Dear M.Sc Physics students,

Warm welcome to the II Batch of M.Sc students in Applied Physics, Department of Physics, National Institute of Technology Srinagar.

This e-brochure contains practical information of the programme in a simple and systematic manner with all required information. The Applied Physics programme with its core-specialization structure offers a wide variety of possibilities, enabling you to pursue your particular ambitions and interests in this fascinating area of science. Courses at different levels of specialization will enable you to deepen your physics knowledge and find out how it is applied in modern research and development.
There are various electives and few courses are on nanosciences, which is interdisciplinary and has immense applications in all sectors of life. It is at par from the existing syllabi of other universities.
Our Laboratories are well- equipped with start of art instruments (including Scanning Electron Microscope) and efforts to make them the best in the region is directly under the able guidance of Hon'ble Director. The laboratories once established in all respects shall be made open to the interested students of the country, where they can carry their summer/winter internships also.
We are convinced that we have created a rewarding and challenging post graduate programme that keeps its promise which will prepare you for the future. The academic loss if any due to prevailing conditions can be compensated.

We wish you a good start and lots of success!

Dr. M.A.Shah
Programme Director and Coordinator
on July 1, 2016

Post Graduate Programme

In

Applied Physics

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Syllabus for Credit Based Curriculum

by

Department of Physics

National Institute of Technology, Srinagar

Jammu and Kashmir

July, 2014

National Institute of Technology Srinagar: A Brief Profile

The National Institute of Technology, Srinagar (NIT), one of the leading institutes in north of the country, was established in 1960. In 2004, it had the unique distinction of becoming an Institute of National Importance under the NIT Act under the auspices of Ministry of Human Resources Development, Govt. of India.

Being fully residential, the campus located on the western bank of the Dal Lake near the famous Hazratbal Shrine, provides comfortable accommodation to all faculty and students. The institute has signed Memorandum of Understanding (MOU) with various national and international academies, professional and research institutes as well as industry to augment the learning process. These ties are a means for our students to gain valuable and relevant knowledge and experience, providing them with the building blocks for a successful future career. Students from all over the country epitomize a healthy amalgamation of different cultures, religions and languages on the campus and present a classical example of a mini cultural India.

The prestigious technical institute has ten departments which cater six postgraduate and ten undergraduate programmes besides offering Ph.D. degree in all Engineering and Science disciplines. Since its inception, the **Department of Physics** is offering the General Physics courses Physics I and Physics II for all branches of B.Tech. students during first and second semesters respectively. In addition, the department offers several electives to various branches. The Department has full-fledged laboratories for research and offers Ph.D./M.Phil. programmes in Solid state physics, Materials science, Nanotechnology, Nuclear physics, Space physics, and in renewable energy sectors. Presently, the department has six faculty members and the faculty has developed research collaborations with several premier institutions across the globe. In order to inculcate the academic culture, the department regularly organizes lecture/quiz competitions and invited talks by the eminent scientists. So far the department has produced maximum M.Phil. and Ph.D. scholars in the Institutes. Unending efforts are being made by the department to develop the well equipped research laboratories to cater the needs of master’s programme which is likely to be approved. In this programme, we have offered intrinsically challenging and didactically inspiring courses.

Small but academically sound galaxy of eminent faculty having specializations in thrust areas are actively engaged in research and other academic assignments including teaching to B.Tech students. Dozens of students pursuing Ph.D under their guidance have collaborations with reputed laboratories across the globe. The faculty has always brought laurels to the institute. However, the Institute overall has witnessed a remarkable growth in all sectors under the able guidance of our Director Prof. Rajat Gupta, from the last three years.

Programme Structure:

Entire two years Masters Programme has been divided into four semesters. In first year (two semesters) all the core courses have been introduced with more information with relevant updated topics with a view to link earlier (B.Sc) programme. In second year, courses have been designed to accommodate more applied subjects (electives) and comprehensive project work in industry or any national laboratory of repute.

Total No of seats: Twenty five (25)

Reservation for open, SC/ST, OBC and PH are as per Govt. of India rules.

Eligibility Criteria:

Students for admission to M.Sc. Programme must satisfy the criteria:

Bachelor's degree with at least 60% marks/6.5 CGPA (on 10 point scale) or equivalent, with **Physics** as main and **Mathematics** as a subsidiary subject **OR** with **Physics and Mathematics** among the main subjects. 5% or 0.5 in CGPA on a 10 point scale relaxation may be extended to candidates belonging to SC/ST/OBC/PH candidates.

Admission Procedure:

Interested candidates satisfying the eligibility criteria will have to submit their application form in the prescribed format, which will be made available on the institute web page (www.nitsri.net). Applicant should be a citizen of India. Admission of foreign nationals, if any, shall be governed by the rules stipulated by the Government of India from time to time. Two step processes to admit the students into M.Sc. programme shall be carried as:

(i) Short listing of candidates as per eligibility.

(ii) Performance in written test examination.

The examination pattern (Theory as well as Practical) approved by the senate will be followed for the programme.

Entrance will be conducted by Institute.

Course Monitoring and Course Evaluation

- Academic coordinator for each semester should be notified by the National Institute of Technology/Institution/Dean much before the start of the semester course work.
- Two independent sets of question papers for the end semester examination should be got set by the academic coordinators for all the courses in each semester. This action should be taken by the academic coordinators much before the start of the semester course work.
- The question paper shall be uniformly distributed over the syllabus giving equal weightage to all the units. The students have to do five questions selecting at least one from each unit.However, all the procedures of the institute shall be followed for the course evaluation.

PROGRAMME AT A GLANCE

Name of Degree	Name of Programme	Intake (Full-time)	Year of starting proposed	Duration	Name of Degree & Eligibility for Admission
M.Sc.	APPLIED PHYSICS	25	2014	2 years	Bachelor's degree in Science and Engineering with at least 60% marks/6.5 CGPA (on 10 point scale) or equivalent, with **Physics** as main and **Mathematics** as a subsidiary subject **OR** with **Physics and Mathematics** among the main subjects. For SC/ST candidates 55% marks or CGPA 5.5/10 in aggregate in the qualifying examination.

Course Structure

The Credit structure is as follows:

Core: 56

Electives: 04

Projects: 30

Total Credits: 90

PROGRAMME STRUCTURE

SEMESTER - I   Total Credits: 90

S. No.	Course Code	Courses	L	T	P/	Credits	Page No.
1.	PSPHY 101	Mathematical Methods for Physics	3	1	0	4	01
2.	PSPHY 102	Classical Mechanics	3	1	0	4	02
3.	PSPHY 103	Quantum Mechanics	3	1	0	4	03
4.	PSPHY 104	Solid State Physics	3	1	0	4	04
	PSPHY LB1	**Solid State Physics Lab**			4	2	05
	PSPHY LB2	**Advanced Optics Laboratory**			4	2	05
	Total		**15**	**5**	**8**	**20 (Twenty)**	

SEMESTER - II

S. No.	Course Code	Courses	L	T	P/	Credits	
1.	PSPHY 201	Classical Electrodynamics	3	1	0	4	06
2.	PSPHY 202	Electronics	3	1	0	4	07
3.	PSPHY 203	Thermodynamics and Statistical Mechanics	3	1	0	4	08
4.	PSPHY 204	Atomic and Molecular Physics	3	1	0	4	09
	PSPHY LB3	**Electronics and Instrumentation Lab.**			4	2	10
	PSPHY LB4	**Characterization Lab.**			4	2	10
	Total		**15**	**5**	**8**	**20 (Twenty)**	

SEMESTER – III

S. No.	Course Code	Courses	L	T	P/	Credits	
1.	PSPHY 301	Condensed Matter Physics	3	1	0	4	11
2.	PSPHY 302	Nuclear and Particle Physics	3	1	0	4	12
3	PSPHY 303	Computational Methods in Physics	3	1	0	4	13
		Electives: **one elective as per choice.**					
1.	PSPHY EL1	Renewable Sources of Energy	3	1	0	4	14
2.	PSPHY EL2	Nanoscience and Nanotechnology	3	1	0	4	15
3	PSPHY EL3	Atmospheric Physics	3	1	0	4	16
4.	PSPHY EL4	Fiber Optics	3	1	0	4	17
5	PSPHY EL5	Material Science	3	1	0	4	18
6	PSPHY EL6	Semiconductor Physics	3	1	0	4	19
7	PSPHY El 7	Quantum Field Theory	3	1	0	4	20
8.	PSPHY El 8	Group Theory	3	1	0	4	21
9.	PSPHY El 9	Integrated Electronics	3	1	0	4	22
	PSPHYLB5	**Computational Physics Lab.**			4	2	24
	PSPHY LB 6	**Materials Science Lab.**			4	2	24
	Total		**15**	**5**	**8**	**20 (Twenty)**	

