Classical Mechanics

UG/PG: PG	Department: Physics
Course Code: PHT651	Course Name: Classical Mechanics
Credits: 4	L-T-P: 3-1-0
Course Type: Core	
Pre-requisite course:	

Holonomic and non-holonomic constraints, Newton's equation with constraints, virtual work, generalized coordinates, D' Alembert's principle, Lagrange's equation and its applications, velocity dependent potentials and the dissipation functions, calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle. method of Lagrange's multipliers, cyclic coordinates, conservation theorems and symmetry principles, Noether's theorem.

[13 Lectures]

Central forces, virial theorem, Kepler's problem, Laplace-Runge-Lenzvector, scattering from a central force field in center of mass and laboratory coordinate systems, rigid body kinematics, orthogonaltransformations, Eulerian angles, Euler theorem, force free motion of a rigid body, uniformly rotating frames, coriolis force, small oscillations and normal modes.

[13 Lectures]

Legendre Transformations and the Hamilton equations of motion, Routh's Procedure, derivation of Hamilton's equations from a variational principle, canonical transformations, examples of canonical transformations, phase space diagram, stability analysis, Poisson brackets, Liouville's Theorem Hamilton Jacobi theory. [12 Lectures]

Lorentz transformations, Minkowski spacetime, light cone, four vector formalism, metric tensor, contravariant and covariant tensor, four vector formalism of electrodynamics, covariant Langrangian and Hamiltonian formulation. [4 Lectures]

Books recommended:

1. Classical Mechanics –Goldstein, Poole and Safko (Pearson Education).
2. Classical Mechanics – N. C. Rana and P. S. Joag (Tata McGraw Hill).
3. Mechanics – L. D. Landau and E. M. Lifshitz (Pergamon Press, Oxford).
4. Classical theory of fields L. D. Landau and E. M. Lifshitz (Pergamon Press, Oxford).
5. Classical Mechanics: Kibble and Berkshire (World Scientific)
6. Introduction to Classical Mechanics: R. G. Takwale and S. Puranik (Tata McGraw Hill).
7. Classical Mechanics: W. Greiner (Springer).
8. Theory and Problems of Theoretical Mechanics: M.R. Spiegel (Mc Graw-Hill).
9. Introduction to Classical Mechanics with Problems and Solutions: David Morin (Cambridge University Press).

Mathematical Physics

UG/PG: PG	**Department: Physics**
Course Code: PHT652	**Course Name: Mathematical Physics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Vector spaces, matrices, eigen values and eigenvectors, Cayley-Hamilton theorem, Gram-Schmidt orthoganlization process, elements of complex analysis, analytic functions, Taylor and Laurent series, poles, residues and evaluation of integrals. [11 Lectures]

Cartesian tensors, first and zero order cartesian tensors, second and higher order cartesian tensors, algebra of tensors, quotient law, isotropic tensors, improper rotations and pseudo tensors, dual tensors, physical applications of tensors, non- cartesian coordinates, metric tensor, general coordinate transformations and tensors, relative tensors.

[13 Lectures]

Laplace transforms and their properties, Fourier transforms and their properties, inverse Laplace and Fourier transforms, application of Laplace and Fourier transforms in solving linear differential equations, Sturm-Liouville's equation, Green's function and its applications. [12 Lectures]

Probability theory, random variables, binomial, Poisson and normal distributions, central limit theorem, groups, finite groups, non-abelian groups, permutation groups, mapping between groups, subgroups, sub dividing a group, SU(3) and O(3). [6 Lectures]

Books recommended :

1. Mathematical Methods for Physicists: G. Arfken (Academic Press).
2. Elements of Group Theory for Physicists: A.W. Joshi (Wiley Eastern Ltd.).
3. Mathematical Methods: Potter and Goldberg (Prentice Hall of India).
4. Mathematical Physics: Morse and Freshbach (2 vols.).
5. Mathematical Physics: I. C. Goyal.
6. Mathematical Physics: H. K. Das (S. Chand and Co.).
7. Introduction to Mathematical Physics: C. Harper (Prentice Hall of India 2006).
8. Mathematical Methods of Physics: Mathews and Wallker (Pearson Educations 2005).
9. A Course of Modern Analysis: Whittaker and Watson (Cambridge University Press).

