DAV UNIVERSITY JALANDHAR

Scheme & Syllabus

For

M.Sc. (HONOUR SCHOOL) PHYSICS

(Program ID-)

1st TO 4th SEMESTER

Examinations 2015–16 Session

Syllabi Applicable For Admissions in 2015

Scheme of Courses M.Sc.

M. Sc. (HONS) PHYSICS

Semester 1

S. No	Course Code	Course Type	Course Name	L	T	P	Cr
1	PHY501	Core	Classical Mechanics	4	0	0	4
2	PHY502	Core	Mathematical Physics	4	0	0	4
3	PHY508	Core	Electronics-I	4	0	0	4
4	PHY504	Core	Quantum Mechanics-I	4	0	0	4
6	PHY506	Core	Advanced Physics Lab-1	0	0	9	4
7	Interdisciplinary Course -I						4
	Total						24

L: Lectures T: Tutorial P: Practical Cr: Credits

Interdisciplinary Course -I

Sr. No.	Course Code	Course Name	L	T	P	Cr
1	CSA557	Computer Fundamental	2	0	0	2
	CSA558	Computer Fundamental Lab	0	0	4	2
2	CHE616	Medicinal Chemistry	4	0	0	4

Scheme of Courses M.Sc.

M. Sc. (HONS) PHYSICS

Semester 2

S. No	Course Code	Course Type	Course Name	L	T	P	Cr
1	PHY511	Core	Quantum Mechanics-II	4	0	0	4
2	PHY512	Core	Atomic and Molecular Spectroscopy	4	0	0	4
3	PHY513A	Core	Statistical Physics	4	0	0	4
4	PHY514	Core	Electrodynamics-I	4	0	0	4
5	PHY515	Core	Computational Physics	4	0	0	4
6	PHY516	Core	Computation Physics Lab	0	0	4	2
7	PHY517	Core	Advanced Physics Lab-II	0	0	9	4
Total							26

L: Lectures T: Tutorial P: Practical Cr: Credits

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

Semester 3

Sr. No.	Course Code	Course Type	Course Name	L	T	P	Cr
1	PHY601	Core	Electrodynamics-II	4	0	0	4
2	PHY602	Core	Nuclear Physics	4	0	0	4
3	PHY603	Core	Condensed Matter Physics-I	4	0	0	4
4	PHY605A	Core	Electronics-II	4	0	0	4
5	PHY606	Core	Advanced Physics Lab-III	0	0	9	4
6	PHY635	Core	Project Part-I				2
7	Departmental Elective-I						4
Total							26

Departmental Elective (Chose any one course)

Sr. No.	Course Code	Subject	L	T	P	Cr
1	PHY627	Experimental Techniques	4	0	0	4
2	PHY626	Non Linear and Fiber Optics	4	0	0	4

Scheme of Courses M.Sc.

M. Sc. (HONS) PHYSICS

Semester 4

Sr. No.	Course Code	Course Type	Course Name	L	T	P	Cr
1	PHY611	Core	Condensed Matter Physics-II	4	0	0	4
2	PHY604	Core	Particle Physics	4	0	0	4
3	PHY612	Core	Project				6
4	Interdisciplinary Course-II						4
5	Departmental Elective-II						4
6	Departmental Elective-III						4
Total							26

Interdisciplinary Course -II

Sr. No.	Course Code	Course Name	L	T	P	Cr
1	CHE615	Chemistry of Materials	4	0	0	4
2	MGT551	Research Methodology	4	0	0	4
3	MTH690	MATLAB	2	0	4	4

Departmental Elective-II (Chose any one course)

Sr. No.	Course Code	Course Name	L	T	P	Cr
1	PHY621	Physics of Liquid crystals	4	0	0	4
2	PHY622	Plasma Physics	4	0	0	4
3	PHY623	Physics of Nanomaterials	4	0	0	4

Departmental Elective-III (Chose any one course)

Sr. No.	Course Code	Course Name	L	T	P	Cr
1	PHY624	Advanced Nuclear Physics	4	0	0	4
2	PHY628	Spintronics	4	0	0	4
3	PHY629	Solar cell: Fundamentals and Applied Aspects	4	0	0	4

FIRST SEMESTER

Course Code: PHY501

CLASSICAL PHYSICS

L	T	P	Cr.
4	0	0	4

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 (15)

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 (15)

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 (15)

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.

Reference Books:

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

Course Code: PHY502
MATHEMATICAL PHYSICS
Total Lecture-60

L	T	P	Credit
4	0	0	4

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.

Reference Books:

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

PHY508 Electronics-I
Max.Marks:100
Total Lecture-60

L	T	P	Credit
4	0	0	4

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.

Semiconductor Materials: 15

Semiconductor Materials: Energy bands, Carrier concentrations, Doping, Direct and Indirect band semiconductors, Degenerate and compensated semiconductors; Carrier Transport in Semiconductors: Carrier Drift under low and high fields in (Si and GaAs), Saturation of drift velocity, High field effects in two valley semiconductors, Carrier diffusion, Carrier injection, Generation and recombination processes, Minority carrier life time, Drift and diffusion of minority carriers (Haynes–Shockley Experiment), Four probe experiment and Hall coefficient measurements.

