Department of Physics
Savitribai Phule Pune University

Two-year M.Sc. (Physics) full-time course

(Credit and Semester based Syllabus to be implemented from Academic Year 2018-19)

Revision of Structure and Syllabi

M. Sc. (Physics) Semester-wise course structure

Total Number of Credits: 20 (Compulsory # 20, Elective # 00)

Semester - I			
Core Courses			
Subject Code	**Subject Title / Course**	**Number of Credits**	**Remark**
PHY-C103	Mathematical Methods in Physics-I	**4**	Compulsory
PHY-C104	Classical Mechanics	**4**	Compulsory
PHY-C105	Quantum Mechanics-I	**4**	Compulsory
PHY-C106	Basic Electronics	**2**	Compulsory
PHY-C107	Atomic and Molecular Physics	**2**	Compulsory
PHY-C101/C102	Basic Physics Laboratory-I / Computer Programming and Numerical Methods	**4**	Compulsory
Total		**20**	

Total Number of Credits: 20 (Compulsory # 20, Elective # 00)

Semester II			
Core Courses			
Subject Code	**Subject Title**	**Number of Credits**	**Remark**
PHY-C203	Statistical Mechanics	**4**	Compulsory
PHY-C204	Electrodynamics-I	**4**	Compulsory
PHY-C205	Solid State Physics	**4**	Compulsory
PHY-C206	Quantum Mechanics-II	**2**	Compulsory
PHY-C207	Applied Electronics	**2**	Compulsory
PHY-C201/C202	Basic Physics Laboratory-I / Computer Programming and Numerical Methods	**4**	Compulsory
Total		**20**	

Total Number of Credits: 20 (Compulsory # 20, Elective # 00)

Semester III			
Core Courses			
Subject Code	**Subject Title**	**Number of Credits**	**Remark**
PHY-S 351 to 369	Special paper-I	4	
PHY-C302	Electrodynamics-II	2	
PHY-C301	Basic Physics Laboratory-II	4	
Total		**10**	

Total Number of Credits: 20 (Compulsory # 10, Elective # 10)

Elective Courses			
Subject Code	**Subject Title**	**Number of Credits**	**Remark**
PHY-E311	Methods of Experimental Physics	4	
PHY-E312	Methods of Computational Physics	4	
PHY-E313	Atomic and Molecular spectroscopy	4	
PHY-E314	Optoelectronics and Devices	4	
PHY-E315	Radiation Physics	2	
PHY-E316	Medical Physics	2	
PHY-E317	Radiation Biology	2	
PHY-E318	Physics of diagnostic instruments	2	

PHY-E319	Biophotonics	2	
PHY-E320	Physics of Nuclear Medicine	2	
PHY-E321	Crystallography	2	
PHY-E322	Laser Physics and Lasers in technology	4	
PHY-E323	Mathematical Methods in Physics-II	4	
PHY-E324	Special topics in Quantum Mechanics	2	
PHY-E325	Hydrodynamics	2	
PHY-E326	Electrodynamics-III	2	
Special paper-I			
PHY-S351	CONDENSED MATTER-I	4	
PHY-S352	ACCELERATOR PHYSICS-I	4	
PHY-S353	ADVANCED QUANTUM MECHANICS-I	4	
PHY-S354	NONLINEAR DYNAMICS-I	4	
PHY-S355	MATERIALS SCIENCE-I	4	
PHY-S356	CHEMICAL PHYSICS – I	4	
PHY-S357	ASTRONOMY AND ASTROPHYSICS-I	4	
PHY-S358	NANOTECHNOLOGY-I	4	
PHY-S359	NUCLEAR TECHNIQUES-I	4	
PHY-S360	ENERGY STUDIES-I	4	
PHY-S361	BIO-PHYSICS-I	4	
PHY-S362	SOFT CONDENSED	4	

	MATTER-I		
PHY-S363	BIO-ELECTRONICS-I	4	
PHY-S364	PLASMA PHYSICS AND TECHNOLOGY – I	4	
PHY-S365	LASER-I	4	
PHY-S366	PHYSICS OF SEMICONDUCTOR DEVICES-I	4	
PHY-S367	THIN FILM PHYSICS AND DEVICE TECHNOLOGY-I	4	
PHY-S368	QUANTUM INFORMATION AND QUANTUM COMPUTATION -I	4	
PHY-S369	NONEQUILIBRIUM STATISTICAL MECHANICS -I	4	

Total Number of Credits: 20 (Compulsory # 10, Elective # 10)

Semester IV			
Core Courses			
Subject Code	**Subject Title**	**Number of Credits**	**Remarks**
PHY- S 451-469	Special paper-II	2	
PHY-C402	Nuclear Physics	4	
PHY-C400	Project	4	
Total		**10**	

Total Number of Credits: 20 (Compulsory # 10, Elective # 10)

