SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)

Syllabus of M.Sc. Physics

Effective from Academic Session
2018-2019

Patel Nagar, Dehradun, Uttarakhand

M.Sc. PHYSICS SYLLABUS

Course Code	SEMESTER-I	L-T-P	Credits
MPHC101	Classical Mechanics	4-0-0	4
MPHC102	Mathematical Physics	4-0-0	4
MPHC103	Electrodynamics and Astrophysics	4-0-0	4
MPHC104	Electronics	4-0-0	4
MPHL105	Laboratory Course I	0-0-3	3
MPHL106	Laboratory Course II	0-0-3	3
			Total Core Credits = 22

Course Code	SEMESTER-II	L-T-P	Credits
MPHC201	Atomic and Molecular Physics	4-0-0	4
MPHC202	Solid State Physics	4-0-0	4
MPHC203	Statistical Physics	4-0-0	4
MPHC204	Quantum Mechanics	4-0-0	4
MPHL205	Laboratory Course I	0-0-3	3
MPHL206	Laboratory Course II	0-0-3	3
			Total Core Credits = 22

Course Code	SEMESTER-III	L-T-P	Credits
MPHC301	Advanced Quantum Mechanics	4-0-0	4
MPHC302	Nuclear Physics	4-0-0	4
MPHL303	Laboratory Course I	0-0-3	3
MPHE304 **MPHE305** **MPHE306** **MPHE307** **MPHE308**	Condensed Matter Physics - A Electronics - A Laser Physics - A Astrophysics - A High Energy Physics - A	Students have to select any two elective papers out of four 4-0-0	2 X 4 = 8
MPHL309	Laboratory Course II (Based on E304/305/306/307/308)	0-0-3	3
MPHS310 **MPHS311**	**SELF STUDY COURSES:** Physics Of Nano Materials Quantum Electrodynamics	Students have to select any one paper out of two	3
Total Credits (excluding Self-study Course) = 22 (Core Credits = 11 + Elective Credits = 11)			

Course Code	SEMESTER-IV	L-T-P	Credits
MPHC401	Computational Physics	4-0-0	4
MPHC402	Particle Physics	4-0-0	4
MPHL403	Laboratory Course	0-0-3	3
MPHE404 **MPHE405** **MPHE406** **MPHE407** **MPHE408**	Condensed Matter Physics - B Electronics - B Laser Physics - B Astrophysics - B High Energy Physics - B	Students have to select those two elective papers out of four which are selected in III semester 3-0-0	2 X 3 = 6
MPHE409	Project	0-0-3	3
MPHS410 **MPHS411**	**SELF STUDY COURSES:** Environmental Physics Bio Physics	Students have to select any one paper out of two	3
Total Credits (excluding Self-study Course) = 20 (Core Credits = 11 + Elective Credits = 09)			

Grand Total Credits: 86 (Core Credits - 66 + Elective Credits – 20)

Max. Marks for each paper: 100 (40 – Sessional Tests + 60 - End Term Test).

Sessionals may be in the form of Mid Term Test, Assignment, Classroom Seminar & Laboratory Work, Internship, Industrial / Institutional visits, winter / Summer Training based report Writing & Presentation, Report based on workshop organized by Department etc.

The 2- Year Master's Programme will have the following components:

1) Core course (C): Minimum 66 credits.
2) Elective course (E): Minimum 20 credit
3) Self-study course (S): Maximum 06 credits (one minimum 03 credits course shall be mandatory but not to be included while calculating grades). Students have to opt self-study courses either in third semester or in fourth semester. This will be conducted and evaluated at Departmental level.

SEMESTER - I

MPHC101: CLASSICAL MECHANICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I

Lagrangian formulation and Variational Principle: Mechanics of particles and system of particles, conversion law, constraints, degree of freedom, generalized coordinates, D'Alembert's principle, Lagrange's equations of motion from D'Alembert's principle, application of Lagrange's equation of motion to a particle and system of particles, conservation theorem, Hamilton's variational principle, Euler- Lagrange's differential equation

Unit II

Hamilton's formalism: Need of Hamilton's procedure , Legendre's transformation and Hamilton's equation of motion, physical significance of H, cyclic coordinates, Hamilton's equation in cylindrical and spherical coordinates and applications, applications of Hamilton's equation of motion to a particle and system of particles

Unit III

Principle of least action (no proof): Canonical or contrast transformation, their advantages and examples, condition for a transformation to be canonical, infinitesimal contact transformation (ICT) Poisson brackets: Definition and properties, Invariance with respect to Canonical transformation, equation of motion in Poisson's Bracket form, Jacobian's form.

Unit IV

Mechanics of Rigid Bodies and Theory of Small Oscillations: Coordinates of rigid body motion, Euler's angle, angular momentum of a rigid body moments and products of inertia, principle axis transformation, Euler's equation of motion of a rigid body, stable and unstable equilibriums. Lagrange's equation of motion for small oscillators, normal coordinates and normal mode frequency of vibrations, free vibration of linear triatomic molecules

Reference Books:

1.N C Rama and P S Joag: Classical Mechanics (Tata McGraw Hill, 1991)
2.H Goldstein: Classical Mechanics (Addition Wesley, 1980)
3.A Sommerfield: Mechanics (Academic Press, 1952) .
4. I Peiceivel and D Richards: Introduction to Dynamics (Cambridge University Press)

MPHC102: MATHEMATICAL PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Differential Equations: Special equations of Mathematical Physics, Legendre and Associated Legendre Equations.Hermite equation, Laguerre equation, Bessel's equation, Beta and Gamma functions. Fourier and Laplace Transforms, Laplace equation and its solution, Poisson, Diffusion and Wave equations, vibrating membrane.

Unit II
Group Theory: Definition, Classification of groups, subgroup, cyclic group, isomorphism and homomorphism, classes, vector spaces, representation theory of finite groups, Reducible and Ir-reducible representations, Schur's Lemmas and orthogonality theorem, Characters of representations.

Unit III
Complex Variable: Function of complex variable, Analytic functions, Cauchy's integral theorem and Cauchy's integral formula, Taylor and Laurent's expressions, theorem of residues, Contour integration.

Unit IV
Matrix and Tensors: Inverse and Trace of Matrix, Unitary Matrices, Orthogonality, Eigen values-Eigen vectors and Diagonalistaion of matrices, Coordinate transformation, Covariant and contravariant Tensors, addition, multiplication and contraction of tensors, Associated tensors.

Reference Books:
1. G Arfken: Mathematical Methods for Physicist (Academic Press)
2. Pipes and Harvil: Mathematical Methods for Engineers and Physicist
3. C Harper: Introduction to Mathematical Physics (Prentice Hall of India)
4. A W Joshi: Element of Group Theory for Physicists (Wiley Eastern)

MPHC103: ELECTRODYNAMICS AND ASTROPHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I

Maxwell's equations and Electromagnetic waves: Maxwell's equations and their physical significance. Equation of continuity and relaxation time, Vector and scalar potentials, Lorentz and Coulomb gauge, electromagnetic energy and Poynting's theorem, electromagnetic wave equations in free space, their plane wave solutions . Concept of Retarded potentials, Lienard Wiechert potentials, Multipole expansion of EM fields, Electric dipole radiations, field due to oscillating electric dipole, magnetic dipole radiations, electric quadrupole radiation

Unit II

Radiations from moving charges: Fields produced by moving charges, radiations from an accelerated charged particle at low velocities, radiations from a charged particles with co-linear velocity and acceleration. Radiations from an accelerated charged particle at low velocities in circular orbits-Larmor formula, Radiations from an accelerated charged particle at relativistic velocities in circular orbits relativistic generalization of Larmor Formula.