Unit-II.

Junction Diodes: 15

Junction diodes: Energy band diagrams for homo and hetero junctions, Current flow mechanism in p-n junction, Metal-semiconductor (Schottky Junction) and their applications: Energy band diagram, current flow mechanisms in forward and reverse bias, effect of interface states, Zener diode, switching diodes, Tunnel diode, Photodiodes and solar cells, Metal-Oxide-Semiconductor (MOS) diodes: Energy band diagram, depletion and inversion layer, Applications of MOS diode.

Unit-III.

Transistors and Other Devices: 15

Transistors: BJT, JFET, MOSFET and MESFET Transistors: Structure, working and characteristics, Charge Coupled Devices (CCD), Unijunction transistor (UJT), Four layer (PNPN) devices, Semiconductor Controlled Rectifier (SCR), Regulated power supplies, Gunn diode, IMPATT devices, Liquid crystal displays.

Unit-IV.

Operational Amplifier: 15

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.

Reference 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. Eraser D.A. *The Physics of Semiconductor Devices*. London: Oxford Physics Series, 1986
5. Tyagi M.S. *Introduction to Semiconductor Devices and Materials.* New York: John Wiley & Sons, 1991
6. Gupta K. C. *Microwaves.* New Delhi: Wiley Eastern Ltd.,1983

Course Code: PHY504

QUANTUM MECHANICS-I

Total Lecture-60

L	T	P	Credit
4	0	0	4

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, Hermitian and Unitary operators, change of basis, Eigen value and Eigen vectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schroedinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble.

Unit II

Angular Momentum (14):

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. co- efficients, 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.

Reference Books:

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

SECOND SEMESTER

Course Code: PHY511

QUANTUMMECHANCIS-II
Total Lecture-60

L	T	P	Credit
4	0	0	4

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 waves 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, Covariant perturbation theory, Feynman diagrams and their applications

Reference Books:

1. Quantum Mechanics: M.P. Khanna, (HarAnand, NewDelhi),2006.
2. Lectures on Quantum Field Theory: A. Das(World Scientific),2008.
3. A Text book of Quantum Mechanics: P.M.Mathews and K.Venkatesan,(TataMcGraw Hill, NewDelhi),2004.
4. Quantum Mechanics: V.K. Thankappan, (NewAge,NewDelhi),2004.
5. Quantum Field Theory: H.Mandl and G. Shaw,(Wiley,NewYork) 2010.
6. Advanced Quantum Mechanics: J.J. Sakurai (Addison-Wesley,Reading), 2004.

Course Code: PHY512

ATOMIC AND MOLECULAR PHYSICS

Total Lecture-60

L	T	P	Credit
4	0	0	4

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.

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 (15)

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: PHY513A
Course Name: STATISTICAL PHYSICS

L	T	P	Credit
4	0	0	4

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 **(15)**

Introduction to Statistical Physics, Macrostate, Microstates, Specification of states of a system, Contact between statistics and thermodynamics, Postulate of equal a prior probability, Boltzmann's postulate of entropy, Classical ideal gas, Entropy of mixing and Gibb's paradox, The phase space of classical system, trajectories and density of states, Liouville's theorem and its consequences.

UNIT II **(15)**

Ensemble theory, Microcannonical ensemble with example, The canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations in the canonical ensemble. Equipartition theorem, Virial theorem, The grand canononical ensemble, the physical significance of the statistical quantities, Cluster expansion of classical gas, the virial equation of state.

UNIT III **(15)**

Statistics of various ensembles, Statistics of indinguishable particles, Maxwell-Boltzmann distribution, determination of undetermined multipliers, Bose-Einstein statistics, the Bose-Einstein gas, Bose-Einstein condensation, Fermi-Dirac statistics, the Fermi-Dirac gas, the electron gas.

UNIT IV **(15)**

Phase transitions, Phase diagram of He, Superfluity in He II, Landau theory of phase transition, spontaneous magnetization, Ising model, the Bragg-Williams approximation, critical exponents, Scaling hypothesis for the thermodynamic functions, Fluctuations, correlation functions, Fluctuations and thermodynamic properties, Brownian motion, Langevin equation, Einstein Diffusion 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.

L	T	P	Credits
4	0	0	4

Course Code: PHY514
Course Name: ELECTRODYNAMICS-I
Total Lecture-60

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.

UNIT I **(15)**

Electrostatics in Vacuum: Coulomb's Law, Gauss Law, Scalar potential. Laplace and poisson's equations. Electrostatic potentials, energy and energy density of the electromagnetic field.

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 polarzbility and electric susceptibility. Clasusius-Mossetti relations. Models of Molecular Polarizbility. Energy of charges ind 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 inionosphere. Reflection and Refraction of EM waves at plane interface, Frensel's amplituderelations. Reflection and transmission coefficients. Polarization by reflection. Brewster's angle,Total internal reflection, Wave guides, TE and TM waves, Rectangular wave guides. Energyflow and attenuation in wave guides, Cavity resonators.

