T.U

Institute of Science and Technology

Master of Science in Physics

M.Sc. Physics

Curriculum

1999

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Kirtipur, *Kathmandu*

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Kathmandu, Nepal

Gunace

Introduction

Master level physics syllabus has been upgraded and updated as per three years B.Sc. physics. The new courses have been designed keeping in view with recent developments in Physics. Availability of additional specialties in new areas and upgraded quality of course will meet the requirement of prospective students. Various elective courses are incorporated in the syllabus and some of the old courses are thoroughly revised.

Objectives

The courses are designed with the following objectives:

1. To give students the up to date knowledge of the fundamentals of Physics.
2. To impart skill to the students in areas of Theoretical and Experimental Physics.
3. To acquaint students with the recent trends in Physics.
4. To develop manpower in teaching physics at the tertiary level and to conduct research in fundamental as well as in application of physics.
5. To produce high level research oriented manpower in physics so that they can be able to cope with high- tech. industry and environment.

Eligibility for Admission:

The candidates who have passed B.Sc. degree with major in Physics from Tribhuvan University or equivalent degree with the same major from Tribhuvan University or a university recognized by Tribhuvan University shall be considered eligible to apply for admission to M.Sc. Physics degree course.

Admission Criteria:

An applicant seeking admission to M.Sc. Physics must appear in an Entrance Examination of two hours' duration conducted by the Central Department of Physics / Campus. The applicant who fails to appear in the Entrance Examination or to obtain a minimum qualifying score will not be given admission. A merit list of the qualified applicants will be prepared by adding the percentage of marks in their B. Sc. Examination with the marks obtained by them in the Entrance Examination. Admission of the students will be based strictly on the merit list and on the enrollment capacity of the Central Department of Physics / Campus.

Course Structure

There will be altogether ten courses, five in each academic year carrying full mark of 100 each. In each theory course, the minimum number of period per week is four and duration of a period is one hour. In the first year, all five papers are compulsory and in the second year, there will be three compulsory papers including practical/project work and two elective papers. A student can choose any two papers from the electives. There will be an option between one of the elective courses and the dissertation. The practical course in the second year is divided into two parts namely general and special. The special practical will be in the form of a small project work (A student who does theoretical dissertation work will have to do experimental project work and vice versa). For practical class, a student has to work five days a week working four hours a day. The remaining one day of the week is set for departmental seminar/discussions.

First year

Course No.	Course title	Full Mark	Pass Mark
Phy 511	**Mathematical Physics**	100	40
Phy 512	Classical and Statistical Mechanics	100	40
Phy 513	Quantum Theory and Spectroscopy	100	40
Phy514	Electromagnetism and Electronics	100	40
Phy 515	Practical (General and Electronics)	100	40

Second Year

Course No.	Compulsory courses	Full Mark	Pass Mark
Phy 621	Quantum Mechanics and Electrodynamics	100	40
Phy 622	Physics of Nuclei, Particles and Solids	100	40
Phy 623	a) General Physics Practical b) Special Practical/ Project work	50 50	20 20
	Elective Courses **(Any Two) including dissertation**	100	40
Phy 624	Solid State Physics		
Phy 625	Condensed Matter Physics		
Phy 626	Microelectronics and Optoelectronics		
Phy 627	Physics of Liquid State, Liquid Crystals and Polymers		
Phy 628	Seismology (Geophysics)		
Phy 629	Atmospheric Physics		
Phy 630	Plasma Physics		
Phy 631	Biomedical Physics		
Phy 632	Gravitation and Cosmology		
Phy 650	Dissertation	100	40

Note: An elective course will be offered subject to the concurrence of the Department. The physics subject committee may also develop new elective courses in future.

Course Duration:
The entire course is spread over two academic years. There is a separate annual examination after the end of each academic year.