Unit III

The Solar System: Aspects of the sky: Concept of Celestial Coordinates and spherical astronomy. Astronomical telescopes. The early years of solar system, the solar system today. Study of Planets: Classification of the Planets, Orbits, Laws of planetary motion, Physical features, surface features, Internal Structure, Atmosphere, Satellites and Rings. Minor Bodies in Solar System: Asteroids, Meteors and Meteorites**:** Discovery of minor planets (Asteroids), their orbits and physical nature. Origin of the minor planets. Meteors and Meteorites. Observation of meteor showers and sporadic meteors. Orbits of sporadic meteoroids and meteor showers. Meteorites, its types and composition. Meteorite craters. Comets- Discovery and designation. Periodic comets. Physical nature. Spectra. Brightness variation. Gas production rates, dust and ion tails. Nature of dust particles and origin of comets.

Unit IV

Stellar System: Sun As A Star: History of Sun, Sun's interior, the photosphere, the solar atmosphere (Chromosphere & corona). Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trigonometric. secular. and moving cluster parallaxes.

Stellar motions. Magnitude scale and magnitude systems. Atmospheric extinction. Absolute magitudes and distance modulus. color index. The Hertzberg- Russell Diagram: The colour, Brightness or luminosity, the population of star. Elementary idea of Binary & Variable Stars. Nuclear fission, Nuclear fusion, condition for nuclear reaction in stars. Types of galaxies, Structure and features of the Milky Way Galaxy.

Reference Books:

1. D.J. Griffiths: Introduction to Electrodynamics (Prentices Hall, 2002)
2. J.R. Reitz, F.J. Milford & R.W. Christy: Foundation of E.M. Theory
3. J.D.Jackson: Classical Electrodynamics (Wiley Eastern)
4. S.P. Puri: Classical Electrodynamics (Tata McGraw Hill, 1990)
5. J.B. Marion: Classical Electromagnetic Radiation
6. Landau and Lifshitz: The Classical theory of Fields (Pergman Press)
7. Panofsky and Philips: Electricity and Magnetism
8. R.N. Singh: Electromagnetic waves and fields (Tata McGraw Hill)
9. Jordan and Balman: Electromagnetic Waves and Radiation system
10. Marc L. Kutner: Astronomy: A Physical Perspective (Cambridge University Press)
11. Shu, F.H.: The Physical Universe An Introduction to Astronomy
12. Robert H. Baker : Astronomy
13. L Motz. & A.Duveen: The Essentials of Astronomy (Colombia University Press)
14. Willian K. Hartmann: Moons & Planets
15. I Morison: Introduction to Astronomy and Cosmology
16. A.W.Joshi & N.Rana: Our solar system
17. Jayant Naralikar: The Structure of Universe
18. K.D. Abhyankar : Astrophysics (Stars & Galaxies)
19. K.S.Krishnaswamy: Physics of Comets
20. McCusky: Introduction to Celestial Mechanics
21. William J. Kaufmann III : Universe
22. Karl F. Kuhn : In Quest Of The Universe
23. Konrad B. Krauskopf & Arthur Beiser : The Physical Universe

MPHC104: ELECTRONICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Power amplifiers: Types of power amplifiers-series fed class A amplifier-series fed transformer coupled class B: push pull circuits-harmonic distortion in amplifiers-class C and D amplifiers-design considerations.

Unit II
Feedback in amplifiers: Feedback principle-effect of feedback on stability-nonlinear distortion input and output impedance-bandwidth-different types of feedback. Criteria for oscillation-phase shift, Wein bridge, crystal oscillator-frequency stability, astable, mono stable and bistable multivibrators, Schmitt trigger-bootstrap sweep circuits.

Unit III
Operational amplifiers: Differential amplifier-ideal and real op—amp-input and output impedance-frequency response-applications: amplifiers, mathematical operations, active filters, waveform generators-analog computations-comparators-S and H circuit-voltage regulator.

Unit IV
Optoelectronics: Optical fibers: graded index step index fibers-refractive index profiles-propagation of optical beams in fibers-mode characteristics and cut off conditions-losses in fibers-signal distortion group delay material and wave guide dispersion. Optical sources: Light emitting diodes-LED structure-internal quantum efficiency-injection laser diode comparison
of LED and ILD.
Optical detectors: PN junction photo diodes-PN photo detectors-avalanche photo diode-performance comparison.

Reference Books:
1. Millman & Halkias : Integrated Electronics (McGraw Hill)
2. Bolested: Electronic devices and circuit theory
3. Ryder : Electronics-fundamentals and applications(PHI)
4. Keiser : Optical fibre communications (McGraw Hill)
5. Agarwal : Nonlinear fibre optics(AP)
6. M.R. Shenoy, Sunil K. Khijwania et.al: Fiber Optics Through Experiments
7. Ajoy Ghatak, K. Thyagarajan : Optical Electronics

MPHL105: Laboratory Course – I

M.M:100 **Credit: 3(Nine hours per week)**

List of experiments: At least 5 experiments are to be performed

1. Study of LCR circuit
2.Transistorized LCR bridge
3. Study of UJT
4. Study of MOSFET
5. Study of NPN and PNP transistor characteristics
6. Study of DIAC
7. Study of TRIAC

*__Seminar: One seminar based on above experiments for each student is compulsory__

MPHL106: Laboratory Course – II

M.M:100 **Credit: 3(Nine hours per week)**

List of experiments: At least 5 experiments are to be performed

1. Study of FET
2. R.C.coupled amplifier
3. T.C. coupled amplifier
4. Study of feedback amplifier
5. Study of Hartley oscillator
6. Study of Colpitt oscillator
7. Study of Wien bridge oscillator
8. Design and study of different network theorems

*__Seminar: One seminar based on above experiments for each student is compulsory__

SEMESTER - II

MPHC201: ATOMIC AND MOLECULAR PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I

Atomic Spectroscopy: Fine structure of Hydrogen lines, alkali atom Spectra, penetrating and non penetrating orbits, electron spin orbit interaction, L-S and J-J coupling schemes, Hunde's rule Spectra of two valence electron atoms, (Helium, Magnesium), selection rules for atomic transitions, multielectron spectra, Central field approximation, Hartree self consistent field theory, Thomas Fermi statistical model, Pauli's exclusion principle and determination of ground state.

Zeeman Effect, Paschen Back Effect, Hyper fine structure, Stark effect, width of spectral lines, lamb shift.

Unit II

Molecular Spectroscopy: Rotational spectra of diatomic molecules, non rigid rotator, vibrational spectra enharmonic oscillator explanation of rotational vibrational spectra in infrared, molecular dissociation and calculation of dissociation energy, Raman effect and intensity alternation of the rotational bands, Applications of infrared and Raman spectroscopy.

Born Oppenheimer approximation, Molecular orbital theory, Heitler-Loudon treatment of Hydrogen molecule ion and Hydrogen molecule, Electronic spectra of molecules, Fortrait Parabola, Deslandres table, vibrational structure of electronic bands, Intensities of electronic transitions, Franck Condon principle, Condon parabola.

Reference Books:

1. Atomic Spectra- H.E white Cambridge University Press, Newyork, 1935
2. Principle of Atomic Spectra - Shore and Menzel
3. Spectra of Diatomic Molecules - G. Herzberg
4. C.B.Banewell: fundamentals of Molecular Spectroscopy
5. Molecular Spectroscopy – Arul Das.