Reference Books:

1. Classical Electrodynamics:S.P.Puri(Narosa Publishing House) 2011.
2. Classical Electrodynamics: J.D.Jackson, (NewAge,NewDelhi)2009.
3. Classical ElectromagneticRadiation : J.B. Marion andM.A. Heald, (Saunders College PublishingHouse) 3rdedition,1995.
4. Introductionto Electrodynamics: D.J. Griffiths(PrenticeHall India, NewDelhi)4thed., 2012.
5. ElectromagneticFields:RonaldK.Wangsness(JohnWileyand Sons) 2ndedition,1986.
6. Electromagnetic FieldTheory Fundamentals : BhagSingh Guru and H.R. Hiziroglu (Cambridge University Press) 2ndedition,2004.
7. IntroductiontoElectrodynamics:A.Z.CapriandP.V.Panat(NarosaPublishingHouse) 2010.

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

L	T	P	Credits
4	0	0	4

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 **15**

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 **15**

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 **15**

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 **15**

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.

REFERENCE BOOKS:

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

Course Code: PHY506/517
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 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.
- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test.

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.

Course Code: PHY516
Course Name: Computational Physics Lab

L	T	P	Credits
0	0	4	2

(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 10-12 experiments out of following list. The experiments performed in first semester cannot be repeated in second Semester.
- The examination for both the courses will beof3 hours duration.
- Total marks of practical will include 20% weightage of Continuous Assessment and 80% end semester exam including Notebook / Viva / Performance/ written test**.**

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.

THIRD SEMESTER

Course Code: PHY601

ELECTRODYNAMICS-II

Total Lecture-60

L	T	P	Credits
4	0	0	4

Unit I **(20)**

Special Theory of Relativity: Lorentz transformation as orthogonal transformation in 4-dimension, relativistic equation of motion, applications of energy momentum conservation, Disintegration of a particle, C.M. System and reaction thresholds. Four vectors in Electrodynamics,4-current density,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 a tlow velocities-Larmor-Power formula. Radiation from a charged particle with collinear velocity and acceleration.Radiationfromachargedparticleinacircularorbit,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

Introduction to Plasma and Charged particle dynamics **(12)**

Occurrence of Plasmas in Nature, Definition of Plasma, Concept of Temperature, Debye Shielding, The Plasma Parameter, Criteria for Plasmas, Motion of charged particle in uniform fields and in a slowly varying magnetic fields, Guiding centre drifts, Magnetic mirrors and plasma confinement, Adiabatic invariance of flux through an orbit

Unit IV

Plasma as Fluids and Waves in Plasmas **(13)**

Plasma as fluids, Relation of Plasma Physics to Ordinary Electromagnetics, The fluid equation of motion, Plasma Oscillations, Plasma frequency, Dispersion relations for electron plasma waves and ion acoustic waves, Comparison of ion and electron waves, Validity of plasma approximation, cutoffs and resonance

Reference Books:

1. Classical Electrodynamics:S.P.Puri(Narosa Publishing House),2011.
2. Classical Electrodynamics:J.D. Jackson (NewAge, NewDelhi),2009.
3. Theory of Relativity:R.K.Patharia (Hindustan Pub., Delhi)2nd ed.,1974.
4. General Relativity:I.R.Kenyon(Oxford Univ.Press) 2001.
5. Classical ElectromagneticRadiation:J.B. Marion andM.A. Healed (Saunders College Publishing House),3rd ed.1995.
6. Introduction to Electrodynamics: D.J.Griffiths (Prentice-Hall Learning),2009.
7. AnIntroduction to General Relativity:S.K. Bose (Wiley EasternLimited, NewDelhi),1980.
8. Principles of Cosmology and Gravitation:M.Berry(OverseasPress,NewDelhi),2005.
9. Introduction to Plasma Physics and Controlled Fusion: F FChen(Plenum Press, New York) 1980.

Course Code: PHY602
NUCLEAR PHYSICS

L	T	P	Credits
4	0	0	4

Unit I Nuclear Interactions (10)
Evidence for saturation of nuclear density and binding energies, Two nucleon system, Deuteron problem (basic idea), 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)
Types of nuclear reactions, Basic concept of reaction cross-sections, Conservation laws, energetics of nuclear reactions, Direct and compound nuclear reaction mechanisms, Compound nucleus, Coulomb scattering and Coulomb excitation, Nuclear scattering, optical model (qualitative idea), scattering matrix, Reciprocity theorem, Breit Wigner one level formula, Resonance scattering.

Reference Books:

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

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

L	T	P	Credits
4	0	0	4

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;

UNIT-IV **(13)**

Dielectric Properties of Materials :

Polarization mechanisms, Dielectric function from oscillator strength, Clausius-Mosotti relation;piezo, pyro- and ferro-electricity.