SEMESTER – IV

S. No.	Course Code	Courses	L	T	LAB	Credits	
1	PSPHY PR1	Research Methodology	3	1	0	4	26
2	PSPHY PR2	Project/Dissertation and Viva voce			50/6mon	**26**	27
	Total					**30 (Thirty)**	

PSPHY 101 **MATHEMATICAL METHODS FOR PHYSICS** **C L T P**

4 3 1 0

Unit I

Complex Variables:

Complex numbers. Equations to curves in the plane in terms of z and z*. The Riemann sphere and stereographic projection. Analytic functions of z and the Cauchy Riemann conditions. The real and imaginary parts of an analytic function. The derivative of an analytic function. Power series as analytic functions. Convergence of power series. Cauchy's integral theorem. Singularities, removable singularity, simple pole, multiple pole, essential singularity. Laurent series. Singularity at infinity. Accumulation point of poles. Meromorphic functions. Cauchy's integral formula Solution of differential equations using generating functions and contour integration. Summation of series using contour integration. Evaluation of definite integrals using contour integration.

Unit II

Gamma function

Definition of the gamma function and its analytic continuation. Analytic properties. Connection with gaussian integrals. Mittag-Leffler expansion of the gamma function. Logarithmic derivative of the gamma function. Infinite product representation for gamma function. beta function. Reflection and duplication formulas for gamma function.

Unit III

Multivalve functions; integral representations

Branch points and branch cuts. Algebraic and logarithmic branch points, winding point. Riemann sheets. Contour integrals in the presence of branch points. An integral involving a class of rational functions. Contour integral representation for the gamma function. Contour integral representations for the beta function and the Riemann zeta function. Connection with Bernoulli numbers. Zeroes of the zeta function. Statement of the Riemann hypothesis. Contour integral representations of the Legendre functions of the first and second kinds. Singularities of functions defined by integrals. End-point and pinch singularities, examples. Singularities of the Legendre functions. Dispersion relations for the Legendre functions.

Laplace transforms and Green Function

Definition of the Laplace transform. The convolution theorem. Laplace transforms of derivatives. The inverse transform, Mellin's formula. The LCR series circuit. Laplace transform of the Bessel and modified Bessel functions of the first kind. Laplace transforms and random processes: the Poisson process. Laplace transforms and random processes: biased random walk on a linear lattice and on a d-dimensional lattice.

Green functions. Poisson's equation. The fundamental Green function for thelaplacian operator. Solution of Poisson's equation for a spherically symmetric source. The Coulomb potential in d dimensions. Ultraspherical coordinates. A divergence problem. Dimensional regularization. Direct derivation using Gauss' Theorem. The Coulomb potential in d = 2 dimensions.

Text Books

1. L.A. Pipes and L.R. Harvill, Applied Mathematics for Engineers and Physicists, McGraw-Hill (1970).
2. G. B. Arfken and H.J. Weber, Mathematical Methods for Physicists, 5th edition, Academic Press (2001).
3. E. Kreyszig, Advanced Engineering Mathematics, 8th edition, John Wiley & Sons Inc. (1999).
4. W.W Bell: Special functions for scientists and engineers.
5. J. Mathews and R L Walker: Mathematical Methods of Physics.

PSPHY 102 **CLASSICAL MECHANICS** **C L T P**

4 3 1 0

Unit I

Lagrangian Formulation

Newtonian mechanics and its limitations. Constrained motion. Constraints and their classification. Principle of virtual work. D' Alembert's principle. Generalized coordinates. Deduction of Lagrange's equations from D' Alembert's Principle. Generalized momenta and energy. Cyclic or ignorable coordinates. Rayleigh' s dissipation function. Integrals of motion. Symmetries of space and time with conservation laws. Problems. Rotating frames. Inertial Forces. Electromagnetic analogy of inertial forces. Terrestrial and astronomical applications of Conolis force. Foucault's pendulum. Problems.

Unit II

Central Force Problem

Central force. Definition and properties of central force. Two-body central force problem. Stability of orbits. Conditions for closure. General analysis of orbits. Kepler's laws. Kepler's equation. Artificial satellites. Rutherford scattering. Problems.

Principle of least action. Hamilton's principle. The calculas of variations. Derivation of Hamilton's equations of motion for holonomic systems from hamilton's principle. Hamilton's principle and characteristic functions.

UNIT III

Canonical Transformations

Generating functions. Poisson bracket. Poisson's Theorem. Invariance of PB under canonical transformations. Angular momentum PBs. Hamilton-Jacobi equation. Connection with Classical Mechanics canonical transformation. Problems. Small oscillations. Normal modes and coordinates. Problems.

Principles and postulates of relativity, Lorentz Transformation, Effects thereof, Tensors, transformation properties, symmetric and anti-symmetric properties, Four Vector notation, Energy Momentum four vector for a particle, relativistic invariance of Physical Laws. Lagrangian and Hamiltonian of a relativistic particle.

Text Books

1. H. Goldstein, C. poole and J. Safko, Classical Mechanics, 3nd edition, Addison & Wesley(2000).
2. L.D. Landau and E.M. Lifshitz, Mechanics, Buttorworth-Heinemann (1976).
3. W. Greiner, Classical Mechanics – Point particles and Relativity, Springer-Verlag (1989).
4. N.C Rana and P.S Joag, Classical Mechanics.
5. A.P French: Special Relativity.

PSPHY 103 **QUANTUM MECHANICS** **C L T P**
4 3 1 0

UNIT I

Fundamental Concepts

Basic postulates of quantum mechanics. Linear operators Hermitian operators. Orthogonality of Eigen functions of a Hermitian operator. Completeness of Eigen functions. Commuting operators and their Eigen functions. Dirac's bra and ket notation. Representation of operators as matrices. Change of basis. Unitary transformation and its significance. Equations of motion. Schrodinger picture and Heisenberg picture. Interpretation of the wave function. Schwartz Inequality and Uncertainty Principle. Classical limit of the Schrodinger equation. operator methods in Q Mechanics, Double Stren-Gerlach experiment for spin half system.

UNIT II

Angular Momentum

Definition of generalized angular momentum, operators for J_+, J_- , J_z commutation relation of angular momentum with r & p. Spectrum of Eigen values of J^2 and Jz, operators for orbital angular momentum L in spherical polar coordinates, Eigen values and Eigen functions of L^2 & L_z. Spin angular momentum, Eigen values and Eigen functions of S^2 & S_z.
Matrix representation of J^2, J_z, J_+, J_-, J_x, J_y for j=1/2, 1. Pauli's Spin Matrices and their properties. Addition of two angular momenta, coupled & uncoupled representation, Clebsch Gorden co-efficients, Spectrum of eigen values of total angular momentum. Calculation of C.G. co-efficients when (1) $j_1=1/2$, $j_2=1/2$ (2) $j_1=1/2$, $j_2= 1$

UNIT III

Symmetry in Quantum Mechanics

Symmetries in classical physics. Symmetry in quantum mechanics. Conservation laws and de-generacies. Parity, or space inversion. Lattice translation as a discrete symmetry. Time reversal discrete symmetry.

Approximate Methods

Time independent perturbation theory. Perturbation of non-degenerate states. First order perturbation. Second order perturbation. Perturbation of an oscillator. Perturbation of degenerate states. Removal of degeneracy. First order Stark effect in hydrogen atom. Time dependent perturbation theory. Transition probability. The variation method with simple applications. Green's functions incoming and outgoing solutions.

Text Books

1. P.M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill (1977).
2. J.L. Powell and B. Crasemann, Quantum Mechanics, Narosa Publishing House (1993).
3. J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley (1999).
4. E. Merzbacher: Quantum Mechanics.
5. Cohen and Tanandji: Quantum Mechanics.