Elective Courses			
Subject Code	**Subject Title**	**Number of Credits**	
PHY-E411	Vacuum and low temperature Physics	4	
PHY-E412	Advanced Experimental Laboratory	4	
PHY-E413	Advanced Theory Laboratory	4	
PHY-E414	Accelerator Physics	2	
PHY-E415	Solar energy Materials	2	
PHY-E416	Plasma Physics	2	
PHY-E417	Functional Materials	2	
PHY-E418	Spintronics	2	
PHY-E419	Physics of Driven	2	

	Systems		
PHY-E420	Dielectrics, Magnetism and superconductivity	4	
PHY-E421	Special Topics in Theoretical Physics	4	
PHY-E422	Advanced Mathematical Methods	2	
PHY-E423	Nonlinear Dynamics	4	
PHY-E424	CONDENSED MATTER-III	2	
PHY-E425	ACCELERATOR PHYSICS-III	2	
PHY-E426	ADVANCED QUANTUM MECHANICS-III	2	
PHY-E427	NONLINEAR DYNAMICS-III	2	
PHY-E428	MATERIALS SCIENCE-III	2	
PHY-E429	CHEMICAL PHYSICS – III	2	
PHY-E430	ASTRONOMY AND ASTROPHYSICS-III	2	
PHY-E431	NANOTECHNOLOGY-III	2	
PHY-E432	NUCLEAR TECHNIQUES-III	2	
PHY-E433	ENERGY STUDIES-III	2	
PHY-E434	BIO-PHYSICS-III	2	
PHY-E435	SOFT CONDENSED MATTER-III	2	
PHY-E436	BIO-ELECTRONICS-III	2	
PHY-E437	PLASMA PHYSICS AND TECHNOLOGY – III	2	

PHY-E438	LASER-III	2	
PHY-S439	PHYSICS OF SEMICONDUCTOR DEVICES –III	2	
PHY-E440	THIN FILM PHYSICS AND DEVICE TECHNOLOGY-III	2	
PHY-E441	QUANTUM INFORMATION AND QUANTUM COMPUTATION -III	2	
PHY-E442	NONEQUILIBRIUM STATISTICAL MECHANICS –III	2	
Special paper-II			
PHY-S451	CONDENSED MATTER-II	2	
PHY-S452	ACCELERATOR PHYSICS-II	2	
PHY-S453	ADVANCED QUANTUM MECHANICS-II	2	
PHY-S454	NONLINEAR DYNAMICS-II	2	
PHY-S455	MATERIALS SCIENCE-II	2	
PHY-S456	CHEMICAL PHYSICS – II	2	
PHY-S457	ASTRONOMY AND ASTROPHYSICS-II	2	
PHY-S458	NANOTECHNOLOGY-II	2	
PHY-S459	NUCLEAR TECHNIQUES-II	2	
PHY-S460	ENERGY STUDIES-II	2	
PHY-S461	BIO-PHYSICS-II	2	

PHY-S462	SOFT CONDENSED MATTER-II	2	
PHY-S463	BIO-ELECTRONICS-II	2	
PHY-S464	PLASMA PHYSICS AND TECHNOLOGY – II	2	
PHY-S465	LASER-II	2	
PHY-S466	PHYSICS OF SEMICONDUCTOR DEVICES –II	2	
PHY-S467	THIN FILM PHYSICS AND DEVICE TECHNOLOGY-II	2	
PHY-S468	QUANTUM INFORMATION AND QUANTUM COMPUTATION -II	2	
PHY-S469	NONEQUILIBRIUM STATISTICAL MECHANICS -II	2	

Total Number of Credits: 20 (Compulsory # 10, Elective # 10)

PHY-C103: Mathematical Methods in Physics – I

Module-1 : (15L, 4T/S/D): Linear spaces and operators : Vector spaces, Linear independence, Bases, dimensionality isomorphisms. Linear transformations, inverses, matrices, similarity transformations, Eigenvalues and Eigenvectors. Inner product, orthogonality and completeness, complete orthogonal set, Gramm Schmidt orthogonalization procedure, Self-adjoint and unitary transformations. Eigenvalues and Eigenvectors of Hermitian and Unitary transformations, diagonalization. Function space and Hilbert space. Complete orthonormal sets of functions. Weierstrass's theorem (without proof) approximation by polynomial.

Module-2 : (15L, 4T/S/D): Complex Analysis : Analytical functions, Cauchy-Riemann conditions, Rectifiable arcs, Line integrals, Cauchy's theorem, Cauchy integral formula, Derivatives of analytical functions, Liouville's theorem. Power series Taylor's theorem, Laurent's theorem. Calculus of residues, evaluation of real definite integrals, summation of series, elementary discussion of branch cuts, Applications : Principal value integrals and dispersion relations.