Suggested Books:

1. Introductionto SolidState Physics:C. Kittel(Wiley,NewYork), 8thed. 2005.
2. QuantumTheoryofSolids:C. Kittel(Wiley,NewYork) 1987.
3.Principlesof theTheoryofSolids: J. Ziman(CambridgeUniversity Press)1972.
4.SolidStatePhysics:H.Ibachand H. Luth(SpringerBerlin) 3rd.ed.2002.
5.SolidStateTheory:WalterA.Harrison(TataMcGraw-Hill,NewDelhi) 1970.

Course Code PHY605A
Course Name: Electronics-II
Total Lecture 60

L	T	P	Credits
4	0	0	4

Unit I. Digital Principles (15)

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 (17)

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 (15)

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 (13)

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

Reference 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.

Course Code: PHY606
Advanced Physics Laboratory-III
(120hrs)

L	T	P	Credits
0	0	9	4

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

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 storageoscilloscope, Multimeter, Wave-form generator. Experience in electronics & mechanicalworkshops.
2. To study temperature-dependence of conductivity of a given semiconductor crystalusing 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 oftemperature.
7. Temperature dependence of a ceramic capacitor -Verification of Curie-Weiss law forthe electrical susceptibility of a ferroelectric material.
8. To determine Percolation threshold and temperature dependence of resistance incomposites.
9. Tracking of the Ferromagnetic-paramagnetic transition in Nickel through electricalresistivity measurements.
10. To study the characteristics of a PN junction with varying temperature & thecapacitance 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*β 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 πμ 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).

Course Code: PHY626
NONLINEAR AND FIBER OPTICS
Total Lecture-60

L	T	P	Credits
4	0	0	4

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.

Reference Books:

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

Course Code: PHY-627
EXPERIMENTAL TECHNIQUES

L	T	P	Credits
4	0	0	4

Total Lecture-60

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.

Reference Books:

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.

Course Code: PHY635
Project Part-I

L	T	P	Credits
0	0	0	2

The aim of project work in M.Sc.(H.S.) 3rd 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 2nd semester. A report of about 20 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 physics department. 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 physics department.
This load (equivalent to 2hours per week) will be counted towards the normal teaching load of the teacher.

FOURTH SEMESTER

CONDENSED MATTER PHYSICS-II

Course Code: PHY611:

Total Lectures 60

L	T	P	Credits
4	0	0	4

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.

Reference Books:

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

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Course Code: PHY 604
PARTICLE PHYSICS

L	T	P	Credits
4	0	0	4

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.

Reference Books:

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

PHY612 PROJECT PART II
Max.Marks: 100

L	T	P	Credits
0	0	0	6

(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 may be an extension of work done in Project Part-I.

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 Physics Department. 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 Physics Department.

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	Credits
4	0	0	4

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.

Reference Books:

1. Liquid Crystals : S. Chandrasekhar (Cambridge University), 2nd ed. 1992.
2. The Liquid Crystal Phases : Physics & Technology : T.J. Sluckin, Contemporary Physics (Taylor & Francis), 2000.
3. Physics of Liquid Crystals : Michael J. Hird, 1970

Course Code: PHY622
PLASMA PHYSICS

L	T	P	Credits
4	0	0	4

Total Lecture-60

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.

Reference Books:

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

Course Code: PHY623

PHYSICS OF NANOMATERIALS
Lecture-60

L	T	P	Credits
4	0	0	4

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-IIIQUANTUM 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.

Reference Books:

1. Thin Film fundamentals: A. Goswami-New age International, 2007
2. Introduction to Nanotechnology: Charles P. Poole Jr. and Franks J. Qwens, John Wiley & Sons, 2006.
3. Quantum Dot Heterostructures: D. Bimerg, M. Grundmann and N.N. Ledentsov (Wiley),1998.
4. Nanoparticles and Nanostructured Films–Preparation, Characterization and Application: J.H. Fendler (Wiley), 1998.
5. Physics of Semiconductor Nanostructures: K.P. Jain (Narosa), 1997.
6. Physics of Low-Dimension Semiconductors: J.H. Davies (Cambridge Univ. Press) 1998.
7. Advances in Solid State Physics (Vo.41) : B. Kramer (Ed.) (Springer), 2001.
8. Nanotubes and Nanowires: CNR Rao and AGovindaraj-Royal Society of Chemistry,2005.

Course Code: PHY624

Advanced Nuclear Physics

L	T	P	Credits
4	0	0	4

Unit I Heavy Ion Nuclear reactions (15)

Q-value and Invariance in nuclear reactions, Cross section: Total cross section, Partial cross section, differential cross section, Cross section in terms of partial wave analysis.
Elastic and inelastic scattering, Qualitative features and phenomenological potentials, Heavy ion potentials, Nucleon transfer reactions, Compound nucleus formation in heavy ion reactions, Fusion of heavy ions, Fusion of loosely bound nuclei (qualitative idea)

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 Detectors and Accelerators (15)

Interaction of charged particles with matter, Basis of detection, Gas filled counters- Proportional and G M counter, Scintillation detectors, Semiconductor detectors, Solid state nuclear track detectors, Counting statistics, Measurement of nuclear lifetimes.
Accelerators- Classification and performance characteristics, Ion sources, Cockcroft and Walton generators, Betatron.