Hours of instruction:

a) Working days : 150 days in an academic year.

b) Class hour :

i) Theory: One theory paper of 100 marks will have 4 hours lecture per week.

ii) Practical: One practical paper of 100 marks will have 20 hours of practical per week

c) Attendance : 70 percent attendance in the class is required

Examination

The examinati:on in each course will be a written examination carrying 100 full mark and of 4 hours duration. The number of questions in each paper will be 14, of which ten will be short answer type and four will be long answer type. It is envisaged that at least each unit of the syllabus appears in the question. There will be a choice in the question from within the unit and a choice of around 32% will be given in each paper. The practical examination will be of 6 hours duration.

Evaluation:

Institute of Science and Technology, Tribhuvan University will conduct annual examinations. The students will have to pass each course at each level separately. The minimum pass marks is 40 percent both for theory and practical.

A student having passed his / her two years of study will be graded as below on the basis of the average marks received in the two years:

75 percent and above	Distinction
60 percent and above	First Division
50 percent and above	Second Division
40 percent and above	Third Division

Mathematical Physics

Course No.: Phy 511
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : I

Course description:
The aim of this course is to train students to apply mathematical methods in Physics.

Objectives:
The objective of this course is to provide the students with adequate knowledge and skills of Mathematical physics to study and understand different courses of master's level physics as well as for higher studies, research in physics, and other related fields.

Course Contents:

1. **Vector Analysis:** 1.1 Scalar and Vector fields, Law of transformation of vectors, Polar and axial vectors, Solenoidal vectors, Rotational and Irrotational vectors, Vortex lines., 1.2 Curvilinear co-ordinates: Direction cosines, Scale factors, Curvature of co-ordinate lines, Volume element, Rotation of axes, Contravariant and Covariant vectors., 1.3 Gradient, Divergence, Curl and Laplacian in curvilinear co-ordinates., 1.4 Special orthogonal curvilinear co-ordinates: Cylindrical, Spherical, Ellipsoidal, Hyperbolic and Parabolic co-ordinates.

2. **Tensor Analysis:** 2.1 Contravariant, Covariant and Mixed Tensors, Kronecker delta, Tensors of rank greater than two, Scalars or invariants, Tensor Fields, Symmetric and skew symmetric tensors, Fundamental operations with tensors, Stress tensor, 2.2 Line element and Metric tensor., Reciprocal tensors, Associated tensors, Length of a vector, Angle between vectors, Physical components., 2.3 Christoffel's symbols, Transformation laws of Christoffel's symbols, Geodesics, Covariant derivatives, 2.4 Tensor form of gradient, divergence, curl and Laplacian.

3. **Linear Vector spaces:** 3.1 Vectors in n dimensions, Linear independence, Inner Product, Schwartz inequality., Representation of vectors and linear operators with respect to a basis, Change of basis, Schmidt orthogonalization process., 3.2. Linear operators and their matrix representation: Symmetric, Hermitian,Orthogonal, Unitary (normal) matrices., 3.3. Determination of eigen values and eigen vectors of a matrix, Diagonalization.

4. **Fourier Series and Transforms:** 4.1 Complex Fourier series representation, Even and odd functions, Fourier series expansion of square, triangular, Sawtooth waves and output of full wave rectifier, Dirac delta function, Parseval relation., 4.2. Fourier transform and convolution

theorem., 4.3. Laplace transform, Laplace transform of derivatives and integrals, derivative of Laplace transform., 4.4. Use of Fourrier and Laplace transform in solving partial differential equations.

5. **Differential equations:** Series solution of Bessel's, Legendre's, Hermite's, Laguerre's differential equations. Rodrigue's formula, Recurrence relations, Associated Legendre and Laguerre polynomials, Orthogonality and generating functions.

6. **Partial Differential equations:** Wave equations, Laplace, Poisson and diffusion equations, Boundary value problems, Green's method of solving partial differential equations.

7. **Complex Variable:** 7.1. Functions of a complex variable, single and multivalued functions, Riemann sheets., 7.2. Analytic functions and Cauchy - Riemann conditions., 7.3. Cauchy integral theorem and formula., 7.4, Taylor and Laurent expansions of functions of a complex variable., 7.5. Residue theorem and applications, 7.6. Conformal Transformations.

