DAVUNIVERSITYJALANDHAR

Scheme & Syllabus

For

M.Sc.(HONOURSCHOOL)PHYSICS

(Program ID-41)

1^{st} TO 4^{th} SEMESTER

Examinations2014–2015 Session

Syllabi Applicable For Admissions in 2014

Instruction for candidates (Theory Paper)

- The question paper for end-semester examination will have a weightage of 25%. It will consist of 100 objective questions of equal marks. All questions will be compulsory.
- Two preannounced test will be conducted having a weightage of 25% each. Each preannounced test will consist of 20 objective type, 5 short questions/problems on the UGC-NET (objective type) pattern as well as one long answer type question. The student is expected to provide reasoning/solution/working for the answer. The candidates will attempt all question. Choice will be given only in long answer type. The question paper is expected to contain problems to the extent of 40% of total marks.
- Four objective/MCQ type surprise test will be taken. Two best out of four objective/MCQ type surprise test will be considered towards final each of 12.5% weightage to the final. Each surprise test will include 20-25 questions.
- The books indicated as text-book(s) are suggestive However, any other book may be followed.

* Wherever specific instructions are required these are given at the starting of that particular subject/paper

Instruction for candidates (Practical Paper)

- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

This syllabus has been designed as per national syllabus suggested by UGC and covers 20% extra syllabus as per requisite of honors degree.

Scheme of Courses M. Sc.
M.Sc.(HONOURSCHOOL)PHYSICS

Semester 1

S. No	Subject	Sub Code	L	T	P	C	% Weightage A	B	C	D	Marks
1	Classical Mechanics	PHY-501	4	1	0	4	25	25	25	25	100
2	Mathematical Physics	PHY-502	4	1	0	4	25	25	25	25	100
3	Electronics-I	PHY-503	4	1	0	4	25	25	25	25	100
4	Quantum Mechanics-I	PHY-504	4	1	0	4	25	25	25	25	100
5	Computer Lab	PHY-505	0	0	4	2	25	25	25	25	50
6	Advanced Physics Lab-1	PHY-506	0	0	9	4	0	0	0	0	100
7	Academic Activity	PHY-507	_	_	_	2	0	0	0	0	50
			16	4	13	22					600

Semester 2

S. No	Subject	Sub Code	L	T	P	C	% Weightage A	B	C	D	Marks
1	Quantum Mechanics-II	PHY-511	4	1	0	4	25	25	25	25	100
2	Atomic and Molecular Spectroscopy	PHY-512	4	1	0	4	25	25	25	25	100
3	Statistical Physics	PHY-513	4	1	0	4	25	25	25	25	100
4	Electrodynamics-I	PHY-514	4	1	0	4	25	25	25	25	100
5	Computational Physics	PHY-515	4	1	0	4	25	25	25	25	100
6	Computation Physics Lab	PHY-516	0	0	4	2	0	0	0	0	50
7	Advanced Physics Lab-II	PHY-517	0	0	9	4	0	0	0	0	100
			20	5	13						650

Scheme of Courses M. Sc.
M.Sc.(HONOURSCHOOL)PHYSICS

Semester 3

S. No	Subject	Sub Code	L	T	P	C	% Weightage A	B	C	D	Marks
1	Electrodynamics-II	PHY-601	4	1	0	4	25	25	25	25	100
2	Nuclear Physics	PHY-602	4	1	0	4	25	25	25	25	100
3	Condensed Matter Physics-I	PHY-603	4	1	0	4	25	25	25	25	100
4	Particle Physics	PHY-604	4	1	0	4	25	25	25	25	100
5	Electronics-II	PHY-605	4	1	0	4	0	0	0	0	100
6	Advanced Physics Lab-III	PHY-606	0	0	9	4	0	0	0	0	100
			20	5	9	24					600

Semester 4

S. No	Subject	Sub Code	L	T	P	C	% Weightage A	B	C	D	Marks
1	Condensed Matter Physics-II	PHY-611	4	1	0	4	25	25	25	25	100
2	Matlab	ECE-650	0	1	4	2	25	25	25	25	50
3	Elective-I*		4	1	0	4	25	25	25	25	100
4	Elective-II*		4	1	0	4	25	25	25	25	100
5	Project/ Advanced Physics Lab-IV	PHY-612	_	_	_	4	0	0	0	0	100
6	Academic Activity	PHY-613	_	_	_	2	0	0	0	0	50
7	CSIR Format	PHY-614	_	_	_	2	0	0	0	0	50
			12	4	4	22					550

* The elective papers will be offered depending upon the availability of teachers, and the students will be allotted one of the courses being taught, on the basis of their option and percentage of marks in M.Sc. (H.S.) I examination. List of elective papers is given below.

Semester	List of Elective Subject*	Sub Code	L	T	P	C	% Weightage				Marks
							A	B	C	D	
Fourth	Physics of Liquid crystals	PHY-621	4	1	0	4	25	25	25	25	100
Fourth	Plasma Physics	PHY-622	4	1	0	4	25	25	25	25	100
Fourth	Physics of Nanomaterials	PHY-623	4	1	0	4	25	25	25	25	100
Fourth	Advanced Nuclear Physics	PHY-624	4	1	0	4	25	25	25	25	100
Fourth	Advanced Particle Physics	PHY-625	4	1	0	4	25	25	25	25	100
Fourth	Non Linear and Fiber Optics	PHY-626	4	1	0	4	25	25	25	25	100
Fourth	Experimental Techniques	PHY-627	4	1	0	4	25	25	25	25	100

1. If a course is being taught by two teachers, they should coordinate among themselves for assessment and material being taught.
2. Internal assessment in all the papers will be as per university rules.
3. **S**tudents will be allotted project on the basis of their option, availability of teacher and percentage of marks in M.Sc. (H.S.) I examination, while all other students will do p hysics Laboratory IV.
4. The pass marks is 40% in each subject.

FIRST SEMESTER

Course Code: PHY 501

CLASSICAL PHYSICS

L	T	P	Marks
4	1	0	100

Total Lectures-60

AIM

The aim and objective of the course on **Classical Mechanics** is to equip the students of **M.Sc. (Hons)** with the knowledge of Lagrangian and Hamiltonian principles, equations, canonical transformations and small oscillations, so that students may apply these equations and principles in modern physics research

Unit-I

Lagrangian Formulation (12):

Historical overview and significance of Classical mechanics, Newtonian mechanics of one and a system of particles, Conservation theorems for linear momentum, angular momentum and energy, constraints of motion, generalized coordinates, principle of virtual work, D' Alembert's Principle and Lagrange's velocity dependent forces and the dissipation function, Applications of Lagrangian formulation.

Unit-II

Hamilton's Principle and equations (8):

Method of calculus of variation and its examples, Hamilton principle, Lagrange's equation from Hamilton's principle, Symmetry properties of space and time, Conservation theorems, Legendre Transformation, Hamilton's equations of motion, Cyclic coordinates Hamilton's equations from variational principle, Principle of least action.

Unit-III

Canonical transformation and Hamilton-Jacobi theory (10):

Canonical transformation and its examples, Lagrange brackets, Poisson's brackets, Equation of motion, Angular momentum, Poisson's Brackets relations, infinitesimal canonical transformation, Conservation Theorems, Hamilton-Jacobi equation for Hamilton's principal function, Harmonic Oscillator problem.

Unit-IV Rigid Body Motion and small oscillations (15)

Reduction to equivalent one body problem, the equation of motion and first integrals, classification of orbits, the differential equation for orbits, the Kepler's problem, scattering in central force field. The Euler's angles, rate of change of a vector, the Coriolis force and its applications. Euler equation of motion, Torque free motion of rigid body, motion of a symmetrical top, Eigen value equation, Free vibrations, Normal coordinates.

SUGGESTED BOOKS:

1. Goldstein, H., Poole, C. and Safko,J. *Classical Mechanics*. New Delhi: Pearson Education Asia, 2002.
2. Hand, Louis N. and Finch, Janet D. *Analytical Mechanics.* United States of America: Cambridge University Press 1998.
3. Gregory, R Douglas. *Classical Mechanics.* United Kingdom: Cambridge University Press, 2006.
4. Kibble, Tom W. and Berkhire, Frank H. *Classical Mechanics.* London: Imperial College Press, 2004.
5. Strauch, Dieter. *Classical Mechanics.* Berlin: Springer 2009.

Course Code: PHY-502:
MATHEMATICAL PHYSICS
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM

The course on **Mathematical Physics** is introduced to familiarize the students of M.Sc.(Hons.) with the mathematical techniques that will be useful in understanding theoretical treatment in different courses taught in this class and for developing a strong background if they want to pursue research in theoretical physics.

Unit-I (19)

Vector Calculus, Matrices and Tensors

Vector algebra and vector calculus, Orthogonal, Unitary and Hermition matrices, Inverse of a matrix, Cayley-Hamilton Theorem, Eigen Values and Eigen Vectors, Tensors: Covariant, Contravariant, and mixed tensors, Algebraic operations on tensors.

Group Theory

Definition of a group, Multiplication table, Conjugate elements and classes of groups, directs product, Isomorphism, homeomorphism, permutation group, Definitions of the three dimensional rotation group and SU(2).