MPHC202: SOLID STATE PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit-I

Crystal Structure: Periodic arrays of atoms, Primitive lattice cell, fundamental types of lattices, index system for lattice planes, Simple crystal structure, Atomic radii, coordination number, Cesium chloride structure. Hexagonal Close Packed Structure, Diamond Structure, cubic Zinc Sulphide structure, point group.

Unit-II

Reciprocal lattice: diffraction waves by crystals, Bragg's law, Scattered wave amplitude, Laue equations. Brillouin zones, reciprocal lattice to SC lattice, B C C lattice, F C C lattice, structure factor of B C C structure, F C C lattice, Atomic form factor.

Unit -III

Crystal Binding and Elastic Constants: Ionic Crystal, Covalent Crystal, Metals, Hydrogen bonds, analysis of elastic springs, elastic compliance and stiffness constants, Elastic waves in cubic crystals, Experimental determination of elastic constants.

Unit- IV

Lattice Vibrations: Vibrations of crystals with monoatomic basis, First Brillouin zone, Group Velocity, Long wavelength limit, Two atoms per primitive basis, quantization of elastic waves, Phonons, Phonon momentum, Inelastic scattering of photons by phonons.

Reference Books:

1. Introduction of Solid State Physics - C Kittel
2. Solid State Physics - N W Ashcroft & N David Mermin
3. Solid State Physics - Ajay Kumar Saxena
4. A J Dekker: Solid State Physics
5. Azaroff: Introduction to solids
6. Aschroft and Mermin: Solid State Physics
7. Peterson: Introduction to Solid State Physics
8. Verma and Srivastava: Crystallography for Solid State Physics

MPHC203: STATISTICAL PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Basic Postulates- Phase space, relation between eigen states and phase space volume, Liouville's theorem, ensembles, microcanonical, canonical and grand canonical ensembles, Maxwell's Boltzmann's distribution and Gibb's formulation for canonical and grand canonical ensembles, partition function, their thermodynamic properties, laws of thermodynamics.

Unit II
Application of classical distribution to the ideal gases: Degrees of freedom, translational motion, Helmholtz free energy, Gibb's free energy, entropy and thermodynamic properties, Gibb's paradox, Sakur-tetrode equation.
Imperfect gases: Difference between ideal and real gas, imperfect gases, Vander Waal's equation, virial coefficients, condensation of gases, general properties of liquids, Fermi theory, liquid Helium, phase rule.

Unit III
Quantum Statistics: Drawbacks of M B distribution, Bose-Einstein's and Fermi-Dirac distribution, symmetric and antisymmetric particles, partition functions, non degenerate, weakly degenerate and strongly degenerate cases, B.E. condensation, application to He, pressure-energy relationship, electronic specific heat of solids and paramagnetism.

Unit IV
Black Body Radiation: Planck's distribution, pressure and energy relationship of photons, black body radiation, Rayleigh Jean's formula, Wein's law, Wein's displacement formula, absorption and emission of radiation, Stefan's law, high temperature measurements.

Reference Books:

1. Glasstone: Theoretical Chemistry
2. E.S. Raj Gopal: Statistical Mechanics and Properties of Matter
3. Mayer And Mayer: Statistical Mechanics
4. Landau and Lifshitz: Statistical Physics
5. Pointon: Introduction to Statistical Physics
6. Huang: Statistical Mechanics
7. Wanier: Statistical Physics

MPHC204: QUANTUM MECHANICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Introduction:
A brief review of foundations of quantum mechanics, basic postulates of quantum mechanics, uncertainty relations, Schrodinger wave equation, expectation value and Ehrenfest theorem. Relationship between space and momentum representation.
Applications: One dimensional potential step, tunneling, Hydrogen atom, particle in a three dimensional box.

Unit II
Matrix Formulation of Quantum Mechanics:
Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Unit III
Symmetry in Quantum Mechanics:
Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J_+, J_-, J_z, J^2. Concept of spin, Pauli spins matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recursion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator.
Applications: non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Unit IV
Approximation Methods for Bound State:
Time independent perturbation theory for non-degenerate and degenerate systems upto second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect with electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

Reference Books:

1. L. I. Schiff, Quantum Mechanics (McGraw Hill).
2. V. K. Thankappan, Quantum Mechanics (Wiley Eastern).
3. P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH)
4. C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vols-I&II (John Wiley).
5. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley).
6. A. K. Ghatakh and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan).

MPHL205: Laboratory Course – I

M.M:100 **Credits: 3(Nine hours per week)**

List of experiments: At least 5 experiments are to be performed

1. Multivibrator: bistable / monostable / Astable
2. Ionization potential of Mercury using gas filled diodes
3. Michelson interferometer
4. Fabry Perot interferometer
5. Fresnel's law
6. Determination of absorption coefficient of iodine vapour
7. B-H curve

*__Seminar: One seminar based on above experiments for each student is compulsory__

MPHL206: Laboratory Course – II

M.M:100 **Credits: 3(Nine hours per week)**

List of experiments: At least 5 experiments are to be performed

1. Study of amplitude modulation and demodulation
2. Study of frequency modulation and demodulation
3. Lecher wire experiment
4. Determination of magnetic susceptibility
5. Study of CRO.
6. Velocity of Ultrasonic waves
7. Linear Air track
8. Determination of Planks constant

*__Seminar: One seminar based on above experiments for each student is compulsory__

SEMESTER - III

MPHC301: ADVANCED QUANTUM MECHANICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Scattering Theory:
General considerations: kinematics, wave mechanical picture, scattering amplitude, differential and total cross section. Green's function for scattering. Partial wave analysis: asymptotic behaviour of partial waves, phase shifts, scattering amplitude in terms of phase shifts, cross-sections, Optical theorem. Phase shifts and its relation to potential, effective range theory. Application to low energy scattering; resonant scattering, Breit-Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances. Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Born approximation; its validity, Born series.

Unit II
Identical Particles:
The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and Para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

Unit III
Relativistic Wave Equations:
Generalization of the Schrodinger equation; Klein-Gordon equation, plane wave solutions, charge and current densities, interaction with electromagnetic fields, Hydrogen-like atom (to show it does not yield physical spectrum), non-relativistic limit. Extension of Klein-Gordon equation to spin 1 particles.
Dirac Equation; relativistic Hamiltonian, probability density, expectation values, Dirac gamma matrices, and their properties, non-relativistic limit of Dirac equation. Covariance of Dirac equation and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

Unit IV
Quantization of wave fields: The quantization of wave fields, Classical and quantum field equations quantization of non-relativistic Schrodinger equation, second quantization, N-representation, creation and annihilation operators.

References Books:
1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH)
2. A. S. Davydov, Quantum Mechanics (Pergamon).
3. L. I. Schiff, Quantum Mechanics (McGraw Hill).

4. J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics (McGraw Hill).
5. J. J. Sakurai, Advanced Quantum Mechanics (Addison Wesley).
6. V. K. Thankappan, Quantum Mechanics (Wiley Eastern).
7. R.P Feynman and A.R.Hibbs; Quantum Mechanics and Path Integrals.
8. L.H. Ryder, Quantum field Theory (Academic Press).

MPHC302: NUCLEAR PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
General Properties & Models-: Nuclear size, nuclear angular momentum (Spin), Nuclear magnetic moments, statistics, Binding energy, Liquid drop model, Shell model, Collective model.

