DEPARTMENT OF PHYSICS

Course Structure & Syllabi for BTech [Engineering Physics] – (2025-batch onwards)

Course Number	Course Name	type	L	T	P	C	total	Course Number	Course Name	type	L	T	P	C	total
Semester I								**Semester II**							
CH1103H	Basic Inorganic Chemistry	BSE	3	0	0	3		PH1230	Electrodynamics	BSE	3	1	0	8	
CS1104	Programming and Data Structures	BSE	3	0	0	6		CE1206	Engineering Drawing	BSE	1	0	3	5	
CS1108L	Programming and Data Structures Lab	BSE	0	0	3	3		DA1201H	Fundamentals of Data Science	BSE	3	0	0	3	
MA1308H	Single Variable Calculus	BSE	3	1	0	4		EE1202H	Electric Circuits	BSE	3	0	0	3	
MA1508H	Multi Variable Calculus	BSE	3	1	0	4		EE1207H	Digital and Analog Electronics	BSE	3	0	0	3	
ME1104	Engineering Mechanics	BSE	2	1	0	6		EE1212L	Basic Electronics Lab	Lab/BSE	0	0	3	3	
ME1109L	Workshop Practice	Workshop/BSE	0	0	3	3		MA1408H	Linear Algebra	BSE	3	1	0	4	
PH1100L	Basic Physics Lab	Lab/BSE	0	0	3	3		MA1608H	Complex Analysis	BSE	3	1	0	4	
PH1130	Classical Mechanics	BSE	3	0	0	6	38	EE1220	Signal and systems	core	3	1	0	8	41
Semester 3								**Semester 4**							
PH2510	Mathematical Physics	core	3	0	0	6		PH2610	Statistical Mechanics	core	3	1	0	8	
PH2110H	CMOS analog circuit Design	core	2	1	0	3		PH2620	Numerical methods and programming	core	2	0	2	6	
PH2520	Quantum Mechanics	core	3	1	0	8		BT1201H	Evolution and Genetics	BSE	3	0	0	3	
PH2530	Heat and Thermodynamics	BSE	3	0	0	6		HSXXXX	HSS-2	HSS	3	0	0	6	
HSXXXX	HSS-1	HSS	3	0	0	6		PH2630	Advanced Quantum mechanics and Spectroscopy	core	3	0	0	6	
PH2540	Engineering Optics	core	3	0	0	6		PH2200L	General Physics and semiconductor device Laboratory	lab	0	0	6	6	
PH2100L	Analog circuit design Lab	lab	0	0	4	4	39	PH2640	Semiconductor devices	core	3	0	0	6	41

Semester-I

PH1100L: General Physics Lab-1 (0 0 3 3)

List of Experiments: Determination of g by Compound pendulum, Surface tension of a liquid by Jaeger's Method, Magnetic field along the axis of a coil, Resonance and Q factor of a LCR circuit, Hall Effect in an extrinsic semiconductor, Newton's ring, Plane Transmission Grating, Linear Air track, Error analysis.

Text:

1. *Taylor, John R. "Error analysis." Univ. Science Books, Sausalito, California 20 (1997).*
2. *Ghatak, Ajoy. Contemporary Optics. Springer Science & Business Media, 2012.*
3. *Mahajan, A. and Rangawala, A. Electricity and Magnetism. Mc. Gras Hill (2017).*
4. *Mathur D.S. Elements of Properties of Matter. S. Chand (2010)*

PH 1130: Classical Mechanics (2 1 0 6)

Course Content/ Syllabus:

Review of kinematics: Position, velocity, acceleration vectors in rectilinear, plane polar, cylindrical and spherical polar coordinate systems. Review of Newtonian mechanics in rectilinear coordinate system; Motion in plane polar coordinates; forces and equations of motion, simple harmonic motion. System of particles, center of mass, center of mass coordinates, conservation of momentum; Work-energy theorem, conservation laws; non-conservative forces.

Rigid body dynamics: Angular momentum and fixed axis of rotation; dynamics of fixed axis rotation, work-energy theorem and rotational motion; Moment of Inertia tensor; Euler angles; Euler equations.

