BSc Physics (Regular) Syllabus (CBCS)

Revision Cycle 1.0, May 2019

Physics Department, Gauhati University
WEB : https://gauhati.ac.in
GUWEB : http://web.gauhati.ac.in/syllabus

BSc Physics (Regular) Syllabus (CBCS)
physics@gauhati.ac.in

May 2019

Legends : L - Lecture P - Practical H - Home Assignments T - Tutorial

Course Structure for BSc in Physics (Regular) under CBCS

May 2019

Semester	Type	Core	AECC	SEC	DSE
	Credits	12 × 6 = 72	2 × 4 = 8	4 × 4 = 16	6 × 6 = 36
I		PHY-RC-1016	ENG-AE-1014		
		-			
		-			
II		PHY-RC-2016	ENV-AE-1014		
		-			
		-			
III		PHY-RC-3016		PHY-SE-3XX4	
		-			
		-			
IV		PHY-RC-4016		PHY-SE-4XX4	
		-			
		-			
V				PHY-SE-5xx4	PHY-RE-5XX6
					-
					-
VI				PHY-SE-6XX4	PHY-RE-6XX6
					-
					-

Legends

RC : Core Papers
RE : Discipline Specific Elective Papers
SE : Skill Enhancement Papers

List of Papers

Core Papers

1. PHY-RC-1016 : Mechanics (PHY-HG-1016)
2. PHY-RC-2016 : Electricity, Magnetism (PHY-HG-2016)
3. PHY-RC-3016 : Thermal Physics & Statistical Mechanics (PHY-HG-3016)
4. PHY-RC-4016 : Waves & Optics (PHY-HG-4016)

Discipline Specific Elective Papers

1. PHY-RE-5016 : Experimental Techniques (PHY-HE-5016)
2. PHY-RE-5026 : Embedded Sys : Introduction to Microcontrollers (PHY-HE-5026)
3. PHY-RE-5036 : Advanced Mathematical Physics I (PHY-HE-5036)
4. PHY-RE-5046 : Physics of Devices and Instruments (PHY-HE-5046)
5. PHY-RE-6016 : Communication Electronics (PHY-HE-6016)
6. PHY-RE-6026 : Digital Signal Processing (PHY-HE-6026)
7. PHY-RE-6036 : Advanced Mathematical Physics II (PHY-HE-6036)
8. PHY-RE-6046 : Biophysics (PHY-HE-6046)
9. PHY-RE-6056 : Astrophysics (PHY-HE-6056)

Skill Based Papers

10. PHY-SE-3014 : Renewable Energy and Energy Harvesting (PHY-SE-3014)
11. PHY-SE-4014 : Basic Instrumental Skill (PHY-SE-4014)
12. PHY-SE-5XX4
13. PHY-SE-6XX4

Note : ***(a) The details of the DSE and SEC papers will be given later.***

(b) The courses given in Red colour are equivalent in content to the corresponding courses given alongside.

(c) In the Lab classes, wherever applicable, students and instructors can use either of C, C++, FORTRAN 90/95, Matlab, Scilab, or Python environment.

Course Pre-Requisites

1. Physics Regular Course : Physics and Mathematics in Class XII (or equivalent)

Paper Pre-Requisites

1. PHY-HG-1016 2. PHY-HG-2016 3. PHY-HG-3016 4. PHY-HG-4016	Physics in Class XII (or equivalent)
5. PHY-HE-5016 / PHY-RE-5016 6. PHY-HE-5026 / PHY-RE-5026 7. PHY-HE-5036 / PHY-RE-5036 8. PHY-HE-5046 / PHY-RE-5046	PHY-HG-1016, 2016, 3016, 4016 or PHY-RC-1016, 2016, 3016, 4016
9. PHY-HE-6016 / PHY-RE-6016 10. PHY-HE-6026 / PHY-RE-6026 11. PHY-HE-6036 / PHY-RE-6036 12. PHY-HE-6046 / PHY-RE-6046	All earlier Pre-Requisites & PHY-HE-5016, 5016, 5016, 5016 or PHY-RE-5016, 5016, 5016, 5016

Contents

Part I

Core Papers

1

PHY-RC-1016 (PHY-HG-1016) Mechanics

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

1.1 Theory

1.1.1 Unit I : *Vectors* (Lectures 06)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. (4 Lectures) Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

1.1.2 Unit II : *Laws of Motion* (Lectures 10)

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

1.1.3 Unit III : *Momentum and Energy* (Lectures 06)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

1.1.4 Unit IV : *Rotational Motion* (Lectures 05)

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

1.1.5 Unit V : *Gravitation* (Lectures 07)

Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).

1.1.6 Unit VI : *Oscillations* (Lectures 07)

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Compound pendulum.

1.1.7 Unit VII : *Elasticity* (Lectures 08)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – q, η and σ by Searles method.