Unit II
Nuclear Forces and Detector – Ground state of deuteron, Low energy neutron-proton scattering and proton-proton scattering, Exchange and tensor forces, G.M. Counter, Electron & Proton Synchrotron.

Unit III
Radioactive decay: Radioactive decay equation equilibrium units, Gamow's theory of alpha decay and Geiger Nuttal law, Fermi's theory of beta decay, parity violation in beta decay, electromagnetic decays.

Unit IV
Nuclear Reactions- Q-value of nuclear reaction, Bohr's Theory of compound nucleus, Scattering cross section of nuclear reaction (phase shift method), Breit Wigner single level resonance formula for scattering cross section.

References Books:
1- I. Kaplan: Nuclear Physics
2- H.A. Enge : Nuclear Physics
3- R.Roy & B.P. Nigam : Nuclear Physics
4- R.D. Evans: Nuclear Physics
5- W.E. Bucham & M. Jobes : Nuclear & Particle Physics (AWL)
6- D. Halliday : Nuclear Physics
7- E. Segre : Nuclei & Particles.
8- B.R. Martin : Nuclear & Particle Physics.
9- B.L. Cohen : Concepts of Nuclear Physics.
10- S.S.M. Wong : Introductory Nuclear Physics
11- S.B. Patel : Nuclear Physics
12- M.K. Pal : Theory of Nuclear Structure
13- S.N. Ghoshal : Nuclear Physics.
14. B.B. Srivastava : Fundamental Of Nuclear Physics
15. S.L. Kakani, Subhra Kakani : Nuclear and Particle Physics

MPHL303: Laboratory Course- I

M.M:100 **Credits: 3(Nine hours per week)**

List of experiments: At least10 experiments are to be performed
1. e/m by Zeeman effect
2. G.M.counter
3. Study of IC- Based Power supply
4. Absorption spectroscopy by spectrophotometer
5. Study of optoelectronic devices
6. Design and study of FET amplifier
7. Design and study of MOSFET amplifier
8. Study of SCR
9. Measurement of wavelength of He-Ne laser using interference and diffraction pattern
10. Measurement of thickness of thin wire using laser.
11. Logic gate AND/OR /NAND/NOR/NOT gates
12. Design and study of UJT relaxation oscillator
13. Study of pin connection and biasing of various linear IC's and timers 555
14. Design and study of phase shift oscillator
15. Study of operational amplifier

*__Seminar: One seminar based on above experiments for each student is compulsory__

MPHE304: CONDENSED MATTER PHYSICS - A

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit-I
Defects in crystals: Point defect, Impurities, Vacancies, Frenkel defects, Schottky defects, Intrinsic vacancies.
Concentration of Schottky defects, Concentration of frenkel defects, extrinsic vacancies, Diffusion, Colour centres, F-Centre, V-Centre, dislocation, Line defects, edge dislocation, screw dislocation, Burger vector.

Unit-II
Magnetism: Dia, Para and ferromagnetism, Langevin's theory of paramagnetic, Ferromagnetism, Weiss molecular theory, Ferromagnetic domains, Antiferromagnetism, Neel's theory, Two sub lattice model, ferrites.

Unit-III
Energy Bands: Origin of energy gap, Magnitude of the energy gap, Bloch function, Bloch theorem, Kronig penny model, Number of possible wave function in a band, crystal momentum, the concept of effective mass. Concept of holes, hole band construction, metal, insulator and semiconductor.

Unit-IV
Dielectric and electrical properties of insulators: Macroscopic description of dielectric constants, static, electronic and ionic polarizability of molecules, orientation polarization, Internal Lorentz field static dielectric constant, Complex dielectric constant, Dielectric loss and relaxation time, Optical absorption.

Reference Books:
1. Kittel: Introduction to solid state Physics
2. Ziman: Principles of theory of solids
3. J. Callaway: Quantum theory of solids
4. A.J. Dekker: Solid State Physics
5. Animalu: Intermediate Quantum theory of crystalline solids
6. Solid State Physics: N W Ashcroft and N David Mermin
7. Solid State Physics: Ajay Kumar Saxena

MPHE305: ELECTRONICS - A

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I

Number Systems, Boolean Algebra & Basic Logic Gates: Binary, Octal, Decimal & Hexadecimal Numbers, Base conversions and arithmetic, Complements, Signed Binary numbers, Binary codes (Weighted, BCD, 2421, Gray code, Excess 3 code, Error detecting code, Error correcting codes, ASCII, EBCDIC), Conversion among codes.
Boolean postulates and laws, Dual & Complement, De-Morgan's Theorem, Boolean expressions and functions. Minimization of Boolean expressions, Sum of Products (SOP), Product of Sums (POS), Minterms &Maxterms, Karnaugh maps and minimization.

Unit II

Logic Gates & Combinational Circuits: Logic Gates: AND, OR, NOT, NAND, NOR, XOR, XNOR. Universal Gates, Positive and Negative Logic, Implementations of Logic Functions using gates, TTL and CMOS Logic and their characteristics, 7400 Series. Adders, Subtractors, Serial adder/ Subtractor, Parallel adder/ Subtractor, Carry look ahead adder, BCD adder, Magnitude Comparator, Multiplexer, Demultiplexer, Encoder, Decoder, Parity-checker, Code converters

Unit III

Sequential Circuits: Flip flops: Latches, RS, JK, T, D and Master-Slave, Characteristic table and equation.Edge triggering, Level Triggering. Registers & Counters: Asynchronous/ Ripple counters, Synchronous counters, Modulo–n Counters, Shift registers, Universal shift register, Shift counters, Ring counters.

Unit IV

Memory Devices & IC-Technology: Classification of memories, RAM organization, Write/Read operations, Memory cycle, Timing wave forms, Memory decoding, Memory expansion , Static RAM Cell-Bipolar RAM cell, MOSFET RAM cell, Dynamic RAM cell, ROM organization – PROM, EPROM, EEPROM, EAPROM , Programmable Logic Devices, Programmable Logic Array (PLA), Programmable Array Logic (PAL)
Basic Ideas of IC-Technology, Monolithic IC's, IC Components- Resistors (Integrated, Diffused, Thin Film), MOS Capacitors, Inductors, Bipolar Transistors, Thin Film Technology, LSI, MSI.

Reference Books:

1. Malvino & Leach: Digital Principles and Applications
2. Morris Mano: Digital Design
3. Thomas L. Floyd: Digital Fundamentals
4. Millman & Halkias: Integrated Electronics
5. A. Anand Kumar : Fundamentals Of Digital Circuits

MPHE306: LASER PHYSICS - A

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Basic principles: Basic principles and theory of absorption and emission of radiation, Einstein's coefficients, line-broadening mechanisms, rate equations for three and four level laser systems, population inversion, theory of optical resonators, laser modes, spatial and temporal coherence,

Unit II
Types of lasers: Gas lasers, He-Ne, argon ion, N2, CO2 lasers; dye lasers, solid state, Semiconductor lasers: Ruby, Nd:YAG and Nd:glass lasers, Fabrication technology of lasers, diode lasers, colour centre and spin flip lasers, laser spikes, mode locking Q-switching, CW and pulsed lasers.

