WEST BENGAL STATE UNIVERSITY

B.Sc. with Physics (Hons) & B.Sc. (General) with Physics

Choice Based Credit System Syllabus

First Draft
(With updated paper codes)

4 Scheme for CBCS Curriculum B.Sc. (General) Program with *Physics* as one of the disciplines

- ## Scheme for CBCS Curriculum

Semester	Course Name	Course Detail	Credits
I	Ability Enhancement Compulsory Course – I	English communication / Environmental Science	2
	Core course – I (from Physics)	**PHSGCOR01T** : Mechanics	4
		PHSGCOR01P : Mechanics Lab	2
	Core course – II	DSC 2A (from Discipline 2)	6
	Core course – III	DSC 3A (from Discipline 3)	6
II	Ability Enhancement Compulsory Course – II	English communication / Environmental Science	2
	Core course – IV (from Physics)	**PHSGCOR02T** : Electricity and Magnetism	4
		PHSGCOR02P : Electricity and Magnetism Lab	2
	Core course – V	DSC 2B (from Discipline 2)	6
	Core course – VI	DSC 3B (from Discipline 3)	6
III	Core course – VII (from Physics)	**PHSGCOR03T** : Thermal Physics and Statistical Mechanics	4
		PHSGCOR03P : Thermal Physics and Statistical Mechanics Lab	2
	Core course – VIII	DSC 2C (from Discipline 2)	6
	Core course – IX	DSC 3C (from Discipline 3)	6
	Skill Enhancement Course – 1	TBD	2
IV	Core course – X (from Physics)	**PHSGCOR04T** : Waves and Optics	4
		PHSGCOR04P : Waves and Optics Lab	2
	Core course – XI	DSC 2D (from Discipline 2)	6
	Core course – XII	DSC 3D (from Discipline 3)	6
	Skill Enhancement Course-2	TBD	2
V	Skill Enhancement Course-3	TBD	2

	Discipline Specific Elective – 1	TBD (from Physics)	6
	Discipline Specific Elective – 2	TBD (from Discipline 2)	6
	Discipline Specific Elective – 3	TBD (from Discipline 3)	6
VI	Skill Enhancement Course-4	TBD	2
	Discipline Specific Elective – 4	TBD (from Physics)	6
	Discipline Specific Elective – 5	TBD (from Discipline 2)	6
	Discipline Specific Elective – 6	TBD (from Discipline 3)	6

*TBD: To be decided by the student among the available choices mentioned below.

5. Syllabi of Core Papers (from Physics) for B.Sc. General with Physics

- ## PHSGCOR01T - Mechanics

Mechanics	
60 Lectures	**4 Credits**
Mathematical Methods	**10 Lectures**
Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous and inhomogeneous differential equations with constant coefficients.	
Particle Dynamics	**21 Lectures**
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.	
Gravitation	**8 Lectures**
Gravitation: 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). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	
Oscillations	**6 Lectures**
Oscillations: Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced harmonic oscillations, resonance.	
Elasticity	**8 Lectures**
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.- Bending of beam.

Special Theory of Relativity	7 Lectures

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

Reference Books

- ► Classical Mechanics. T.W.B. Kibble and F.H. Berkshire, 2004, Imp. Col. Press, World Scientific.
- ► An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- ► Classical Dynamics of Particles and Systems. S.T. Thornton and J. B. Marion, 2009, Brooks/Cole.
- ► Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- ► Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- ► University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- ► Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- ► Classical Mechanics and General Properties of Matter. S.N. Maiti and D.P. Raychaudhuri, New Age
- ► Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- ► Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- ► Special Relativity (MIT Introductory Physics). A.P. French, 2018, CRC Press.
- ► University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- ► Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.

- **PHSGCOR01P – Mechanics Lab**

Mechanics	
60 class hours	**2 Credits**

General Topic

Discussion on random errors in observations. Measurement principles of length (or diameter) using vernier caliper, screw gauge and travelling microscope. Discussion on the parts of Sextant.

List of Practical

1. To study the random error in observations of time period of some oscillation using chronometer.
2. To determine the Moment of Inertia of a regular body using another auxilary body and a cradle suspeded by a metalic wire.
3. To determine g and velocity for a freely falling body using Digital Timing Technique
4. To determine the Young's Modulus by flexure method.
5. To determine the Modulus of Rigidity of a Wire by a torsional pendulum.
6. To determine the height of a building using a Sextant.
7. To determine the elastic Constants of a wire by Searle's method.
8. To determine the value of g using Bar Pendulum.
9. To determine the value of g using Kater's Pendulum.
10. To study the Motion of Spring and calculate, (a) Spring constant, (b) g and (c) Modulus of rigidity.