Unit IV Nuclear Potentials (15)

Types of nuclear potentials, theoretical cross section with optical model, Comparison with experiments, optical giant resonances, optical model parameters, microscopic potentials, single and double folding potentials.

Reference Books

1. Nuclear physics-Experimental and Theoretical: H.S. Hans (New Academic Science) 2nd ed (2011).
2. Introduction to Nuclear and Particle Physics: V. K. Mittal, R. C. Verma and S.C. Gupta (Prentice Hall of India) 2013.
3. Basic Ideas and Concepts in Nuclear Physics: K. Hyde (Institute of Physics) 2004.
4. Nuclear Physics-Principles and Application: John Lilley (Wiley) 2001.
5. Concepts of Nuclear Physics: Bernard L Cohen (Tata McGraw-Hill) 2004.
6. Nuclear Physics-Theory and Experiment: R R Roy and B P Nigam (New Age Int.) 1996.
7. Nuclear Structure from a simple perspective: R F Casten (Oxford University Press) 1990.
8. Models of the atomic nucleus: N D Cook (Springer) 2006.
9. Theory of nuclear shell model: R D Lawson (Oxford University Press) 1980.

L	T	P	Credits

Course code: PHY628
Course Name: Spintronics
Total Lectures- 60

4	**0**	**0**	**4**

UNIT 1

Optical Phenomena and Bipolar Spintronics (15)

Optical properties of III-V-based MAS, Hole-mediated ferromagnetism, Optical properties, Photo induced ferromagnetism, Photo-induced magnetization rotation effect of spin injection, Spin dynamics, Magnetization reversal by electrical spin injection, Circularly polarized light emitters and detectors, Bipolar spintronics, Concept of spin polarization, Optical spin orientation, Spin injection in metallic F/N junctions, Spin relaxation in semiconductors, Bipolar spin-polarized transport and applications, Magnetic p-n junctions.

UNIT II

Spin Effects in Quantum Dots (15)

Charge and spin in single quantum dots, Constant interaction model, Spin and exchange effect, Controlling spin states in single quantum dots, Charge and spin in double quantum dots Hydrogen molecule model, Stability diagram of charge states, Spin relaxation in quantum dots, Spin blockade in single-electron tunnelling, Cotunneling and the Kondo effect.

UNIT III

Spin-Dependent Transport in Single Electron Devices (15)

Single-electron transport, Model Hamiltonian, Metallic or ferromagnetic island, Quantum dot Transport regimes, Weak coupling, Quantum dots, Non-Collinear geometry, Ferromagnetic islands, Metallic islands and Shot noise, Cotunneling, Strong coupling – Kondo effect, RKKY interaction between quantum dots.

UNIT IV

Spin-Transfer Torques, Nanomagnets and Tunnel Spin Injectors (15)

Spin-transfer torques, Intuitive picture of spin-transfer torques, two magnetic layers, Spin-transfer-driven magnetic dynamics, Applications of spin transfer torques, Electrons in micro- and nanomagnets, Micron-scale magnets and Coulomb blockade, Ferromagnetic nanoparticles, Magnetic molecules and the Kondo effect,Magnetic tunnel junctions, Tunnel-based spin injectors, Spin-Hall effect.

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

Reference Books:

1. SadamichiMaekawa, Concepts in Spin Electronics, Oxford University Press, ISBN 978–0198568216
2. Tomasz Dieti, David D Awshalom, Maria kaminska, Hideo Ohno, Spintronics, ISBN, 978-0-08-044956-2
3. FarzadNasirpouri, Alain Nogaret, Nanomagnetism and Spintronics:Fabrication, Materials, Characterization and Applications, World Scientific, ISBN-13 978-981-4273-05-3

Course code: PHY629
Course Name: Solar cell: Fundamentals and Applied aspects
Total Lectures- 60

L	T	P	Credits
4	0	0	4

Unit I: Fundamentals of Solar cells (15)

Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources. Basic of Semiconductor Physics- the p-n junction, charge carriers in semiconductors, optical properties of semiconductors, Hetero- junctions, Solar radiation outside the Earth's Atmosphere, Solar radiation at the earth's surface Instrument for measuring the solar radiation and sunshine, solar radiation data, solar radiation Geometry, solar radiation at tilted surfaces, Solar energy fundamentals-nature of solar energy, conversion of solar energy, photochemical conversion of solar energy, photovoltaic conversion, photophysics of semiconductors and semiconductor particles, photocatalysis.

Unit II: Silicon solar cells (15)

Types of solar cells, p-n junction solar cell, current density, open circuit voltage and short circuit current, description Device physics of silicon solar cells- Semiconductor device equations, The p-n junction model of Shockley, Real diode characteristics, Description and principle of working of crystalline silicon solar cells- Silicon cell development, Substrate production, cell processing, cell cost, Opportunities for improvement, polycrystalline and amorphous silicon solar cells, conversion efficiency. Elementary ideas of Tandem solar cells Manufacturing costs, Environmental issues,Challenges for the future.