Unit III
Non linear optics: Theory of non linear phenomenon, second and third harmonic generation, phase matching, parametric generation, self focussing,

Unit IV
Laser spectroscopy: Laser fluorescence spectroscopy using CW and pulsed lasers, Single photon counting.
Laser Raman spectroscopy, multiphoton processes, photo acoustic and photon electron spectroscopy, stimulated Raman spectroscopy, Coherent antistokes Raman spectroscopy.

Reference Books:

1. Ghatak and Thyagrajan: Lasers
2. O. Svelto: Principles of Lasers
3. Silvfast: Lasers
4. B.B.Loyd: Lasers

MPHE307: ASTROPHYSICS - A

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Physics of the Stars : Apparent and Mean Position of stars. Effects of atmospheric refraction, aberration, parallax, precession, nutation and proper motion on the coordinates of stars. Reduction from apparent to mean places and vice versa. Spectra of Stars. Distribution of stars in space. Statistical parallaxes. Local standard of rest. Solar motion and its determination. Peculiar velocities. Single and Two star stream hypothesis. Velocity ellipsoid. Comparison with solar neighbourhood. Bottlinger's diagram. HR diagram, HD and MK spectral classification of stellar spectra. Radiation laws and basic ideas on spectral line formation. Explanation of stellar spectra in terms of Boltzmann and Saha equations. Spectroscopic parallax.

Unit II
Fundamental Equations: Equation of mass distribution. Equation of hydrostatic equilibrium. Equation of energy transport by radiative and convective processes. Equation of thermal equilibrium. Equation of state. Stellar opacity. Stellar energy sources.Stellar models:The overall problem and boundary conditions. Russell- Voigt theorem. Dimensional discussions of mass-luminosity law. Polytropic configurations. Homology transformations.

Unit III
Stellar Evolution : Abundance of elements in the sun by the method of fine analysis-Stromgren's method, use of weight functions, abundances of elements in normal stars. Composition of differences in population I and II stars. Anomalous abundances in cool stars. Peculiar A stars and metallic line stars. Magnetic field in stars. Jean's criterion for gravitational contraction and its difficulties. Pre-main-sequence contraction under radiative and convective equilibrium. Evolution in the main sequence. Growth of isothermal core and subsequent development. Ages of galactic and globular clusters.

Unit IV
Superdense Objects: Mechanism of Mass transfer in Binary Stars. Use of polytropic models for completely degenerate stars. Mass-radius relation. Non-degenerate upper layers and abundance of Hydrogen. Stability of white dwarfs. Final cooling of white dwarfs. Accretion by white dwarfs and its consequences. Pressure ionisation and mass-radius relation for cold bodies. Formation , features and properties of Neutron stars,
Pulsars and black holes.

Reference Books:
1. D.Mihalas: Galactic Astronomy
2. S.Chandrasekhar: Principles of Stellar Dynamics
3. James Binney and Scoth Tremaine: Galactic Dynamics (Princeton University Press)
4. K.C.Freeman: Galaxies and Universe

5. D.Mihalas and J.Binney: Galactic Astronomy
6. S.D.M.White: The Origin and Evolution of Galaxies
7. S.M.Alladin: Lecture notes on "Dynamics of Stellar Systems".
8. W.M.Smart: Text book of Spherical Astronomy
9. K.D.Abhyankar: Astrophysics:Stars and Galaxies (Tata McGraw Hill Publication)
10. G.Abell: Exploration of the Universe.

MPHE308 - HIGH ENERGY PHYSICS - A

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I:
Classical and Quantum Field Equations, Coordinates of the field, Classical Lagrangian Equation, Classical Hamiltonian Equations, Quantum Equations for the Field, Fields with more than one component, Complex Field, Quantization of the Non-relativistic Schrodinger Equation, Classical Lagrangian and Hamiltonian Equations, Quantum Equations, The N-representation, Creation and Destruction Operators, Number Operators, Anti-commutation Relations, Equations of Motion, Physical Implications of Anti-commutation, Representation of Anti-commuting operators

Unit II:
Quantization of fields: Quantization of neutral and complex scalar fields, U (1) Gauge Invariance, Quantization of Dirac field covariant anti-commutation relations, Quantization of electromagnetic field. Interaction Lagrangian for the fields, QED Lagrangian.

Unit III:
Scattering Matrix and Feynman Rules: The S-Matrix reduction of S- Matrix chronological product, Wicks theorem Furry's theorem Covariant perturbation theory interaction lagrangian for QED, Feynman Diagrams and Feynman rules for QED in configuration and momentum space, Electron-Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation , Compton scattering.

Unit IV:
Renormalization of QED: Self energy correction, vacuum polarization and vertex correction, classification of Divergences, Renormalization of mass and charge, wave function renormalization .

Reference Books:
1. Theory of photons and electrons, J.M. Jauch and E. Rohrlich
2. Relativistic Quantum field, J.D. Bjorken and S. D. Drell.
3. Quantum electrodynamics , A.I. Akhiezer and Berestetski
4. Quantum Electrodynamics, Walter Greiner

MPHL309: Laboratory Course II (Based on E304/305/306/307/308)

M.M:100 **Credits: 3 (Nine hours per week)**

Condensed Matter Physics:

List of experiments: At least 5 experiments are to be performed
1. Determination of elastic constant of crystals by optical methods
2. Study of fluorescence spectra of a given compound
3. Study of color centers
4. Determination of lattice parameters using powder method.
5. Determination of hall coefficient using Hall effect
6. Determination of Energy gay of a semiconductor by four probe method
7. ESR
8. Dielectric constant

Electronics:

List of experiments: At least 5 experiments are to be performed
1. Study of regulated power supply (723).
2. Study of Timer (555).
3. A to D and D to A convertor
4. 1 of 16 Decoder/Encoder
5. Study of Multiplexer/Demultiplexer
6. Study of Comparator and Decoder
7. Study of different flip- flop circuits (RS, JK, D type, T-type, Master slave).
8. Study of Digital combinational and sequential circuits
9. Study of Microprocessor (8085)
10. Study of SCR, DIAC, TRIAC
11. Study of IC- Based Power supply
12. Microwave experiment.
13. Shift Registers
14. Fiber Optics communication

Laser Physics:

List of experiments: At least 5 experiments are to be performed
1. Study of the vibrational levels of Iodine.
2. Measurement of the fluorescence spectra of Uranyl Nitrate Hexahydrate.
3. Determination of the intrinsic life time for a dye molecule.
4. Determination of change in dipole moment in excited state using Solvatochromic shift method.
5. Measurement of non radiative decay rate for a known sample.
6. Determination of the quantum yield of known samples using steady state spectroscopy.
7. Study of electro optic effect
8. Study of Acousto-optic effect

Astrophysics:

List of experiments: At least 5experiments are to be performed

1. Study of Hubble's law (from given data)
2. Study of constant density neutron star
3. Study of the static parameters of a Neutron Star model with inverse square density distribution
4. Study of star cluster from a given data
5. Study of Extinction coefficients
6. Study of variability of stars

High Energy Physics:

List of experiments: At least 5 experiments are to be performed

1. Characteristic curve of a GM Detector and Absorption coefficient of a using aluminum GM Detector.
2. Energy spectrum of gamma rays using gamma ray spectrometer.
3. Absorption coefficient of aluminum using gamma-ray spectrometer.
4. Characteristics of Scintillation Detector.
5. Study of gamma-gamma unperturbed angular correlations.
6. Study of particle tracks using a Nuclear Emulsion Detector.
7. Classification of tracks in interaction with Nuclear Emulsion and determination of excitation energy.
8. Mossbauer spectrometer

Note: Students have to perform those experiments which are related to their chosen elective Paper

*__Seminar: One seminar based on above experiments for each student is compulsory__

SELF STUDY COURSES

MPHS310: PHYSICS OF NANO MATERIALS

M.M: 100

Unit I
Nanoparticles: Synthesis and Properties:
Method of Synthesis: R F Plasma Chemical Methods, Thermolysis, Pulsed laser Methods, Biological Methods, Synthesis using micro-organisms, Synthesis using Plant extract, Metal Nanoclusters, Magic Numbers, modeling of Nano Particles, Bulk of Nano Transitions.

