Himalayan Garhwal University
Uttarakhand (India)

A STUDY AND EVALUTION SCHEME
OF
MASTER OF SCIENCE OF PHYSICS

M.Sc. (Physics)

Academic Session 2017-18 onwards

SUMMARY

Programme	M.Sc. (Physics)
Duration	Two year (Four Semester)
Medium	English
Maximum Credits	72

Semester – I

S.No.	Subject Code	Subject Name	Effective Teaching (Hours/Week)			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
1	MPH 101	Classical Mechanics	3	-	-	3	40	60	100
2	MPH 102	Mathematical Physics	3	-	-	3	40	60	100
3	MPH 103	Electrodynamics & Astrophysics	3	-	-	3	40	60	100
4	MPH 104	Electronics	3	-	-	3	40	60	100
5	MPH P 15	Lab. Course-I	-	-	6	3	40	60	100
6	MPH P 16	Lab. Course-II	-	-	6	3	40	60	100
Table			**12**	**-**	**12**	**18**	**240**	**360**	**600**

SEMESTER – II

S.No.	Subject Code	Subject Name	Effective Teaching (Hours/Week)			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
1	MPH 201	Atomic & Molecular Physics	3	-	-	3	40	60	100
2	MPH 202	Solid State Physics	3	-	-	3	40	60	100
3	MPH 203	Statistical Physics	3	-	-	3	40	60	100
4	MPH 204	Quantum Mechanics	3	-	-	3	40	60	100
5	MPH P 25	Lab. Course-I	-	-	6	3	40	60	100
6	MPH P 26	Lab. Course-II	-	-	6	3	40	60	100
Table			**12**	**-**	**12**	**18**	**240**	**360**	**600**

SEMESTER – III

S.No.	Subject Code	Subject Name	Effective Teaching (Hours/Week)			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
1	MPH 301	Advanced Quantum Mechanics	3	-	-	3	40	60	100
2	MPH 302	Nuclear Physics	3	-	-	3	40	60	100
3	MPH 303	Electronics - I	3	-	-	3	40	60	100
4	MPH 304	Laser Physics - I	3	-	-	3	40	60	100
5	MPH P 35	Lab. Course-I	-	-	6	3	40	60	100
6	MPH P 36	Lab. Course-II	-	-	6	3	40	60	100
Table			**12**	**-**	**12**	**18**	**240**	**360**	**600**

SEMESTER – IV

S.No.	Subject Code	Subject Name	Effective Teaching (Hours/Week)			Credit	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
1	MPH 401	Computational Physics	3	-	-	3	40	60	100
2	MPH 402	Partical Physics	3	-	-	3	40	60	100
3	MPH 403	Electronics – II	3	-	-	3	40	60	100
4	MPH 404	Laser Physics - II	3	-	-	3	40	60	100
5	MPH P 45	Lab. Course	-	-	6	3	40	60	100
6	MPH P	Project Work	-	-	-	3	40	60	100

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Table			**12**	**-**	**6**	**18**	**240**	**360**	**600**

SEMESTER I

MPH 101 CLASSICAL MECHANICS **Credits : 3**

Unit-I

Lagrangian formulation and Variational Principle: Mcchanics of particles and system of particIcs. convcrsion law. constraints degree of freedom generalized coordinates, D Alembert's principle Lagrange's cquations of motion from D'Alemberi'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 diffrential equation.

Unit-II

Hamilton's formalism: Need of Hamilton's procedure, Legendre's transformation and Hamilton's equation of motion, physical significance of II 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 or 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 Cnonical transformation equation of motion in Poission's Brackct form. Jacobian's form.