Lagrangian and Hamiltonian mechanics: Degrees of freedom, Constraints and constraint forces, D'Alembert's principle, Generalized coordinates, Principle of least action; Lagrange's equations of motion, Generalized momentum, Ignorable coordinates; symmetry and conservation theorems; Concept of phase space, Hamilton's equations of motion and applications, Poisson Brackets.

Central Force problem: Central force as a one-body problem; planetary motion; Equation of orbit.

Oscillations: Small oscillations in a bound system, stability, normal modes, damped oscillations, driven damped oscillations, resonance.

Special Theory of Relativity: Postulates of special theory of relativity; Lorentz transformation; Time dilation; Doppler effect; Length contraction; Twin paradox; Relativistic addition of velocities; Mass and energy; Energy Momentum relationships.

Texts:

1. *John Taylor, Classical mechanics (University Science Books, 2005).*
2. *D. Kleppner and R. Kolenkow, An Introduction to Mechanics, 2nd Ed. Cambride University Press (2014).*

References:

1. *Resnick, Robert. Introduction to special relativity. John Wiley & Sons, 1991.*
2. *Goldstein H. Classical mechanics. Pearson Education India; 2011.*
3. *L.D. Landau and E.M. Lifshitz, Mechanics, Elsevier (2005).*
4. *Takwale R and Puranik P, Introduction to Classical Mechanics, (McGraw Hill Education, 1st Ed., 2017).*

Semester-II

PH1230: Electrodynamics (3 1 0 8)

Course Content/ Syllabus:

Essential mathematical tools: Review of Stokes and Gauss' divergence theorem, Curvilinear coordinates, Gradient, divergence, and curl in curvilinear coordinates; Dirac Delta function.

Electrostatics: Gauss law in integral and differential forms; Scalar potential, potential due to charge distributions, and Laplace/Poisson equation; Work and energy; Uniqueness theorem, Dirichlet and Neumann boundary conditions; Image charge problems, point charge in front of an infinite grounded conducting plane, point charge in front of a grounded conducting sphere and conducting infinite plane.

Solutions of Laplace Equation: Separating variables in Cartesian, spherical, and cylindrical coordinates and general solution (Legendre polynomials, Bessel functions). Multipole expansion.

Dielectrics: Polarization, Surface and volume-bound charges; Gauss' law in dielectrics, Displacement vector; Boundary value problem with linear dielectric; Image charge problem with dielectric; Forces on dielectrics.

Magnetism: Review of Biot-Savart's law, Lorentz Force. vector potential, and forces on magnetic dipoles; Magnetic materials, Bound currents, Boundary value problems. Magnetic field in conductors.

Steady current and electromagnetic fields: Review of Ohm's law, Faraday's law, Lenz's law, and Electromotive force; Ampere's law and Displacement current; Maxwell's equations in vacuum and media; Gauge transformation and gauge conditions; Poynting vector and Poynting theorem; Plane waves, Polarization of EM field; Propagation in nonconducting and conducting media. Reflection and refraction with normal and oblique incidence, Fresnel relations, Brewster's angle.

Dipole radiation: Radiation, dipole radiation from oscillating electric dipole, Retarded potential, Intensity distribution of radiating dipole.

Texts:

1. *Griffiths, David J. Introduction to electrodynamics. Cambridge University Press, 2023.*
2. *Sadiku MN, Kulkarni SV. Principles of electromagnetics. New Delhi, India: oxford university Press; 2015 Sep*

Semester-III

PH2510 Mathematical Physics (3 0 0 6)

Partial Differential Equations: Method of separation of variables, Laplace equation, Heat Equation, Wave equations in Cartesian and curvilinear coordinates, Green's function and its applications
Integral transformations: Laplace transformations and applications to differential equations, Fourier series, Fourier integrals; Fourier transforms, sine and cosine transforms; solution of PDE by Fourier transform.
Group Theory: Groups, subgroups, conjugacy classes, cosets, invariant subgroups, factor groups, kernels, continuous groups, Lie groups, generators, SO(2) and SO(3), SU(2), crystallographic point groups.