Electronics

UG/PG: PG	**Department: Physics**
Course Code: PHT653	**Course Name: Electronics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Basic differential amplifier circuit, operational amplifier-characteristics, applications-summer, scalar and subtractor, integrator, differentiator , active filters & oscillators, wave shapers-comparators, clippers and clampers, Schmitt trigger, voltage limiter , the 555 timer - monostable and astable multivibrator, voltage regulators.

[25 Lectures]

Digital electronics- Boolean algebra, De Morgan's theorems, standard forms of Boolean expressions, K-map, number systems and codes, flip-flops - edge triggered flip flops, registers, counters, D/A conversion and A/D conversion.

[15 Lectures]

Klystron-an introduction

[2 Lectures]

Books recommended:

1. Electronic Principles: Malvino Bates (Tata McGraw Hill).
2. Op-Amps and Linear Intergrated Circuits: Ramakanth A.Gayakwad (PHI)
3. Digital Principles and Applications: A.P.Malvino and Donald P.Leach (TMH)
4. Modern Digital Electronic: R.P.Jain (TMH)
5. Electronic Devices and Circuit Theory: Robert Boylestad and Louis Nashdsky (PHI)
6. Digital Fundamentals: Floyd & Jain (Pearson Education)
7. Microwave Devices and Circuits: S.Y.Liao (PHI)
8. Digital Electronics : Morris Nano (Pearson)

Quantum Mechanics

UG/PG: PG	**Department: Physics**
Course Code: PHT654	**Course Name: Quantum Mechanics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Basics of quantum mechanics: state vector, vector spaces, Hilbert space, Dirac notation, probabilities in coordinate and momentum space , operators and expectation values of dynamical variables, commutators and operator algebra, Schrodinger equation(time-dependent and time-independent), eigen values and eigen functions, eigen value problems, Schrodinger picture, Heisenberg picture. [13 Lectures]

Expectation values and Ehrenfest's theorem, Heisenberg uncertainty principle, Harmonic oscillator: raising and lowering operators, two body problem, hydrogen atom. [12 Lectures]

Symmetries, conservation laws, invariance under space and time translations and space rotation, angular momentum algebra, spin, addition of angular momenta, Clebsch-Gordan Coefficients. [10 Lectures]

Time independent perturbation theory, normal Zeeman and Stark effects, WKB approximation and variational methods. [7 Lectures]

Books recommended :

1. Quantum Mechanics – A Modern Approach: Ashok Das and A.C. Milissiones, (Gordon and Breach Science Publishers).
2. Quantum Mechanics: E. Merzbacher, (Wiley).
3. Quantum Mechanics: L.I. Schiff, (McGraw Hill).
4. Quantum Mechanics, Theory and Applications: A.K. Ghatak and S. Loknathan,(McMillan India).
5. Quantum Mechanics: L. D. Landau and E. M. Liefshitz (Pergamon Press).
6. Introduction to Quantum Mechanics: David J. Griffiths (Pearson Education).
7. Quantum Mechanics- An Introduction: Walter Greiner (Springer).
8. Modern Quantum Mechanics: J.J. Sakurai, (Addision Wesley Publishing Co.).
9. Relativistic Quantum Mechanics-Wave Equations: Walter Greiner (Springer)
10. Quantum Mechanics: R. Shankar.
11. Feynmann Lecturers: Vol I, II & III.
12. Quantum Mechanics, B.H. Bransden, C.J. Joachain
13. Quantum Mechanics, Stephen Gasiorowicz.

Atomic & Molecular Spectroscopy

UG/PG: PG	Department: Physics
Course Code: PHT661	Course Name: Atomic & Molecular Spectroscopy
Credits: 4	L-T-P: 3-1-0
Course Type: Core	
Pre-requisite course: Quantum Mechanics	

Spectra of hydrogen and helium like atoms, spin-orbit interaction, fine structure, magnetic dipole interaction and hyper fine structure, Lamb shift (only qualitative treatment); interaction with external fields: Stark effect, Zeeman and Paschen-Back effect, general factors influencing spectral line width and intensities. [18 Lectures]

System with identical particles: exchange symmetry, hydrogen Molecular Ion, valence band theory, hydrogen molecule, Heitler-London method, Born-Oppenheimer approximation; rotational, vibrational and electronic spectra of diatomic molecules, Frank-Condon principle, Raman effect. [16 Lectures]