Reference Books

► Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
► A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal
► Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
► Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

- ## PHSGCOR02T - Electricity and Magnetism

Electricity and Magnetism	
60 Lectures	**4 Credits**
Vector Analysis	**12 Lectures**
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).	
Electrostatics	**18 Lectures**
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. Electric potential due to an electric dipole. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate 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.	
Magnetism	**10 Lectures**
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.	
Electromagnetic Induction	**6 Lectures**
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.	
Linear Network	**5 Lectures**
Impedance of L, C, R and their combinations. Thevenin & Norton's Theorem. Maximum power transfer theorem and superposition theorem. Anderson's bridge.	
Maxwell`s Equations and Electromagnetic Wave Propagation	**9 Lectures**
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.

Reference Books

► Foundations of Electromagnetic Theory. J.R. Reitz, F.J. Milford and R.W. Christy, 2010, Pearson.

► Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education

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

► Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education

► Electromagnetism. I.S. Grant and W.R. Phillips, 2013, Wiley.

► Classical Electromagnetism. J. Franklin, 2008, Pearson Education.

► Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.

► Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

- ## PHSGCOR02P – Electricity and Magnetism Lab

Electricity and Magnetism	
60 class hours	**2 Credits**

General topic

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances (e) Checking electrical fuses and (f) circuit continuity check**.** Demonstration on Carey Foster's bridge, potentiometer, resistance box, inductor coil, moving coil galvanometer (in dead beat and ballistic mode), etc.

List of Practicals

1. To determine an unknown Low Resistance using Carey Foster's Bridge.
2. To verify the Thevenin and Norton theorems.
3. To verify the Superposition and Maximum power transfer theorems.
4. To determine self-inductance of a coil by Anderson's bridge.
5. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.
7. To study the characteristics of a series RC Circuit.
8. To determine an unknown Low Resistance using Potentiometer.
9. To determine the resistance of a galvanometer using Thomson's method.
10. Measurement of field strength B and its variation in a solenoid (determine dB/dx)

Reference Books

► Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
► A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
► Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
► A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

- ## PHSGCOR03T - Thermal Physics and Statistical Mechanics

Thermal Physics and Statistical Mechanics	
60 Lectures	**4 Credits**
Laws of Thermodynamics	**22 Lectures**
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 and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.	
Thermodynamic Potentials	**10 Lectures**
Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations.	
Kinetic Theory of Gases	**10 Lectures**
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.	
Theory of Radiation	**6 Lectures**
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.	
Statistical Mechanics	**12 Lectures**
Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only) - Fermi-Dirac distribution law (statement only) - electron gas as an example of Fermi gas - Bose-Einstein distribution law (statement only) - photon gas as an example of Bose gas- comparison of three statistics.	
Reference Books	
▶ Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford Univ Press.	

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and
- G.L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

- ## PHSGCOR03P – Thermal Physics and Statistical Lab

Thermal Physics and Statistical	
60 class hours	**2 Credits**

List of Practical

1. Verification of Stefan's law using a torch bulb.

2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.

3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).using constant current source

4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.

5. To calibrate a thermocouple to measure temperature in a specified Range by Null Method using a potentiometer.

6. To calibrate a thermocouple to measure temperature in a specified Range by direct measurement using Op-Amp differential amplifier and to determine Neutral Temperature

7. Measurement of unknown temperature using Diode sensor.

8. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

9. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.

10. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

Reference Books

► Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.

► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

► A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

► A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

- ## PHSGCOR04T - Waves and Optics

Waves and Optics	
60 Lectures	**4 Credits**
Superposition of Two Collinear Harmonic oscillations	**4 Lectures**
Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).	
Superposition of Two Perpendicular Harmonic Oscillations	**2 Lectures**
Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.	
Waves Motion- General	**7 Lectures**
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.	
Fluids	**6 Lectures**
Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature lubrication. Qualitative discussion on water waves.	
Sound	**6 Lectures**
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.	
Wave Optics	**3 Lectures**
Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.	
Interference	**10 Lectures**

Interference: 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 (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

Michelson's Interferometer	3 Lectures

Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.

Diffraction	14 Lectures

Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

Polarization	5 Lectures

Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.