Unit III: Dye sensitized solar cell (15)

Photoelectrochemical solar cell, semiconductor electrolyte interface, Basic principle and working of Graetzel Cell i.e., dye sensitized solar cells (DSSCs), Derivation of the Lifetime in DSSCs, factors affecting on efficiency of DSSCs, present DSSCs research and developments, limitations of DSSCs,

Unit IV: Polymer based and Quantum Dot Sensitized Solar Cells (15)

Introduction to conducting polymers, basic principle of HOMO & LUMO, bulk heterojunction polymer: solar cell Basic working principles, device architectures, single layer, Bilayer, Bulk heterojunction, diffuse bilayer heterojunction, tandem solar cell, efficiency relationship in organic bulk heterojunction solar cells. Quantisation effects in semiconductor nanostructures, optical spectroscopy of quantum wells, superlattices and quantum dots, Basic principle and working of quantum dot sensitized solar cells, effect of device architecture, theory of electron and light dynamic in QDSSCs.

Reference Books:

1. Physics of solar cells from principles to new concepts: Peter Wurfel
2. Photoelectrochemical Solar Cells: Suresh Chandra
3. Solar energy conversion: A. E. Dixon and J. D. Leslie
4. Solar cells: Martin A. Green
5. Solid State electronic Devices: B.G. Streetman
6. Photoelectrochemical solar cell: Suresh Chandra
7. Dye sensitized solar cell: Michael Graetzel (Review Articles)
8. N. S. Sariciftci and A. J. Heeger in Handbook of Organic Conductive Molecules and Polymers Vol. 1, edited by H. S. Nalwa, John Wiley & Sons, 1997
10. Nanostructured and photoelectrochemical systems for solar photon conversion: Mary D.

Course Code: CSA557
Course Name: Computer Fundamental
Total Lectures-30

L	T	P	Credits
2	0	0	2

Unit I. Computer basics (8)

Computer basics, hardware and software, flowchart, flowchart symbols, computer languages, low level languages, high level languages, FORTRAN language, implicit, constants and variables, declaration of reals and integers, arithmetic expressions, real and integer expressions, some problems due to rounding of real numbers, mixed mode expressions, special functions.

Unit II. Computer programming in FORTRAN (8)

Program preparation preliminaries, Input/output statements, list directed input/output statements, PRINT statement, Control statements, relational operators, logical IF statements, nested IF statements, arithmetic IF statement, DO statement, rules to be followed in utilizing DO loops, REPEAT WHILE structure, subscripted variable, use of multiple subscripts, subscript expressions, DIMENSION statement, FORMAT description for PRINT statement, WRITE statement, multi record For Mats, Logical expressions and decision tables.

Unit III. Functions and subroutines in FORTRAN (8)

Functions, statement functions, function subprograms, syntax rules for function subprograms, subroutines, COMMON declaration, processing files in FORTRAN, creating a sequential file, updating a sequential file, merging two sequential files, direct access files, CHARACTER manipulations in FORTRAN, string expressions, substrings, double precision facility in FORTRAN, use of complex quantities, DATA statement, EQUIVALENCE declaration.

Unit IV. Graphical plotting of data (6)

Graphical plotting of data, 2D plotting, 3D plotting, contour plotting, data plotting softwares such as Excel, Origin, Sigma etc.

Reference Books:

1. V Rajaramanm, Computer Programming in Fortran 77, PHI Learning Pvt. Ltd., 1997.
2. Ian D Shivers and J Sleight, Interactive Fortran 77, A hands on Approach, Ellis Horwood Ltd; 1990.

Course Code: CSA558
Course Name: Computer Fundamental

L	T	P	Credits
0	0	4	2

Computer Programming in FORTRAN 77

Write an algorithm, flowchart and computer program for the following problems.

1. Picking greatest number of given five numbers.
2. Sum of n consecutive integers, sum of n consecutive odd integers and sum of n consecutive even integers.
3. Compute the total resistance of four resistances connected in parallel and in series.
4. Compute the roots of a quadratic equation.
5. Compute the determinant and inverse of a matrix.
6. Solution of n linear equations.
7. Compute the value of energy and radius of first Bohr´s orbit of Hydrogen atom.
8. Compute and plot the trajectory of a projectile thrown with some velocity u at an angle θ. Compute the horizontal range for a projectile fired with velocity 10 m/s and θ=35.
9. Compute and plot the trajectory of Earth around the Sun.
10. Compute the root of equation x=sin (x) using the Newton-Raphson´s method.
11. Integrate the equation $F(x)=x^{7/3}+x^2+x$ in the limits 0 and 1 for N=10 using Simpson and Trapezoidal rule and compare the results.
12. Solve Harmonic oscillator problem using Runge-Kutta method.

L	T	P	Credits
4	0	0	4

Course Title: Chemistry of Materials

Course Code: CHE 615

Course Objectives:
This course is intended to learn the basic concepts of material science. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the students.

Expected Prospective: This course will equip students with the necessary chemical knowledge concerning the fundamentals in the basic areas of Industrial chemistry. The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers.