Module -3: (18 L, 4 T/S/D) Fourier series, Fourier integrals, Fourier transform, Parseval Relations, Convolution, Applications; Laplace transform, Bromwich integral (without proof) simple applications; Power series and contour integral solutions of second order diff. equations (Legendre, Bessel, Hermite, Laguerre as special examples properties of these functions). Legendre polynomials, Spherical harmonics and associated Legendre polynomials. Hermite polynomials. Sturm-Liouville systems and orthogonal polynomials.

Books :

Text Books:

1. Finite dimensional vector spaces, P. R. Halmos (Springer Verlag).
2. Mathematics of Classical and Quantum Physics, F.W. Byron and R.W. Fuller (Dover).
3. Linear Algebra, K. Hoffman and R. Kunze (Pearson).
4. M. Artin, Algebra, (Pearson).
5. Matrix Analysis, R.A. Horn and C.R. Johnson (Cambridge University Press).
6. Differential Equations with Applications, G. Simmons (Pearson).
7. Complex variables and Applications, R. V. Churchill (McGraw Hill).
8 Complex variables, Ablowitz and Fokas (Cambridge Univ. Press).
9. Complex analysis, Ahlfors (Springer).
10. Fourier series and Boundary value problems, R. V. Churchill (McGraw Hill).
11. Functions of Mathematical Physics, B. Spain and M.G. Smith (Van Nostrand Reinhold).
12. Green's Functions and Boundary value problems, I. Stakgold and M.J. Holst (Wiley).
13. Mathematics for Physicists, Dennery& Krzywicki (Dover)
14. Mathematical Physics, S. Hassani (Springer)
15. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris (Academic Press).
16. Mathematical Methods in Classical and Quantum Physics, TulsiDassand S.K. Sharma (Orient Blackswan).17. Advanced Engineering Mathematics, E. Kreyszig (John Wiley & Sons).
17. Mathematical Methods of Physics, J. Mathews and R.L. Walker (Addison Wesley).
18. Advanced Engineering Mathematics, E. Kreyszig (John Wiley & Sons).

PHY-C104: Classical Mechanics

Module 1 : 1.5 credits (16L + 7T)
Generalized coordinates and momenta, Phase space, Variational Calculus, Hamilton's principle of least action, Derivation of Lagrangian and Hamilton's equations of motion from principle of least action, Phase portraits of some simple systems, Symmetries and conservation laws, Noether's theorem, Canonical Transformations. Poisson brackets, Hamilton-Jacobi equation. Action-angle variables.

Module 2 : 1.5 credits (16L + 6T)
Central forces. Two body problem. Stability of orbits. Classification of orbits.
Application to planetary motion: Kepler's laws.
Scattering in central force fields: centre of mass and laboratory frames of reference, scattering kinematics. Rutherford scattering.
Rigid body dynamics: Euler-Chasle theorems, Moment of inertia tensor. Euler's equation of motion, Euler angles. Symmetric top.
Non-inertial reference frames, Pseudo forces – centrifugal, Coriolis and Euler forces. Applications

Module 3 : 1 credit (10L + 5T)
Small oscillations. Systems of coupled oscillators. Normal modes and normal coordinates. Generalization to continuum limit.

Books:

1. Classical Mechanics, Goldstein, Poole, &Safko (Pearson).
2. Mechanics, Landau &Lifshitz (Butterworth-Heinemann).
3. Classical Mechanics, Taylor (University Science Books).
4. Classical Mechanics, Rana &Joag (McGraw Hill).
5. Classical Mechanics, Gregory (Cambridge University Press).
6. Classical Dynamics of Particles and Systems, Marion & Thornton (Cambridge University Press).
7. Classical Mechanics: Systems of Particles and Hamiltonian Dynamics, Greiner (Springer).
8. Classical Dynamics: A Contemporary Approach, Jose &Saletan (Cambridge University Press).
9. Classical Mechanics, Strauch (Springer).
10. Classical Mechanics, A.K. Raychaudhuri (Oxford University Press)

PHY-C105: QUANTUM MECHANICS – I

Module-1: 2 credits (24 L, 6T/S/D):

1-D problems in quantum mechanics,Wells and barriers, Harmonic oscillator, Hermite polynomials and their properties, Qualitative plots of wave functions and their interpretation.

Formalism of Quantum Mechanics: State Vectors, Observables and operators, Ket space, Bra space and Inner product, Hermitian operators, Eigenvalues and Eigenfunctions, Completeness, Matrix representation of states and operators, Commutability and compatibility, Uncertainty relation for x and p from their commutator, Change of basis, Unitary transformations, Representations in different bases. Simple harmonic oscillator by operator method, States with minimum uncertainty product.

Time-evolution of a quantum system: Schrödinger, Heisenberg and Interaction pictures, Constants of the motion.