Reference Books

► Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
► Vibrations and Waves. A.P. French, 2003, CBS.
► Vibrations & Waves. G.C. King, 2009, Wiley.
► The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
► General Properties of Matter. B. Brown, 1969, Springer Science.
► Classical Mechanics and General Properties of Matter. S.N. Maiti and D.P. Raychaudhuri, New Age
► Optics. E. Hecht, 2003, Pearson Education.
► Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
► Principles of Optics, B.K. Mathur, 1995, Gopal Printing
► Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
► University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley

• PHSGCOR04P – Waves and Optics Lab

Waves and Optics	
60 class hours	2 Credits

List of Practical

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To determine dispersive power and resolving power of a plane diffraction grating.
8. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
9. Familiarization with: Schuster`s focusing; determination of angle of prism.
10. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
11. To investigate the motion of coupled oscillators.
12. To determine the wavelength of sodium source using Michelson's interferometer.

Reference Books

► Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
► A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

6. Syllabi of Department Specific Electives Papers (from Physics) for B.Sc. General with Physics

- ## PHSGDSE01T - Digital, Analog Circuits and Instrumentation

Digital, Analog Circuits and Instrumentation	
60 Lectures	**4 Credits**
Digital Circuits	**15 Lectures**

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion, AND, OR and NOT Gates (Realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map

Binary Addition. Binary Subtraction using 2's Complement Method). Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.

Semiconductor Devices and Amplifiers	**15 Lectures**

Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Active, Cutoff & Saturation regions Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q- point. Voltage Divider Bias Circuit for CE Amplifier. H-parameter, Equivalent Circuit. Analysis of single-stage CE amplifier using hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

Operational Amplifiers (Black Box approach)	**14 Lectures**

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closed- loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector.

Sinusoidal Oscillators: Barkhausen's Criterion for Self-sustained Oscillations. Determination of Frequency of RC Oscillator

Instrumentations	16 Lectures

Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation.

Timer IC: IC 555 Pin diagram and its application as Astable and Monostable Multivibrator.

Reference Books

- ► Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- ► Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill
- ► Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- ► Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
- ► Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw Hill
- ► Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- ► Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
- ► OP-AMP & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

- **PHSGDSE01P – Digital, Analog Circuits and Instrumentation Lab**

Digital, Analog Circuits and Instruments	
60 class hours	2 Credits

List of Practical

1. To measure (a) Voltage, and (b) Frequency of a periodic waveform using CRO
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To minimize a given logic circuit.
4. Half adder, Full adder and 4-bit Binary Adder.
5. Adder-Subtractor using Full Adder I.C.
6. To design an astable multivibrator of given specifications using 555 Timer.
7. To design a monostable multivibrator of given specifications using 555 Timer.
8. To study IV characteristics of PN diode, Zener and Light emitting diode
9. To study the characteristics of a Transistor in CE configuration.
10. To design a CE amplifier of given gain (mid-gain) using voltage divider bias.
11. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
12. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
13. To study Differential Amplifier of given I/O specification using Op-amp.
14. To investigate a differentiator made using op-amp.
15. To design a Wien Bridge Oscillator using an op-amp.

Reference Books

► Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

► Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

► OP-Amps & Linear Integrated Circuit, R.A. Gayakwad, 4th Edn, 2000, Prentice Hall.

► Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

- ## PHSGDSE02T - Perspectives of Modern Physics

Perspectives of Modern Physics	
75 Lectures	**6 Credits**
Relativistic Dynamics	**8 Lectures**
Brief summary of Lorentz transformation and time dilation, length contraction, velocity addition etc. (no derivation required). Elastic collision between two particles as observed from two inertial frames with relative velocity, idea of relativistic momentum and relativistic mass. Mass-energy equivalence.	
Quantum Theory of Light	**5 Lectures**
Review on the limitations of classical theory of electromagnetic radiation within a cavity and its solution by Planck's quantum hypothesis (no derivation required). Statement of Planck's law of black body radiation. Photoelectric effect. Einstein's postulate on light as a stream of photons. Compton's scattering and its explanation.	
Bohr's model	**4 Lectures**
Limitations of Ruherford's model of atomic structure. Bohr's model, its successes and limitations.	
Wave-particle Duality	**6 Lectures**
De Broglie's hypothesis – wave particle duality. Davisson-Germer experiment. Connection with Einstein's postulate on photons and with Bohr's quantization postulate for stationary orbits. Heisenberg's uncertainty relation as a consequence of wave-particle duality. Demonstration by γ-ray microscope thought experiment. Estimating minimum energy of a confined particle using uncertainty principle.	
Wave-function Description	**7 Lectures**
Two slit interference experiment with photons, atoms & particles; linear superposition principle of associated wave functions as a consequence; Departure from matter wave interpretation and probabilistic interpretation of wave function; Schroedinger equation for non-relativistic particles; Momentum and Energy operators; stationary states. Properties of wave function. Probability and probability current densities in one dimension.	
Stationary State Problems	**5 Lectures**
One Dimensional infinitely rigid box, energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example. Quantum mechanical scattering and tunnelling in one dimension - across a step potential and	