1.1.8 Unit VII : *Special Theory of Relativity* (Lectures 07)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

1.2 Lab

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g.

Reference Books

[1] An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.

[2] Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.

[3] Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

[4] Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.

[5] Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[6] Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

[7] University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

[8] Mechanics, D. S. Mathur, S. Chand and Company Limited, 2000

[9] University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley

[10] Physics for Scientists and Engineers with Modern Phys., J. W. Jewett, R. A. Serway, 2010, Cengage Learning

[11] Theoretical Mechanics, M. R. Spiegel, 2006, Tata McGraw Hill.

2

PHY-RC-2016 (PHY-HG-2016) Electricity & Magnetism

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

2.1 Theory

2.1.1 Unit I : *Vector Analysis* (Lectures 12)

Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

2.1.2 Unit II : *Electrostatics* (Lectures 22)

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem – Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

2.1.3 Unit III : *Magnetism* (Lectures 10)

Magnetostatics: Biot-Savart's law & its applications – straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia, para, and ferro-magnetic materials.

2.1.4 Unit IV : *Electromagnetic Induction* (Lectures 06)

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

2.1.5 Unit V : *Maxwell's Equations and EM Wave* (Lectures 10)

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

2.2 Lab

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer
   (a) Measurement of charge and current sensitivity
   (b) Measurement of CDR
   (c) Determine a high resistance by Leakage Method
   (d) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q .
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem.
10. To verify the Superposition, and Maximum Power Transfer Theorem.

Reference Books

[1] Electricity, Magnetism and Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

[2] Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

[3] Introduction to Electrodynamics, D. J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.

[4] Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education

[5] Elements of Electromagnetics, M. N. O. Sadiku, 2010, Oxford University Press.

[6] Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

3

PHY-RC-3016 (PHY-HG-3016)
Thermal Physics & Statistical Mechanics

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

3.1 Theory

3.1.1 Unit I : *Laws of Thermodynamics* (Lectures 22)

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP & CV, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

3.1.2 Unit II : *Thermodynamic Potentials* (Lectures 10)

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for $(CP - CV)$, CP/CV, TdS equations.

3.1.3 Unit III : *Kinetic Theory of Gases* (Lectures 10)

Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

3.1.4 Unit IV : *Theory of Radiation* (Lectures 06)

Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.

3.1.5 Unit V : *Statistical Mechanics* (Lectures 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity – Quantum statistics – Fermi-Dirac distribution law – electron gas – Bose-Einstein distribution law – photon gas – comparison of three statistics.

3.2 Lab

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
9. To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system.
10. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.

Reference Books

[1] Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

[2] A Treatise on Heat, Meghnad Saha, and B. N.Srivastava, 1958, Indian Press

[3] Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill

[4] Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

[5] Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

[6] Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

[7] Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

[8] Statistical Mechanics, R. K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.

[9] Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

[10] Statistical and Thermal Physics, S. Lokanathan and R. S. Gambhir. 1991, Prentice Hall

4

PHY-RC-4016 (PHY-HG-4016) Waves & Optics

Total Lectures : 60 **Credits : 6 (Theory : 04, Lab : 02)**

4.1 Theory

4.1.1 Unit I : *Superposition of Two Collinear Harmonic Oscillations* (Lectures 04)

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

4.1.2 Unit II : *Superposition of Two Perpendicular Harmonic Oscillations* (Lectures 02)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

4.1.3 Unit III : *Waves Motion* (Lectures 07)

General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

4.1.4 Unit IV : *Fluids* (Lectures 06)

Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaegar's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

4.1.5 Unit V : *Sound* (Lectures 06)

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

4.1.6 Unit VI : *Wave Optics* (Lectures 03)

Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

4.1.7 Unit VII : *Interference* (Lectures 10)

Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination and Fringes of equal thickness . Newton's Rings: measurement of wavelength . Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

4.1.8 Unit VIII : *Michelson Interferometer* (Lectures 03)

(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Refractive Index. (4) Visibility of fringes. (3 Lectures)

4.1.9 Unit IX : *Diffraction* (Lectures 14)

Fresnel and Fraunhofer diffraction . 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. Fresnel diffraction pattern of a straight edge and at a circular aperture . Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit , Diffraction grating . Resolving power of grating.

4.1.10 Unit X : *Polarization* (Lectures 05)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light, Production and analysis of polarized light. Retarding plates.

4.2 Lab

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda^2 - T$ Law.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster's focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton's Rings.

Reference Books

[1] Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

[2] Fundamentals of Optics, F. A. Jenkins and H.E. White, 1981, McGraw-Hill

[3] Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

[4] Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

[5] The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

[6] The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

[7] Fundamental of Optics, A. Kumar, H. R. Gulati and D. R. Khanna, 2011, R. Chand Publications.