Texts:

1. *G. B. Arfken, H. J. Weber and F. E. Harris, Mathematical Methods for Physicists, Seventh Edition, Academic Press (2012).*
2. *A. W. Joshi, Elements of Group Theory, New Age International Publishers; Fifth edition (2018).*

References:

1. *M. L. Boas, Mathematical Methods in Physical Sciences, John Wiley & Sons (2005).*
2. *P. Dennery and A. Krzywicki, Mathematics for Physicists, Dover Publications (1996).*
3. *I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, (1957).*

PH2110H CMOS analog circuit Design (2 1 0 3)

MOS Device and Modelling: MOSFET (MOS transistor) – Structure, symbols, I-V characteristics and its derivation, transconductance and small signal model.
Single Stage Amplifiers: Amplifier parameters, common source, common gate and source follower amplifiers.
Differential Amplifiers: Single ended and differential operations, qualitative and quantitative analysis of basic differential pair, small signal model, degenerated differential pair, common mode response and common mode rejection ratio.
Operation Amplifiers: Basic parameters, one stage opamp, two stage opamp, gain boosting. CMOS processing technology overview

Text:

1. *Behzad Razavi, Design of Analog CMOS – Integrated Circuits, McGraw-Hill, 2nd edition (2017).*

References:

1. *R. A. Gayawad, Op-Amp and Linear Integrated Circuits, 4/e, Pearson (1995).*
2. *A.S. Sedra and K. C. Smith, Microelectronics Circuits – Theory and Applications, Oxford University Press, fifth edition, (2009).*
3. *Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, Eastern Economic Edition, 9th edition, (1996).*

PH2520 Quantum Mechanics (3 1 0 8)

Basic principles of quantum mechanics: Heisenberg Uncertainty principle; Introduction to linear vector spaces: bra and ket vectors, completeness, orthonormality, basis vectors, Orthogonal, Hermitian and Unitary operators, change of basis, Eigenvalues and expectation values, position and momentum representation.
Postulates of Quantum Mechanics: Wave particle duality, wave function and its relation to the state vector, probability and probability current density, conservation of probability, equation of continuity, Schrödinger equation.
Simple potential problems: Infinite potential well, step and barrier potentials, finite potential well and bound states; Linear harmonic oscillator, operator algebra of harmonic oscillator, coherent states and their properties.
Three-dimensional problems: spherical harmonics, free particle in a spherical cavity, central potential, Three-dimensional harmonic oscillator, degeneracy, Hydrogen atom.
Angular momentum: Commutation relations, spin angular momentum, Pauli matrices, raising and lowering operators, L-S coupling, Total angular momentum, addition of angular momentum, Clebsch-Gordon coefficients; The spin-orbit coupling and its consequences, charged particle in a uniform magnetic field.

Texts:

1. R. Shankar, Principles of Quantum Mechanics, Springer (India) (2008).
2. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd Ed., Pearson Education (2005)
3. P. W. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1995).

References:

1. J. Sakurai, Modern Quantum Mechanics, Pearson Education (2002).
2. F. Schwabl, Quantum Mechanics, Narosa (1998).
3. L. Schiff, Quantum Mechanics, McGraw-Hill (1968).
4. E. Merzbacher, Quantum Mechanics, John Wiley (Asia) (1999).
5. Ajit Kumar, Fundamentals of Quantum Mechanics, Cambridge University Press (2018).

PH2530 Heat and Thermodynamics (3 0 0 6)

Kinetic theory and Transport phenomena: Equation of state of a perfect gas, Maxwell velocity distribution, real gases and Van der Waals' equation, collisions, mean free path, viscosity and thermal conductivity, diffusion, Brownian motion.
Laws of thermodynamics and applications: Review of thermodynamic systems, state variables, intensive and extensive parameters, thermodynamic processes, Zeroth and first law of thermodynamics, State functions, internal energy and enthalpy, Joule Thomson effect, Carnot process and entropy, second law of thermodynamics, refrigerators and thermodynamic engines, Otto and diesel engines, TdS equations, Third law of thermodynamics
Thermodynamic potentials: Entropy and internal energy as thermodynamic potentials, Legendre transformation, Helmholtz and Gibbs potentials, enthalpy, grand potential, transformation of variables, Maxwell relations, Joule effect, Joule-Thomson effect, Jacobi transformations, response functions and their relations, thermodynamic stability, convex/concave nature of thermodynamic potentials.
Phase equilibria: Gibbs' phase rule, Clausius-Clapeyron equation, phase equilibrium and Maxwell construction, first-order phase transitions, critical point.