PSPHY 104 **SOLID STATE PHYSICS** **C L T P**

4 3 1 0

UNIT I

Crystal Structure

Bravais lattices- primitive vectors, primitive unit cells, conventional unit cells, Wigner Seitz Cell, Symmetry operations and classifications of two and three dimensional Bravias lattices, crystal structure, simple crystals, Miller indices, lattice planes, Bragg's law (SS), structure determination, Laue's method, powder crystal method, rotating crystal method, electron diffraction, neutron diffraction, reciprocal lattice, Ewald's construction, symmetry operations

UNIT II

Lattice Dynamics

classical theory, Lattice specific heat, experimental results, Einstein's theory (SS), density of states in 1-D and 3-D, Debye theory of specific heat, thermal conductivity of solids, thermal resistance of solids. Vibrations of a one-dimensional chain of (a) similar atoms and (b) two types of atoms, optical and acoustic modes, concept of phonons.

UNIT III

Energy band theory of solids

Classical free electron theory of metals, drift current, conductivity, mobility, Hall effect (SS). Wave mechanical treatment of electron in a box, electrons in a periodic potential, Bloch's theorem, Kronig- Penney Model, Brillouin zones, energy band structure in conductors, semiconductors, insulators, Fermi-Dirac distribution, Fermi energy density of states, Fermi surface, effective mass.

Dielectrics and ferroelectrics

Different types of polarization and polarizability (SS) Clausius-Mossotti relation, dielectric constant, dielectric breakdown, dielectric losses, ferroelectric, piezoelectric, pyroelectric behavior. Frequency dependence of dielectric properties, temperature dependence, ferroelectric-paraelectric phase transitions.

Magnetism Properties of solids

Classification of magnetic materials, Langevin's theory of paramagnetism, ferromagnetism, hysteresis, ferromagnetic domains, antiferromagnetism, ferrimagnetism, ferrites, Curie's law, magnetic ordering, Weiss theory of paramagnetism, quantum theory of para & ferromagnetism, paramagnetic resonances, Nuclrar magnetic resonance

Text Books

1. Charles Kittel, Introduction to Solid State Physics, Wiley Eastern, 5th edition (1983).
2. B.S. Saxena, R.C. Gupta, P.N.Saxena, Fundamentals of solid state physics, Pragati prakashan, 7th edition (1999).
3. M.A. Wahab: Fundamentals of Solid State Physics.
4. O. Pillay: Solid State Physics.
5. J.P Srivastava: Elements of Solid State Physics.

LABORATORIES

PSPHY LB1 **SOLID STATE PHYSICS LAB** **C L T P**
2 0 0 4

1. To determine the band gap of given semiconductor crystal using four probe method.
2. To determine the Hall coefficient for given semiconductor and study its field dependence.
3. Study of frequency dependence of dielectric constant for a given sample.
4. To study hysteresis of ferromagnetic material.
5. To Study the Thermo luminescence of F-Centers in Alkali Halides Crystals.
6. To study the morphology of a sample using SEM and to study elemental analysis by EDX method.
7. To measure the frequency dependence of dielectric constant of a ferroelectric material (BaTiO3) using an 'Impedance meter'.
8. Measurement of resistivity of very low to highly resistive samples by four probe method at different temperatures.
9. To study the superconducting transition of YBCO superconductor.
10. Measurement of Magnetoresistance of Semiconductors.

PSPHY LB2 **ADVANCED OPTICS LAB** **C L T P**
2 0 0 4

1. Determination of line width of a laser using monochromator.
2. Diffraction of light due to a straight edge
3. Thickness of the enamel coating on a wire - by diffraction.
4. Production and analysis of linearly, circularly and elliptically polarized light
5. Measurement of screw parameters using a laser beam.
6. Using Michelson's interferometer for the determination of thickness of film and its refractive index.
7. Measurement of coherence length of laser using Michelson interferometer.
8. Construction and reconstruction of an object using holography.
9. Diffraction of light by straight edge.
10. Mach-Zehnder Interferometer using a He-Ne laser.

PSPHY 201 **CLASSICAL ELECTRODYNAMICS** **C L T P**

4 3 1 0

UNIT I

Electrostatics

The concept of a scalar potential. Poisson's and Laplace's equations for scalar potential. Green's theorem, Electrostatic field energy density. Solutions of Laplace's equation in rectangular, spherical and cylindrical coordinates using the method of separation of variables. Multipole expansion of potential due to a localized charge distribution. Dipole and quadrupole fields. Interaction energy of dipole and quadrupole in an external field. Electrostatics in matter; Polarization and electric displacement vector. Electric field at the boundary of an interface. Clausius - Mossotti equation.

UNIT II

Magnetostatics,

Foundations of Magnetostatiscs, Scalar and Vector potentials, Magnetic moment of a current distribution. Macroscopic magnetostatics, Magnetization. M and H vectors, Maxwell's displacement current. Maxwell's equations. Vector and scalar potential. Lorentz and Coulomb gauge. Conservation of energy and momentum of a system of charged particles and electromagnetic fields. Field energy and field momentum.

UNITIII

Solutions of Maxwell's Equations and Radiation

Plane waves in dielectric media. Polarization, reflection and refraction at a plane interface between dielectrics, Fresnel's equations. Phase velocity and group velocity, spreading of a pulse propagating in a dispersive medium, propagation in a conductor, skin depth. Waveguides and cavity resonator. Radiation due to localized oscillatory source, near and far zones, radiated power due to an electric dipole, magnetic pole, example of a centre - fed linear antenna as an electric dipole radiator. Retarded Green's function.

Radiation from Moving Point Charges

Lienard-Wiechert potentials and fields for a point charge. Larmor's formula for power radiated by a slowly moving accelerated charge. Thomson scattering, Rayleigh scattering and application to nanoparticles.

Text Books

1. J.D. Jackson, Classical Electrodynamics, John Wiley & Sons, 2nd edition (1990).
2. D. J. Griffiths, Introduction to Electrodynamics, Pearson Prentice Hall, 3rd edition (1999).
3. J.R. Reitz., F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House (1979).
4. L.C Landau and E.M. Lifshitz Classical theory of fields.
5. Panofsky and Phillips: Classical Electrodynamics.

PSPHY 202 **<u>Electronics</u>** **C L T P**

4 3 1 0

UNIT I

Transistors

Types operation and characteristics, Ebers-Moll model, CE, CB and CC configuration input, output characteristics and graphical analysis of basic amplifier circuits, Biasing and Bias stability, Low frequency, h-parameter model, Analysis and Design of transistor amplifier circuits using h-parameters. High frequency hybrid – pi model, analysis and design of transistor amplifier circuits at high frequencies. Multistage amplifiers, phototransistors, Transistor as a switch, SCR's and Thyistors. Operation and characteristics, model Application at low and high frequency, amplifiers, switching circuits, MOSFET TYPES, Operation and characteristics.

UNIT II

Network Analysis Kirchoff's laws – Thevinin, Norton theorems - superposition, reciprocity, compensation theorems – source transformation – delta and star transformations – Laplace Transformation – convolution integral.

UNIT III Semiconductor Devices, Amplifiers and Oscillators

p-n junction diodes: tunnel diode, Schottky barrier diode – Microwave diodes: varactor diode, p-i-n diode – Optoelectronic devices: solar cell, photodetector, LED, semiconductor laser – basic principles, biasing and characteristics of BJT and JFET – MOSFET: enhancement and depletion modes of operation – basic idea of charge coupled devices.

Low frequency and high frequency amplifiers – power amplifiers – oscillator principle – oscillator types – frequency stability, response – phase shift oscillator – Wein bridge oscillator – LC tunable oscillators – multivibrators – monostable and astable – sine wave and triangle wave generation – clamping and clipping – crystal oscillators and their applications.

Operational Amplifiers and Digital Circuits

Ideal operational amplifier: characteristics, feedback types – *Applications:* basic scaling circuits – current to voltage and voltage to current conversion – sum and difference amplifiers – integrating and differentiating circuits – A.C.amplifiers – instrumentation amplifiers, comparators, filters, PLL. Logic gates – half adder, full adder – comparators, decoders, multiplexers, demultiplexers – design of combinational circuits – sequential circuits – *Flip-flops:* RS flip-flop, JK flip- flop, JK master-slave flip-flops, T flip-flop, D flip-flop – synchronous and asynchronous counters, registers – A/D and D/A conversion – characteristics.

