and Physics.
- Understand the concept of singular points of differential equations.

1. Complex Numbers (9L)

1.1. Introduction to complex numbers
1.2. Rectangular, polar and exponential form of a complex numbers
1.3. Argand diagram
1.4. Algebra of complex numbers using Argand diagram
1.5. De-Moivre's Theorem:Statement
1.6. Eulers Formula
1.7. Power, root and logarithm of complex numbers
1.8. Trigonometric, hyperbolic and exponential functions
1.9. Application of Complex Numbers to determine velocity and acceleration
1.10. Problems.

2. Partial Differentiation (9L)

2.1. Definition of partial differentiation
2.2. Successive differentiation
2.3. Total differentiation
2.4. Exact differential
2.5. Chain rule
2.6. Linear approximation
2.7. Theorems of partial differentiation
2.8. Change of variables from Cartesian to Polar coordinates
2.9. Implicit and Explicit Functions
2.10. Conditions for maxima and minima (without proof)
2.11. Problems

3. Vector Algebra and Analysis(12L)

3.1. Revision of scalar and vector, dot and cross product of two vectors and their physical significance.
3.2. Scalar triple product and its geometrical interpretation
3.3. Vector triple product
3.4. Scalar and vector fields
3.5. Differentiation of vectors with respect to scalar
3.6. Vector differential operator and Laplacian operator
3.7. Gradient of scalar field and its physical significance
3.8. Divergence of scalar field and its physical significance
3.9. Curl of vector field and its physical significance.
3.10. Vector Identities

a. $\nabla X (\nabla\Phi) = 0$
b. $\nabla . (\nabla X V) = 0$
c. $\nabla . (\nabla\Phi) = \nabla^2\Phi$
d. $\nabla . (\Phi A) = \nabla\Phi . A + \Phi (\nabla . A)$
e. $\nabla X (\Phi A) = \Phi (\nabla X A) + (\nabla\Phi) X A$
f. $\nabla . (AXB) = B.(\nabla XA) - A (\nabla X B)$

3.11 Problems

4. Differential Equations (6L)

4.1. Definition of ordinary and partial differential equations

4.2. Frequently occurring partial differential equations (Cartesian Co-ordinates)
4.3. Terminology used in differential equations :Degree, order, linearity and non-linearity, homogeneity and non-homogeneity of a differential equation.
4.4. Concept of Singular point and types of singuiarity
4.5. Example of singular points ($x = 0$, $x = x_0$ and $x = \infty$) of differential equation.
4.6. Problems

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir.
2. Mathematical Physics by B.D.Gupta.
3. Mathematical Physics by Rajput and Gupta.
4. Mathematical Methods in Physical Science by Mary and Boas.
5. Vector analysis by Spiegel and Murrey.
6. Mathematical Methods for Physicists by Arfkenand Weber. (5^{th}Edition)
7. Fundamentals of Mathematical Physics by A.B.Gupta.
8. Vector Analysis by Seymour Lipschutz and Dennis Spellman.

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Syllabus under Autonomy S. Y. B. Sc. (Physics)

Choice Based Credit System Syllabus

Academic Year (2022-2023)

SEMISTER-III

Course code and title: 21SBPH232: Electronics

Total Lectures: 36 (Credits-02)

Learning outcomes: On successful completion of this course the students will be able to

- Apply different theorems and laws to electrical circuits.
- Understand the relations in electricity.
- Understand the parameters, characteristics and working of transistors.
- Understand the functions of operational amplifiers.
- Design circuits using transistors and operational amplifiers.
- Understand the Boolean algebra and logic circuits.

1. **Circuit Elements and Network Theorems (6L)**
   - **1.1.**Kirchhoff's Law
   - **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.**Rectifier (HW/FW/Bridge)
   - **1.8.**Problems

2. **Study of Transistor (9L)**
   - **2.1.**Bi-junction Transistor
   - **2.2.**Revision of bipolar Junction Transistor, Types, Symbol and basic action.
   - **2.3.**Configuration (Common Base, Common Emitter and Common Collector)
   - **2.4.**Current Gain Factors (α and β) and their relations
   - **2.5.**Input, Output and transfer Characteristic of CE Configuration
   - **2.6.**Biasing method and Voltage Divider
   - **2.7.**Problems

3. **Operational Amplifiers and Application (12L)**
   - **3.1.** Introduction
   - **3.2.** Ideal and practical Characteristics
   - **3.3.** Operational Amplifier: IC741- Block Diagram and Pin diagram
   - **3.4.** Concept of Virtual Ground
   - **3.5.** Inverting and Non-inverting operational amplifiers with concept of gain
   - **3.6.** Operational amplifier as an Adder and Subtractor.
   - **3.7.** Oscillators
   - **3.8.** Concept of Positive and negative feed back
   - **3.9.** Barkhaunsen's Criteria for an oscillator
   - **3.10.** Construction, working and application of phase shift oscillator using IC741
   - **3.11.** Problems