Unit II
Carbon Nano Structures:
Nature of Carbon Clusters, Discovery of C60, Structure of C60 and its crystal, Superconductivity in C60,
Carbon Nano Tubes: Synthesis, structure, Electrical and Mechanical Properties.
Graphene: Discovery, Synthesis and Structural Characterization through TEM, Elementary concept of its applications

Unit III
Quantum Wells, Wires and Dots:
Preparation of Quantum Nano Structures, Size Effects, Conduction Electrons and Dimensionality, Properties Dependent on Density of States.
Analysis Techniques for Nano Structures/Particles: Scanning Probe Microscopes (SPM), Diffraction Techniques, Spectroscopic Techniques, Magnetic Measurements.

Unit IV
Bulk Nano Structure Materials:
Methods of Synthesis, Solid Disorders Nano Structures, Mechanical Properties, Nano Structure Multilayers, Metal Nano Cluster, Composite Glases, Porous Silicon.

Reference Books:
1. Introduction to Nano Technology: Poole and Owners
2. Quantum Dots: Jacak, Hawrylak and Wojs
3. Handbook of Nano Structureed Materials and Nano Technology: Nalva(Editor)
4. Nano Technology/ Principles and Practices: S K Kulkarni
5. Carbon Nano Tubes: Silvana Fiorito
6. Nano Technology: Richard Booker and Earl Boysen

MPHS311- QUANTUM ELECTRODYNAMICS

M.M: 100

Unit I

Dirac equations, Properties of Dirac Matrices, Projection Operators, Traces< Feynman’s theory of Position.

Unit II

Second quantization of Klein Gordon field, Creation and annihilation operators, commutation relations, Quantisation of electromagnetic field, Creation and annihilation operators, commutation relation, Fock space representation, interaction fields. Dirac (interaction) picture, S-matrix and ita expansion. Ordering theorems, Feynman graph and Feynman rules. Application to some problems, like Rutherford Scattering and Compton scattering, calculations of cross sections using Feynman graphs.

Reference Books:

1.Bjorken and Drell: Relativistic Quantum Fields
2. Muirhead: The Physics of Elementary Particles
3. Schweber, Bethe and Hoffman: Mesons and Fields
4.Sakurai: Advanced Quantum Mechanics
5.Mandal: Introduction to Field Theory
6. Lee: Particle Physics and Introduction to Field Theory

SEMESTER IV

MPHC401: COMPUTATIONAL PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I
Roots of functions, interpolation, extrapolation, integration by trapezoidal and Simpson's rule, Runge-Kutta Method, Least square fitting method.

Unit II
Eigenvalues and eigenvectors of matrices, power and Jacobi method, solution of simultaneous linear equations Gaussian elimination, Pivoting, Iterative method, matrix inversion.

Unit III
Flowchart and algorithms-Problem analysis flowchart of some basic problems. The concept and properties of algorithmic languages, elementary algorithm development algorithm involving decision and loops.

Unit IV
C-Programming : selection of C and Fortran 90/95 programming loops and control, constructs, arithmetic and logic operators, Strings, arrays, pointers, floats and other types, input, output, control constructs, recursion structures, sub programmes and modules.

Reference Books:
1.B.D.Hahn: Fortran 90 for Scientists and engineers.
2.V Rajaraman: Computer Programming in c.
3.Rajaraman: Computer Oriented numerical methods.
4.Wong: Computational methods in Physics and engineering.
5.S.Balachandra Rao: Numerical Methods.
6.Stephen j Chapman: Fortran 90/95 for Scientists and Engineers.

MPHC402: PARTICLE PHYSICS

M.M: 100 **Credit: 4 (Four Lectures Per Week)**

Unit I : **Classification and Properties of Elementary Particles**
Elementary Particles, their classification on the basis of their mass and spins (Leptons, Mesons, Baryons) and field quanta. Their general properties (mass, spins, life time and their production and decay modes), Antiparticles.

Unit II: Conservation Laws and Gauge Invariances
Conservation of Energy, Linear and Angular momentum, Spin, Charge, Lepton No., Baryon No. Isospin, Hypercharge, Parity, Strangeness, Charge conjugation, Time Reversal, CP, CPT theorem, Global and Local gauge invariances.

Unit III: Fundamental Interaction
Qualitative ideas (Relative strengths, Ranges, Characteristic times and Mediators) of Gravitational, Electromagnetic, Strong and Weak Nuclear interactions. General idea of Electro-week and Grand unifications.

Unit IV: Quark Model
Eight fold way, Quarks as building blocks of hadrons, six quarks (u,d,s,c,t and b), Antiquarks, General properties of quarks (Charge, Mass, Color - A new degree of freedom, quark confinement, Asymptotic freedom) Evidences for Quarks (Lepton scattering, Hadron Spectroscopy, Jet production), Quark compositions of Mesons and Baryons. General idea of Standard Model. Idea of Higgs Boson.

Reference Books:
1. Introduction to High Energy Physics-D.H.Perkins. (Addision – Wesley-1986)
2. Introduction to Nuclear & Particle Physics-VK Mittal, R.c. Verma & S.C.Gupta (Prentice Hall of India, Pvt.Ltd., New Delhi, 2009) (All units approx.)
3. Concepts of Modern Physics- Arthur Beiser (Tata Mc Graw Hill Edu.Pvt Ltd., New Delhi, Sixth Ed. 2009) Chapter 13 page 529.
4. Quarks and Leptons- An Introductory course in Modern Particle Physics-Francis Halzen & A D.Martin(John Wiley & Cons,Inc. Canada,1984),Gauge invariance page-314,315,316, Unit III and Unit IV
5. Nuclear and Particle Physics-W.E. Burcham & M. Jobes(Essex,England ISE Reprint 1998) Unit-II, III, & IV Gauge Invariances pages 484, 485, 486, 487
6. Introduction to Particle Physics-M.P. Khanna (Prentice Hall of India, 1999) Unit II,III,IV
7. Introduction to Elementary Particle Physics-D.Griffiths (John Wiley 4 sons,1987)
8. Elementary Particle Physics-Gasiorowicz (John Wiley & sons, 1966).
9. Nuclear & Particle Physics-B.R. Martin & G. Shaw(John wiley & sons, 1997)
10. A Modern Introduction to Particle Physics- Riyazuddin and Fayazuddin
11. Particle Physics- M.Leon
12. Principles of Physics- Resnick, Halliday & Walker (John wiley & sons,England) 9th Extended edition, 2013, chapter 44)

MPHL403: Laboratory Course

M.M:100 **Credits: 3 (Nine hours per week)**

List of experiments:
1. Study of computational softwares
2. Study of numerical techniques.
3. Computer programming.