Text Books

1. C.L Wadhwa, Network Analysis and Synthesis, New Age International Publishers, (2007).
2. J. Milman and C.C. Halkias, Electronic Devices and Circuits, McGraw-Hill (1981).
3. R. L. Boylsted and L. Nashelsky, Electronic Device and Circuits, Pearson Education (2003).
4. R.J. Higgins, Electronics with Digital and Analogue Integrated Circuits, Prentice Hall (1983).
5. A.P. Malvino, Electronics: Principles and Applications, Tata McGraw-Hill (1991).

PSPHY 203 <u>**THERMODYNAMICS AND STATISTICAL MECHANICS**</u> **C L T P**
4 3 1 0

UNIT I

Thermodynamics and its Statistical Basis

Review of thermodynamic concepts required for Statistical Mechanics, the macroscopic and the microscopic states, specification of states of a thermodynamic system, the principle of maximum entropy, thermodynamic potentials, contact between statistical mechanics and thermodynamics, Euler's equation and the Gibbs-Duhem relation, the Legendre transformation , classical ideal gas, entropy of mixing and Gibb's paradox.

Systems in contact with heat reserviour, expression of entropy, Canonical partition function, Helmholtz free energy, systems in contact with a particle reserviour, chemical potential, grand canonical partition function, fluctuation of particle number, Chemical potential of ideal gas.

UNIT II

Classical Statistical Mechanics

Micro-canonical ensemble, phase space, trajectories and density of states, Liouville's theorem, canonical and grand canonical ensembles; partition function, calculation of statistical quantities, Energy and density fluctuations.

UNIT III

Quantum Statistical Mechanics

Density matrix, statistics of ensembles, statistics of indistinguishable particles, Maxwell-Boltzmann, Fermi-Dirac and Bose Einstein statistics, properties of ideal Bose and Fermi gases, Bose-Einstein condensation.

Real gases, Mayer's cluster expansion for a classical gas, Viral equation of state, Using model, mean-field theories of the Ising model in two and one dimensions. Landau theory of phase transition, critical indices, scale transformation and dimensional analysis. Calculations of exponents from mean field Theory and Laundos theory, Upper critical dimension.

Text Books

1. F. Reif, Fundamentals of Statistical and Thermal Physics, International Students edition, Tata McGraw-Hill (1988).
2. K. Haung, Statistical Mechanics, Wiley Eastern (1991).
3. F.W. Sears and G.L. Salinger, Thermodynamics, Kinetic Theory and Statistical Thermodynamics, 3rd edition, Narosa Publishing House (1998).
4. H.B Callen: Thermodynamics and an introduction to thermostatics.
5. R. Kubo: Statistical Mechanics.

PSPHY 204 **ATOMIC AND MOLECULAR PHYSICS** **C L T P**

4 3 1 0

UNIT I

Hydrogen atom Gross Structures:

Schrödinger's equation, stationary states, Solution of' Schroedinger's equation for Coulomb field, quantum numbers n, l, m, Comparison with Bhor's model, the hydrogen spectrum Problems. The hydrogen atom Fine structure: Electron Spin, Stern-Gerlach experiment, the interaction terms, relativistic correction, spin-orbit interaction, vector model, spectroscopic terms and selection rules, lamb shift, summary of the hydrogen spectrum, Problems.

UNIT II

Two electron system:

Electrostatic interaction and exchange degeneracy ground and excited states of helium, Electron spin functions and Pauli's exclusion principle, periodic table. The central field approximation: the central field, Thomas Fermi-potential, The gross structure of alkalis atoms. Problems

UNIT III

Angular problems in many-electron atoms:

The LS-coupling approximation, allowed term in LS coupling, fine structure in LS coupling, J-J coupling. Problems, hyperfine structures. Interaction with external field: Zeeman, Paschen-Back and Stark effects, problems.

Covalent ionic and Vander Waal's interaction. Rotational, Vibrational, Rotational-Vibrational and electronic spectra of di-atomic molecules, selection rules, Frank-Condon principle. Raman effect and Raman spectra.

Fortrat diagram, Electronic angular momentum in diatomic and classification of states with example of spectrum of molecular hydrogen. Basic principle and use of ESR, NMR and Mossbauer spectroscopy.

Text Books

1. C.N. Banwell, Fundamentals of Molecular Spectroscopy, 4^{th} edition, McGraw-Hill, New York (2004).
2. Manas chanda, Atomic Structure and Chemical Bond, Tata McGraw-Hill, New Delhi (2003).
3. Arthur Beiser, Concepts of Modern Physics, 6^{th} edition, Tata McGraw-Hill, New Delhi (2003).
4. G. Aruldhas, Molecular Structure and Spectroscopy, Prientice Hall of India, NewDelhi (2002).
5. B.H Bransden and C.J Joachain: Physics of atoms and Molecules.

LABORATORIES

PSPHY LB3 ELECTRONICS AND INSTRUMENTATION LAB C L T P
2 0 0 4

1. To study the gain characteristics of a double stage RC coupled BJT amplifier.
2. To study the drain, transfer characteristics of a JFET.
3. To study the input and output characteristics of a differential amplifier.
4. To study MOSFET as output power amplifier.
5. Design and performance study of inverting, non-inverting and unity gain, differentiator, integrator amplifier using op-amp.
6. Design and performance study of Schmidt trigger circuit.
7. Design and performance study of astable multivibrator and mono-stable multivibrator.
8. Design and performance study of active filters (Low pass, high pass, band pass, band reject).
9. Combinational circuits: Adders, multipliers, magnitude comparators.
10. Sequential circuits: Flip flops, counters, shift registers. (Ripple counter with D type flip-flops; J-K flip flop and its application to counting).

PSPHY LB4 CHARACTERIZATION LAB C L T P
2 0 0 4

1. Structural determination of powdered crystalline materials by XRD.
2. Surface morphology of the materials by SEM.
3. Characterization of semiconductors: Determination of number of charge carriers, mobility.
4. Study of Dielectric Constant and Measure Curie temperature of Ferroelectric Ceramics.
5. Apparatus for Measurement of Susceptibility of Paramagnetic Substance in the form of Solution by Quincy's Tube Method.
6. Mossbauer Spectrometer.
7. Ultrasonic testing apparatus.
8. Experimental methods for gamma-ray (G.M. Counter).
9. Determination of the g of DPPH by Electron Spin Resonance Spectrometer (ESR).
10. Determination of band gap of semiconducting materials by UV- Visible spectrometer.

PSPHY 301 **CONDENSED MATTER PHYSICS** **C L T P**

4 3 1 0

UNIT I

Symmetry in Crystals

Concepts of point groups, Crystal Symmetry, Space groups, Symmetry and Degeneracy, Crystal field spiliting, Kramers Degenracy, Quasicrystals, General idea, approximation translational and rotational symmetry of two dimensional penrose tiling.

UNIT II

Electronic Properties

The Boltzmann transport equation, relaxation time, Electrical conductivity of metals, impurity scattering, ideal resistance, thermoelectric effects, thermal conductivity

Electronic properties in a magnetic field, Classical theory of magneto resistance, Hall effect and magnetic resistance, k space analysis of electrons motion in a uniform magnetic theory, Energy levels and density of states in a magnetic field, Quantum hall effect

UNIT III

Optical properties of solids

The dielectric function, the dielectric function for harmonic function, Dielectric losses of electrons, K K Relations, Interaction of phonones and electrons with photons, Interband transition, Direct and indirect transition. Skin effect and anomalous skin effect.

Super conductivity

History, general properties, measurements, critical field, temperature, current, Meissner effect, type-I and type-II superconductors (SS). London equation, penetration depth, optical properties, Cooper pair, BCS theory (Qualitative), coherence length, electron-phonon interaction, flux quantization, Josephsonjunction, high Tc superconductors.