Module-2: 1 credits (12 L, 3T/S/D):

Orbital angular momentum operators, Commutation relations, Raising and lowering operators, Representation of operators and states in spherical coordinates, Spherical harmonics, Plots for spherical harmonics. Spherically symmetric potentials, Solution of hydrogen atom problem, Plots for wave functions.
Intrinsic Spin angular momentum: Pauli matrices and spin 1/2 eigenstates. Addition of angular momenta, Clebsch -Gordan coefficients, Wigner-Eckart theorem(statement). Identical particles: Spin and Statistics. Symmetric and antisymmetric wave functions, Slater determinants and Permanents.

Symmetry in quantum mechanics: Space and time translations. Discrete Parity and time reversal symmetries.

Module-3: 1 credit (12 L, 3 T/S/D):

Time-independent perturbation theory. Non-degenerate and degenerate cases, Fine Structure of the Hydrogen atom. Applications such as the Stark effect, Zeeman effect. Variational method and applications such as the Helium Atom.

WKB approximation: Connection formulas, Bohr-Sommerfeld quantization condition and the Gamow formula for barrier tunneling.

Text Books:

1. Quantum Mechanics, L. I. Schiff (McGraw-Hill).
2. Quantum Physics, S. Gasiorowicz (Wiley International).
3. Modern Quantum Mechanics, J. J. Sakurai (Addison Wesley).
4. Quantum Mechanics, D. J. Griffiths (Pearson Education).

Reference Books:

5. Quantum Mechanics (Non-Relativistic Theory), L.D. Landau and E.M. Lifshitz (Elsevier).
6. Quantum Mechanics : Vols. I & II , C. Cohen-Tannaudji, B. Diu, F. Laloe (John Wiley).
7. Quantum Mechanics: Fundamentals, K. Gottfried and T-Mow Yan (Springer).
8. Introduction to Quantum Mechanics, L. Pauling and E. B. Wilson (McGraw Hill).
9. Quantum Mechanics, B. Crasemann and J.D. Powel (Addison-Wesley).
10. Quantum Mechanics : Vol. I & II, A. P Messiah (Dover) .
11. The Principles of Quantum Mechanics, P. A. M. Dirac (Clarendon Press, Oxford).
12. Quantum Mechanics, I. Levine (Allyn and Bacon).
13. A Modern Approach to Quantum Mechanics, J. Townsend (University Science Books).
14. Essential Quantum Mechanics, G.E. Bowman (Oxford University Press).
15. Quantum Physics, M. Le Bellac (Cambridge University Press).

PHY-C106 : Basic Electronics (2 Credits)

Module-1 : 1 Credit (10L, 5T/S/D)

Network theorem: Kirchhoff's law, Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Bi-junction Transistor (BJT): Transistor fundamentals, Transistor biasing circuits.

Module-2 : 1 Credit (10L, 5T/S/D)

Transistor: AC models, Voltage amplifiers, CC and CB amplifiers, Class A and B Power Amplifiers, push pull for PA system, Differential Amplifier, its parameters, Common Mode Rejection Ration (CMRR).

Books :

1. *Electronics Principles*, A. P. Malvino, Tata McGraw Hill, New Delhi.
2. *Electronics Fundamentals and Applications,* J. D. Ryder, John Wiley-Eastern Publications.
3. *Integrated Circuits, Milman and Halkias*, Prentice-Hall Publications.

PHY-C105 Atomic and Molecular Physics (2 credits)

Module-1: 1 credit (10 L, 5 T/S/D):

Atomic structure and Atomic spectra:

Revision of hydrogen atom (wave functions, orbital and spin angular momentum, magnetic dipole moment, spin-orbit interaction, fine structure, spectroscopic terms). Multi-electron atoms: Central field approximation, Exchange symmetry of wave functions, electron configurations, Hartree-Fock theory, Self-consistent fields, L-S coupling, J-J coupling, Hund's rules. Atoms in an electromagnetic field: Spectral lines, Selection rules, Some features of one-and two-electron spectra, fine structure spectra, hyperfine structure spectra, X-ray spectra, Stark effect , Zeeman effect and Paschen-Back effect

Module-2 : 1 credit (10 L, 5 T/S/D):

Molecular structure and Molecular spectra:

Molecular Structure and Molecular Spectra : Covalent, ionic and van der Waal bonding, Valence bond and molecular orbital approach for molecular bonding and electronic structure of homonuclear diatomic molecules, pairing and valency, heteronuclear diatomic molecules, hybridization, ionic bonding, electro-negativity, electron affinity. Electronic structure of polyatomic molecules: hybrid orbitals, bonding in hydrocarbons. Rotational levels in diatomic and polyatomic molecules: Rigid and non-rigid rotation Vibrational levels in diatomic and polyatomic molecules. Morse oscillator model for vibrational levels.