*__Seminar: Two seminar based on above experiments for each student is compulsory__

MPHE404: CONDENSED MATTER PHYSICS - B

M.M: 100 **Credit: 3 (Three Lectures Per Week)**

Unit-I
Nearly free electron model, One dimensional free electron case, Nearly free electron case, energy bands in one dimension, tight binding approximation, energy surfaces, Wigner Seitz cellular method, Orthogonalized plane wave (OPW) method, Pseudo potential method, Limitations of band theory (Mott Transition)

Unit-II
Dielectrics and ferroelectrics: Polarization, Macroscopic electric field, depolarization fields, local electric field at an atom, fields of dipoles inside cavity, dielectric constant and polarizability, electronic polarizability, structural phase transition, ferroelectric crystals, classification of ferroelectric crystals, displacive transition, soft optical phonons, landau theory of phase transition, Second and first order transition, antiferroelectricity, ferroelectric domains, piezoelectricity, ferroelasticity, optical ceramics.

Unit-III
Superconductivity: Experimental Survey, Occurrence of super conductivity, destruction of superconductivity by magnetic field and temperature, Meissner effects, Type-I and Type-II superconductors, Isotope effect,
Thermodynamics of Superconducting transition, London Equations, Coherence length, BCS Theory, Cooper pairs, Josephson superconductor tunneling, AC & DC Josephson effect, High temperature superconductors, critical fields and critical currents.

Unit-IV

Nano Material Science and Technology: History, Origin, Quantum dots, Synthesis, Applications and advantages, Quantum wires, Quantum well & application, Fullerenes, Carbon nanobuds, carbon nanotubes as quantum wires, Areas of Nanotechnology, nanomaterials, nanoelectronics, nanobiotechnology, nanofabrication, Micro Electro Mechanical systems (MEMS)

Reference books

1. Principle of condensed matter Physics : Chaikimand Lubensky
2. Solid State Physics : Kubo and Ngamia
3. Elements of Solid State Physics : Srivastava
4. Introduction to Solid State Physics : Madelung
5. Introduction to Solid State Physics : Paterson
6. Introduction to Solid State Physics : Kittel
7. Solid State Physics-N W Ashcroft & N David Mermin
8. Solid State Physics-Ajay Kumar Saxena

MPHE405: ELECTRONICS - B

M.M: 100 **Credit: 3 (Three Lectures Per Week)**

Unit I

Modulation -Amplitude Modulation-Theory, Plate Modulated class C amplifier, Balanced Modulator, Single Side Band modulation (phase shift method), Frequency modulation – Theory, Reactance tube modulator, transistor reactance modulator, FET reactance modulator. Digital Modulation, PAM, PPM, PWM, Principle of PCM

Demodulation- Envelope diode detector, super regenerative detection, Foster Seeley phase discriminator, Ratio Detector.

Transmitters & Receivers- A.M Transmitter, F.M. transmitter, TRF Receiver, Super heterodyne receiver, amplitude limiting.

Unit II

Transmission Lines– TL Equations and their solutions, characteristic impedance, lossless open and short circuited lines, standing wave ratio and refection coefficient, stub matching, quarter wave length and half wavelength lines.

Antenna – Radioactive field strength, power and radiation patterns of an elementary electric doublet and linear antenna, effects of ground reflection. Hertz antenna, Marconi antenna, Yagi antenna, loop antenna, direction finding, Resonant & Non resonant Antenna, Antenna array (Broad side & End fire arrays), T.V. aerials. Horn Antenna, Parabolic reflectors, Lens Antenna.

Unit III

Propagation of Radio Waves- Eccles-Larmor theory, Appleton – Hartree theory of sky wave propagation, skip distance and maximum usable frequency, Chapman's theory of layer formation. Pulse method for measuring the height of ionospheric region.

Unit IV

Television Systems-

General Principle of Image transmission and reception of signals, pick up instruments (Iconoscope, Image orthian and Videocon) Image scanning sequence, scanning synchronization, composite video signal, color television.

Radar Systems- Principle of Radar, Basic arrangement of Radar system, Azimuth and Range measurement, operating**,** Characteristics of systems, Radar transmitters and Receivers, Duplexers, Indicator unit, maximum range of a Radar set.

References Books:

1. F.E. Terman – Radio Engineering
2. G. Kennedy & B. Davis – Electronic Communication Systems
3. G.K. Mithal – Radio Engineering Vol. II
4. G. Keiser – Optical Fiber Communication
5. C.K. Sirkar & S.K. Sirkar, Fiber optical Communication Systems.
6. Gupta & Kumar – Handbook of Electronics
7. S.D. Parsonick – Fiber Opitics
8. Introduction to Fiber optics – Ghatak & Thyagarajan.
9. Frenzel – Communication Electronics
10. Rody & Coolen - Communication Electronics.
11. L.E. Frenzel – Communication Electronics
12. A. Ghatak & K. Tyagrajan – Fiber optics & Lasers.
13. M. Satish Kumar – Optical Fiber Communication

MPHE406: LASER PHYSICS - B

M.M: 100 **Credit: 3 (Three Lectures Per Week)**

Unit I

Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acoustic optic effect, Raman and Bragg regimes, acoustic optic modulators, magneto-optic effect, integrated optics, optical directional couplers and optical switches, phase modulators.

Unit II

Optical sources and detectors: Laser devices, radiation pattern and modulation, LED structures, light source materials, liquid crystal diodes, photoelectric, photovoltaic and photoconductive methods of detection of light, photodiodes: structure, materials and working, PIN photodiodes, avalanche photodiodes, micro channel plates, photo detector noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD.

Unit III

Fiber optics: Basic characteristics of optical fibers, fibers structure and fundamentals of waveguides, step and graded index fibers, signal degradation in optical fibers, absorption scattering, radiation and core cladding losses, Design considerations of a fiber optical communication system, analogue and digital modulation, optical fiber amplifiers.

Unit IV

Holography: Basic principles, construction and reconstruction of holograms, applications of holography, laser interferometry, laser applications in industry and medicines

Reference Books:

1. Ghatak and Thyagarajan: Optical Electronics
2. Hawks : Optoelectronics
3. Keiser : Optical fibre communications
4. Ghatak and Thyagrajan:Introduction to fibre optics
5. I.P. Csorba: Image tubes
6. Ed.L.M.Bibermman and S.Hudelman : Photoelectronics

MPHE407: ASTROPHYSICS - B

M.M: 100 **Credit: 3 (Three Lectures Per Week)**

Unit-1

Detectors, Photometry and Spectroscopy: Detectors for optical and infrared regions. Application of CCD's to stellar imaging, photometry and spectroscopy. Techniques of observations of astronomical sources from space in infrared. EUV, X-ray and gamma-ray regions of the electromagnetic spectrum. Astronomical photometry. Simple design of an astronomical photometer. Observing technique with a Photometer Correction for atmospheric extinction. Transformation to a standard photometric system. Astronomical spectroscopy. Spectral classification. Simple design of astronomical spectrograph. Radial velocity measurements. Radio Astronomy Techniques. Electro-magnetic spectrum. Radio window. Design and construction of a simple radio telescope. Receiver systems and their calibration. Design and construction of a simple radio interferometer.

Unit-2

Galactic System: Interstellar Matter: Composition and properties. Of interstellar matter. Oort limit. Interstellar extinction. Estimate of color excess. Visual absorption. Interstellar reddening law and Polarisation. Spin temperature. Interstellar magnetic fields. Stromgren's theory of H II regions. Physical processes in planetary nebulae. Galactic Structure: General galactic rotational law. Oort's theory of galactic rotation. Determination of Oort's constants. Spiral structure of our Galaxy from optical and radio Observations. Size and mass of our galaxy.