Unit-IV

Mechanics of Rigid Bodies and Theory of Small Oscillations: Coordinates of rigid body motion, Euler's ang1e 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

Refrence Books :

1. N C Rama and P S Joag: Classical Mechanics (Tata Mc Graw Hill, 1991)
2. II Goldstein: Classical Mechanics (Addition Wesley, 1980)
3. A Sommerfield: Mechanics (Academic Press 1952)

MPH 102 MATHEMATICAL PHYSICS **Credits : 3**

Unit I

Differential Equations: Special equations of Mathematical Physics, Lcgendre and Associated Legendre cquations. Hermitc equation, Laguerce equation, Bcsscl‘s equation, Beta and Gamma Functions. Fourier and Laplace Transforms Laplace equation and its solution. Poission. Diffusion and Wave equations.. Vibrating membrane.

Unit II

Group Theory: Dcfinition, Classification or groups, subgroup. Cyclic group, isomorphism and homomorphism, classes vector spaces. representation theory of finite groups. Reducible and ir- reducible representations. Schur's Lemmas and orthogenality theorem. Characters of represcntations.

Unit III

Complex Variable: Function of complex variable Analytic functions. Cauchy's integral theorem and Cauchy's integral formula. Taylor and Laurcnt's expressions, theorem of residues Contour intergration.

Unit IV

Matrix and Tensors Inverse and Trace of Matrix, Unitary Matrices. Orthogonality. Eigen values—Eigcn vectors and Diagonalistation of matrices, Coordinate transformation. Covarient and contravarient Tensors, addition multiplication and contraction of tensors. Associated tensors.

Reference Books :

I . G Arfkcn: Mathematical Methods for Physicist (Academic Press)
2. Pipes and lIarvil: Mathematical Methods for Enginecrs and Physicist
i. C Harper: Introduction to Mathematical Physics (Prentice Hall of India)
4. A W Joshi: Element of Group theory for Physicists (Wiley Eastern)

MPH 103 ELECTRODYNAMICS AND ASTROPHYSICS **Credits : 3**

Unit I

Maxwell's equations and Electromagnetic waves: Maxwell's equations and their physical significance. Equation of continuity and rclaxation time, Vector and scalar Potcntials. Lorentz and Coulomb gauge. electromagnetic energy and Poynting's theorem electromagnetic wave equations in free space, thcir plane wave solutions . Concept of Rctarded potentials, Lienard Wiechert potential. 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 astronomv. Astronomical telescopes. The early ycars 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 Metcorites. Observation of meteor showcrs 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 interiors the photosphere, the solar atmosphere (chromospherc & corona) Salient features of sunspots, sun's rotation & solar magnetic field, explanation for observed features of sunspots. Distances of stars from the trignometric. secular. and moving cluster parallaxes. Stellar motions. Magnitude scale and magnitude system. Atmospheric extinction. Absolute magitudes and distance modulus. color index. The Hcrtzberg— Russell Diagram: The colour, Brightncss 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 Electrodyanamics (Prentices Hall 2002).
2. J.R.Reitz. F.J. Milford & R.W. Christy Foundation of E.M. Theory
3. J. D. Jackson: Classical Electrodynamics (Wilcy 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. Mare L. Kutner: Astronomy: A Physical perspective (Cambridge University Prcss)
11. Shu, F.H.The Physical Universe An Introduction to Astronomy

MPH104 : ELECTRONICS

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 fibres: graded index step index fibres-refractive index profiles-propagation of optical beams in fibres-mode characteristics and cut off conditions-losses in fibrwes-signal distortion group delaymaterial and wave guide dispersion.

Optical sources: Light emitting diodes-LED structure-internal quantum efficiency-injection laser diodecomparison 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)

MPH P 15 : Laboratory Course –I

MPH P 16 : Laboratory Course -II

List of experiments : At least 10 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
8. Study of FET
9. R.C.coupled amplifier
10. T.C. coupled amplifier
11. Study of feedback amplifier
12. Study of Hartley oscillator
13. Study of Colpit oscillator

14. Study of Wien bridgev oscillator
15. Design and study of different network theorems

Seminar: Two seminars for each student are compulsory

Laboratry Course: Internal assessment through a written test

M.Sc. Semester II

MPH 201: ATOMIC AND MOLECULAR PHYSICS

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 Hartrees 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.