Unit-II (13)

Complex Analysis

Functions of a complex variable, Single and multi-valued functions, Analytic functions, Cauchy Riemann conditions, Singular points, Cauchy's integral theorem, Taylor and Laurent series, Zeros and poles, Residue theorem and its application to evaluation of definite integrals.

Unit-III (15)

Differential equations and Special functions

Second order differential equations, Power Series method, Frobenius method, Bessel functions of first and second kind, Generating Function, Integral representation and recurrence relations and orthogonally, Legendre functions: Generating functions, recurrence relations and special properties, orthogonality, Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite and Laguerre functions: Solution of Hermite and Lageurre differential equation, generating function and Recurrence relations

Unit-IV (13)

Fourier transformation and Laplace transformation

Fourier transformation

Fourier decomposition, Fourier series, and convolution theorem.Fourier transformations and its application to wave theory.

Laplace transformation

Definitions, Conditions of existence, functions of exponential orders, Laplace transform of elementary functions, Basic theorems of Laplace transforms, Laplace transforms of derivatives, Properties of Laplace transforms, Inverse Laplace transforms: its properties and related theorems, Convolution theorem, Use of Laplace transforms in the solution of deferential equation with constant and variable coefficients and simultaneous differential equations.

SUGGESTED BOOKS:

1. Arfken, G. and Weber, H.J. *Mathematical Methods for Physicists* by (Academic Press, San Diego) 7th edition, 2012
2. Chattopadhyay, P.K *Mathematical Physics*. New Delhi: Wiley Eastern, 2004.
3. Rajput, B.S. *Mathematical Physics* Meerut: Pragati Prakashan, 2005).
4. Speigal, M. R. *Laplace Transforms* (Schaum Series) New Delhi: Tata McGraw-Hill Publishing Company, 1981.
5. Kreyszig, E. *Advanced Engineering Mathematics* New York: John Wiley & Sons, 8th Ed., 2001.
6. Joshi, A.W. *Matrices and Tensors in Physics* 3rd Ed., New Delhi, New Age International Publishers, 1995.
7. Joshi, A.W. *Elements of Group Theory for Physicists* New Delhi: New Age International Publishers, 1997.

L	T	P	Marks
4	1	0	100

PHY-503 Electronics-I
Max.Marks:100
Total Lecture-60 **L T P: 4 1 0**

AIM: The aim and objective of the course on Electronics for the student of M.Sc. (Hons.) Physics is to equip them with the knowledge of electronic devices and applications, circuits and operational amplifier.

Unit-I.
Circuit Analysis **(15):**
Lumped circuits, Non-linear resistors-series and parallel connections, D.C. operating point, small signal analysis, Thevenin and Norton theorems, Mesh and Node analysis. Admittance, impedance, hybrid and Transmission matrices for two and three-port networks and their applications. First-order nonlinear circuits, Dynamic route, jump phenomenon and relaxation oscillator, triggering of bistable circuits.

Unit-II.
Circuit Relations **(15):**
Relation between time and frequency domains (Laplace transforms), Transfer function, Location of poles and zeros of response functions of active and passive systems (Nodal and modified nodal analysis), pole-zero cancellation, Sinusoidal frequency and phase response, Bode plot, Analysis of passive circuits/filters, Phase distortion and equalizers, Transformer - equivalent circuit and transfer function, Autotransformer.

Unit-III.
Electronic Devices and Applications **(18):**
Energy band diagrams, p-n junctions and diodes, Zener diode, Schottky diode, Switching diodes, Tunnel diode, Light emitting diodes, Photodiodes and solar cell, Transistors, Field effect devices, device structure and characteristics, MOSFET, Enhancement and depletion mode, MESFET, Charge Coupled Devices (CCD), Unijunction transistor (UJT), Four layer (PNPN) devices, Semiconductor Controlled Rectifier (SCR) or Thyristor, Regulated power supplies, Gunn diode, IMPATT devices, Liquid crystal displays.

Unit-IV.
Operational Amplifier **(12):**
Differential amplifiers, common mode rejection ratio, Transfer characteristics, Ideal operational amplifier; Open loop operational amplifier, inverting and non-inverting amplifier, voltage follower, Operational Amplifier as; Summing, scaling and averaging amplifiers, instrumentation amplifier, integrator and differentiator, Comparator, Schmitt trigger, Multivibrators; astable, monostable and bistable, square wave and triangular wave generators.

Books:

1. Sze, S.M. *Physics of Semiconductor Devices.* New York: Wiley, 1995.
2. Streetman, B.G., and Banerjee, S. *Solid State Electronics Devices.* New Jersey: Prentice Hall, 1999.
3. Millman, J. and Halkias, C.C. *Electronic Devices and Circuits*. New Delhi: Tata McGraw Hill, 1983.
4. Chua, L. O., Desoer, C. A., and Kuh, E. S. *Linear and Non-linear Circuits*. New York: Tata McGraw, 1987.
5. Geis, L. R. *Applications of Laplace Transforms*. New Jersey: Prentice Hall, 1989.

Course Code: PHY504
QUANTUMMECHANICS-I
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM
The aim and objective of the course on **Quantum Mechanics** is to teach the students the basics of the subject and make them understand the concept of angular momentum, perturbation theory and variation method etc. so that they can use these in various branches of physics as per requirement of the subject.

Unit-I
Matrix Mechanics (16):
Review of wave mechanics: Hydrogen atom, Harmonic oscillator, Vector spaces, Schwarz inequality, Orthonormal basis, Schmidt orthonormalisation method, Operators, Projection operator, HermitianandUnitaryoperators,changeofbasis,EigenvalueandEigenvectorsofoperators, Dirac'sbraandketnotation,commutators,Simultaneouseigenvectors,Postulatesof quantum mechanics,uncertaintyrelation.Harmonicoscillatorinmatrixmechanics,Timedevelopmentof statesandoperators,HeisenbergandSchroedingerrepresentations,Exchangeoperatorand identical particles. Density Matrix and Mixed Ensemble.

Unit-II
Angular Momentum (15):
Angular part of the Schroedinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigenvalues and eigenvectors of L_2 and L_z. Spin angular momentum, General angular momentum, Eigenvalues and eigenvectors of J_2 and J_z. Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients, WKB approximation.

Unit-III
Time Independent Perturbation and Approximate Methods (16):
Non-Degenerate and degenerate perturbation theory and its applications, Variational method with applications to the ground states of harmonic oscillator and other sample systems.

Unit-IV
Time Dependent Perturbation Theory (14):
General expression for the probability of transition from one state to another, constant and harmonic perturbations, Fermi's golden rule and its application to radiative transition in atoms, Selection rules for emission and absorption of light.

TUTORIALS: Relevant problems given in the text and reference books.

Suggested Books:

1. Khanna, M.P *Quantum Mechanics.* NewDelhi: HarAnand, 2006. Print.
2. Mathews, P.M and Venkatesan K. *A Textbook of Quantum Mechanics*. NewDelh: Tata McGraw Hill 2nd edition, 2004.
3. Sakurai, J.J. Modern *Quantum Mechanics*. Reading: Addison Wesley, 2004. Print.
4. Thankappan, V.K. *Quantum Mechanics.* NewDelhi :NewAge. 2004. Print.
5. Powell, J.L. and Crasemann, B. *Quantum Mechanics.* NewDelhi: Narosa. 1995.Print.
6. Gasiorowicz, S. *Quantum Physics.* New York :Wiley. 3rd ed. 2003. Print.

SECOND SEMESTER

Course Code: PHY 511:

QUANTUMMECHANCIS-II
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM
The contents of the course on **Quantum Mechanics-II** are designed with and aim to introduce the M.Sc.(H.S.) student with advance concept of quantum and to equip him/her with the techniques of quantum field theory so that they can use these in various branches of physics.

UNIT-I
Scattering Theory (15):
Scattering Cross-section and scattering amplitude, partial wave analysis, Low energy scattering, Green's functions in scattering theory, Born approximation and its application to Yukawa potential and other simple potentials. Optical theorem, Scattering of identical particles.

UNIT-II
Relativistic Quantum Mechanics (14):
Klein-Gordon equation, Dirac equation and its plane wave solutions, significance of negative energy solutions, spin angular momentum of the Dirac particle. The non relativistic limit of Dirac equation, Electron in electromagnetic fields, spin magnetic moment, spin-orbit interaction, Dirac equation for a particle in a central field, fine structure of hydrogen atom, Lamb shift.

UNIT-III
Field Quantization (16) :
Resume of Lagrangian and Hamiltonian formalism of a classical field. Second quantization: Concepts and illustrations with Schroedinger field. Quantization of a real scalar field and its application to one meson exchange potential

UNIT-IV
Relativistic Quantum Field Theory (15):
Quantization of a complex scalar field, Dirac field and e.m. field, Covarian tperturbation theory, Feynman diagrams and their applications

TUTORIALS: Relevant problems given in the text and reference books.