Principle and Operation of Spectroscopic Techniques : Optical spectroscopy- Raman and FTIR, Mossbauer spectroscopy, X ray- Emission and Absorption spectroscopy, X ray photoelectron spectroscopy. [8 Lectures]

Books recommended:

1. Introduction to Atomic Spectra: H. E. White (McGraw Hill).
2. Molecular Spectra and Molecular Structure: G. Herzberg.
3. Atomic and Molecular Spectroscopy: Dunford.
4. Fundamentals of Molecular Spectroscopy: C. N. Banwell and E. M. McCash (McGraw)
5. Molecular Spectroscopy: K. V. Raman, R. Gopalan and P.S. Raghavan (Thomson).
6. Atoms and Molecules : Bransden and Joachim .
7. Quantum Physics of Atoms, Molecules, Solids and Nuclear Particles: Eisberg and Resnick (Wiley).

Nuclear and Particle Physics

UG/PG: PG	**Department: Physics**
Course Code: PHT662	**Course Name: Nuclear and Particle Physics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Nuclear binding energy, electric and magnetic moments, nuclear force: deuteron, n-p and p-p scattering, semi-empirical mass formula: liquid drop model, nuclear shell model, shell model predictions, selection rules, nuclear isomerism, and collective nuclear model.

[9 Lectures]

Nuclear decay, theories for α, β and γ decay, transition probabilities, selection rules, general characteristics of weak interaction, nuclear reactions, partial wave analysis, compound nucleus formation, resonance scattering and reaction, optical model, reactor physics: fission reactors, four factor formula, schemes for nuclear fusion.

[12 Lectures]

Gas filled counters, scintillator counter**s**, solid state detectors, surface barrier detectors, proton synchrotron, linear accelerations, acceleration of heavy ions. [9 Lectures]

Elementary particles and their interactions, hadrons and leptons, symmetry and conservation laws, elementary ideas of CP and CPT invariance, relativistic kinematics, classification of hadrons, Lie algebra - SU (2) - SU (3) multiplets, quark model, Gell-mann-Okubo mass formula for octet and decuplet hadrons, parity non-conservation in weak interaction.

[12 Lectures]

Books Recommended:

1. Introductory Nuclear Physics: Kennath S Keane (Wiley).
2. Techniques for Nuclear and Particle Physics Experiments: W.R. Leo (Springer, 1994).
3. Radiation Detection and Measurement: G. F. Knoll (John Wiley, 1989).
4. Introduction to the Elementary Particle Physics: David Griffith (Wiley).
5. Introduction to High Energy Physics: Donald H. Perkins (Cambridge University Press).
6. Quark and Leptons: An Introductory Course in Modern Particle Physics: Francis Halzen, Alan D. Martin (John Wiley and Sons).
7. Structure of Nucleus: M.A. Preston and R.K. Bhaduri (Addison Wesley).
8. Nuclear Physics: R.R. Roy and B.P. Nigam (Wiley Eastern).
9. Introduction to Nuclear Physics: H. Enge (Addison Wesley).
10. The Atomic Nucleus: R.D. Evans (McGraw Hill).
11. Nuclear Physics: Kaplan (Addison Wesley).
12. Introductory Nuclear Physics: S. Wong (Prentice Hall of India).
13. Concepts of Nuclear Physics: Cohen (Tata McGraw Hill).
14. Nuclear Reactor Engineering: Glasstone and Sesonske (Van Nostrand Reinhold Co.).
15. Introduction to Experimental Nuclear Physics: R.M. Singru (Wiley Eastern).

Electromagnetic Theory

UG/PG: PG	Department: Physics
Course Code: PHT663	Course Name: Electromagnetic Theory
Credits: 4	L-T-P: 3-1-0
Course Type: Core	
Pre-requisite course:	

Basics of electrostatics and magnetostatics, Poisson's and Laplace's equation, techniques for calculating potentials, first and second uniqueness theorems, method of images, multipole expansion, dielectrics, polarization, magnetic vector potential, fields in dielectric media, boundary conditions. [10 Lectures]

Faraday's law, equation of continuity, Maxwell's displacement current, Maxwell's equations, Maxewell's equations inside the matter for time varying fields, Poynting vector, Maxwells stress tensor. [6 Lectures]

Electromagnetic waves in vacuum, electromagnetic waves in matter, reflection and transmission at normal and oblique incidence, EM waves in conductors, frequency dependence of permittivity, wave guides. [12 Lectures]