Electron interaction via lattice, Cooper pairs, BCS theory, Bogoliubov transformation-notion of quasiparticles, Meissner effectDisordered in condensed matter- substitional , positional and tropographical disorder, Short and long range order, Atomic correlation function and structural description of glasses and liquids, Hubbard Model and koudo effect.

Text Books

1. Solid State Theory: M. Sachs.
2. Principles of the theory of solids: J.M Ziman
3. Solid State Physics: Ashcroft & Mermin
4. Solid State Physics: A. J. Dekker, Macmillan, new Ed, 2011
5. Solid Sachs: Solid State Theory

PSPHY 302 **NUCLEAR AND PARTICLE PHYSICS** **C L T P**

4 3 1 0

UNIT I

Nuclear Properties

Basic nuclear properties, Nuclear size and distribution of nucleons, Energies of nucleons in the nucleus, Angular momentum, Parity and symmetry, Magnetic dipole moment and electric quadrupole moment, Energy levels and mirror nuclei. Characteristics of nuclear forces - Range and strength, Simple theory of two nucleon system-deuterons, Spin states of two nucleon system, Effect of Pauli's exclusion principle, Magnetic dipole moment and electric quadrupole moment of deuteron -The tensor forces.

UNIT II

Experimental Methods of Nuclear & Particle Physics

Interaction of charged particles with matter. Stopping power and raige. Detectors for energetic charged particles; Solid State or Semiconductor detector; Bubble chamber; Nuclear emulsions. Composite relations. E rays, Ionization and scattering measurements in nuclear emulsions, Identification of particles. Need for accelerator of charged particles, Classification of types of accelerators, Proton Synchrotron, Betatron; alternating gradient accelerator, Colliding beam accelerator.

UNIT III

Nuclear reactions and fission

Different types of reactions, Quantum mechanical theory, Resonance scattering, Compound nucleous formation, Statistical theory of nuclear reactions and evaporation probability.

Classification and properties of elementary particles, Leptons, Baryons, mesons particles and antiparticles excited states and resonances. Various types of interactions - gravitational, electromagnetic, weak and strong interactions and their mediating quanta, Conservation rules in fundamental interactions. Charge symmetry and charge independence, Parity and charge conjugation, Conservation of parity and its violation in different types of interactions. Strange particles, associated production, strangeness and decay modes of charged Kaons, Isospin and its conservation. Idea of eight fold way and quarks.

Text Books

1. Heral Enge, Introduction to Nuclear Physics, Addison Wesley (1981).
2. D.C. Tayal, Nuclear Physics, 4th edition, Himalaya House, Bombay (1980).
3. W.C. Burcham, Elements of Nuclear Physics, ELBS (1979).
4. Kenneth S. Krane, Introductory Nuclear Physics, John Wiley & Sons, New York (1988).
5. J.S Lilley: Nuclear Physics.

PSPHY 303 **<u>Computational Methods in Physics</u>** **C L T P**

Unit 1 4 3 1 0

1. Introduction to MATLAB and its use for data analysis
   (i) MATLAB and its IDE; variables and arrays; scalar and array operations; built-in MATLAB functions;
   (ii) Working with data sets: file input/output. Data visualisation and plotting in MATLAB;
   (iii) Revision of error analysis: χ^2 analysis, errors on fitting coefficients, propagation of errors; MATLAB functions for error analysis;
   (iv) User-defined functions in MATLAB;
   (v) Comparison of MATLAB with other languages.

Project 1: Analysis of experimental spectrum data.

Unit II

2. Numerical methods and the solution of ordinary differential equations
   (i) Introduction to numerical computing; errors in numerical methods;
   (ii) Numerical methods for solving ordinary differential equations; Euler's method; higher-order methods; symplectic methods;
   (iii) Implementation of numerical methods in MATLAB programs;
   (iv) The linear driven damped oscillator; phase space; conserved quantities; sources of simulation error;
   (v) Map-based schemes; introduction to nonlinear systems.

Project 2: Numerical integration of the driven damped oscillator.

Unit III

3. The Monte Carlo method and its application to particle transport
   (i) Introduction to Monte Carlo methods; Monte Carlo integration; classical problems;
   (ii) Pseudorandom and quasirandom sampling; methods of generating samples with given probability density;
   (iii) Introduction to particle transport simulation; cross-sections;
   (iv) Simulation of neutron transport and scattering; nuclear criticality with Monte Carlo;
   (v) Importance sampling and statistical errors; Woodcock tracking;
   (vi) Other applications of Monte Carlo methods.

Project 3: Simulation of the penetration of neutrons through shielding.

ELECTIVES

PSPHY EL 01 **Renewable Sources of Energy** **C L T P**

4 3 1 0

Unit I

Renewable Sources of Energy

Relevance of renewable energy in relation to depletion of fossil fuels and environmental considerations, Green Energy

Solar Energy, Sun as a source of energy, nature of solar radiation and sun-earth angles, Flat plate collectors, types of FPC, effects of various parameters on the performance of FPC, Overall heat loss coefficient and heat transfer correlations, collector efficiency factor, Solar thermal applications like solar cooker and solar water heaters solar dyers, solar stills, solar cooling. Solar refrigeration and Carnots refrigeration cycle, thermal energy storage, active and passive heating of buildings.

Unit II

Fundamentals of photovoltaic Energy Conversion, Physics and Materials properties basic to photovoltaic conversion, Optical properties of solids, Direct and indirect transition semiconductors, interrelationship between absorption coeeficient and band gap, recombination of carriers, Types of solar cells, pn junction solar cells, transport equation, current density, open circuit voltage and short circuit current, brief description of single crystal silicon and amorphous silicon solar cells, e.g. tandem solar cells, solid liquid junction solar cells, nature of semiconductor, electrolyte junction, photoelectrochemical solar cells

Unit III

Hydrogen Energy, Solar Hydrogen through photoelectrolysis and photocatalytic process. Physics of material characteristics for production of solar hydrogen, Various factors relevant for safety, use of Hydrogen as fuel, use in vehicular transport, hydrogen for electricity generation, Fuel Cells, Energy Storage, Brief discussion of various storage processes, special feature of solid state hydrogen storage materials, structural and electronic characteristics of storage materials, new storage modes

Wind Energy, Energy and power in Wind, Wind Turbines, Aerodynamics of Wind turbines, Environmental impacts, offshore wind energy, economics

Text Books:

Twidel and Weir, Renewable Energy, E& F N Spon ltd

Bhattacharya, T. Terrestrial Photovoltaics, Narosa

Godfrey Boyle, Renewable Energy: Power for a sustainable Future, Oxford

Duffie, J.A. and W.A. Beckmann. Solar engineering of thermal processes, John Wiley and son’s incorporation, New York.

Sukhatme S.P. Solar Energy, Principles of thermal collection and storage, Tata McGraw Hill Publishing Company Limited New Delhi, 1997.

Garg, H.P and T.C.Kandpal “Laboratory Manual on solar Thermal Experiments “ Narosa publishing House , New Delhi.

PSPHY EL 02 **NANOSCIENCE AND NANOTECHNOLOGY** **C L T P**

4 3 1 0

UNIT I

Basic concepts of Nanomaterials

Detailed Overview of Nanomaterials:

Top-Down and Bottom-Up approaches of nanomaterial (nanoparticles, nanoclusters and quantum dots) synthesis: Top-down techniques: photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, FIB, shadow mask evaporation), probe lithographies, Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Pattern replication techniques: soft lithography, nanoimprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly). Combination of Top-Down and Bottom-up techniques: current state-of-the-art.

UNIT II

Characterization Tools

Characterization Techniques Related to Nanoscience and Nanotechnology: Compositional surface analysis: XPS, SIMS, Contact angles. Microscopies: optical microscopy, fluorescence and confocal microscopy, TEM, SEM, Probe techniques: Scanning tunneling microscopy (STM), Atomic force microscopy (AFM), Scanning Nearfield Optical Microscopy SNOM, Scanning Ion Conducting Microscopy (SICM). Ellipsometry, Neutron Scattering and XRD, Spectroscopic Techniques: UV-visible, FT-IR, Raman, NMR, ESR. Electrochemical Techniques: Voltammetric techniques, AC Impedance Analysis.

UNIT III

Nanomagnetism and Nanoelectronis

Mesoscopic magnetism – Magnetic measurements: miniature Hall detectors, integrated DC SQUID Microsusceptometry – magnetic recording technology, biological magnets.