Suggested Books:

1. Khanna, M.P *Quantum Mechanics.* NewDelhi: HarAnand, 2006. Print.
2. Das, A. *Lectures on Quantum Field Theory* World Scientific. 2008. Print.
3. Mathews, P.M and Venkatesan K. *A Textbook of Quantum Mechanics*. NewDelh: Tata McGrawHill 2ndedition, 2004.
4. Sakurai, J.J. Modern *QuantumMechanics*. Reading: AddisonWesley, 2004. Print.
5. Thankappan, V.K. *Quantum Mechanics.* NewDelhi :NewAge. 2004. Print.
6. Mandl, H.and Shaw, G. *Quantum Field Theory*, NewYork :Wiley. 2010. Print.

Course Code: PHY-512
ATOMIC AND MOLECULAR PHYSICS
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM

The aim and objective of the course on Atomic and Molecular Physics for the student of M.Sc. (Hons.) Physics is to equip them with the knowledge of Atomic, Rotational, Vibrational, Raman and Electronic spectra.

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Unit-I

Spectra of one and two valance electron systems (15):
Quantum states of an electron in an atom, Magnetic dipole moments, Larmor's theorem, Space quantization of orbital, spin and total angular momenta, Vector model for one and two valance electron atoms, Spin-orbit interaction and fine structure of hydrogen, Lamb shift, Spectroscopic terminology, Spectroscopic notations for L-S and J-J couplings, Spectra of alkali and alkaline earth metals, Interaction energy in L-S and J-J coupling for two electron systems, Selection and Intensity rules for doublets and triplets.

Unit-II

Effect of external fields on the spectra (14):
The Doppler effect, Natural width from classical theory, natural width and quantum mechanics, External effects like collision damping, asymmetry and pressure shift and stark broadening, The Zeeman Effect for two electron systems, Intensity rules for the Zeeman effect, The calculations of Zeeman patterns, Paschen-Back effect, LS coupling and Paschen-Back effect, Lande's factor in LS coupling, Stark effect.

Unit-III

Rotational and Vibrational Spectroscopy (16):
Rotational spectra of diatomic molecules as a rigid and non-rigid rotator, Intensity of rotational lines, Effect of isotopic substitution, Microwave spectrum of polyatomic molecules, Microwave oven, The vibrating diatomic molecule as a simple harmonic and an harmonic oscillator, Diatomic vibrating rotator, The vibration-rotation spectrum of carbon monoxide, The interaction of rotation and vibrations, Brief introduction of technique and instrumentation and Fourier transform spectroscopy.

Unit-IV

Raman and Electronic Spectroscopy (16): Quantum and classical theories of Raman Effect, Pure rotational Raman spectra for linear and polyatomic molecules, Vibrational Raman spectra, Structure determination from Raman and infra-red spectroscopy, Electronic structure of diatomic molecule, Electronic spectra of diatomic molecules, Born Oppenheimer approximation-The Franck Condon principle, Dissociation and pre-dissociation energy, The Fortrat diagram, Example of spectrum of molecular hydrogen.

Suggested Books:

1. White, H.E. *Introduction to Atomic Spectra*. London: McGraw Hill, 1934.
2. Banwell, C.B. *Fundamentals of molecular spectroscopy*. New Delhi: Tata McGraw Hill, 1986.
3. Barrow, G.M. *Introduction to Molecular spectroscopy*. New York: McGraw Hill, 1962.
4. Herzberg, G. *Spectra of diatomic molecules*. New York: Van Nostrand Reinhold, 1950.
5. McHale, J. L. *Molecular spectroscopy*. New Jersey: Prentice Hall, 1999.

Course Code: PHY-513:
STATISTICAL PHYSICS

L	T	P	Marks
4	1	0	100

Total Lecture-60

AIM
The course on **Statistical Physics** has been framed to teach the students of M.Sc. (Hons) the techniques of Ensemble theory so that they can use these techniques to understand the macroscopic properties of the matter in bulk in terms of its microscopic constituents.

UNIT I **(19)**
Introduction to Statistical Physics, specification of states of a system, contact between statistics and thermodynamics, classical ideal gas, entropy of mixing and Gibb's paradox.
Microcannonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; Calculation of statistical quantities, fluctuation of energy and density.

UNIT II **(14)**
Density matrix, statistics of various ensembles, Statistics of indinguishable particles, Maxwell-Boltzmann distribution, determination of undetermined multipliers, equi-partition of energy, the Einstein Diffusion equation, Bose-Einstein statistics, the Bose-Einstein gas, Bose-Einstein condensation, Fermi-Dirac statistics, the Fermi-Dirac gas, the electron gas.

UNIT III **(14)**
Cluster expansion for a classical gas, virial expansion of the equation of state, evaluation of the virial coefficients the Ising model, equivalence of the Ising model to other models, spontaneous magnetization, the Bragg-Williams approximation, the Bethe-Peierls approximation.

UNIT IV **(13)**
Phase transitions, Landau theory of phase transition, critical exponents, scaling hypothesis for the thermodynamic functions. Fluctuations, time-dependent, correlation functions, fluctuations and thermodynamic properties. Brownian motion, Langevin theory, fluctuation-dissipation theorem, the Fokker-Planck equation.

SUGGESTED BOOKS:
1. Patharia, R.K. *Statistical Mechanics.* Oxford: Pergamon Press, 1972.
2. Huang, K. *Statistical Mechanics*. New Delhi: Wiley Eastern, 1963.
3. Kittel, C. *Elementary Statistical Physics*. New Delhi: Wiley Eastern, 1976.
4. Aggarwal, B.K., and Eisner, M. *Statistical Mechanics.* New Delhi ; Wiley Eastern Ltd., 1994.
5. Chandler, D. *Introduction to Modern Statistical Mechanics*. New Delhi: Oxford University Press, 1987.

PHY514 ELECTRODYNAMICS-I
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM

The **Classical Electrodynamics and plasma physics is a** course that covers Electrostatics and Magnetostatics as well the basics of plasma physics. The students are made to understand the plasma physics in detail, a major need of the day. It also covers the Maxwell equations and their applications to propagation of electromagnetic waves in dielectrics, metals and plasma media; motions of relativistic and non- relativistic charged particles in electrostatic and magnetic fields.

UNIT I **(15)**

Electrostatics in Vacuum: Coulomb's Law, Gauss Law, Scalar potential. Laplace andpoisson's equations. Electrostatic potentials, energy and energy density of the electromagneticfield.
Multipole Expansion: Multipole expansion of the scalar potential of a charge distribution. Dipole moment, quadrupole moment. Multipole expansion pf the energy of a charge distribution in an external field.
Electrostatics of Dielectrics: Static fields in material media. Polarization vector macroscopic equations. Molecular polarizability and electric susceptibility. Clasusius-Mossetti relations. Models of Molecular Polarizability. Energy of charges in dielectric media.

UNIT II **(16)**

Magnetostatics: the differential equations of magnetostatics, Vector potential. Magnetic field of a localized current distribution.
Boundary value Problems : Uniqueness Theorem. Dirichlet of Neumann Boundary conditions, Green's Theorem, Formal solution of Electrostatic Boundary value problem with Green function. Method of images with examples. Magnetostatic Boundary value problems.

UNIT-III **(15)**

Time Varying Fields and Maxwell Equations: Faraday's Law of induction. Displacement current. Maxwell equations. Scalar and vector potentials. Gauge transformation, Lorentz and Coulomb gauges, General Expression for the electromagnetic fields energy, conservation of energy, Poynting's Theorem. Conservation of momentum.

UNIT-IV **(14)**

Electromagnetic Waves: Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, poynting's theorem for a complex vector field, waves in conducting media, skin depth, EM waves in rare field plasma and their propagation in ionosphere. Reflection and Refraction of EM waves at plane interface, Frensel's amplitude relations. Reflection and transmission coefficients. Polarization by reflection. Brewster's angle, Total internal reflection, Wave guides, TE and TM waves, Rectangular wave guides. Energy flow and attenuation in wave guides, Cavity resonators.

TUTORIALS: Relevant problems are given in each chapter in the text and reference books.

Suggested Books:

1. Puri S.P. *Classical Electrodynamics*. NewDelhi: Narosa Publishing House, 2011.
2. Jackson, J.D *Classical Electrodynamics*. New Delhi: NewAge,NewDelhi, 2009.

3. Marion, J.B.and Heald, M.A *Classical Electromagnetic Radiation* . USA: Saunders College Publishing House, 3rd edition,1995.

4. Griffiths D.J., *Introduction to Electrodynamics.* NewDelhi : Prentice Hall India, 4th ed., 2012.

5. Wangsness Ronald K *Electromagnetic Fields*. NYSE : John Wiley and Sons, 2nd edition,1986.

6. Guru Bhag Singh and Hiziroglu H.R . *Electromagnetic Field Theory Fundamentals*. UK: Cambridge University Press, 2nd edition,2004.

7..Capriand A.Z and Panat P.V. *Introduction to Electrodynamics:* NewDelhi: Narosa Publishing House, 2010.

L	T	P	Marks
4	1	0	100

Course Code: PHY515:
COMPUTATIONAL PHYSICS
Total Lecture-60
AIM

The course on **Computational Physics** has been framed to equip the students of M.Sc.(Hons) with knowledge of programming in Fortran, roots of equation, interpolation, curve fitting, Numerical differentiation, numerical integration and numerical solution of ordinary differential equations.

