Syllabus of Physics for B. Sc. Pass Course
**Syllabus of Physics for B. Sc. (Pass Course)**

**Course Structure**

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Semester</th>
<th>Paper</th>
<th>Contact Hours (Per Week)</th>
<th>Credits (Per Paper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I</td>
<td>PH 1: Mathematical Physics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 2: Waves and Oscillations</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>II</td>
<td>PH 3: Thermodynamics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 4: Optics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-2</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>III</td>
<td>PH 5: Mechanics &amp; Properties of Matter</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 6: Electromagnetism</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-3</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>IV</td>
<td>PH 7: Special Theory of Relativity</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 8: Solid State Physics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-4</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>V</td>
<td>PH 9: Quantum Mechanics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 10: Electronics: Solid State Electronic Devices</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-5</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>VI</td>
<td>PH 11: Nuclear and Particle Physics</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PH 12: Elective Paper</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Physics Lab-6</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td><strong>30</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Elective Paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EL1: Computational Physics</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EL2: Digital Electronics</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EL3: Statistical Mechanics</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>EL4: Atomic &amp; Molecular Spectroscopy</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
PH-01: Mathematical Physics-I

Credit-I


Credit- II


Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).


Suggested Books:
PH 02: Oscillations & Waves

Credit-I


Credit-II


Suggested Books:
Physics Lab I

Total Credit(s): 1

1: General
(1) To use a Multimeter for measuring (a) Resistances, (b) A/C and DC Voltages, (c) AC and DC Currents, (d) Capacitances, and (e) Frequencies.
(2) To test a Diode and Transistor using (a) a Multimeter and (b) a CRO.
(3) To measure (a) Voltage, (b) Frequency and (c) Phase Difference using a CRO.
(4) To study Random Errors.
(5) To determine the Height of a Building using a Sextant.
(6) To study the Characteristics of a Series RC Circuit.

2: Mechanics
(1) To determine the Moment of Inertia of a Flywheel.
(2) To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille’s method).
(3) To determine the Young's Modulus.
(4) To determine the Modulus of Rigidity of a Wire by Maxwell’s needle.
(5) To determine the Elastic Constants of a Wire by Searle’s method.

Note
- Students are required to perform at least 8 Practicals by taking at least 3 from each group.

Suggested Books:
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
PH 03: Thermodynamics

**Credit-I**


(15 Lectures)

**Credit-II**

**Kinetic Theory of Gases**


**Molecular Collisions:** Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.


(15 Lectures)

**Suggested Books:**
PH 04: Optics

Credit-I


Diffraction: Fresnel diffraction: Fresnel’s Assumptions. Fresnel’s Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Comparison of a Zone plate with a Convex lens. Diffraction due to (1) a Straight Edge and (2) a Rectangular Aperture (Slit), (3) a Small Circular Aperture and (4) an Opaque Circular Disc. Fresnel’s Integrals, Cornu’s Spiral: Fresnel Diffraction Pattern due to (1) a Straight Edge, (2) a Slit, and (3) a Wire (Qualitatively using Cornu’s Spiral).

Fraunhofer diffraction: Diffraction due to (1) a Single Slit, (2) a Double Slit and (3) a Plane Transmission Grating. Rayleigh’s criterion of resolution. Resolving Power and Dispersive Power of a Plane Diffraction Grating.

Credit-II

Coherence: Spatial and temporal coherence, Coherence length, Coherence time. Q- factor for LASER. Visibility as a Measure of Coherence. Spatial Coherence and Size of the Source. Temporal Coherence and Spectral Purity.


Suggested Books:
Physics Lab II

Total Credit(s): 1

1: Experiments with Compound Pendulums
(1) To determine g by Bar Pendulum.
(2) To determine g by Kater’s Pendulum.

2: Experiments with Springs
(1) To study the Motion of a Spring and determine (a) Spring Constant (b) Value of g, and
    (c) Modulus of Rigidity
(2) To investigate the Motion of Coupled Oscillators.

3: Experiments with Resistance
(1) To determine a Low Resistance by Carey Foster’s Bridge.
(2) To determine a Low Resistance by a Potentiometer.
(3) To determine High Resistance by Leakage of a Capacitor.

4: Experiments with Capacitance
(1) To determine the Ratio of Two Capacitances by de Sauty’s Bridge.
(2) To determine the Dielectric Constant of a Dielectric placed inside a parallel plate capacitor
    using a B.G.

5: Experiments to understand Self & Mutual Inductance
(1) To determine Self Inductance of a Coil by Anderson’s Bridge using AC
(2) To determine Self Inductance of a Coil by Rayleigh’s Method.
(3) To determine the Mutual Inductance of Two Coils by Absolute method using a B.G.

6: Experiments with A.C. Circuits
(1) To study response curve of a Series LCR circuit and determine its (a) Resonant Frequency,
    (b) Impedance at Resonance and (c) Quality Factor Q, and (d) Band Width.
(2) To study the response curve of a Parallel LCR circuit and determine its (a) Anti-Resonant
    Frequency and (b) Quality Factor Q.