Scalar and vector potentials, potential formulation of Maxwell's equations, gauge transformations, Coulomb and Lorentz gauge, retarded potentials, Lienard-Wiechart potentials, field of a uniformly moving point charge, dipole radiation, power radiated by a point charge. [14 Lectures]

Books recommended:

1. Introduction to Electrodynamics: David J. Griffiths, (Prentice Hall of India).
2. Classical Electrodynamics: J.D. Jackson, (John Wiley and Sons).
3. Foundations of Electromagnetic Theory: J. Reitz and F.J. Milford (Addison-Wesley).
4. Classical Electricity and Magnetism: W.K.H. Panofsky, M. Phillips (Addison Wesley).
5. Fields and Waves Electromagnetics: David K. Cheng (Addison – Wesley).
6. Electromagnetic Waves and Radiating Systems: E.C. Jordan (Prentice Hall of India).
7. The Classical Theory of Fields: L.D. Landau, E.M. Lifshitz (Pergamon Press, Oxford).

Advanced Quantum Mechanics

UG/PG: PG	Department: Physics
Course Code: PHT664	Course Name: Advanced Quantum Mechanics
Credits: 4	L-T-P: 3-1-0
Course Type: Core	
Pre-requisite course:	

Time dependent perturbation theory, first order perturbation or expression for the transition amplitude and probability, harmonic perturbations, transition probability under constant perturbation, Fermi's golden rule. [12 Lectures]

Interaction of radiation with matter, radiation field quantization, spontaneous emission, absorption, induced emission, dipole transitions, selection rules, identical particles, Pauli's exclusion principle, spin-statistics connection. [12 Lectures]

Non-relativistic scattering, solution of scattering problem by the method of partial wave analysis, optical theorem, born approximation and its validity for scattering problems. [8 Lectures]

Introduction to relativistic wave equations, Klien- Gordan equation, plane wave solution of Klein-Gordan equation, Dirac's equation for a free particle, Dirac matrices or Dirac spinors, covariant form of Dirac equation, plane wave solutions of Dirac equation: energy spectrum, negative energy states, spin of the Dirac particle. [10 Lectures]

Books recommended :

1. Quantum Mechanics – A Modern Approach: Ashok Das and A.C. Milissiones, (Gordon and Breach Science Publishers).
2. Quantum Mechanics: E. Merzbacher, (Wiley).
3. Quantum Mechanics: L.I. Schiff, (McGraw Hill).
4. Quantum Mechanics, Theory and Applications: A.K. Ghatak and S. Loknathan, (McMillan India).
5. Quantum Mechanics: L. D. Landau and E. M. Liefshitz (Pergamon Press).
6. Introduction to Quantum Mechanics: David J. Griffiths (Pearson Education).
7. Quantum Mechanics- An Introduction: Walter Greiner (Springer).
8. Advanced Quantum Mechanics: J.J. Sakurai, (Addison Wesley Publishing Co.)
9. Relativistic Quantum Mechanics-Wave Equations: Walter Greiner (Springer).
10. Quantum Mechanics: R. Shankar.
11. Feynmann Lecturers: Vol I, II & III.

Solid State Physics

UG/PG: PG	**Department: Physics**
Course Code: PHT671	**Course Name: Solid State Physics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Review of basic crystal structures and bondings in solids, X-ray diffraction and reciprocal lattice, electron and neutron diffraction, lattice vibrations: dispersion relations and their interpretation for one dimensional mono and diatomic lattice types, concept of phonons Einstein and Debye models, thermal conductivity and thermal expansion. [13 Lectures]

Free electron theory, Bloch theorem, energy bands in solids: Kronig-Penney model, nearly free electron (NFE) model, tight binding approximation, concept of APW and OPW methods, Fermi surfaces, experimental techniques to measure Fermi surfaces: de Haas van Alphen effect and cyclotron resonance. [10 Lectures]

Defects in solids: point, line and planar defects, Schottky defects, Frenkel defects, color centres, order – disorder transformation, atomic diffusion in solids: diffusion mechanisms. [6 Lectures]

Semiconductors: carrier concentration and Fermi level, superconductivity: BCS theory and Josephson effect, quantum theory of magnetism: para- and ferromagnetism, antiferro- and ferrimagnetic materials, dielectric properties and losses, classical and quantum Hall effect, phase transformations: classification, order – disorder transformation, quasicrystals, nanostructures and applications. [13 Lectures]