Unit-I

FORTRAN Programming: Review of fundamental FORTRAN commands and programming structures (sequential, repetitive and selective), data types, subscripted variables, format directed input and output statements, handling of data files, Subprograms: Function and Subroutines.

Unit-II

Fundamental iterative scheme, Bisection method, Newton Raphson method, Secant method, Error analysis, System of linear equations: Gauss elimination method, Jacobi method, Gauss Seidel method, Least squares line fitting, Numerical differentiation and integration: Differentiation using forward, backward and central difference operators, Quadratures: rectangular, trapezoidal and Simpson's rule

Unit-III

Solution of Ordinary Differential Equations: Eulers method, Taylor series method, Runge Kutta methods, Predictor corrector methods, Solution of coupled differential equations, and second order differential equations, Monte Carlo technique: Pseudo random numbers, their generation and properties, Monte Carlo method.

Unit-IV

Algorithmic development for simulation of the following physics problems:-

1. Motion in one dimension in viscous medium
2. Motion of satellite
3. Simple harmonic osciilator
4. Damped oscillator
5. Electric field and potential due to assemble of charges
6. Application of Kirchoffs laws for simple electric circuits
7. Monte Carlo method to find value of pi
8. Monte Carlo technique for simulation of nuclear radioactivity.

SUGGESTED BOOKS:

1. Verma, R.C. Ahluwalia P.K. and Khosla, U.N. *Fortran 77: Programming and Applications* New Delhi: Allied Publishers, 2006
2. Rajaraman V. *Programming with Fortran-77* New Delhi: Tata McGraw-Hill Publishing Company
3. Mittal, V.K. Verma R.C. and Gupta S.C. *Fortran for Computational Physics* New Delhi: Anne Books, 2008.
4. Scarbrough, B.J. *Numerical Mathematical Analysis* New Delhi: Oxford and IBH Publishing Company 1966
5. Verma, R.C. *Computer Simulation in Physics (Fortran based)* New Delhi: Anamaya Publishers, 2009

Course Code:PHY-506/517
Advanced PHYSICS LAB – I &II
(120hrs) **Max Marks:100**

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

Note:

- Students are expected to perform at least eight-ten experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
- The examination for both the courses will be of 3 hours duration

Electronics

1. To study the characteristics of Tunnel diode.
2. To study the characteristics of Junction Field Effect Transistor.
3. To study the characteristic of MOSFET.
4. To study the characteristic of SCR and its application as a switching device.
5. To study the characteristics of Unijunction Transistor (UJT).
6. To study the characteristics of DIAC and TRIAC.
7. Operational amplifier (OP Amp) as integrator & differentiator.
8. To assemble Logic gates using discrete components and to verify truth table.
9. Digital logic trainer (logic gates, Boolean's identity and de-Morgan's theorem).
10. Parity generator and checker.
11. Characterization of the solar cell.
12. To study JK, MS and D-flip flops.
13. To Study the Half and full adder of binary numbers.
14. To study D/A and A/D convertors.
15. To study 4-bit registers
16. To study 4-bit counter (Synchronous and asynchronous).
17. Study of RAM kit.

Spectroscopy

1. To verify the existence of Bohr's energy levels with Frank-Hertz experiments.
2. Determination of Ionization Potential of Lithium.
3. Determination of Lande's g factor of DPPH using Electron-Spin resonance (E.S.R.) Spectrometer.
4. To study the fluorescence spectrum of DCM dyes and to determine the quantum yield of fluorescence maxima and full width at half maxima for this dye using monochromator.
5. To find the grating element of the given grating using He-Ne laser light.
6. To find the wavelength of He-Ne laser using Vernier calipers.
7. To study Faraday Effect using He-Ne Laser.
8. To find the wavelength of monochromatic light using Febry Perot interferometer.

9. Determination of e/m of electron by Normal Zeeman Effect using Febry Perot interferometer.
10. To find the wavelength of sodium light using Michelson interferometer.
11. To calibrate the constant deviation spectrometer with white light and to find the wavelength of unknown monochromatic light.

PHY505/516
COMPUTER Lab
Experiments are common for Computational Lab-I and II
(60hrs) **Max Marks:50**

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying experimental problems using FORTRAN 77 and C.

Note:

- Students are expected to perform at least eight-ten experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
- The examination for both the courses will be of 3 hours duration

Students are required to perform 12 programs in each semester

1. Simple Programmes using Fortran
2. To find the Roots of an Algebraic Equation by Bisection Method.
3. To find the Roots of an Algebraic Equation by Secant Method.
4. To find the Roots of an Algebraic Equation by Newton-Raphson Method.
5. To find the Roots of a Transcendental Equation by Newton-Raphson Method.
6. To find the Roots of Linear Equations by Gauss Elimination Method.
7. To find the Roots of Linear Equations by Gauss-Seidal Iterative Method.
8. To find the Eigenvalue and Eigenvector of a Matrix by Iterative Method.
9. To form a Forward Difference Table from a Given set of Data Values.
10. To form a Backward Difference Table from a Given Set of Data Values.
11. To find the value of y near the beginning of a Table of values of (x, y).
12. To find the value of y near the end of a Table of values of (x, y).
13. To fit a Straight Line to a given Set of Data Values.
14. To fit a Polynomial to a given Set of Data Values.
15. To fit an Exponential Function to a given Set of Data Values.
16. To fit a natural Cubic B-Spline to a given Data.
17. To find the First and Second Derivatives near the beginning of a Table of values of (x,y).
18. To find the First and Second Derivatives near the end of a Table of values of (x, y).
19. To evaluate a Definite Integral by Trapezoidal Rule.
20. To evaluate a Definite Integral by Simpson's 1/3 Rule.
21. To evaluate a Definite Integral by Simpson's 3/8 Rule.
22. To evaluate a Definite Integral by Gauss Quadrature Formula.
23. To solve a Differential Equation by Euler's Method.
24. To solve a Differential Equation by Modified Euler's Method.
25. To solve a Differential Equation by Second Order RungeKutta Method.
26. To solve a Differential Equation by Fourth Order RungeKutta Method.

DAV UNIVERSITY, JALANDHAR

THIRD SEMESTER

Course Code: PHY 601:

ELECTRODYNAMICS-II

Total Lecture-60

L	T	P	Marks
4	0	0	100

AIM

The aim and objective of **Electrodynamics-II** is to understand the nature of space-time and gravity based on the Einstein's theory of relativity. It also covers the applications of the special theory of relativity in modern Physics, Covariant formulation of electrodynamics and Origin of the electromagnetic radiation by an accelerating charge particle. The students will also be able to understand the scattering of electromagnetic wave by free and bound electron.

Unit I **(20)**

Special Theory of Relativity: Lorentz transformation as orthogonal transformationin 4- dimension ,relativistic equation of motion, applications of energy momentum conservation, Disintegration of a particle, C.M. System and reaction thresholds. FourvectorsinElectrodynamics,4-currentdensity,4-potential,covariant continuity equation, wave equation, covariance of Maxwell equations. Electromagnetic field tensor, transformation of EM fields. Invariants of the EM fields. Energy momentum tensor of the EM fields and the conservation laws. Lagrangian and Hamiltonian of a charged particle in an EM field

Unit II **(15)**

Radiation From Accelerated Charges : Lienard-Wiechert Potentials, Field of a charge in arbitrary motion and uniform motion, Radiated power from an accelerated charge at low velocities-Larmor-Powerformula.Radiationfromachargedparticlewithcollinearvelocity and acceleration. Radiation from a charged particle in a circular orbit ,Radiation from an ultra-relativistic particle, Radiation reaction. Line-width and level shift of an oscillator. Thomson scattering, Rayleigh scattering, absorption of radiation by bound electron.

Unit III **(15)**

Charged Particle Dynamics: Non-relativistic motion in uniform constant fields and in a slowly varying magnetic field, Adiabatic invariance of flux through an orbit, magnetic mirroring, Cross electrostatic and magnetic fields and applications, Relativistic motion of a charged particle in electrostatic and magnetic fields.

Unit IV **(10)**

Definition of plasma, concept of temperature, Debye shielding, criteria for plasma, single particle motion in E and B fields, magnetic mirrors and plasma confinement, plasma as a fluid, the fluid equation of motion, Plasma frequency, electron plasma waves, ion waves, electron and ion oscillations, cutoffs and resonance.

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TUTORIALS: Relevant problems given in the books listed below.

Suggested Books:

1. Puri S.P. *Classical Electrodynamics*. NewDelhi: Narosa Publishing House, 2011.
2. Jackson, J.D *Classical Electrodynamics*. New Delhi: NewAge,NewDelhi, 2009.
3. Patharia R.K. *Theory of Relativity.* Delhi, Hindustan Pub., 2nded.,1974.
4. Kenyon I.R. *General Relativity.* Oxford: Oxford Univ. Press, 2001.

5. Marion, J.B.and Heald, M.A *Classical Electromagnetic Radiation* . USA: Saunders College Publishing House, 3rd edition,1995.
6. Griffiths D.J., *Introduction to Electrodynamics.* NewDelhi : Prentice Hall India, 4th ed., 2012.
7. Bose, S.K. *An Introduction to General Relativity*. NewDelhi: Wiley Eastern Limited,1980.
8. Berry M. *Principles of Cosmology and Gravitation.* NewDelhi: Overseas Press, 2005.
9. Chen, F F. *Introduction to Plasma Physics and Controlled Fusion.* Plenum Press, New York 1980.