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 Openheimer 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, Franek 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.

MPH 202 : SOLID STATE PHYSICS

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-2
Reciprocal lattice: diffraction waves by crystals,Braggs 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 -3
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-4:
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

MPH 203 : STATISTICAL PHYSICS

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 Boltzmnn'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

MPH 204 : QUANTUM MECHANICS

Section A

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.

Section B.

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.

Section C

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 spin 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.

Section D

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.

Books Recommended

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).

MPH P 25 : Laboratory Course-I

MPH P 26 : Laboratory Course-II

List of experiments: At least 10 experiments are to be performed

1. Multivibrator bistable/monostable/Astable
2. Ionisatin potential of Mercury using gas filled diodes
3. Michelson interfermeter
4. Fabry Pert interferometer
5. Fresnals law
6. Determination of absorption coeficient of iodine vapour
7. B-H curve
8. Study of amplitude modulation and demodulation
9. Study of frequency modulation and demodulation
10. Lecher wire experiment
11. Determination of magnetic susceptibility
12. Study of CRO.
13. Velocity of Ultrasonic waves
14. Linear Air track
15. Determination of Planks constant

Seminar: Two seminars for each student are compulsory

Laboratry Course: Internal assessment through a written test

M.Sc. Semester III

MPH 301 : ADVANCED QUANTUM MECHANICS

Section A

Scattering Theory:
General considerations; kinematics, wave mechanical picture, scattering amplitude, differential and total crosssection. 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.

Section B

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.

Section C

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.

Section D

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.

Books Recommended

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).

MPH 302 : NUCLEAR PHYSICS

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 Detectros – Ground state of deuteron, Low energy neutron-proton scattering and protonproton 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.

MPH 303 : ELECTRONICS- I

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

MPH 304 : LASER PHYSICS- I

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, N_2, CO_2 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 apectroscopy, multiphoton processes, photo accoustic 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

MPH P 35 : Laboratory Course- I (General)

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. Logicom 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: Two seminars for each student are compulsory

Laboratory Course: Internal assessment through a written test

MPH P 36 : Laboratory Course (Circuit Design)

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 Comprator and Decoder
7. Study of different flip- flop circuits (RS, JK, Dk 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

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 gama-ray spectrometer.
4. Characteristics of Scintillation Detector.
5. Study of gama-gama 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

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 colour 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

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

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

M.Sc. Semester IV

MPH 401 : COMPUTATIONAL PHYSICS

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 algorithons-Problem analysics 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.

MPH 402 : PARTICLE PHYSICS

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, Colour - 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.

Books and References:

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)

MPH 403 : ELECTRONICS- III

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.

Demodulation- Envelope diode detector, super regenerative detection, Foster Seely 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 wave length lines.

Antenna – Radioactive field strength, power and radiation patterns of an elementary electric doublet and linear antenna, effects of ground reflection. Hertz antenna, Marconi antenaa, 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-

Electes-Larmor theory, Applecton – Hartree theory of sky wave propagation, skip distance and maximum usable frequency, Chapmann'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, colour 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

MPH 404 : LASER PHYSICS- II

Unit I

Electro optic effect, longitudinal and transverse phase modulation, consideration of modulator designs and circuit aspects, acousto optic effect, Raman Nath and Bragg regimes, acousto 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 photconductive methods of detection of light, photodiodes: structure, materials and working, PIN photodiodes, avalanche photodiodes, microchannel plates, photodetector noise responsivity and efficiency, photomultipliers, image intensifier tubes, Videocon and CCD.

Unit III

Fibre optics: Basic characterstics of optical fibres, fibre structure and fundamentals of waveguides, step and graded index fibres, signal degradation in optical fibres, absorption scattering, radiation and core cladding losses, Design considerations of a fibre optical communication system, analogue and digital modulation, optical fibre 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 Thyagrajan :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

MPH P 45 : Laboratory Course

List of experiments:

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

MPH P 46 : Project work for all specializations

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.