across a rectangular potential barrier (qualitative discussion with statements of end results only).

Atomic Physics	15 Lectures

Quantization rules   energy and orbital angular momentum from Hydrogen and Hydrogen like atoms (no derivation); s, p, d,shells-subshells. Space quantization. Orbital Magnetic Moment and Magnetic Energy of electron, Gyromagnetic Ratio and Bohr magneton. Zeeman effect.

Electron Spin as relativistic quantum effect (qualitative discussion only), Spin Angular Momentum. Spin Magnetic Moment. Stern-Gerlach Experiment. Larmor Precession. Spin-orbit interaction. Addition of angular momentum (statement only). Energy correction due to relativistic effect and spin-orbit ineraction (statement only). Fine-structure splitting.

Multi-electron atoms. Pauli's Exclusion Principle (statement only). Spectral Notations for atomic States. Aufbau principle, $n+l$ rule (qualitative discussion only). Periodic table.

Nuclear Physics	15 Lectures

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph. Binding energy curve.

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay, beta decay, gamma emission – basic characteristics.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Basic principle of a nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and basic principle of thermonuclear reactions

X-ray and Crystal Structure of Solids	10 Lectures

Generation of X-ray. Mosley's law, explanation from Bohr's theory. Amorphous and crystalline solids. Lattice structure of crystalline (no categorisation required). Unit cell and basis vectors of a lattice. Diffraction of X-ray by crystalline solid. Bragg's law.

Reference Books

► Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles. R. Eisberg and R. Resnick, 1985, Wiley.
► Perspectives of Modern Physics. A. Beiser, 1969, McGraw-Hill.
► Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
► Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
► Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
► Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill

- ## PHSGDSE03T – Solid State Physics

Solid State Physics	
60 Lectures	**4 Credits**
Preliminary Topics	**4 Lectures**
Review on Schroedinger equation in one dimension, stationary states. Maxwell-Boltzman distribution law.	
Crystal Structure	**12 Lectures**
Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.	
Elementary Lattice Dynamics	**8 Lectures**
Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein theories of specific heat of solids. Debye correction (qualitative idea), T3 law (statement only).	
Magnetic Properties of Matter	**12 Lectures**
Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia – and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.	
Dielectric Properties of Materials	**9 Lectures**
Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena.	
Elementary band theory	**10 Lectures**
Kronig Penny model. Band Gaps. Conductors, Semiconductors and insulators. P and N type Semiconductors. Conductivity of Semiconductors, mobility, Hall Effect, Hall coefficient.	
Superconductivity	**5 Lectures**

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors.

Reference Books

► The Oxford Solid State Basics. S. H. Simon, 2013, Oxford.

► Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

► Introduction to Solid State Physics, Charles Kittel, 8th Ed., 2004, Wiley India Pvt. Ltd.

► Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

► Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill

► Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning

► Solid State Physics, Rita John, 2014, McGraw Hill

► Solid-state Physics, H. Ibach and H. Luth, 2009, Springer

► Solid State Physics, M.A. Wahab, 2011, Narosa Publications

- ## **PHSGDSE03P – Solid State Physics Lab**

Solid State Physics	
60 class hours	**2 Credits**

List of Practical

1. To determine the Coupling Coefficient of a Piezoelectric crystal.

2. To measure the Dielectric Constant of a dielectric Materials with frequency

3. To study the characteristics of a Ferroelectric Crystal.

4. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.

5. To measure the resistivity of a semiconductor (Ge) with temperature by reverse bias characteristics of Ge diode (room temperature to 80 oC) and to determine its band gap.