Books:

1. Atomic Spectra and Atomic Structure by G. Herzberg, New York Dover Publication 1944
2. Atomic Spectra and Radiative Transitions by Igor I. Sobelman, Springer series on Atoms and Plasmas 1991
3. Molecular Spectra and molecular structure I, II, III, G. Herzberg, D. Van Nostrand Company Inc. , 1963.
4. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles Robert Eisberg and Robert Resnick, John Wiley and Sons
5. Fundamentals of Molecular Spectroscopy, C. N. Banwell and E. M. McCash, Tata, McGraw-Hill Publishing Company Limited.
6. Atoms, Molecules and photons by Wolfgang Demtröder, Springer -2005

PHYC201/Basic Physics Laboratory-I

Proposed list of the experiments for Basic Physics Laboratory I (Any 12 experiments)

i) Use of IC 555 as a astable/monostable/bistable oscillator OR In put and out put characteristics of Class A transistor

ii) Characteristics of operational amplifier
(Here students are expected to make the connections using soldering gun)

iii) Magnetic Susceptibility

iv) Temperature transducer (T to F convertor)

v) Thermionic emission

vi) Mass Absorption

vii) Counting Statistics

viii) Zeeman Effect

ix) Fabry Perot Interferometer

x) Michelson interferometer

xi) Absorption spectra of I_2 molecule

xii) Determination of Seebeck coefficient and understanding of Thermocouple working.

xiii) Recording and analysis of B-H curve

xiv) Millikan Oil drop method

xv) e/m

PHY-C-102 : Computer Programming and Numerical Methods

FORTRAN PROGRAMMING AND NUMERICAL METHODS

A. Basic Linux commands, text editors and gnuplot (in Lab); FORTAN Commands and Computer basics.

B. Exercises for acquaintance (only some experiments are listed here): (Using FORTRAN90/95):

1. To find the largest or smallest among a set of numbers.
2. To arrange a given set of numbers in ascending/descending order using Bubble sort algorithm.
3. To generate and print first hundred prime numbers.
4. Matrix addition and multiplication using subroutine.
5. Transpose of a square matrix using only one array.
6. Evaluate a polynomial using Horner's method.

C. Numerical Methods:

1. Root finding methods (i) Bisection Method (ii) Newton-Raphson Method (iii) Secant method
and applications.
2. Regression models: (i) Linear fit, (ii) Spline fit and applications.
(a) Fit a given data set as well as find the standard deviation or error.
3. Lagrange Interpolation and Divided difference interpolation and its uses.
5. Numerical differentiation using forward, backward and mean difference method
6. Numerical Integration : (i) Simpson's rule, (ii) Gaussian Quadrature and applications.
7. Numerical solution of a first order differential equation. (Euler's methods) and applications.
8. Solution of simultaneous equations : (i) Gaussian Elimination method and applications.

(Note: The course is expected to comprise of 20 exercises).

Books:

1. Programming in Fortran 90/95 V. Rajaraman (Prentice□Hall of India).
2. A first course in Computational Physics, 2nd Ed., P. L. DeVries & J. E. Hasbun (Jones & Bartlett)
Computer Oriented Numerical Methods, V. Rajaraman (Prentice Hall of India).
3. Numerical Methods for Scientist and Engineers, H. M. Antia (Tata McGraw Hill).
4. Numerical Methods with Fortran IV case studies, Dorn & McCracken (John Wiley and Sons).
5. Numerical Recipes in FORTRAN (2nd Edn.), W. H. Press, S. A. Teakalsky, W. T. Vellerling, B. P.Flannery (Cambridge University Press).

PHY-T203: STATISTICAL MECHANIC

Module1: 1 credit (10L + 5T)
A brief revision of the laws of thermodynamics. Thermodynamical work for magnetic,dielectric, elastic systems. Legendre transformation, Thermodynamic potentials.Statistical basis of thermodynamics. Elements of ensemble theory. Microcanonical ensemble.Macroscopic and microscopic states. Classical phase space, Statistical distribution function,Liouville's theorem, Statistical origin of entropy. Application to the ideal gas. Gibbs paradoxand Gibbs correction term. Quantum states and the phase space.

Module 2: 1 credit (10L + 5T)
Canonical ensemble, Partition function and thermodynamic variables, Energy fluctuations.Boltzmann distribution. Applications to the thermodynamics of an ideal gas, Specific heat ofsolids (classical and Einstein models), and Paramagnetism (Langevin and Brillouin models).Equipartition and virial theorem.Thermodynamics of interacting systems – Van der Waals gas and 1D Ising model.

Module 3: 1 credit (10L, 5T)
Grand canonical ensemble, Partition function and thermodynamical variables,Density and energy fluctuations, Application to the problem of adsorption.First order and second order phase transitions, Phase equilibriaQuantum statistics: Density matrix. Pure states and statistical mixtures. Density matrices formicrocanonical, canonical and grand canonical ensembles. Representation of density matricesin energy, coordinate and momentum bases, with suitable examples.