4. **Number System and Logic Gates (6L)**
   - **4.1.** Number System: Binary, Binary coded Decimal (BCD), Octal, Hexadecimal
   - **4.2.** Basic Logic gates (OR, AND, NOT)
   - **4.3.** Derived gates: NOR, NAND, EXOR, EXNOR, with symbols and truth table
   - **4.4.** Boolean Algebra
   - **4.5.** De Morgan's theorem and its verification
   - **4.6.** Problems

5. **Arithmetic circuits and Memory(3L)**
   - **5.1.** Binary addition and Binary subtraction
   - **5.2.** 2's complement (positive and negative numbers)
   - **5.3.** Arithmetic building blocks: Half and Full Adders
   - **5.4.** Memory and its Characteristics
   - **5.5.** Types of memory
   - **5.6.** Problems

Reference Books:

1. **Electronic Principles**, Malvino, 7th Edition Tata Mc-Graw Hills publication.
2. **Principles of Electronics**, V.K. Mehta, S. Chand publication.
3. **Op-amp and Linear Integrated Circuit**, Ramakant Gaikwad, Prentice Hall of India publication.
4. **Integrated Circuit,** Botkar, Khanna Publication, New Delhi.
5. **Digital Principles and Application**, 6th Edition, Malvino and Leech, Tata Mc-Graw Hills publication.

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Choice Based Credit System Syllabus
Academic Year (2022-2023)

SEMISTER-III

Course code and title: 21SBPH233: Practical Course (Credits-2)

Learning Outcome: After completing this practical course students will be able to

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

Total Experiments to be performed by a student must include atleast six experiments from Section I and twoexperiments from Section II so as to complete: (A) **10 Experiments** OR(B) **8 Experiments + Two Activities**

Section I: Electronics

1. Circuit Theorems (Thevenin's, Norton's and Maximum Power Transfer Theorems)
2. Transistor Characteristics (Input, Output and transfer characteristics of CE Configuration)
3. Single Stage Transistor Amplifier
4. Study of Rectifiers (Half Wave, Full Wave and Bridge) with different filters

5. Zener diode as a Regulator (Line and Load Regulation)
6. Op-amp as inverting and non-inverting amplifier
7. Study of Wein Bridge / Phase Shift Oscillator using IC741
8. Op-amp as an adder and subtractor
9. Study of logic gates and verification of de Morgan's theorems
10. Use of CRO(AC/DC Voltage measurement, Frequency measurement)

Section II: Use of Computer

1. Plotting of various trigonometric functions: sin(x), cos(x), tan(x), ex, e^{-x}, log(x), ln(x), x^n etc. using spread sheet/any graphic software viz. Microsoft Excel or Origin.
2. Plotting of conic sections: circle, ellipse, parabola, hyperbola using spreadsheet /any graphic software viz. Microsoft Excel or Origin.
3. Finding Inverse, determinant of matrix, solution of linear equations using Microsoft Excel or Origin software.

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

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Choice Based Credit System Syllabus
Academic Year (2022-2023)

SEMISTER-IV

Course code and title:21SBPH241: Oscillations, Waves, and Sound

Total Lectures: 36 (Credits-02)

Learning Outcomes:
On completion of this course, the learner will be able:

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

1. Undamped Free Oscillation (7L)

1.1. Different types of equilibria (static, dynamic, stable, unstable and metastable equilibrium) – definitions only with examples.
1.2. Definitions of linear Simple Harmonic Motion (S.H.M) and angular S.H.M.
1.3. Differential equation for linear S.H.M. and it's solution.
1.4. Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1 (analytical method).
1.5. Lissajous' figures, their demonstration (optical and electrical method) and applications.
1.6. Problems.

2. Damped Oscillations (7L)

2.1. Introduction
2.2. Differential equation for damped harmonic oscillator and it's 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. Problems.

3. Forced Oscillations (8L)

3.1. Introduction.
3.2. Differential equation for forced oscillations and itssolution.
3.3. Resonance: mechanical, acoustic 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. Examples/Demonstration of forced Oscillations
3.10. Application of forced oscillations- LCR series circuit.
3.11. Problems

4. Wave Motion (6L)

4.1. Introduction.
4.2. Equation for longitudinal waves and its solution (one dimension only).
4.3. Equation for transverse waves and its solution (one dimension only).
4.4. Energy density and intensity of a wave.
4.5. Doppler effect
4.6. Symmetric and Asymmetric nature of Doppler effect
4.7. Applications: Radar, Speed of distant star, Rotational speed of binary star, Red Shift and Width of spectral line.
4.8. Problems.