Texts:

1. *M. W. Zeemansky and R. H. Dittman, Heat and thermodynamics, McGraw-Hill, 1997*
2. *W. Pauli, Thermodynamics and kinetic theory of gases, Dover Publications, 2010*

References:

1. *F. W. Sears and G. L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Narosa, New Delhi, 1975.*
2. *N. D. Hari Dass, The Principles of Thermodynamics, CRS Press, Taylor and Francis Group, Boca Raton, Florida, (2014).*
3. *C. Kittel and H. Kroemer, Thermal Physics, W. H. Freeman & Co., 1980.*
4. *F. Mandl, Statistical Physics, John Wiley, 1978.*
5. *W. Greiner, L. Neise and H. Stocker, Thermodynamics and Statistical Mechanics, Springer, 1995.*

PH2540 Engineering Optics (3 0 0 6)

Geometrical Optics: Fermat's principle, refraction as spherical surface, image formation by a thin lens and a thin lens combination, total internal reflection and propagation through a step index optical fiber, working principle of a camera, microscope and a telescope, cardinal points of a thick lens, matrix method of ray tracing, basic idea of monochromatic and chromatic aberrations.
Polarization: Linear and elliptically polarized light, Bi-refringence-e-ray and o-ray, polarization by scattering and reflection, waveplates, Faraday effect, Kerr and Pockels effect, liquid crystal variable retarder, Jones vector, Stokes and Poincare representation;
Interference: Conditions for interference, coherence, Two and Multiple beam interference, Michelson and Fabry-Perot interferometer; multilayer thin films as antireflection coatings.
Diffraction: Huygen-Fresnel principle, Fresnel and Fraunhofer diffraction, Fraunhofer diffraction of a single slit and circular aperture; Airy pattern and resolution of imaging system, plane diffraction and blazed grating.

Fourier optics: 1-D and 2-D Fourier transforms, lens as a Fourier transformer, Dirac -delta function, sine and cosine functions, linear system, convolution, Fraunhofer diffraction using Fourier method, auto and cross correlation, transfer function, Abbe's theory of image formation, spatial frequency filtering; working principle of holography.
Computational Optics: Image formation by a lens combination using matrix method, Point spread function of an imaging system using Fourier transform, Low pass and high pass filtering of an Image, Simulation of propagation of light through an optical fibre.

Texts:

1. *Hecht, Eugene. Optics. Pearson Education India, 2012.*
2. *Goodman JW. Introduction to Fourier optics. Macmillan Learning, 2017.*
3. *Poon, Ting-Chung, and Taegeun Kim. Engineering optics with Matlab®. 2006*

Reference:

1. *Born, Max, and Emil Wolf. Principles of optics: electromagnetic theory of propagation, interference and diffraction of light. Elsevier, 2013*
2. *Lipson, Ariel, Stephen G. Lipson, and Henry Lipson. Optical physics. Cambridge University Press, 2010*
3. *Pedrotti, Frank L., Leno M. Pedrotti, and Leno S. Pedrotti. Introduction to optics. Cambridge University Press, 2017*

PH2100L Analog Circuit Design Lab (0 0 4 4)

Single-stage and multiphase amplifiers; frequency response; various amplifier classes and their frequency response; differential amplifiers; op-amp-based circuits; filters; oscillators; modulation circuits. Measurement of depletion layer capacitance and the effect of temperature. Controller circuits.

References:

1. P.B.Zbar and A.P. Malvino, Basic Electronics: A text-lab manual, Tata McGraw-Hill, 7th edition, 2001.
2. A. P. Malvino and D. Bates, Electronic Principles, 8th edition. Tata McGraw-Hill, 2016.
3. P. Horowitz and W. Hill, The Art of Electronics, 3rd edition. Cambridge Univ. Press, 2015.
4. R. A. Gayakwad, Op-amps and Linear Integrated Circuits, 4th edition. PHI, 2000