Course Code: PHY602

NUCLEAR PHYSICS

L	T	P	Marks
4	1	0	100

Total Lectures-60

AIM: The aim and objective of the course on Nuclear Physics is to equip the students of M.Sc (Hons.) Physics with the knowledge of nuclear interactions, decay, models and reactions.

Unit- I

Nuclear Interactions (10):

Evidence for saturation of nuclear density and binding energies, Two nucleon system, Deuteron problem, binding energy, nuclear potential well, pp and pn scattering experiments at low energy, meson theory of nuclear forces, exchange forces and tensor forces, effective range theory, spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction.

Unit-II

Nuclear Decay (10):

Barrier penetration of alpha decay & Geiger-Nuttal law, Beta decay, Fermi theory of beta decay, shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Kurie plots and comparative half-lives, Allowed and forbidden transitions, selection rules, parity violation in beta-decay, Two component theory of Neutrino decay, Detection and properties of neutrino, Gamma decay, Multipole transitions in nuclei, Angular momentum and parity selection rules, Internal conversion, Nuclear isomerism.

Unit-III

Nuclear Models (15):

Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell effects, Shell Model, Spin-Orbit coupling, Magic numbers, Applications of Shell model like Angular momenta and parities of nuclear ground states, Quantitative discussion and estimates of transition rates, magnetic moments and Schmidt lines, Collective model, nuclear vibrations spectra and rotational spectra, applications, Nilsson model.

Unit-IV

Nuclear Reactions (10):

Nuclear reactions and cross-sections, Conservation laws, energetics of nuclear reactions, Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, Compound nucleus, Coulomb excitation, scattering matrix, Reciprocity theorem, Breit Wigner one level formula, Resonance scattering.

SUGGESTED BOOKSs:

1. Burcham,W.E. and Jobes,M. *Nuclear and Particle Physics,*United Kingdom : Pearson 1995.
2. Enge,Herald.*Introduction to Nuclear Physics,* London: Addison-Wesley 1971.
3. Kaplan Irving *Nuclear Physics,*New Delhi: Narosa 2002.
4. Roy,R.R. and Nigam,B.P. *Theory of Nuclear Structure,* New Delhi: New Age 2005.
5.Hans, H.S. *Nuclear physics-Experimental and Theoretical,*Tunbridge Wells: New Academic Science 2011.
6. Hyde,K.*Basic Ideas and Concepts in Nuclear Physics*United Kingdom: Institute of Physics 2004.

Course Code: PHY603:
CONDENSED MATTERPHYSICS-I
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM
The contents of the course on **Condensed Matter Physics-I are designed so a**s to expose the students of M.Sc.(H.S.) class to the topics like elastic constants, energy band theory and transport theory so that they are able to use these techniques in investigating the aspects of the matter in condensed phase.

UNIT I **(17)**
Elastic constants: Resume of binding in solids; Stress components, stiffness constant, elasticConstants, elastic waves in crystals.
Lattice Dynamics and Thermal Properties:
Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamicProperties of crystal, anharmonic effects, thermal expansion. (Books 3, 4 and 6).

UNIT-II **(16)**
Energy Band Theory:
Review of electrons in a periodic potential; nearly free electron model; tight binding method;Impurity levels in doped semiconductors, Band theory of pure and doped semiconductors.

UNIT-III **(14)**
Transport Theory:
Electronic transport from classical kinetic theory; Introduction to Boltzmann transport equation,calculation of relaxation time in metals; thermal conductivity of metals and insulators;thermoelectric effects; Hall effect and magnetoresistance; Transport in semiconductors.

UNIT-IV **(13)**
Dielectric Properties of Materials :
Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation;piezo, pyro- and ferro-electricity.

TUTORIALS: Relevant problems given in the books listed below.

Suggested Books:

1. Kittel, C. *Introductionto Solid State Physics.* NewYork: Wiley 8thed. 2005.Print.
2. Kittel, C. *Quantum Theory of Solids.* NewYork: Wiley 1987.Print.
3. Ziman, J. *Principles of the Theory of Solids.* UKCambridge University Press,1972.Print.
4. Ibach, H. and Luth, H. *Solid State PhysICS.* Belin: Springer. 3rd.ed. 2002. Print.
5. Harrison, Walter A. *Solid State Theory.* NewDelhi :Tata McGraw-Hill 1970. Print.

Course Code: PHY 604
PARTICLE PHYSICS

L	T	P	Marks
4	1	0	100

Total Lectures-60

AIM

The aim and objective of the course on **Particle Physics** is to equip the students of **M.Sc. (Hons)** with the knowledge of invariance principles, hadron-hadron interactions, quark model and weak interactions

Unit-I
Introduction (15):

Fundamental interactions - electromagnetic, weak, strong and gravitational, fermions and bosons, particles and antiparticles, quarks and leptons, interactions and fields in particle physics, classical and quantum pictures, Yukawa picture.

Unit-II
Invariance Principles and Conservation Laws (15):

Invariance in classical mechanics and in quantum mechanics, Symmetries: Discrete and continuous. Parity, Pion parity, Charge conjugation, Positronium decay. Time reversal invariance, CPT theorem.

Unit-III
Hadron-Hadron Interactions (15):

Cross section and decay rates, Pion spin, Isospin, SU(3), SU(4), SU(5) and SU(6), Two nucleon system, Pion-nucleon system, Strangeness and Isospin, G-parity, Total and Elastic cross section, Particle production at high energy.

Unit-IV
Static Quark Model of Hadrons and Weak Interactions (15):

The Baryon decuplet, quark spin and color, baryon octer, quark-antiquark combination. Classification of weak interactions, Fermi theory, Parity nonconservation in β-decay, experimental determination of parity violation, helicity of neutrino, K-decay, CP violation in K- decay and its experimental determination.

SUGGESTED BOOKS:

1. . Burcham, W.E. and Jobes, M. *Nuclear and Particle Physics,*United Kingdom : Pearson 1995.
2. Mittal,V. K., Verma,R. C. and Gupta,S.C. *Introduction to Nuclear and Particle Physics,* New Delhi:Prentice Hall of India 2013.
3. Perkins, D.H. *Introduction to High Energy Physics* United Kingdom: Cambridge University Press, 4th ed. 2000.
4. Hughes,I.S. *Elementary Particles* United Kingdom: Cambridge University Press 3rd ed. 1991.
5. Close,F.E. *Introduction to Quarks and Partons,* London:Academic Press 1979.
6. Khanna,M.P. *Introduction to Particle Physics,* New Delhi: Prentice Hall of India 2004.
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PHY-605

Electronics-II

Max.Marks:100 **Total Lecture-45** **L T P: 3 1 0**

Unit-I.

Digital Principles (10):

Binary, octal and Hexadecimal number system, BCD and ASCII code system, Binary arithmetic, Logic gates, Boolean equation of logic circuits, de Morgans theorem, Karnaugh map, Encoders & Decoders, Multiplexers and Demultiplexers, Parity generators and checkers, Adder-Subtractor circuits.

Unit-II.

Sequential Circuits (12):

Flip-Flops–RS, JK, D, clocked, preset and clear operation, race- around conditions in JK Flip-flops, master-slave JK flip-flops, Shift registers, Asynchronous and Synchronous counters, D/A converter, A/D converter using counter, Successive approximation A/D converter.

Unit-III.

Microprocessor (12):

Buffer registers, Bus organized computers, SAP-I, Microprocessor (μP) 8085 Architecture, memory interfacing, interfacing I/O devices. Assembly language programming: Instruction classification, addressing modes, timing diagram, Data transfer, Logic and Branch operations-Programming examples.

Unit-IV.

Semiconductor Memories (11):

ROM, PROM and EPROM, RAM, Static and Dynamic Random Access Memories (SRAM and DRAM), content addressable memory, other advanced memories.

SUGGESTED BOOKS:

1. Malvino, A.P.and Leach, D. P. *Digital Principles and Applications.* New Delhi: Tata McGraw Hill, 1986.
2. Malvino, A.P. *Digital Computer Electronics*. New Delhi: Tata McGraw Hill, 1986.
3. Gothmann, W.H. *Digital Electronics*. New Delhi: Prentice Hall, 1980.
4. Gaonkar, R.S. *Microprocessor Architecture, Programming and Applications with 8085*. New Delhi: Prentice Hall, 2002.

FOURTH SEMESTER

Course Code: PHY611:
CONDENSED MATTERPHYSICS-II

L	T	P	Marks
4	1	0	100

Total Lecture-60

AIM

The aim and objective of the course on **Condensed Matter Physics II** is to equip the M.Sc. (H.S.) students with techniques that will help them understand the properties of matter in deep. it covers topics like magnetic resonance techniques, superconductivity and defects in solids so that they are confident to use these methods in their later career.

UNIT I **(12)**

Optical Properties : Macroscopic theory – generalized susceptibility, Kramers- Kronig relations, Brillouin scattering, Raman effect; interband transitions.