Module 4: 1 credit (10L, 5T)
Ideal Bose gas: Bose-Einstein statistics, Partition function, Thermodynamic behaviour,Bose-Einstein condensation in ideal Bose gas. Applications: Black body radiation. Planck's law and its limiting cases (Raleigh-Jeans law,Wien's displacement law), Stefan-Boltzmann law.Phonon gas. Specific heat of solids (Einstein and Debye models).Ideal Fermi gas.: Fermi-Dirac statistics, Partition function, Thermodynamic behaviour Applications: Degenerate electron gas (free electrons in a metal), Fermi energy and meanenergy, Fermi temperature, Fermi velocity and specific heat. Estimation of the size of white dwarfs.

Books:

1. Statistical Mechanics, Pathria and Beale (Academic Press).
2. Statistical Mechanics, Huang (Wiley).
3. Statistical Physics of Particles, Kardar (Cambridge University Press).
4. Statistical and Thermal Physics, Gould &Tobochnik (Princeton University Press).
5. An Introduction to Statistical Mechanics and Thermodynamics, Swendsen (Oxford
6. University Press).
7. Thermodynamics and Statistical Mechanics, Greiner, Neise, Stocker, Springer, 2010.
8. Statistical Mechanics, Reif
9. Statistical Physics (Part 1), L.D. Landau and E. M. Lifhsitz (Elsevier)

PHY-C204: Electrodynamics – I

Module-1: 1 Credit (10 L, 5 T/S/D)
Coloumb's law, Gauss's law, Poisson's equation and Laplace's equation, Electrostatic potential energy, Simple applications, Simple boundary value problems illustrating various techniques such as method of images, separation of variables, Green's functions, Multipole expansion.

Module-2: 1 Credit (10 L, 5 T/S/D)
Dielectric materials, Polarization, Electric field of a polarized material, Bound charges, Gauss's law in dielectric materials, Linear dielectric materials, Boundary conditions at the interface of two dielectrics.

Module-3: 1 Credit (10 L, 5 T/S/D)
Steady currents, Biot-Savart law and Ampere's law, Simple applications, Magnetic vector potential, Multipole expansion, Magnetic materials, Magnetization, Magnetic field of magnetized material, Bound currents, Linear magnetic materials, Boundary conditions
.

Module-4: 1 Credit (10 L, 5 T/S/D)
Electromotive force, Electromagnetic induction: Faraday's law, Inductance, Energy in magnetic fields, Maxwell correction to Ampere's law, Maxwell equations, Wave equations for electric and magnetic fields.

Books:

1.Introduction to electrodynamics,D. J. Griffiths (Prentice Hall).
2. Classical Electrodynamics,J. D. Jackson (John Wiley).
3. Classical theory of fields,L. D. Landau and E. M. Lifshitz (Addison-Wesley).
4. Electrodynamics of continuous media,L. D. Landau and E. M. Lifshitz (Addison-Wesley).
5. Electrodynamics, A. Somerfield (Academic Press, Freeman and Co.).
6. Classical Electricity and Magnetism,W.K.H. Panofsky and M. Phillips (Addison-Wesley).
7. Feynman LecturesVol. II. R. P. Feynman, Leighton and Sands (Narosa).
8. Berkeley SeriesVolume II, E.M.Purcell (McGraw-Hill).
9. Electricity and Magnetism,Reitz, Milford and Christy (Pearson).
10. Introduction to Electrodynamics,A. Z. Capri and P. V. Panat (Narosa).

PHY-C205: Solid State Physics

PHY-C206: QUANTUM MECHANICS – II

Module-1: 1 credits (12 L, 3 T/S/D):

Time-dependent perturbation theory: Interaction picture, Dyson series, Transition probability, Constant perturbation, Fermi's golden rule, Harmonic perturbation, Transition probability and interpretation as absorption and emission, principle of detailed balance.
Application to ionization of hydrogen atom.

Application to interaction of classical radiation field with matter: Absorption and induced emission, Electric dipole transitions, Selection rules, Decays and lifetime, natural line-width. Transition probability for spontaneous emission, Detailed balance and Planck distribution formula, Einstein A and B coefficients. The Photoelectric effect for H-atom.
Adiabatic and sudden approximations.

Module 2 : 1 credits (12 L, 3 T/S/T):

Scattering theory: Scattering amplitude, differential scattering cross section and total scattering cross section, the Lippman-Schwinger equation, the Born approximation, Applications and validity of the Born approximation, Optical theorem.
Method of partial waves: Partial wave expansion, Unitarity and Phase shifts; Scattering by a perfectly rigid sphere and square well potential, Ramsauer-Townsend effect; Complex potential and absorption, Collision of identical particles, Levinson's theorem (Statement).