Basics of nanoelectronics – Single Electron Transistor – quantum computation – tools of micro-nanofabrication – nanolithography – quantum electronic devices – MEMS and NEMS – dynamics of NEMS – limits of integrated electronics.

Text Books:

1. Jan Korvink and Andreas Greiner, Semiconductors for Micro and Nanotechnology – an Introduction for Engineers, Weinheim Cambridge: Wiley-VCH (2001).
2. M.A. Shah and T Ahmad, Principles of Nanoscience and Nanotechnology, Narosa, New Dehli
3. N John Dinardo and Weinheim Cambridge, Nanoscale Characterisation of Surfaces & Interfaces, 2nd edition, Wiley-VCH (2000).
4. M.S Rao and Singh, Nanotechnology, Wiley (2012)
5. M.A. Shah and K. A. Shah, Nanotechnology-The Science of Small, Wiley, (2013).

PSPHY EL 03 **ATMOSPHERIC PHYSICS** **C L T P**

4 3 1 0

UNIT I

Plasma fundamentals:

Plasma definition and general properties charge neutrality and collective behavior, Debye length, Plasma Frequency concept of equilibrium, plasma temperature and plasma in nature. Basic plasma processes: Charged particle interactions in plasma, Elastic and inelastic collisions, Cross section and frequencies, diffusion, mobility, Einstein relationship, Ohms law, Excitation, Ionization, Recombination processes, Radiation form plasma. E x B drifts, Grad-B drifts, curvature drift, polarization drift, magnetic moment, Adiabatic invariants, motive force, Diffusion , Plasma Kinetic equation Liouxille equation, Vlasov Equation Landau Damping Electromagnetic waves in magnetized plasma, concept of waves, Dispersion relationship, Phase and group velocity, wave phenomena unmagnified, plasma electromagnetic wave propagation, Hydro magnetic waves, Alfven velocity, cut off and resonance.

UNIT II

Formation of Layers

Introduction, source of ionization, formation of an ionized layer, The ionospheric regions, Distribution of ion in the topside ionosphere, Magnetic field variation and concepts of atmospheric dynamo and motor, Moments in the atmospheric plasma and neutral atmospheric interaction currents in ionosphere, storm time distribution, motion in the upper atmosphere. Production of irregularities in the ionosphere

UNIT III

Magnetosphere

Formation of magnetosphere, Sudden changes in the magnetospheric dimensions, the reconnected magnetosphere, Magnetosphere and ionosphere coupling during sub storms. X-ray radiation of the sun: Introduction to X-Ray emission from active region, energy loss and energy input, evolution of large scale structures, X-ray spectra and flare model, X-ray emission, X-ray emission from solar flare. Theory of whistlers: Magneto-ionic theory, Quasi longitudinal (QL) approximation, dispersion, Ray path, Group ray, Refractive index, theory of trapping ducts, coupling between ionosphere and earth ionosphere Wave guide, earth-ionosphere wave guide propagation Whistler source, identification of one hop and two hop whistler

Text Books

1. J.A Ratcliffe, The magnetoionic theory, Cambridge Univ. Press (1959).
2. A. Nishida, Geomagnetic Diagnosis of Magnetosphere, (1990).
3. R.A Helliwell, Whistlers and related Ionospheric Phenomena, (1965)
4. J.R Winckler, Particle and field in the Magnetosphere, (1970)
5. M. Zeilik and E.V.P Smith: Introductory Astronomy and astrophysics.

PSPHY EL 04 **FIBER OPTICS** **C L T P**

4 3 1 0

UNIT I
Introduction:

Ray Theory, Transmission, Electromagnetic mode theory for optical propagation, Cylindrical fiber, Single-mode fiber. Step-index fibers, Graded-index fibers, Fiber modes, Single-mode fibers, Multimode fibers, Dispersion, Mode coupling, and Loss Mechanics, Glass materials, Fiber fabrication, and Characterization techniques.
Attenuation, Scattering losses, Bending losses, Mid-infrared and far infrared transmission, Dispersion, Dispersion modified single-mode fibers

UNIT II
Optical Fiber Connection:

Introduction, Fiber alignment and joint loss, Fiber splices, Fiber connectors, Expanded-beam connectors, Fiber couplers.Fiber attenuation measurements, Fiber dispersion measurements, Fiber refractive index profile measurements, Fiber numerical aperture measurements, Fiber diameter measurements, Field measurements.

Unit III
Fiber Optic Communication:
Different fiber optic communication generations: some general considerations. Self Phase modulation, Cross phase modulation, Four Wave Mixing, Stimulated Brillouin Scattering, Stimulated Raman Scattering
Semiconductor Optical Amplifiers, Doped Fiber Amplifiers, Raman Amplifiers
Light-emission processes in semiconductors, Light-emitting diodes (LEDs). Semiconductor laser diodes (LDs), Modulation response, Source-fiber coupling.

Text Books

1. G.P. Agarwal, Fiber optic Communication systems, 2nd Ed, John Wiley & Sons, New York(1997).
2. Franz & Jain, Optical Communication Systems, Narosa Publications, New Delhi (1995).
3. G. Keiser, Optical fiber communication systems, McGraw-Hill, New York (2000).
4. Franz & Jain, Optical communication, Systems and components, Narosa Publications, New Delhi (2000).
5. Optical Fiber Communications: *principles and practice*, John M. Senior, Prentice-hall of India.

PSPHY EL 05 **Materials science** **C L T P**

4 3 1 0

UNIT I

Introduction to materials

Classification of materials: Crystalline & amorphous materials, high Tc superconductors, alloys & composites, semiconductors, solar energy materials, luminescent and optoelectronic materials, Polymer, Liquid crystals and quasi crystals, Ceramics. composites

Preparation of materials by different techniques: Single crystal growth, zone refining, epitaxial growth. Melt-spinning and quenching methods, sol-gel, polymer processing. Preparation of ceramic materials; Fabrication, control and growth modes of organic and inorganic thin films: different technique of thin film preparations: Basic principles

Point defect, line defect, plane defect, volume defect, dislocation, stacking faults, application, Burger vectors.

UNIT II

Structure of metals, semiconductors and ceramics

Difference between structures of metals and ceramics, close-packed structures: BCC, FCC & HCP metals. Structure of semiconductors: Si, Ge, ZnS, pyrites, chalcopyrite’s, ZnO etc.; structure of ceramics: metal oxides, nitrides, carbides, borides, ferrites, perovskites, etc.

X-ray energy level schemes, diagram and non-diagram lines, Absorption of X-rays and theory of filters. X-ray scattering: General description of scattering process, coherent and incoherent scattering, total scattering from a spherically symmetric electron cloud, Quantum mechanical treatment of scattering in outline. Perfect crystal theory: Intensity form a small single crystal, Integrated intensity from a small perfect crystal (no deduction), integrated reflection from Mosaic and powder crystal.

UNIT III

Microstructure characterization by direct & indirect methods

Diffraction techniques: interpretation of x-ray powder diffraction patterns, Identification & quantitative estimation of unknown samples by X-ray powder diffraction technique and fluorescent analysis. Theory and method of particle size analysis. Integral breadth method, Warren-Averbach’s Fourier method, profile fitting method, Rietveld Method.

Text Books

1. Materials science and Engineering by V. Raghavan, Prentice-Hall Pvt. Ltd.
2. Thin Solid Films by K. L Chopra.
3. Elements of X-ray diffraction by B. D. Cullity, Addison-Wesley Publishing Co.
4. Elements of crystallography by M. A. Azaroff.
5. Engineering Materials by Kenneth G. Budinski.

PSPHY EL 06 **Semiconductor Physics** **C L T P**

4 3 1 0

UNIT I

SEMICONDUCTOR DEVICES

Semiconducting Materials, Conduction in semiconductor, Charge densities in a semiconductor, powerless diffusion and drift of carries, PN junction, space charge and electric field distribution at junctions forward and reverse biased conditions, carrier in junctions minority and majority carrier currents, Space charge capacitances Zener and avalanche breakdowns, Schottky barrier, zener diodes, varactor diode, tunnel diode, photodiode LED, SCR. Two port network analysis. h, y and z parameters, active circuit models, Bipolar junction Transistor (BJT), Ebers Moll Model, equivalent circuit for BJT in CE configuration, parameters of CE amplifier using h parameters The T -network equivalent circuit, constants of CB and CE amplifier using emitter, base, collector resistance, Field-Effect Transistors (FET), MOSFET, equivalent circuit for FET, FET common source amplifier, source follower.