UNIT I **(18)**

Magnetism : Dia- and para-magnetism in materials, Pauli paramagnetism, Exchange interaction. Heisenberg Hamiltonian – mean field theory; Ferro-, ferri- and antiferro- magnetism; spin waves, Bloch $T^{3/2}$ law.

UNIT I **(15)**

Superconductivity : Experimental Survey; Basic phenomenology; BCS pairing mechanism and nature of BCS ground state; Flux quantization; Vortex state of a Type II superconductors; Tunneling Experiments; High Tc superconductors.

UNIT I **(15)**

Defects and Disorders in Solids : Basic concepts in point defects and dislocations; Noncrystalline solids: diffraction pattern, glasses, amorphous semiconductors and ferromagnets, heat capacity and thermal conductivity of amorphous solids, nanostructures – short expose; Quasicrystals.

TUTORIALS : Relevant problems given at the end of each chapter in the books listed below.

SUGGESTED BOOKS: :

1. Kittel, C. *Introduction to Solid State Physics.* NewYork: Wiley 8thed. 2005.Print.
2. Kittel, C. *Quantum Theory of Solids.* NewYork: Wiley 1987.Print.
3. Ziman, J. *Principles of the Theory of Solids* .Cambridge University Press,1972.Print.
4. Ibach, H. and Luth, H. *SolidStatePhysi.* Belin:Springer. 3rd.ed. 2002. Print.
5. Taylor P.L. *A Quantum Approach to Solids.* Englewood Cliffs :Prentice-Hall. 1970.Print.
6. Animalu, A.O.E. *Intermediate Quantum Theory of Solids.* New Delhi :East-West Press,1991.Print.
7. Ashcroft and Mermin. *Solid State Physics.* Berlin: Reinhert & Winston. 1976. Print.

Course Code: PHY 606
Advanced Physics Laboratory-III
(120hrs) **Max Marks:100**

Objective: The laboratory exercises have been so designed that the students learn to verify some of the concepts learnt in the theory courses. They are trained in carrying out precise measurements and handling sensitive equipments.

Note:
- Students are expected to perform at least eight experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
- The examination for both the courses will be of 3 hours duration.

NUCLEAR
1. To study the characteristics and dead time of a GM Counter.
2. To study Poisson and Gaussian distributions using a GM Counter.
3. To study the alpha spectrum from natural sources Th and U.
4. To determine the gamma-ray absorption coefficient for different elements.
5. To study absorption of beta rays in Al and deduce end-point energy of a beta emitter.
6. To calibrate the given gamma-ray spectrometer and determine its energy resolution.
7. To find the absorption coefficient of given material using G.M. counter.
8. To verify the inverse square law using gamma rays.
9. To estimate the efficiency of GM detector for (a) gamma source (b) beta source
10. To find the Linear & mass attenuation coefficient using gamma source.
11. To study the Solid State Nuclear Track Detector.
12. To determine the mass absorption coefficient for beta rays.
13. To study the counting statistics for radioactive decay using SSNTD.
14. To determine the operating voltage of a photomultiplier tube.
15. To find the photopeak efficiency of a Nal(Tl) crystal of a given dimensions for gamma rays of different energies.
16. To determine the range and energy of alpha particles using spark counter
17. To study Compton Scattering.
18. To study the Rutherford scattering.
19. To study Poisson and Gaussian distributions using a GM Counter.
20. To calibrate a gamma ray spectrometer and to determine the energy of a given gamma ray source.
21. To determine the beta ray spectrum of beta source (like Cs-137) and to calculate the binding energy of K-shell electron of given source.
22. To study the various modes in a multichannel analyser and to calculate the energy resolution, energy of gamma ray.
23. To study time resolution of a gamma-gamma ray coincidence set-up.
24. To study anisotropy of gamma-ray cascade emission in 60Ni (60Co source) using acoincidence set-up.
25. Time calibration and determination of the time resolution of a coincidence set-up using a multi-channel analyzer.
26. To study calibration of a beta-ray spectrometer.
27. To study scattering of gamma rays from different elements.
28. To determine range of Alpha-particles in air at different pressure and energy loss in thin foils.
29. To determine strength of alpha particles using SSNTD.
30. To measure*p*b of a particle using emulsion track.
31. To study p-p interaction and find the cross-section of a reaction using a bubble chamber.
32. To study n-p interaction and find the cross-section using a bubble chamber.
33. To study k-d interaction and find its multiplicity and moments using a bubble chamber.

SOLID STATE PHYSICS

1. Study of various Measurement techniques: Data and error analysis, Plotting and curve fitting software, Introduction to electronic components & use of instruments: Oscilloscope, Digital storage oscilloscope, Multimeter, Wave-form generator. Experience in electronics & mechanical workshops.
2. To study temperature-dependence of conductivity of a given semiconductor crystal using four probe method.
3. To determine the Hall coefficient for a given semi-conductor.
4. To determine dipole moment of an organic molecule, Acetone.
5. To study the characteristic of B-H curve using ferromagnetic standards.
6. To determine the velocity of ultrasonic waves using interferometer as a function of temperature.
7. Temperature dependence of a ceramic capacitor -Verification of Curie-Weiss law for the electrical susceptibility of a ferroelectric material.
8. To determine Percolation threshold and temperature dependence of resistance in composites.
9. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electrical resistivity measurements.
10. To study the characteristics of a PN junction with varying temperature & the capacitance of the junction.
11. To study the characteristics of a LED and determine activation energy.
12. To determine the g-factor of free electron using ESR.
13. To study thermoluminescence of F-centres in alkali halide crystals.
14. To study Zeeman effect by using Na lamp.
15. To measure magnetoresistance of a thin (0.5 mm) sample of p-doped (or n-doped) germanium as a function of magnetic field for 3 different sample current.
16. To measure magnetic susceptibility of a solution of a paramagnetic salt in water for 3 different concentrations by using Quincke's method.
17. To measure dielectric constant of a ferroelectric material as a function of temperature and to observe ferroelectric to paraelectric transition.
18. To study Faraday effect using He-Ne Laser.
19. Measurement of lattice parameter and indexing of lattice planes of an unknown sample photographpowder diffraction pattern method.
20. Hands on experience on X-ray diffractometer for studying (i) Crytal structure (ii) Phaseidentification and (iii) size of nanoparticles. sing SSNTD.

20. *To measure* $p\beta$ of a particle using emulsion track.
21. To study p-p interaction and find the cross-section of a reaction using a bubble chamber.
22. To study n-p interaction and find the cross-section using a bubble chamber.
23. To study k-d interaction and find its multiplicity and moments using a bubble chamber.
24. To study a $\pi\mu$ event using emulsion track.
25. To design (i) Low pass filter (ii) High pass filter (iii) All-pass filter (iv) Band pass filter (v) Band-reject filter using 741 OPAMP.
26. To study of Switched-mode power supply.
27. To study Phase Locked Loop (PLL) – (i) adjust the free running frequency (ii) determination of lock range and capture range (iii) determine the dc output from Frequency modulated wave.
28. Frequency modulation using Varactor and Reactance modulator and Frequency demodulation using Quadrature detector and Phased Locked Loop detector.
29. Computer controlled experiments and measurements (Phoenix kit and Python language) – Digital and analog measurements based experiments.
30. Control of devices and data logger using parallel port of PC – programming using Turbo C.
31. Programming of parallel port of PC using C-language and control of devices connected.
32. Microprocessor kit: (a) hardware familiarization

(b) programming for (i) addition and subtraction of numbers using direct and indirect addressing modes (ii) Handling of 16 bit numbers (iii) use of CALL and RETURN instructions and block data handling.

33. (a) Selection of port for I & O and generation of different waveforms (b) control of stepper motor.
34. Microcontroller kit: hardware familiarization of µController and universal programmer and programming for four digit seven segment multiplexed up-conter upto 9999.
35. (a) EEPROM based 8 to 3 encoder using microcontroller (b) interfacing with ADC (temperature sensor) and DAC (variable voltage source).

PHYS612PROJECT WORK

Max. Marks: 100 **(4 hrs/week)**

The aim of project work in M.Sc.(H.S.) 4th semesters is to expose some of the students (20) to preliminaries and methodology of research and as such it may consist of review of some research papers, development of a laboratory experiment, fabrication of a device, working out some problem, participation in some ongoing research activity, analysis of data, etc. Project work can be in Experimental Physics or Theoretical Physics in the thrust as well as non-thrust research areas of the department.

A student opting for this course will be attached to one teacher of the department before the end of the 3rd semester. A report of about 30 pages about the work done in the project (typed on both the sides of the paper and properly bound) will be submitted by a date to be announced by the PGAPMEC. Assessment of the work done under the project will be carried out by a committee on the basis of effort put in the execution of the project, interest shown in learning the methodology, report prepared, grasp of the problem assigned and viva-voce/seminar, etc as per guidelines prepared by the PGAPMEC.

This load (equivalent to 4 hours per week) will be counted towards the normal teaching load of the teacher.