Books:

1. Modern Quantum Mechanics, J. J. Sakurai (Addison Wesley).
2. Quantum Mechanics, L. I. Schiff (McGraw-Hill).
3. Quantum Physics, S. Gasiorowicz (Wiley International).
4. Quantum Mechanics(Non-Relativistic Theory), L.D. Landau and E.M. Lifshitz (Elsevier).
5. Quantum Mechanics, Cohen-Tannaudji, Din, Laloe Vols. I & II (John Wiley).
6. Quantum Mechanics: Fundamentals, K. Gottfried and T-Mow Yan (Springer).
7. Introduction to Quantum Mechanics, L. Pauling and E. B. Wilson (McGraw Hill).
8. Quantum Mechanics, B. Crasemann and J.D. Powel (Addison-Wesley).
9. Quantum Mechanics -Vol. I & II, A.P Messiah (Dover).
10. The Principles of Quantum Mechanics, P. A. M. Dirac (Clarendon Press, Oxford).
11. Quantum Mechanics, I. Levine (Allyn and Bacon).
12. Quantum Mechanics, D. J. Griffiths (Pearson Education).
13. A Modern Approach to Quantum Mechanics, J. Townsend (University Science Books).
14. Essential Quantum Mechanics, G.E. Bowman (Oxford University Press).
15. Quantum Physics, M. Le Bellac (Cambridge University Press).

PHY-C207: Applied Electronics (Credit: 2)

Module 1 : 1 Credit (10L, 5T/S/D)

OPAMP : Op Amp Theory, Linear Op Amp Circuits, Non Linear Op Amp Circuits, applications (Adder, subtractor, active filters, AC voltmeter). Positive and negative feedback and their effects on the performance of amplifier, Barkhausen criteria, Oscillators-LC and RC : Wien bridge, phase shift Hartley and Colpitt. IC based oscillators and timer circuits. Regulated power supplies-series, shunt and line filters, Wave shaping circuits.

Module- 2 : 1 Credit (10L, 5T/S/D)

Digital Electronics-Logic gates, Arithmetic circuits, Flip Flops, Digital integrated circuits-NAND & NOR gates as building blocks, X-OR Gate, simple combinational circuits, K-Map, Half & Full adder, Flip-flop, shift register, counters, Basic principles of A/D & D/A converters; Simple applications of A/D & D/A converters. Introduction to Microprocessors. Elements of Microprocessors.

Books :

1. *Electronics Principles,* A. P. Malvino, Tata McGraw Hill, New Delhi.
2. *Electronics Fundamentals and Applications,* J. D. Ryder, John Wiley-Eastern Publications.
3. *Integrated Circuits, Milman and Halkias,* Prentice-Hall Publications.
4. *Digital Principles and Applications,* A. P. Malvino, D.P. Leach, McGraw Hill Book Co., 4th Edition (1986).

Syllabus for Basics of Electrodynamics (Courses which can be opted for by students from outside departments)

Module-1: 1 Credit (10 L, 5 T/S/D)
Coloumb's law, Gauss's law, Poisson's equation and Laplace's equation, Electrostatic potential energy, Simple applications, Dielectric materials, Polarization, Electric field of a polarized material, Bound charges, Gauss's law in dielectric materials, Linear dielectric materials

Module-2: 1 Credit (10 L, 5 T/S/D)
Steady currents, Biot-Savart law and Ampere's law, Simple applications, Magnetic vector potential, Magnetic materials, Magnetization, Magnetic field of magnetized material, Bound currents, Linear magnetic materials, Electromotive force, Electromagnetic induction: Faraday's law, Maxwell equations.

Books:

1.Introduction to electrodynamics,
D. J. Griffiths (Prentice Hall).
2. Classical Electrodynamics,
J. D. Jackson (John Wiley).
3. Classical theory of fields,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
4. Electrodynamics of continuous media,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
5. Electrodynamics,
A. Somerfield (Academic Press, Freeman and Co.).
6. Classical Electricity and Magnetism,
W.K.H. Panofsky and M. Phillips (Addison-Wesley).
7. Feynman Lectures
Vol. II.
R. P. Feynman, Leighton and Sands (Narosa).
8. Berkeley Series
Volume II,
E.M.Purcell (McGraw-Hill).
9. Electricity and Magnetism,
Reitz, Milford and Christy (Pearson).
10. Introduction to Electrodynamics,
A. Z. Capri and P. V. Panat (Narosa).

PHY-OD02: FUNDAMENTALS OF QUANTUM MECHANICS

(ONLY FOR THE STUDENTS OUTSIDE THE DEPARTMENT)

Module-1: 2 credits (24 L, 6T/S/D):

Inadequacy of classical concepts, Wave-particle duality, Thought experiments, Uncertainty relations. Bohr Model of Hydrogen atom, Schrödinger equation, continuity equation, Ehrenfest's theorem; solutions of Schrödinger equation, admissible wave functions, stationary states.
1-D problems in quantum mechanics Wells and barriers, Harmonic oscillator, Qualitative plots of wave functions and their interpretation

Hydrogen Atom problem, Qualitative discussion on multi-electron atoms

1. Quantum Mechanics, L. I. Schiff (McGraw-Hill).
2. Quantum Physics, S. Gasiorowicz (Wiley International).
3. Quantum Mechanics, B. Crasemann and J.D. Powel (Addison-Wesley).
4. Quantum Mechanics, D. J. Griffiths (Pearson Education).