Note
• Each Student is required to perform at least 8 Practicals by taking at least 1 practical
  from each unit.

Text and Reference Books
2. B. L. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New
   Delhi.
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
4. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani
   Publication House, New Delhi.
PH 05: Mechanics

Credit-I


Elastic and Inelastic Collisions between particles. Centre of Mass and Laboratory Frames.


Elasticity: Relation Between Elastic Coefficients. Twisting Torque on a Cylinder or Wire.


(15 Lectures)

Credit-II


(15 Lectures)

Suggested Books:
2. Charles Kittel, Walter Knight, Malvin Ruderman, Carl Helmholtz, Burton Moyer, Mechanics Berkeley physics course.
PH 06: Electricity and Magnetism

Credit-I


(15 Lectures)

Credit-II


(15 Lectures)

Suggested Books:
4. David J. Griffiths, Introduction to Electrodynamics, Benjamin Cummings, 1998 (Also, PHI).
Physics Lab III

Total Credit(s): 1

1: Experiment on Mechanical Equivalent of Heat
   To determine J by Callender and Barne’s constant flow method.

2: Experiments on Thermal Conductivity
   (1) To determine the Coefficient of Thermal Conductivity of Copper by Searle’s Apparatus.
   (2) To determine the Coefficient of Thermal Conductivity of Copper by Angstrom’s Method.
   (3) To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton’s disc method.

3: Experiments with Resistance and Temperature Devices
   (1) To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
   (2) To calibrate a Resistance Temperature Device (RTD) to measure temperature in a specified range using Null Method/ Off-Balance Bridge with Galvanometer based Measurement.

4: Experiments with Thermocouples
   (1) To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
   (2) To Calibrate a Thermocouple to measure Temperature in a Specified Range using (1) Null Method (2) Direct Measurement using an Op-Amp Difference Amplifier and to determine Neutral Temperature.

Note
- Each student is required to perform at least 6 experiments with at least 1 experiment from each unit.

Text and Reference Books
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
PH 07: Special Theory of Relativity

Credit-I

Tensors

Michelson-Morley Experiment and its Outcome.


Credit-III

Bucherer’s experiment. Segnac’s experiment.

Suggested Books

1. David J. Griffiths, Introduction to Electrodynamics, Benjamin Cummings, 1998 (Also, PHI).
PH 08: Solid State Physics

Credit-I


(15 Lectures)

Credit-II


(15 Lectures)

**Reference Books**
Physics Lab IV

Total Credit(s): 1

1: Experiments on Reflection, Refraction and Dispersion
(1) To determine the Refractive Index of the Material of a given Prism using Mercury Light.
(2) To determine the Refractive Index of a Liquid by Total Internal Reflection using Wollaston’s Air-film.
(3) To determine the Refractive Index of (1) Glass and (2) a Liquid by Total Internal Reflection using a Gaussian Eyepiece.
(4) To determine the Dispersive Power of the Material of a given Prism using Mercury Light.
(5) To determine the value of Cauchy Constants.
(6) To determine the Resolving Power of a Prism.

2: Experiments on Interference
(1) To determine wavelength of sodium light using Fresnel Biprism.
(2) To determine wavelength of sodium light using Newton’s Rings.
(3) To determine the Thickness of a Thin Paper by measuring the Width of the Interference Fringes produced by a Wedge-Shaped Film.
(4) To determination Wavelength of Sodium Light using Michelson’s Interferometer.

3: Experiments on Diffraction
(1) To determine the Diameter of a Thin Wire by studying the Diffraction Produced by it.
(2) To determine the wavelength of Laser light using Diffraction of Single Slit.
(3) To determine the wavelength of (1) Sodium and (2) Mercury Light using Plane Diffraction Grating.
(4) To determine the Dispersive Power of a Plane Diffraction Grating.
(5) To determine the Resolving Power of a Plane Diffraction Grating.
(6) To determine the (1) Wavelength and (2) Angular Spread of He-Ne Laser using Plane Diffraction Grating.
(7) To study the Polarization of Light by Reflection and to determine the Polarizing Angle for air- glass interface.
(8) To measure the Intensity using Photosensor and Laser in diffraction patterns of single and double slits.

Note
- Students are required to perform 8 experiments with at least 2 experiments from each unit.

Text and Reference Books
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
PH 09: Quantum Mechanics

Credit-I


Quantum Mechanics


Credit-II

Applications of Schrödinger Wave Equation:
Eigen Functions and Eigenvalues for a Particle in a One Dimensional Box.