Books recommended:

1. Introduction to Solid State Physics: C. Kittel, 7th Ed. (John Wiley and Sons).
2. Solid State Physics: N. Ashcroft and N.D. Mermin (Holt, Rinehart and Winston).
3. Solid State Physics: H. Ibach and H. Lueth (Kluwer Academic Pub.).
4. Solid State Physics: Wahab (Narosa).
5. Solid State Physics: Azaroff (McGraw Hill).
6. Solid State Physics: M.S. Rogalski and S.B. Palmer (Gordon & Breach Science Pub.).
7. Introductory Solid State Physics: H.P. Myers (Viva books Pvt. Ltd.).
8. Solid State Physics: A.J. Dekker (Prentice Hall of India, New Delhi).
9. Solid State Physics: Gerald Burns (Academic Press).
10. Introduction to Nanotechnology: Poole Jr. and Owens (J. Wiley and Sons).

Statistical Mechanics

UG/PG: PG	**Department: Physics**
Course Code: PHT672	**Course Name: Statistical Mechanics**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Review of thermodynamics. Introduction to statistical methods: micro and macro states, phase space, Liouville's theorem, postulates of statistical mechanics, system in thermal equilibrium, statistical ensembles, micro canonical ensembles, statistical interpretation of entropy, Gibbs paradox, law of equipartition of energy and its applications, canonical and grand canonical ensembles, partition functions and its properties (factorizability), methods of calculation of thermodynamic quantities using ensemble approach and applications; fluctuations in energy and other thermodynamic quantities.

[18 Lectures]

Quantum distribution functions: B-E and F-D statistics, vis–a–vis classical M-B statistics, Applications of F-D and B-E statistics: such as paramagnetism, liquid Helium problem etc.; Boltzmann Transport Equation and its applications, Phase transitions and its classifications: order parameter critical exponents and some important phase transitions. statistical models: Ising model, Potts and Kac model etc.; concept of non-equilibrium thermodynamics.

[24 Lectures]

Books recommended:

1. Statistical Mechanics: K. Huang (John Wiley and Sons).
2. Fundamentals of Statistical and Thermal Physics: Reif (McGraw Hill).
3. Statistical Mechanics and Thermal Physics: Rice (John Wiley).
4. Elementary Statistical Mechanics: C.Kittel (Dover Pub.).
5. Statistical Mechanics: R. K. Patharia (Butterworth Heinemann).
6. Manchester series of books: undergraduate physics.
7. Statistical Mechanics: B.K. Agarwal and Melvin Eisner (John Wiley and Sons, 1988).
8. Treatise on Heat : Saha and Srivastava (Wiley)
9. Statistical and Thermal Physics: Loknathan and Gambhir (Prentice Hall India)

Numerical Methods and Computer Programming

UG/PG: PG	**Department: Physics**
Course Code: PHT681	**Course Name: Numerical Methods and Computer Programming**
Credits: 4	**L-T-P: 3-1-0**
Course Type: Core	
Pre-requisite course:	

Programming basics in C / C++ language, data types, decision control structure, loop control structure, case control structure, function and pointers, arrays etc.

[15 Lectures]

Solving numerical method problems through computer programming, finite difference calculus, interpolation and extrapolation, roots of equations, solution of simultaneous linear algebraic equations, least squares curve fitting, monte carlo simulation for numerical integration, numerical solution of ordinary differential equations, runga kutta method IV order, matrix eigen value problems.

[20 Lectures]

Introduction to modelling and simulation, simple examples, particle in a box, random walk problem, Rutherford scattering.

[7 Lectures]

Books recommended:

1. Computer Oriented Numerical Methods: V. Rajaraman (Prentice Hall of India).
2. Introduction to Numerical Methods and Fortran Programming: T.R. McCalla (John Wiley and Sons).
3. Numerical Analysis: M. K. Jain.
4. Introduction to C++: Balaguruswamy.
5. Introduction Methods of Numerical Analysis: C.S. Sastry (PHI).
6. Numerical Analysis: E. Krishnamurthy.
7. Monte Carlo Simulation: Binder and Herman.
8. An Introduction to Computation Physics: T. Tang (Cambridge Univ. Press 1997).
9. Schaum Series: (McGraw Hill).