Course Code: PHY621:
PHYSICS OF LIQUID CRYSTALS

L	T	P	Marks
4	1	0	100

Total Lecture-60

AIM

The aim and objective of the course on **Physics of Liquid crystals** is to familiarize the students of M.Sc. (H.S.) to the various aspects related to basic as well as advanced concept of liquid crystals. It covers topic like type, properties and chemical structure of liquid crystals. The use of these materials in TFTs is also explained so as to equip the students with knowledge of technology being used in LCDS.

UNIT-I **(18)**

Classification of liquid crystals, Polymorphism in thermotropics, relevant phenomenon in liquid crystas, blue phases, polymer liquid crystals, distribution function and order parameters, macroscopic and microscopic order parameters, measurement of order parameters, magnetic resonance, electronic spin resonance, scattering and X-ray diffraction

UNIT-II **(15)**

Theories of liquid crystal: Nature of phase transition and crtical phenomenon in liquid crystals, hard particales, Maier-Saupe and Van Der Waals theories for nematic-isotropic and nematic-smectic A transition theory, Landau theory, continuum theory of nematic and smectic A Phases, Freedrickz transitions, field inducd cholestric-nematic transition

UNIT-III **(15)**

Ferroelectric liquid crystals, symmetry arguments, discotic and banana shaped liquid crystals, Chemical structure of nematic and ferroelectric liquid crystals

UNIT-IV **(12)**

Application and types of liquid crystals materials used in various devices like Thermometer, calculators etc. Construction and functioning of TFT Screens.

SUGGESTED BOOKS

1. Chandrasekhar, S. *Liquid Crystals*. Cambridge University Press, 2nd ed. 1992.

2. Sluckin, T.J. *The Liquid Crystal Phases : Physics & Technology*. Contemporary Physics: Taylor & Francis, 41:1, 37 – 56 2000.

3. de Gennes P. G. and J. Prost , *The Physics of Liquid Crystals*, Oxford: Oxford Science Publications, 1993

4. Collings, Peter J. and Hird. Michael, *Introduction to liquid crystals chemistry and physics* ,London ; Bristol, PA : Taylor & Francis, 1997

5. Collings, Peter J. *Liquid Crystals:Nature's Delicate Phase of Matter* , UK: Princeton University Press, Second Edition, 2001.

Course Code: PHY-622:
PLASMA PHYSICS
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM: The course on **Plasma Physics** is introduced to familiarize the students of M.Sc. (Hons.) with the basics of plasma, Particle orbit theory, Plasma as a fluid, Waves in Fluid Plasma, stability of fluid plasma and nuclear fusion. As, we know that Plasma find applications in many diverse fields like space, controlled thermonuclear fusion, plasma processing, environment and health science, material synthesis etc. So, keeping in view the importance of Plasma Science and Technology, our main aim is to train the students of M.Sc (Hons.) as better professionals and researchers in this field.

Unit-I **(16)**
Introduction to Plasma:- Definition of Plasma, Concept of temperature, Debye shielding and other plasma parameters, Occurrence and importance of Plasma for various applications, Production of Plasmas in Laboratory.
Nuclear Fusion: - Introduction, Lawson criteria, Fundamentals of inertial confinement fusion, Fundamentals of magnetic confinement method, Tokamak, Hydrodynamics of implosion.

Unit-II. **(14)**
Single Particle motions: -Drifts of charged particles under the effect of different combinations of electric and magnetic fields, Crossed electric and magnetic fields, Homogeneous electric and magnetic field, spatially varying electric and magnetic field, Particle motion in large amplitude waves, Adiabatic invariants, Plasma properties from Orbit theory

Unit-III **(14)**
Fluid description of Plasma:-Distribution function and Liouville equation, Macroscopic variables of Plasma, Fluid equations, Two Fluid plasma theory, One fluid plasma theory; Magnetohydrodynamics, Approximations commonly used in one fluid theory, Simplified one fluid equations and the MHD equation, Properties of Plasma described by the one fluid and MHD models.

Unit-IV **(16)**
Waves in Fluid Plasma and Stability of the fluid plasma:- Dielectric Constant of field free plasma, Plasma Oscillations, Space Charge Waves of warm plasma, Dielectric Constant of a cold magnetized Plasma, ion-acoustic Waves, Alfven Waves, Magnetosonic Waves. The equilibrium problem, Classification of Plasma instabilities, Methods of stability analysis, Regions of Stability, Two stream instability of space charge waves, Fire-hose instability of an Alfven Waves, Plasma supported against gravity by magnetic field, Energy Principle.

SUGGESTED BOOKS:

1. Chen, F.F. *Introduction to Plasma Physics and Controlled Fusion*. New York: Plenum Press, 1984.
2. Krall, N.A. and Trivelpiece, A.W *Principle of Plasma Physics.* San Fransisco Press, 1986
3. Dendy, R. Press. *Plasma Physics*. New York: Cambridge University, 1996
4. Goldston R.J. and Rutherford P.H. *Introduction to Plasma Physics*. New York: IOP, 1995
5. Schimdt, G. *Physics of High Temperature Plasmas*. 2nd Edition, Academic Press, 1979

Course Code: PHY623

PHYSICS OF NANOMATERIALS
Lecture-60

L	T	P	Marks
4	1	0	100

AIM: The aim and objective of the course on **Physics of Nano-materials** is to familiarize the students of M.Sc.(Hons.) to the various facets related to synthesis, characterization and study of diverse properties of the nanomaterials so that they can understand the new developments in this emerging field.

UNIT-I
INTRODUCTION AND SYNTHESIS (16):
Free electron theory and its features, Idea of band structure of metals, insulators and semiconductors. Density of state in one, two and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap, Examples of nanomaterials. Top-down and bottom-up approaches, Physical and chemical methods for the synthesis of nanomaterials with examples.

UNIT-II
GENERAL CHARACTERIZATION TECHNIQUES (15):
Determination of particle size, study of texture and microstructure, Increase in x-ray diffraction peaks of nanoparticles, shift in photoluminescence peaks, variation in Raman spectra of nanomaterials, photoemission and X-ray spectroscopy, magnetic resonance, microscopy: transmission electron microscopy, scanning probe microscopy.

UNIT-III
QUANTUM NANOSTRUCTURES (16):
Introduction to quantum wells wires and dots**;** preparation using lithography; Size and dimensionality effects: size effects, conduction electrons and dimensionality, potential wells, partial confinement, properties dependent on density of states, surface passivation and core/shell nanoparticles, Nanostructured semiconductors and films, single electron tunneling; Application: Infrared detectors, Quantum dot Lasers.

UNIT-IV CARBON NANOSTRUCTURES (13):
Carbon molecules: nature of carbon bond; new carbon structures; Carbon clusters: small carbon clusters, structure of C60, alkali doped C60; Carbon nanotubes and nanofibres: fabrication, structure, electrical properties, vibrational properties, mechanical properties, Application of carbon nanotubes: field emission and shielding, computers, fuel cells, chemical sensors, catalysis.

SUGGESTED BOOKS:
1. Goswami A. *Thin Film fundamentals*. New Delhi: New age International, 2007
2. Poole Jr. C.P. and Owens F.J. *Introduction to Nanotechnology*. New Jersey: John Wiley & Sons, 2006.
3. Bimerg D., Grundmann M. and Ledentsov N.N. *Quantum Dot Heterostructures*. New Jersey: John Wiley & Sons, 1998.
4. Fendler J.H. *Nanoparticles and Nanostructured Films–Preparation, Characterization and Application.* New Jersey: John Wiley & Sons, 2008.
5. Jain K.P. *Physics of Semiconductor Nanostructures*. New Delhi: Narosa Publishing House, 1997.
6. Davies J.H. *Physics of Low-Dimension Semiconductors*. Cambridge: Cambridge Univ. Press, 1998.
7. Kramer B. *Advances in Solid State Physics (Vo.41). Berlin:* Springer-Verlag, 2001.
8. Rao C.N.R. and Govindaraj A.*Nanotubes and Nanowires.* London: Royal Society of Chemistry,2005.

Course Code: PHY624

Advanced Nuclear Physics

L	T	P	Marks
4	**1**	**0**	**100**

Total Lectures-60

AIM

The aim and objective of the course on Advanced **Nuclear Physics is** equip the students of **M.Sc.(Hons)** with knowledge of basics of nuclear reactions, nuclear forces, deuteron problem, and nuclear structure models

Unit-I

Basics of Nuclear reactions and Nuclear forces (15):

Qualitative features and phenomenological potentials, Charge symmetry and charge independence of nuclear forces. Exchange forces, Generalized Pauli exclusion principle, Meson theory of nuclear forces, Relationship between the range of the force and mass of the mediating particle.

Types, Q-value and Invariance in nuclear reactions, Basic concepts of cross section: Total cross section, Partial cross section, differential cross section, Cross section in terms of partial wave analysis.

Unit-II

Deuteron Problem (15):

Physical properties of deuteron: Mass, binding energy, spin, parity, magnetic and electric quadrupole moment. Ground state of deuteron (square well potential), Range depth relationship for square well potential. Neutron-proton scattering at low energy, Concept of scattering length and significance of its sign. Spin dependence of neutron-proton scattering, Effective range theory of neutron-proton scattering.

Unit-III

Introduction to Nuclear Structure (10):

The Nuclear Force, Pauli Principle and Antisymmetrization, Two-State Mixing, Multistate Mixing, Two-State Mixing and Transition Rates, The nuclear landscape.