Syllabus for ED – II
(Compulsory)

Module-1: 1 Credit (10 L, 5 T/S/D)
Motion of a charged particle in EM fields, Lorentz force, Motion in uniform, static, electric and magnetic fields and combined static EM fields, some applications.

Module-2: 1 Credit (10 L, 5 T/S/D)
Plane waves, Spherical waves, Phase and group velocities, Electromagnetic plane waves, Poynting vector and Poynting theorem, Momentum and energy densities associated with electromagnetic wave, Linear, Circular and Elliptic polarizations, Stokes parameters. Propagation of electromagnetic waves in dielectric materials, Reflection and refraction of plane waves, Polarization on reflection and refraction.

Books:

1.Introduction to electrodynamics,
D. J. Griffiths (Prentice Hall).
2. Classical Electrodynamics,
J. D. Jackson (John Wiley).
3. Classical theory of fields,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
4. Electrodynamics of continuous media,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
5. Electrodynamics,
A. Somerfield (Academic Press, Freeman and Co.).
6. Classical Electricity and Magnetism,
W.K.H. Panofsky and M. Phillips (Addison-Wesley).
7. Feynman Lectures
Vol. II.
R. P. Feynman, Leighton and Sands (Narosa).
8. Berkeley Series
Volume II,
E.M.Purcell (McGraw-Hill).
9. Electricity and Magnetism,
Reitz, Milford and Christy (Pearson).
10. Introduction to Electrodynamics,
A. Z. Capri and P. V. Panat (Narosa).

Syllabus for ED – III
(Optional)

Module-1: 1 Credit (10 L, 5 T/S/D)
Propagation of electromagnetic waves in conducting medium, Wave guides, TE and TM modes, Modes in a rectangular wave guide, Cavities and Modes.

Module-2: 1 Credit (10 L, 5 T/S/D)
Gauge transformations, Retarded potentials, Lienard-Wiechert potentials of a point charge, Electric dipole radiation, Magnetic dipole radiation, Radiation from half wave and full wave antenna, Radiation from an accelerated point charge, Larmor formula, Synchrotron radiation.

Books:

1.Introduction to electrodynamics,
D. J. Griffiths (Prentice Hall).
2. Classical Electrodynamics,
J. D. Jackson (John Wiley).
3. Classical theory of fields,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
4. Electrodynamics of continuous media,
L. D. Landau and E. M. Lifshitz (Addison-Wesley).
5. Electrodynamics,
A. Somerfield (Academic Press, Freeman and Co.).
6. Classical Electricity and Magnetism,
W.K.H. Panofsky and M. Phillips (Addison-Wesley).
7. Feynman Lectures
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8. Berkeley Series
Volume II,
E.M.Purcell (McGraw-Hill).
9. Electricity and Magnetism,
Reitz, Milford and Christy (Pearson).
10. Introduction to Electrodynamics,
A. Z. Capri and P. V. Panat (Narosa).

Elementary Thermodynamics (PHY-OD06) 2 Credits

Thermal Equilibrium and the First Law of Thermodynamic (1 Credit, 15 L/T)

Concept of temperature. Ideal gas temperature scale. Absolute temperature. Zeroth law of thermodynamics and the concept of thermal equilibrium. Concepts of heat and work. Quasi-static, reversible and irreversible processes. First law of thermodynamics and its applications.

Entropy and the second law of thermodynamics. (1 Credit, 15 L/T)

Conversion of work into heat and vice versa. Heat engines. Cornot cycle. Entropy. Second law of thermodynamics (different statements). Applications of second law. Equations of state (ideal gas example). Van der Waals gas equation.

Thermal properties of materials -heat capacity, thermal conductivity, thermal compressibility etc.

Black-body radiation, Planck's law (no derivation).

Basics of Classical Mechanics (PHY-OD03) 2 Credits

Newtonian mechanics (1 Credit, 15 L/T)

Newton's laws, Application of Newton's laws, Momentum, work and energy, Motion under central force, Harmonic oscillator.

Formulation of Lagrangian and Hamiltonian mechanics (1 Credit, 15 L/T)

Constraints and generalized coordinates. Lagrangian and Hamiltonian equation of motion (without derivations) – choosing appropriate generalized coordinates, constructing Lagrangian and Hamiltonian functions, and obtaining equations of motion.

Reference Books

1. An introduction to mechanics by D. Kleppner& R. Kolenkow, Tata-McGraw Hill, 2007.
2. *Classical Mechanics* by N. C. Rana & P. S. Joag, Tata-McGraw Hill, 2001.
3. *Classical Mechanics* by H. Goldstein, C. Poole & J. Safko, Addison-Wesley, 2001.
4. Physics Part-I by Halliday and Resnick, New Age International Publishers, 1995.