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Unit -3

Extragalactic Systems: Classification of galaxies and clusters of galaxies. Hubble sequence. Galaxy interactions. Determination of the masses. Determination of extragalactic distances. Active Galaxies: Active galaxies and galactic nuclei. Properties of Radio galaxies and Quasars. Their energy problem and accretion discs. Dark matter in galaxies and clusters of galaxies.

Unit-4

Gravitation & Cosmology: Conceptual foundations of GR and curved space-time: Principle of equivalence, Connection between gravity and geometry, Form of metric in Newtonian, limit Metric tensor and its properties, Einstein's field equations, observational tests of general relativity. Models of the universe: Steady State Models. Standard Model: The expanding universe, Hubble's law. Microwave background radiation Friedman-Robertson-Walker models, the early universe, Thermodynamics of the early universe Primordial neutrinos. Elementary ideas on structure formation. Implications of the dark matter in modern cosmology.

References Books:

1. A.Unsold: New Cosmos.
2. Baidyanath Basu: Introduction to Astrophysics.
3. Harold Zirin: Astrophysics of the Sun.
4. Gibson: The Quiet Sun.

5. G.Abell: Exploration of the Universe.
6. K.D. Abhayankar: Astrophysics of the solar system.
7. M.Schwarzschild:Stellar Evolution
8. S.Chandrasekhar:Stellar Structure
9. K.D.Abhyankar:Astrophysics: Stars and Galaxies
10. Menzel,Bhatnagar and Sen:Stellar Interiors.
11. Cox and Guili:Principles of Stellar Interiors - Vol.I and II.
12. Shapiro and Tevkolsky: White Dwarfs, Neutron Stars and Black Holes.
13. R.Bowers and T.Deeming:Astrophysics(John and Barlett.Boston).

MPHE408 -HIGH ENERGY PHYSICS - B

M.M: 100 **Credit: 3 (Three Lectures Per Week)**

Unit-I:
Symmetries and conservation laws, Norther's Theorem, U (1) Gauge Invariance, Baryon and Lepton number conservation, The concept of gauge invariance; Global and Local gauge invariance, spontaneous Breaking of Global gauge invariance, Goldstone Bosons, the Higgs mechanism, Generalized local gauge invariance- Abelian and non-Abelian gauge invariance.

Unit-II:
Weinberg- Salam theory of electroweak unification, The matter fields, the gauge fields, the gauging of SU (2) XU (1), The vector bosons, The fermions sector, Helicity states, parity, charge conjugation Fermion masses, Fermion assignments in the electroweak model, spontaneous symmetry break down, Fermion Mass generation, The color gauge theory of strong interactions.

Unit-III:
Color gauge invariance and QCD, The standard model of fundamental interaction, general mass terms, Cabibbo Angle, Kobayashi- Maskawa matrix and CP violation, The SU (5) Grand unified theory, The generators of SU (5), The choice of Fermion representations spontaneous breaking of SU (5) symmetry Fermion masses and mixing angles.

Unit-IV:
The classic predictions of SU (5) Grand Unified, Theory, quark and Lepton masses, The SO(N), The SO (10) Grand Unified Theory, Fermion Masses in SO (10), Neutrino Mass in SO (10).

Reference Books:

1. A Modern Introduction to Particle Physics, Riazuddin and Fayyazudin.
2. Modern Elementary Particle Physics G. L. Kane (Addison- Wesley 1987).
3. Grand Unified theories, Graham Ross.
4. Gauge Theories of Strong, Weak and Electromagnetic Interactions, C. Quigg (Addison – Wesley)
5. Gauge Theory of Elementary Particle Physics, T.D. Cheng and Ling Fong Li (Clarendon Oxford)

MPHE409 - Project

M.M:100 **Credits: 3**

This course will be based on preliminary research oriented topics both in theory and experiment. The teachers who will act as supervisors for the projects will float projects and any one of them will be allocated to the students. At the completion of the project by the semester end, the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examinations shall consist of presentation and comprehensive viva-voce.

SELF STUDY COURSES

MPHS410 - ENVIRONMENTAL PHYSICS

M.M: 100

Unit I

Essentials of Environmental Physics: Structure and thermodynamics of the atmosphere. Composition of air. Green House Effect, Transport of Matter, Energy and momentum in Nature. Stratification and stability of atmosphere. Laws of motion, hydrostatic equilibrium.

Unit II

Solar and Terrestrial: Physics of Radiation, Interaction of light with matter, Rayleigh and Mie scattering, laws of radiation (Kirchhoff's law, Plank's law, Wien's displacement law etc.), solar and terrestrial spectra, and UV radiation. Ozone depletion problem, I R absorption.

Unit III

Environmental Pollution and Degradation: Elementary fluid dynamics, Diffusion, Turbulence and turbulent diffusion, Factors Governing air, water and noise Pollution, Air and water quality standards. Waste Disposal. Gaseous and particulate matters, wet and dry deposition.

Unit IV

Environmental Changes and Remote Sensing: Energy sources and combustion processes. Renewable Sources of energy: Solar energy, wind energy, bioenergy, hydropower, fuel cells, Nuclear energy.

Unit V

Global and regional Climate: Elements of whether and climate. Stability and vertical motion of air, Horizontal motion of air and water, Pressure gradient forces, viscous forces.
Inertia forces, Reynolds number, enhanced Greenhouse effect, Global Climate Models.

Reference Books:

1. Egbert Boeker & Rienk Van Groundelle : Enviromental Physics (john wiley)
2. J.T. Hougtion : The Physics of Atmosphere (Cambridge Univ.Press. 1977)
3. J. Twidell and J.Weir : Renewable Energy Resources (Elbs, 1988)
4. Sol Wieder : An Introduction to Solar Energy for Scientists and Engineers (John Wiley,1982
5. R.N. Keshavsamurthy and M.Shankar Rao : The Physics of Monsoons(Allied Publuishers,1992)
6. J. Haltiner and R.T. Williams : Numerical Weather Prediction (John Wiley, 1980**)**

MPHS411- BIO PHYSICS

M.M: 100

Unit I

Introduction to Bio Physics: Molecular Organization, Different levels, Organization of Proteins- Primary, Secondary, tertiary and quaternary structures, Osmosis, Diffusion and Donnan Equilibrium.

Unit II

Conformational Analysis: Nucleic acids and their organization in living cells; interactions of Nucleic acids.

Unit III

Methods in Biophysical Analysis: CD, ORD & Fluorescence Spectroscopy, Raman Spectroscopy, Separation and Characterization of bio molecules using centrifugal, electrophoretic and chromatographic techniques. Absorption and Emission Spectroscopy- Principles and applications of visible, UV, IR, NMR, ESR and MS Spectroscopy. Characterization of macromolecules using X-ray diffraction analysis. Use of analytical microscopy in elucidating the structure function relationship in-
Prokaryotes: Electron Microscopy, Phase Contrast and Fluorescence microscopy and scanning tunneling microscopy. Radio Isotope Techniques: Detection and measurement of radioactivity, Geiger Muller Counters, Scintillation counting, Autoradiography and RIA; Applications of isotopes in biological studies.

Reference Books-

1.David Freifelder: Physical Biochemistry
2.Willard Merrit, Dean and Settle: Instrumental methods of analysis
3.D R Browning: Spectroscopy
4. Wilson and Walker: Principles and Techniques of Practical Biochemistry
5. D A Skoog: Instrumental methods of analysis