Unit-IV

Shell model and residual Interactions (20):

The independent particle model, Shell model: two-particle configurations, Residual interactions: the delta-function, Geometrical Interpretation, Pairing Interaction, Multipole decomposition of residual interactions, some other results like average shifts, Hole, particle-hole configurations.

SUGGESTED PHYSICS:

1. Hans, H.S. *Nuclear physics-Experimental and Theoretical,* Tunbridge Wells: New Academic Science 2011.
2. Hyde, K.*Basic Ideas and Concepts in Nuclear Physics*United Kingdom: Institute of Physics 2004.
3. Mittal,V. K., Verma, R. C. and Gupta, S.C. *Introduction to Nuclear and Particle Physics,* New Delhi:Prentice Hall of India 2013.
4. Lilley,John. *Nuclear Physics Principles and Application,* New Delhi: Wiley-India2001.
5. Cohen, Bernard L. *Concepts of Nuclear Physics,* New Delhi:Tata McGraw-Hill 2004.

Course Code: PHY625
Advanced Particle Physics
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM

The aim and objective of the course on Advanced **Particle Physics is** equip the students of **M.Sc.(Hons)** with the knowledge of symmetries, symmetry breaking, quark model, and standard model.

Unit-I

Overview to Sub-Nuclear Physics and Symmetries and Symmetry Breaking (20):

(i) Overview: Particle classification, leptons and quarks, fundamental interactions, towards a unification of fundamental interactions.

(ii) Continuous groups: U(1)~SO(2), SO(3)~SU(2)~spin(3), SU(3) and Unitary groups. Lorentz group SO(1,3) and its representations. Dirac, Weyl and Majorana fermions.

(iii) Global and Local invariances of the Action. Approximate symmetries. Noether's theorem. Spontaneous breaking of symmetry and Goldstone theorem. Higgs mechanism.

Unit-II

Abelian and Non-Abelian gauge fields (8):

Lagrangian and gauge invariant coupling to matter fields. Elements of Quantization and Feynman rules.

Unit-III

QCD and quark model (15):

Asymptotic freedom and Infrared slavery, confinement hypothesis, Approximate flavor symmetries of the QCD Lagrangian: Chiral symmetry and it's breaking. Classification of hadrons by flavor symmetry : SU(2) and SU(3) multiplets of Mesons and Baryons.

Unit-IV

Standard Model and Beyond (17):

SU(3) x SU(2) x U(1) gauge theory, Coupling to Higgs and Matter fields of 3 generations, Gauge boson and fermion mass generation via spontaneous symmetry breaking, CKM matrix , Low energy Electroweak effective theory and the V-A 4-fermion interactions, Elementary electroweak scattering processes, Grand unification, the SU(5) model, Neutrino masses and Neutrino oscillations, Grand unification and big bang, towards a theory of everything.

SUGGESTED BOOKS:

1. Mittal,V. K., Verma, R. C. and Gupta, S.C. *Introduction to Nuclear and Particle Physics,* New Delhi:Prentice Hall of India 2013.
2. Perkins, D.H. *Introduction to High Energy Physics* United Kingdom: Cambridge University Press, 4th ed. 2000.
3. Burcham, W.E. and Jobes, M. *Nuclear and Particle Physics,*United Kingdom : Pearson 1995.
4. Griffiths, D. *An Introduction to Elementary Particles* Germany: Wiley 2008.
5. Close,F.E. *Introduction to Quarks and Partons,*London:Academic Press 1979.
6. Khanna,M.P. *Introduction to Particle Physics* New Delhi:Prentice-Hall of India 2004.

7. Quigg, C.*Gauge Theories of Weak, Strong and Electromagnetic Interactions,* United States of America Addison-Wesley 1994.
8. Cheng,T.P and Li,L.F. *Gauge Theory of Elementary Particle Physics* Oxford:Oxford UniversityPress 2000.
9. Lahiri,A. and Pal,P. *First Book of Quantum Field Theory*, New Delhi:Narosa 2nd ed. 2007.

Course Code: PHY- 626
NONLINEAR AND FIBER OPTICS

L	T	P	Marks
4	1	0	100

Total Lecture-60

AIM
The aim and objective of the course on **Nonlinear optics and fiber optics** is to equip the students of M.Sc.(Hons) with knowledge of basics of nonlinear optics, various nonlinear phenomena, multiphoton processes, nonlinear optical materials and fiber optics.

Unit-I
Nonlinear Optics (17)
Introduction, frequency dependent and intensity dependent refractive index, Wave propagation in an anisotropic crystal, Polarization response of materials to light, Second harmonic generation, Sum and difference frequency generation, Phase matching, four wave mixing, Third harmonic generation, Self focusing, Parametric amplification, Bistability.

Unit-II
Multiphoton Processes (14)
Two photon process, Theory and experiment, Three photon process parametric generation of light, Oscillator, Amplifier, Stimulated Raman scattering, Intensity dependent refractive index optical Kerr effect, photorefractive, electron optic effects.

Unit-III
Nonlinear Optical Materials (13)
Basic requirements, Inorganics, Borates, Organics, Urea, Nitro aniline, Semi organics, Thio urea complex, X-ray diffraction, FTIR and FT-NMR qualitative study, Kurtz test, Laser induced surface damage threshold.

Unit-IV
Fiber Optics (16)
Introduction, Optical fibers-Principle, Structure of Optical fibers, Acceptance angle and cone, Numerical aperture and acceptance angle, Fiber modes, Types of optical fibers, Fiber bandwidth, Fabrication of optical fibers, Loss in optical fibers, Fiber optical communication, splicing, Light source for optical fiber, Photo-detectors, Fiber optical sensors and its classification, Fiber endoscope, Attenuation coefficient – Material absorption.

SUGGESTED BOOKS:

1. Boyd, Robert W. *Nonlinear Optics*: 2nd Edition, Academic Press, New York, 2003.
2. Mills, D.L. *Nonlinear Optics:Basic Concepts*. Berlin: Springer, 1998.
3. Shen Y.R. *The Principles of Noblinear Optics*: John Wiley, New York, 1984.
4. Laud B.B. *Lasers and Nonlinear Optics*: 2nd Edition, New Delhi: New Age International (P) Ltd.
5. Agarwal Govind P *Fiber-Optics Communication Systems*. 3rd Edn. Singapore: John Wiley & Sons, 2003.

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Course Code: PHY-627
EXPERIMENTAL TECHNIQUES
Total Lecture-60

L	T	P	Marks
4	1	0	100

AIM: The aim and objective of the course on Experimental Techniques for the student of M.Sc. (Hons.) Physics is to equip them with the knowledge of various experimental and characterization techniques.

Unit-I.
Vacuum & Low Temperature Techniques (15):
Vacuum techniques, Basic idea of gas throughput, conductance, mass flow, viscous and molecular flow regimes, transition regime conductance, pumping speed, Production of Vacuum; Mechanical pumps (Rotary, Root and Turbomolecular pumps), Diffusion pump, Getter and Ion pumps, Measurement of Pressure; Thermal conductivity Gauge, Penning gauge, Ionization Gauge, Low temperature: Cooling a sample over a range upto 4 K and measurement of temperature.

Unit-II.
Thin film deposition techniques (15):
Physical Vapor Deposition; Hertz Knudsen equation, mass evaporation rate, Directional distribution of evaporating species, Evaporation of elements, compounds, alloys, e-beam, pulsed laser and ion beam evaporation, Glow Discharge and Plasma, Sputtering- mechanisms and yield, DC and RF sputtering, Nucleation & Growth: capillarity theory, atomistic and kinetic models of nucleation, basic modes of thin film growth, stages of film growth & mechanisms.

Unit-III.
Spectroscopic techniques (15):
Electrical, optical and mechanical methods for determination of the thickness of thin films, AES, XPS/ESCA, RBS and SIMS techniques for the analysis of surfaces, X-ray diffraction, data manipulation of diffracted X-rays for structure determination, X-ray fluorescence spectrometry for element detection with concentration, EPMA and EDX for composition analysis.

Unit-IV.
Electron Microscopy and Error Prediction (15):
Scanning Probe Microscopy, Scanning electron microscopy, Transmission electron microscopy, Scanning-tunneling microscopy, Electron probe-microanalysis, Atomic force microscopy, Optical microscopy, Error analysis; Least square fitting, Chi square test, Normal and Poisson distribution, propagation of errors, Plotting of graphs.

SUGGESTD BOOK

1. Roth, A. *Vacuum Technology*. Oxford: Pergamon Press Ltd., 1998.
2. O'Hanlon, J. F. *A User's Guide to Vacuum Technology*. New York: John Wiley & Sons, 1989.
3. Chopra, K. L. *Thin Film Phenomena*. New York: McGraw Hill Inc., 1969.
4. Ohring, M. *The Materials Science of Thin Films*. San Diego: Academic Press, 1992.
5. Zhang, S., Li, L., and Kumar, A. *Materials Characterization Techniques.* Boca Raton: CRC Press, 2009.
6. Egerton, R. F. *Physical Principles of Electron Microscopy: An Introduction to TEM, SEM and AEM.* New York: Springer, 2005.