Unit I **(15)**

Solid State Chemistry

Types of solids, band and bond theories, crystal lattice energy, point defects in metals and ionic compounds, energy and entropy of defects, their concentration, diffusion and electrical conduction via defects, non-stoichiometry types, colour centres and electrical properties of alkali halides, electron theories for metal conduction in metals , in insulators, impurity semi-conductors, reactions in organic solids, photochemical reactions, solid-solid reactions, decomposition and dehydration reaction.

Unit II **(15)**

Macromolecules

Types of polymers, regular and irregular polymers, synthesis of polymers by chain and step reactions, physical properties of solid polymers(crystallinity, plasticity and elasticity), vulcanization of rubbers, molecular mass determination by osmometry, viscometer, light scattering and ultracentrifuge methods, number and mass average molecular masses, polymer solutions, factors affecting the solubility of polymers , conducting polymers, doping of polymers, mechanism of conduction, polarones and bipolarons.

Unit III **(15)**

Glasses and Ceramics

Factors affecting glass formation, oxide glasses, electronegativity and bond type, viscosity, structural effects (zachariasen's rule (1932), criteria of SUN and Rawson, thermodynamics of glass formation, behavior of liquids on cooling, kinetics of crystallization and glass formation, structure of glasses: vitreous silica, silicate glasses, vitreous B_2O_3 and borate glasses, viscosity, electrical conductivity of glasses and the mixed alkali effect, commercial silicate and borate glasses, metallic glasses , glass ceramics, refractories, important glass-ceramics compositions, properties of glass ceramics, applications.

Unit IV **(15)**

Smart Materials

Methods of preparation- conventional ceramic methods, hot pressing and hot static pressing techniques, precursor method, gel method, co-precipitation method, glass crystallization methods, vacuum techniques- chemical vapor deposition method. , organic superconductors, magnetism in organic materials, magnetic nano materials, energy storage materials, nanomaterials for targeted drug delivery, fullerenes as superconductors. High temperature ceramic superconductors, electrical and magnetic properties of superconductors, critical temperature Tc, thermodynamics of superconductors, London equation, BCS theory, applications.

Reference Books:

1. Cornell, P. J. Flory. *Principles of polymer chemistry*, University Press.
2. Tager, A. J. *Physical chemistry of polymers,* Mir Publishers.
3. Dekker, A. J. *Solid state physics,* MacMillan Publishers.
4. West, A. R. *Solid state chemistry and its applications,* Wiley Publishers.
5. Byrn, S. R. *Solid state chemistry of drugs,* Academic Press.
6. Puri, Sharma and Pathania, *Principles of physical chemistry,* Vishal Publishers.
7. Gray, G. W. *Thermotropic Liquid crystals*, John Wiley.
8. Malcolm, P and Stevens, *Polymer Chemistry,* Oxford University Press.
9. Keer, H. V. *Principles of Solid States*, Wiley Eastern.

Course Title: Medicinal Chemistry
Course Code: CHE616
Time: 04 Hours

L	T	P	Credits
4	0	0	4

Course Objectives:
This course is intended to learn the basic concepts of Medicinal Chemistry. The present syllabus has been framed as per the latest UGC guidelines and recent research trends in the subject. The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic interest.

Expected Prospective: This course will equip students with the necessary medicinal chemistry knowledge concerning the fundamentals in the basic areas of pharmaceutical sciences The students will be able to pursue their career objectives in advance education, in scientific research and in teaching careers.

Unit I

Enzymes **(15)**

Basic considerations. Proximity effects and molecular adaptation. Introduction and historical prospective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and koshland's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labelling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-menten and lineweaver-Burk plots, reversible and irreversible inhibition.

Mechanism of Enzyme Action

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonucleases, lysozyme and carboxypeptidase A.

Unit II **(15)**

Kinds of Reaction Catalysed by Enzymes

Nucleophilic displacement on a phosphorus atom, multiple displacement reaction and the coupling of ATP cleavage to endergonic processes. Transfer of sulphates, addition and elimination reactions, enolic intermediates in isomerization reactions, β-cleavage and condensation, some isomerisation and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

Unit III **(15)**

Co-Enzyme Chemistry

Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological function of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, LIPOIC ACID, vitamin B12. Mechanisms of reactions catalysed by the above cofactors.

Unit IV **(15)**

Drug Design

Development of new drugs, procedures followed in drug design, concepts of lead compound and lead modification, concepts of prodrugs and soft drugs, structure-activity relationship (SAP), factors affecting bioactivity, resonance, inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drug activity: occupancy theory, rate theory, induced fit theory. Quantitative structure activity relationship. History and development of QSAR. Concepts of drug receptors. Elementary treatment of drug receptors interactions. Physico-chemical parameters:

lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton and surface activity parameters and redox potentials. LD-50, ED-50 (Mathematical equations excluded)

Reference Books:

1. Lehninger, *Principles of Biochemistry,* WH-Freeman, 5th edition.
2. Silverman, R. B. *The organic chemistry of drug design and drug action,* Academic press 2nd edition, 2004.
3. Pandeya S. S. and Dimmock, J.R. *An introduction to drug design,* New Age International.