UNIT II

TRANSISTOR BIASING AND AMPLIFIERS

Biasing technique to BJT, stabilization factor, temperature stabilization, operating point, fixed bias, emitter feedback bias, voltage feedback bias, bias for emitter follower; frequency response, cascade design, phase frequency curves, two-stage CE amplifier, high frequency equivalent circuit, RC coupled FET amplifiers, Mid-frequency parameters frequency response of RC amplifier, gain frequency Bode’s plots, bandwidth of cascaded amplifiers.

UNIT III

FEEDBACK PRINCIPLE

Negative feedback, current and voltage feedback, effect of negative feedback on input/output resistances and voltage gain, gain stabilization, effect of negative feedback on band width, effect on amplifier parameters voltage-series feedback, voltage shunt feedback applied to BJT, current series feedback, feedback in cascaded systems, general principle of analysis. Wave-shaping circuits (Linear and Non-linear), Multivibrators, Flip-Flop circuit, clipping and clamping circuit, Generation of rectangular and saw tooth waves, positive feedback oscillator and phase shift oscillator, Operational amplifier and its applications inverting, non-inverting amplifier, integrator, differentiator, wave form generator & schmitt trigger, OR, AND, NOT, NAND, NOR & XOR gates. Microwaves, Principle of velocity modulation and bunching of electrons, Theory and operation of klystron, magnetron characteristics of microwave diode, cavity resonator.

Text Books

1. John D. Ryder; Electronic Fundamentals and Applications.
2. Millman and Halkins; Electronic Devices and Circuits.
3. Ben G. Streetman; Solid State Electronic Devices.
4. Ramabhadran S.; Electronics.
5. Boylestad & Nasheisky; Electronics Devices and Circuit theory.

PSPHY EL 07 **Quantum Field Theory** **C L T P**

4 3 1 0

UNIT I

Quantum -Mechanics in Phase-Space

Basic properties of the Wigner phase space distribution function, Line Canonical transformations in classical and quantum mechanics, Wave packet spreads in terms of canonical transformation, Minimum uncertain states, Canonical transformations of coherent and squeezed states in tl Wigner phase space, Covariant phase space representation of harmonic oscillators, Representation of Poincare and Homogeneous Lorentz- group using covariant harmonic oscillator formalism.
Klein Gordon, Dirac, Weyl and Majorana Eqns. Plane wave Solutions and observation. Non-relativistic limits of Dirac Eqn. Foly Wouthyer transformation. Canonical quantization of neutral scalar, Charged scalar, spin 1/2 and massive spin-i fields, Pock space and observables. Field commutation, an commutation relations

UNIT II
Interacting Fields and Quantum Electrodynamics

Interaction picture. Normal product. Wick's theorem. Feynman propagat S-matrix. Feynman diagrams for itheory. Quantization of electromagnetic field. Gupta-Bleuler condition. Indefinite metric. Feynman diagrams of QED. Tree level calculations of Moll Bhabha, Compton and Scattering in external field. General Formulation. Conjugate Momentum and Quantization. Neutral Scalar Field. Commutation Relations, Normal Ordering, Bose Symmetry, Fock Space.

UNIT III
Dirac Field:
The Dirac Equation, Relativistic Covariance. Anti-Commutators. Quantization of the Dirac Field, Electrons and Positrons. Connection between Spin and Statistics. Discrete Symmetries, Parity, Charge Conjugation, Time Reversal, CPT Theorem. Gauge Invariance and Gauge Fixing. Quantization of the Electromagnetic Field, Propagator, Vacuum Fluctuations.

Text Books
:

1. Bogolinbov & Shirkov : Introduction to Quantized Field Theory.
2. Bjorken & Drell : Quantum Field Theory.
3. Itzyksen & Zuber : Quantum Field Theory (McGraw Hill).
4. Quantum Field Theory, C. Itzykson and J. B. Zuber, McGraw-Hill Book Co (1985).
5. Quantum Field Theory, L. H. Ryder, Cambridge University Press (2008).

PSPHY EL 08 **Group Theory** **C L T P**

4 3 1 0

Unit-I

Review of basic concepts of finite group theory, permutation group, Cayley's theorem, applications of Cayley's theorem for determining group structures of finite groups of order 3, 4, 5 and 6; Lagrange theorem, its application for finding group structures of order 4, 5 and 6. Quotient group, self conjugate sub groups, Matrix representation, equivalent representation, unitary representation.

Reducible and irreducible representation, characters of irreducible representations, Schur's Lemmas, statement and proof of orthogonality theorem for irreducible representative of a group. Interpretation of orthogonality theorem, orthogonality of characters and character tables. Continuous groups, Lie groups, general properties and examples of Lie groups.

Unit-II

General concept of symmetries, Translation, the operator for translation, Translational invariance, Space reflection, Space reflection operator, Time reversal, Time reversal operator, effect of time reversal on wave function of a single particle and many particle states (Bound systems).The axial rotation group SO(2), Generators of SO(2), 3-dimensional rotation group SO(3), its generators and irreducible representation.

Unit-III

O(4) and SO(4) groups, SO(4) as a direct product of two SO(3) groups, Special unitary group SU(2), its irreducible representation. Homomorphism of SU(2) on SO(3), Generators of U(n) and SU(n), Generators of SU(2), physical applications of SU(2).

Special unitary group SU(3), physical applications of SU(3), Gelman's representation of SU(3) and quarks. Detailed study of Lorentz group, applications of group theory to isotropic harmonic oscillator and Hydrogen atom.

Text and Reference books:

1. Quantum Mechanics/Symmetries (2nd edition), W.Greiner and B.Muller
2. Introduction to group theory, A.W. Joshi
3. Group theory, Hammer Mesh.
4. Group theory and Quantum Mechanics, M. Tinkham
5. Nuclear structure, vol. **1** (Benjamin, New York), A. Bohr and B.R. Mottelson

PSPHY EL 09 **Integrated Electronics** **C L T P**

4 3 1 0

Unit I

Carrier Concentration & Transport

Introduction to electronic materials, Crystal planes (Miller Indices), Crystal structures of Si & GaAs, Band theory of solids, Fermi levels in intrinsic and doped semi-conductors, Degenerate semi-conductors, Derivation of intrinsic carrier concentration, carrier mobility and drift velocity, Resistivity and Conductivity, Hall effect, Diffusion phenomenon, Haynes-Shockley experiment, Einstein's relations, Carrier injection and Direct bandgap, Recombination processes (Direct), Auger recombination, Continuity equation, High field effects.

Unit II

P-N Junction Theory

P-N junction: Thermal equilibrium condition, Depletion region (abrupt and linearly graded junctions), Depletion capacitance: C-V characteristics, Impurity distribution and varactor; I-V characteristics; generation-recombination and high–injection effects, temperature effect, charge storage and transient behaviour; minority carrier storage, diffusion capacitance, junction breakdown: tunneling effect and avalanche multiplication; semiconductor heterojunctions.

Unit III

Photonic Devices and BJTs

Energy momentum relationship, direct and indirect bandgap semiconductors, Transferred electron effect (Gun Diode), Quantum mechanical phenomenon, Tunnel diode, IMPATT Diode, Semiconductor LEDs and LASERs, Photodiodes (Heterojunctions) emission in semiconductors, optical absorption, spontaneous and stimulated emission.

The Transistor action, active mode operation, current gain, Static characteristics, modes of operation (Ebers-Moll Model), I-V characteristics of CB and CE configurations, frequency response of BJTs , basic concepts of HBT and thyristors.

Combinational Logic Circuits:

Review of Boolean Laws and theorems; Logic families; TTL AND, OR, NAND, NOR and NOT gate circuits; Standard forms of Boolean expressions (SOP & POS form) and their implementation; Karnaugh simplification of SOP and POS expressions (up to 5- variables); Don't care conditions; Simplification by Quine McClusky method; Data selector/ multiplexer (4-1, 8-1 & 16-1) ; Encoder (decimal to BCD) and Demultiplexer (1-16) ; Decoder (BCD to decimal); seven segment display.