Suggested Books:
2. E. Merzbacher, Quantum Mechanics, 3rd edition, (John Wiley & Sons, Inc1997)
**PH 10: Electronics: Solid State Electronic Devices**

**Credit-I**

**Circuit Analysis:** Kirchhoff’s Laws, Mesh and Node Analysis of dc and ac Circuits, Duality in Networks, Network Theorems. Norton’s Theorem. Thevenin’s Theorem. Equivalent Star (T) and delta (π) Networks of a Given Network, Star to Delta and Delta to Star Conversion. Wheatstone Bridge and its Applications to Wein Bridge and Anderson Bridge.


**Two-terminal Devices and their Applications:** (1) Rectifier Diode. Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency. Qualitative idea of C, L and π - Filters. (2) Zener Diode and Voltage Regulation. (3) Photo Diode, (4) Tunnel Diode, (5) LED (6) Varactor Diode. **(15 Lectures)**

**Bipolar Junction transistors:** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α, β and γ and Relations between them. Load Line Analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff, and Saturation Regions. Transistor in Active Region and Equivalent Circuit. **(15 Lectures)**

**Credit-III**


**Suggested Books:**
Physics Lab V

Total Credit(s): 1

1: Experiments for Determination of Fundamental Constants
(1) To determine the value of Boltzmann Constant by studying Forward Characteristics of a Diode.
(2) To determine the value of Planck’s Constant using a Photoelectric Cell.
(3) To determine the value of Planck’s Constant using LEDs of at least 4 Different Wavelengths.

2: Experiments on Atomic & Molecular Physics
(1) To determine the value of e/m by (a) Magnetic Focussing or (b) Bar Magnet to determine the wavelengths of Hydrogen spectrum and hence to determine the value of Rydberg’s Constant.
(2) To determine the Wavelength of H-alpha Emission Line of Hydrogen Atom.
(3) To determine the Absorption Lines in the Rotational Spectrum of Iodine Vapour.

3: Miscellaneous
(1) To determine the Wavelength and the Angular Spread of a He-Ne Laser.
(2) To determine the value of Stefan’s Constant.

Note
- Each Student is required to perform 6 experiments with at least 1 experiment from each unit.

Text and Reference Books
3. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi.
PH 11: Nuclear & Particle Physics

Credit-I


β-decay: Energy Spectra and Neutrino Hypothesis.

γ-decay: Origin of γ-rays, Nuclear Isomerism and Internal Conversion.


Credit-II

Accelerators: Van de Graaff Generator, Linear Accelerator, Cyclotron, Betatron and Light and Heavy Ion Synchro-Cyclotron. Idea of Large Hadron Collider.


Suggested Books:
PH12: Elective Paper

One has to choose one of the following four elective papers

Elective 1: Computational Physics

Exercises to understand any five of the following problems:

Credit-I

(i) Solving differential equations
(ii) Evaluating integrals
(iii) Stochastic methods, especially Monte Carlo methods
(iv) Specialized partial differential equation methods, for example the finite difference method and the finite element method
(v) The matrix eigen value problem – the problem of finding eigen values of very large matrices, and their corresponding eigenvectors (eigen states in quantum physics).

Credit-II

(vi) Understanding Molecular dynamics by computational means.
(vii) Understanding Computational fluid dynamics
(viii) Understanding Computational Magneto-hydrodynamics

Suggested Books:

Elective 2: Digital Electronics

Credit-I


Credit-II


Suggested Books:
Elective 3: Statistical Mechanics

Credit-I


Credit-II

Quantum Theory of Radiation


Suggested Books:

2. S.Lokanathan and R.S. Gambhir, Statistical and Thermal Physics: An introduction PHI.
Elective 4: Atomic and Molecular Spectroscopy

Credit-I
Determination of e/m of the Electron. Thermionic Emission. Isotopes and Isobars.


**Atoms in External Magnetic Fields:** Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Credit-II


**Suggested Books:**

3. Ghatak and Thyagarajan, Optoelectronics, Oxford University Press.
Physics Lab VI

Total Credit(s): 1

1: Experiments on Nuclear Detectors
(1) To study GM characteristics and determine slope of the plateau of GM tube.
(2) To study random behaviour of nuclear phenomena.
(3) To determine the attenuation coefficient using Gama radiations.

2: Combinational Logic
(1) To verify and design AND, OR, NOT and XOR gates using NAND gates.
(2) To design a combinational logic system for a specified Truth Table.
(3) To convert a Boolean Expression into Logic Gate Circuit and assemble it using logic gate ICs.
(4) To minimize a given Logic Circuit.

3: Multivibrators and Sweep Circuits
(1) To study the characteristics of a UJT and design a simple Relaxation Oscillator.
(2) To design an Astable Multivibrator of given specifications using 555 Timer.
(3) To design a Monostable Multivibrator of given specifications using 555 Timer and to measure the Pulse-Width of its output.
(4) To design a Sweep of given Amplitude and Time.

2: Modulation
(1) To study Amplitude Modulation using Transistor.
(2) To study Pulse Width / Pulse Position and Pulse Amplitude Modulation using ICs.

Note
- Each student is required to perform at least 8 experiments with at least 1 experiment from each unit.