Course Code: MTH690
Course Name: MALAB
Total Lectures-60

L	T	P	Credits
4	0	0	4

COURSE OBJECTIVE: The objective of this course is to teach the basics of MATLAB. For the purpose of learning programming skill Numerical problems with quantum mechanics are included.

Unit I **(10)**
Basic Operations of Matlab: The Desktop Layout, Syntax, and Operations, Variable names, Operator and delimiter symbolic, Multiple operations, Displaying content of multi-element variables, Importing and Exporting Information, Command Line Import, Import Functions, M-file Scripts, Export Functions
Unit II **(20)**
Computing and Programming: Computational Procedures: Special Built-in Constants and Functions, Computing with matrices and vectors, Simultaneous linear equations, Eigenvectors and Eigenvalues
Programming: Using the Editor, Types and Structures of M-files, Passing variables by name and value, Function evaluation and function handles, Flow control: if, else, and elseif, for, while, switch and case, break, return, nested loops, Sorting and Searching
Unit III **(15)**
Graphics and Data Analysis: Graphics and Data Visualization, Two dimensional plotting, Sub plotting Patching and Filling, Three dimensional plotting, The Handle Graphics system, saving and exporting graphics, Sub plotting Patching and Filling, Three dimensional plotting, Saving and exporting graphics
Unit IV **(15)**
Working with the various practical examples of Quantum Mechanics:
1. Writing differential operators as matrix,
2. Construction of wavepacket,
3. Eigen functions and energy eigen values of free particle,
4. Eigen functions and eigen energies of one -dimensional Schrödinger equation for arbitrary potentials,
5. Probability density for particle in double well potential
6. Time dependent Schrödinger equation in one dimension: Reflection at a potential cliff
7. Time dependent Schrödinger equation in two-dimensions: Reflection at a potential barrier

Reference Books:

1. Chapman, S., *MATLAB Programming for Engineers*, *4th Edition*, Cengage Learning, Engineering, 1120 Birchmount Rd, Toronto, ON, M1K5G4, Canada. 2008.
2. Duffy, D.G., *Advanced engineering mathematics with MATLAB*, Boca Raton, FL: CRC Press, 2003.
3. Register, A.H., *A guide to MATALB object-oriented programming*, Boca Raton, FL: CRC Press, 2007.
4. Kalechman, M., *Practical MATALB applications for engineers*, Boca Raton, FL: CRC Press, 2009.
5. Poularikis, A.D., *Discrete random signal processing and filtering primer with MATLAB*, Boca Raton, FL: CRC Press

Course Title: Research Methodology
Course Code: MGT551

L	T	P	Credits
4	0	0	4

Course Objective: The course is designed to enable students to understand & apply concepts research process on real research problems

Learning Outcomes: At the end of the course a student should be able to design research proposal and apply statistical tools manually as well as with the help of software.

Unit – I **(5)**

Research Methods-Introduction : Introduction to Research-Basic and applied Research Methods, Road Map to Learn Business Research Methods, Business research methods: A Decision Making Tool, Use of Software in Data Preparation and Analysis, Introduction and Business Research Process Design

Unit- II **(15)**

Introduction and Scales of Measurement, Four Levels of Data Measurement, The Criteria for Good Measurement, Factors in selecting an appropriate Measurement Scale, Questionnaire: Introduction and Design Process.

Introduction to Sampling- Importance and Sampling Design Process, Random Sampling Methods and Non-Random Sampling, Central Limit Theorem and Sampling distribution. Classification of Secondary Data Sources, Road Map to Use Secondary Data, Survey and Observation: Classification of Survey Methods, Observation Techniques and Classification of Observation Methods, Experimental Research Designs

Unit-III **(25)**

Field-work and Data Preparation, Hypothesis Testing for Single Population: Introduction, Hypothesis Testing Procedure, Two-Tailed Test of Hypothesis and One - Tailed Test of Hypothesis, Type-I and Type-II Error,

Hypothesis Testing for a Single Population Mean Using the Z and T statistic, Hypothesis Testing for a Population Proportion, Hypothesis Testing for Two Populations, Hypothesis Testing for the Difference Between Two Population Means Using the z and t-Statistic,

Statistical Inference About the Difference between the means of Two Related Population, One way ANOVA and Experimental Research Designs

Unit –IV **(15)**

Hypothesis testing for Categorical data (Chi-square test), Non-parametric statistics , Correlation-Karl Pearson and Spearman's Rank Correlation,

Introduction of Simple Linear Regression and Determining the Equation of a Regression Line,

Presentation of Result: Report Writing, Organization of Written Report, Tabular and Graphical Representation of Data, Oral Presentation

Reference Books:

1. Business Research Methods by Naval Bajpai, Pearson, 1st Edition, (2011)
2. Research Methodology: Methods and Techniques by C R Kothari, New Age International (2004)
3. Marketing Research: Text and Cases by Nargundkar, R., Tata McGraw Hill, 3rd Edition, (2010)