6. To determine the Hall coefficient of a semiconductor sample.

7. To study temperature coefficient of a semiconductor (NTC thermistor)

8. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)

9. To measure the Magnetic susceptibility of Solids.

10. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)

11. To determine the refractive index of a dielectric layer using SPR

Reference Books

► Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
► Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
► A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal
► Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

- ## PHSGDSE04T - Nuclear and Particle Physics

Nuclear And Particle Physics	
75 Lectures	6 Credits
Preliminary Topics	3 Lectures
Review of mass-energy equivalence, quantum tunnelling. Qualitative discussion on properties of semiconductors.	
General Properties of Nuclei	9 Lectures
Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.	
Nuclear Models	11 Lectures
Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.	
Radioactivity decay	10 Lectures
(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) -decay: energy kinematics for -decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.	
Nuclear Reactions	8 Lectures
Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering(Rutherford scattering).	
Interaction of Nuclear Radiation with matter	8 Lectures
Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction	

with matter.

Detector for Nuclear Radiations	7 Lectures

Basic principles of ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators	5 Lectures

 Linear accelerator, Cyclotron, Synchrotrons.

Particle physics	14 Lectures

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

Reference Books

► Nuclear Physics. J.S. Lilley, 2001, John Wiley & Sons.
► Nuclear and Particle Physics. B.R. Martin, 2006, John Wiley & Sons.
► Nuclear and Particle Physics, W.F. Burcham and M. Jobes, 1995, Pearson.
► An Introduction to Nuclear Physics. W. N. Cottingham and D.A. Greenwood, 2004, Chambridge.
► Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
► Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
► Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
► Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
► Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
► Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
► Basic ideas and concepts in Nuclear Physics - An Introductory Approach by
► K. Heyde (IOP- Institute of Physics Publishing, 2004).
► Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
► Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

7 Syllabi of Generic Elective Papers (from Physics) for B.Sc. Honours in Subjects Other than Physics

Syllabus for **PHSHGEC01T: Mechanics** is identical with

that of **PHSGCOR01T: Mechanics** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC01P : Mechanics Lab** is identical with

that of **PHSGCOR01P : Mechanics Lab** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC02T: Electricity and Magnetism** is identical with

that of **PHSGCOR02T: Electricity and Magnetism** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC02P: Electricity and Magnetism Lab** is identical with

that of **PHSGCOR02P: Electricity and Magnetism Lab** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC03T: Thermal Physics and Statistical Mechanics** is identical with

that of **PHSGCOR03T : Thermal Physics and Statistical Mechanics** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC03P: Thermal Physics and Statistical Mechanics Lab** is identical with

that of **PHSGCOR03P: Thermal Physics and Statistical Mechanics Lab** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC04T: Waves and Optics** is identical with

that of **PHSGCOR04T : Waves and Optics** offered for B.Sc. General with Physics

Syllabus for **PHSHGEC04P: Waves and Optics Lab** is identical with

that of **PHSGCOR04P : Waves and Optics Lab** offered for B.Sc. General with Physics

8 Skill Enhancement Courses

• PHSSSEC01M - Basic Instrumentation Skills

Basic of Measurement	
30 class hours	**2 Credits**

Basic of Measurement

Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter

Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier-rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance.

Cathode Ray Oscilloscope

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Signal Generators and Analysis Instruments

Block diagram, explanation and specifications of low frequency signal generators. Pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters

Block diagram of bridge: working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Digital Instruments

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter

Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books

► A text book in Electrical Technology - B L Theraja - S Chand and Co.
► Performance and design of AC machines - M G Say ELBS Edn.
► Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

► Logic circuit design, Shimon P. Vingron, 2012, Springer.

► Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

► Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

► Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer

► Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

- ## PHSSSEC02M - Computational Physics Skills

Computational Physics	
30 class hours	2 Credits

Introduction

Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

Scientific Programming

Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN/ C++, Basic elements of FORTRAN 90/95 or C++: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran 90/95 or C++ Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

Control Statements

Types of Logic (Sequential, Selection, Repetition), Branching Statements, Looping Statements, Jumping Statements, Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming

1. Exercises on syntax on usage of FORTRAN 90/95 or C++
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN 90/95 or C++.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.

5. Calculating Euler number using exp(x) series evaluated at x=1

Scientific word processing: Introduction to LaTeX

TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

Visualization

Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

Reference Books

► Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
► Computer Programming in Fortran 90 and 95. V. Rajaraman, 1997 (Publisher: PHI).
► Object Oriented Programming with C++. E. Balaguruswamy, 2017. McGraw Hill, India.
► LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
► Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

► Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

► Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)

► A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

► Elementary Numerical Analysis, K.E. Atkinson, 3 rd Edn., 2007, Wiley India Edition.