5. Sound and Doppler Effect (8L)

5.1. Definition of sound Intensity, Loudness, Pitch, Quality, and timbre.
5.2. Reverberation time and reverberation of hall.
5.3. Newton's formula for velocity of Sound
5.4. Effect of Pressure, Humidity and temperature on velocity of sound.
5.5. Velocity of sound in water, isotropic solids

5.6. Wave velocity and molecular velocity
5.7. Problems.

Reference Books:

1. Waves and Oscillations by Stephenson.
2. The Physics of Waves and Oscillations by N. K. Bajaj, Tata McGraw-Hill, publication.
3. Fundamentals of Vibrations and Waves by S. P. Puri, Tata McGraw-Hill publication.
4. Waves and Oscillations Second revised edition, Subramanyam and Brijlal, Vikas Prakashan.
5. Sound by Mee, Heinmann Edition, London.
6. Waves and Oscillations - R.N. Chaudhari, New Age International (p) ltd.
7. A Textbook on Oscillations, Waves and Acoustics by M. Ghosh, and D. Bhattacharya, S. Chand and Company Ltd.

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Choice Based Credit System Syllabus
Academic Year (2022-2023)

Course code and title: 21SBPH232: Optics

Total Lectures: 36 (Credits-02)
Learning Outcomes:

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

- Acquire the basic concept of wave optics.
- Describe how light can constructively and destructively interfere.
- Explain why a light beam spread out after passing through an aperture
- Summarize the polarization characteristics of electromagnetic wave
- Understand the operation of many modern optical devices that utilize wave optics
- Understand optical phenomenon such polarization, diffraction and interference in terms of the wave model
- Analyze simple examples of interference and diffraction.

1. **Geometrical Optics (8L)**
   1.1. Introduction to lenses and sign conventions.
   1.2. Thin lenses: lens equation for convex lens
   1.3. Lens maker equation
   1.4. Concept of magnification, deviation and power of thin lens
   1.5. Equivalent focal length of two thin lenses
   1.6. Concept of cardinal points
   1.7. Problems

2. **Lens Aberrations (8L)**
   2.1. Introduction
   2.2. Types of aberration: Monochromatic and chromatic
   2.3. Types of monochromatic aberrations and their reductions
   2.4. Types of chromatic aberrations
   2.5. Achromatism: lenses in contact and separated by finite distance
   2.6. Problems

3. **Optical Instruments (6L)**
   3.1. Introduction
   3.2. Simple Microscope
   3.3. Compound Microscope
   3.4. Ramsden's eye piece
   3.5. Huygens eye piece
   3.6. Problems

4. **Interference and Diffraction (8L)**
   4.1. Introduction
   4.2. Phase change on reflection. (Stokes treatment)
   4.3. Interference due to wedge shaped thin film
   4.4. Newton's ring
   4.5. Diffraction types: Fresnel's diffraction and Fraunhofer's diffraction
   4.6. Fraunhofer's diffraction at single slit
   4.7. Plane diffraction grating, Rayleigh criterion for resolution
   4.8. Problems

5. **Polarization (6L)**
   5.1. Introduction
   5.2. Brewster's law
   5.3. Law of Malus
   5.4. Polarization by double refraction.
   5.5. Nicol's Prism
   5.6. Problem

Reference Books:

1. **Optics** by A. R. Ganesan, IVth edition, Pearson Education, E. Hetch.
2. **A Textbook of Optics** by N Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand Publication
3. **Physical Optics** by A.K. Ghatak, McMillan, New Delhi
4. **Fundamental of Optics** by F. A.Jenkins, H. E.White Mc Graw-Hilll International edition
5. **Principles of Optics**, by D. S. Mathur, Gopal Press, Kanpur.

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Choice Based Credit System Syllabus
Academic Year (2022-2023)

Course code and title:SBPH410: Practical Course

Learning Outcome:(Credits-2)

After completing this practical course students will be able to

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

Total number of experiments to be performed by a student:

(A) 10 Experiments comprising of 5 experiments from Section I and Section II each

OR

(B) 8 Experiments comprising of 4 experiments from Section I and Section II each + **Any two additional activities**

Section I: Oscillations, Waves and Sound

1. Study of coupled oscillators comprising two simple pendulum (Mechanical) and determination of coupling coefficient.

2. Measurement of coefficient of absorption of sound for different materials (cork, thermocol, mica, paper etc.).
3. Study of Lissajous figures and determination of unknown frequency.
4. Determination of speed of sound by Quincke's method interferometer.
5. Directional characteristics of Microphone.
6. Velocity of sound by Phase shift method.
7. To determine the frequency of an electrically maintained tuning fork by stroboscopic method.
8. To Determine the velocity of sound in air at room temperature with Kundt's Tube.
9. 'g' by bar pendulum.

Section II: Optics

1. Newton's Ring: Determination of wavelength (λ) of monochromatic light source.
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. Goniometer to determine cardinal points and focal length.
7. To determine temperature of sodium flame.
8. Double refracting prism.
9. 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.