Text Books:

1. Semiconductor Devices: Physics and Technology; S. M. Sze, John Wiley & Sons.
2. Solid State Electronics Devices: Ben. G. Streetman; Prentice- Hall of India Ltd.
3. Physics of Semiconductor Devices; M Shur; Prentice- Hall of India Ltd.
4. Physics of Semiconductor Devices; S. M. Sze, Wiley Eastern Ltd.
5. Semiconductor Devices & Integrated Electronics; A.B. Milnes; B.S. Publishers & Distributors, New Delhi.

LABORATORIES

PSPHY LB 05 **Computational Physics Lab** **C L T P**

2 0 0 4

1: Programming in C and elementary graphics rendering. Solution of the one-dimensional wave equation with the leapfrog algorithm and visualization.
2: Elements of FORTRAN. Array constructs and operations with arrays.
3: Blurring of an image. Discretized Laplacian. The diffusion equation. Review of the finite and continuum Fourier transform and the fast Fourier transform (FFT).
4: Eigenvectors of the discretized Laplacian. Instability of the algorithm for solving the diffusion equation. Unblurring the image
5: Solution of the equation for the electrostatic potential in presence of conductors. Relaxation algorithms and their relation with a diffusion process. Critical slowing down. Mention of multiscale methods.
6: Solution of the one-dimensional time-dependent Schr□odinger equation by a split operator Formalism and the FFT. Visualization of the evolution. Importance of preserving unitarity.
7: Generation of (pseudo)random numbers. Monte Carlo integration.
8: Monte Carlo simulation of the Ising model. Parallel computing and MPI (message passing interface)

PSPHY LB 06 **Materials Science Laboratory** **C L T P**

2 0 0 4

Materials Science Special Practical Experiments:

1. To study the temperature dependence of Hall coefficient of a given semiconductor.
2. Determination of Band gap of a given semiconductor material by four probe technique.
3. Design/fabrication of a temperature controller and to study the performance of the designed controller using PID Controlled Oven.
4. Determination of Lattice parameters, particles sizes etc. of different powder samples of bulk-/nano-systems (ferrite, α-Fe2O3, γ-Fe_2O_3) using X-ray diffractograms.
5. Determination of Miller indices and lattice parameter of an unknown powder material by x-ray diffraction.
6. Phase identification of an unknown sample by x-ray diffraction.
7. Determination of particle size and lattice strain of an unknown powder specimen applying marq2 software and Scherrer equation.
8. Preparation of nanocrystalline powder specimen by ball milling: analysis of their x-ray spectra and particle size estimation by Scherrer formula.
9. Preparation of nanocrystalline powder specimen by chemical route: analysis of their x-ray spectra and particle size estimation by scherrer formula.
10. Study of porosity and grain size of thin film and powder sample by SEM.

PSPR1 **Research Methodology** **C L T P**

4 3 1 0

UNIT I

Nanofabrication.

Introduction,Top –Down Fabrication methods; Arc Discharge Method, Laser Ablation Method, Ball Milling ,Inert Gas Condensation. Bottom Up Fabrication Methods: Chemical Vapour Deposition ,Sol-Gel Method,Hydrothermal Synthesis, Microwave Method.

UNIT II

Fundamental Tools for Nanoscale Characterization

SPM-Scanning Probe Microscope(fundamental principle and working),AFM-Atomic Force Microscope(fundamental principle and working),SCM-Scanning Electron Microscope(fundamental principle only),TEM-Transmission Electron Microscope(Fundamental Principle and Working).

UNIT III

Properties of Nanomaterials

Mechanical properties, Optical properties, Electrical Properties, Dielectric materials and Properties, Magnetic properties, Supermagnetism, Electrochemical properties and Chemical sensing properties.

Text Books:

1)Nanotechnology –The science of small:M.A.Shah,K.A.Shah.Wiley Publications.
2)Principles of Nanoscience and Nanotechnology-M.A. Shah and Tokeer Ahmad. Narosa Publications.
3) Nanoscience and nanotechnology. Fudamentals to frontiers. M.S. Ramachandra Rao and Shubra Singh, Wiley Publications.

PROJECT WORK

In any National Laboratory

PSPHY PR 01	**C L T P**
	26 0 0 52

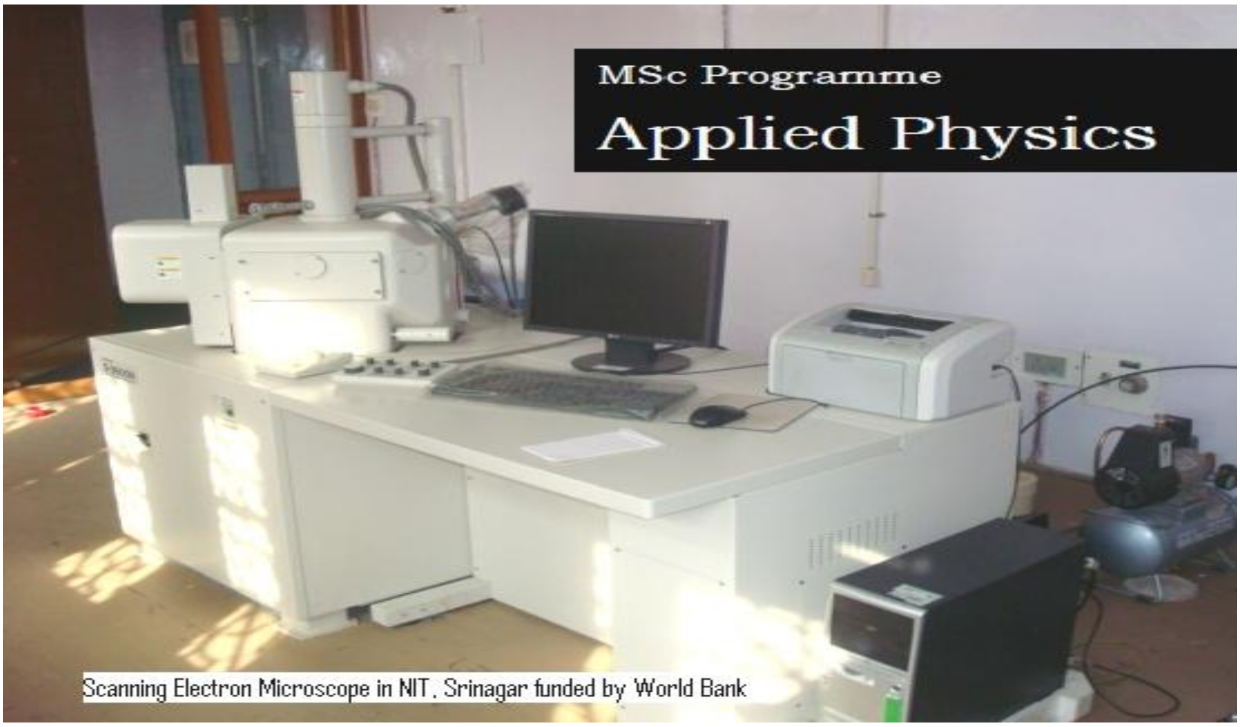
Guidelines for Project in M.Sc. Course:

1. Projects would be allotted to M.Sc. (Previous) students which have to be carried out and completed all Semesters.

2. A list of projects will be finalized and announced by the Department. The students will have an option to select the project in their field of interest.

3. The project will comprise of the following:
   a. Study of background material, Literature review *etc*.
   b. Collection of data, procurement and fabrication of experimental Set up and writing of computer programs, if needed.
   c. Giving a preliminary seminar before the final presentation for the purpose of internal assessment whose weight age would be 25%.
   d. Writing a dissertation or project report. This will be submitted by the M.Sc. (Final) students.

4. The Final evaluation of the project work completed will be examined by external and internal examiners appointed by the Board of Studies on the basis of an oral presentation and the submitted Project-Report. The weight age of the final evaluation would be 75%.



Proposed plan and structure

by

Dr.M.A.Shah

Programme Coordinator

Department of Physics

July, 2014