8. **Numerical Analysis:** 8.1. Interpolation and extrapolation: Approximation of given data by a polynomial, interpolation and extrapolation of data., 8.2. Solution of equation: Polynomial equation, Determination of roots., 8.3. Numerical integration: Trapezoidal, Simpson and Romberg method., 8.4. Matrices: Eigenvalues and eigen vectors. Inverse of square matrix by Gauss-Jordan elimination method., 8.5. Differential equation: Solution of Differential equation by Runge-Kutta method.

9. **Statistics:** 9.1. Probability: Definition, Conditional probability. Dependent and independent events. Probability distributions., 9.2. Data Handling: Histogram, mean, mode, median and standard deviation. Moments, Skewness, Kurtosis., 9.3. Distribution functions: Binomial, Normal and Poisson distributions., 9.4. Curve fitting: Least square fit for straight lines and curves., 9.5. Chi Square test: Observed and Theoretical frequencies, Definition of chi square, Significance tests, Chi square test for goodness of fit. , 9.6. Error analysis:,

Text books:

1. Copson, E.T. - **An introduction to the theory of functions of complex variable,** Oxford Clarendon Press (1935).
2. Matthew, J and Walker, R - **Mathematical methods physics**, Ben Jamin, Menlo Park, (1970).
3. Margenu and Murphy - **Mathematics for physicist and Chemist**, East West press Pvt. Ltd., New Delhi.
4. Spiegel Murray R - **Theory and problems of statistics (Schaum Series).** Mc. Graw Hill, London (1992)
5. Scarborough - **Numerical Analysis**. John Hopkins Press, U. S. A. ,1962
6. Press.M. et al - **Numerical Recipe in C**, Cambridge University Press, or Foundation book, India (1998).

7. Spiegel Murray R - **Vector Analysis, (Schaum Series)**. Mc Graw Hill, London (1992).
8. Morse P. M. and Feshbach H. **Methods of Theoritical Physics, Part I and II**. Mc Graw Hill, New York

Reference:

1. Rajput - **Mathematical physics**. Pragati Prakashan. India (1997).
2. Gupta, B.D. - **Mathematical Physics**, Vikash Publishing House, India, (1994).

Classical and Statistical Mechanics

Course No.: Phy 512 | Full Marks: 100
Nature of the course: Theory | Pass Mark: 40
Year : I

Course description:
The aim of this course is to give students the knowledge of Classical and Statistical Mechanics and to train them to apply knowledge in theoretical methods in physics.

Objectives:
The objective of this course is to provide the students with adequate knowledge of classical and statistical mechanics, and enable them to apply the knowledge for solving various problems in related topics, and also for higher studies and research.

Course Contents:

1. **Constrained motion and Constraints.:** 1.1. Constraints - types of constraints, and force of constraints, 1.2. Generalised Co-ordinates, generalised displacements, generalised velocity, generalised acceleration, generalised momentum, generalised force and generalised potential., 1.3. Degrees of freedom.

2. **Variational principle and Lagrangian formulation.:** 2.1. Calculus of variation, geodesics, surface of revolution, brachistochrone problem., 2.2. Hamilton's principle and derivation of Lagrange's equation. 2.3. Method of Lagrange's undetermined multipliers, 2.4. Conservation Theorems and symmetry principle.

3. **Hamiltonians formulation of mechanics.:** 3.1. Con-figuration space and phase space., 3.2. Hamilton's cannonical equation of motions, 3.3. Legendre's Transformation, 3.4. Conservation Theorem and Physical Significance of the Hamiltonian., 3.5. Derivation of Hamilton's equation of motion from variational principle., 3.6. The principle of least action, 3.7. Cannonical transformation., 3.8. Generating functions, 3.9. Integral invariance of Poincare, 3.10. Lagrange's and Poisson's brackets., 3.11. Equation of motion in Poisson brackets., 3.12. Infinitesimal contact transformation and symmetry properties, 3.13. The angular momentum in Poisson's bracket notation, 3.14. Liouville's theorem.

4. **Hamilton-Jacobi theory.:** 4.1.The Hamilton-Jacobi equation for Hamilton's principal function, 4.2. Hamilton's characteristic function., 4.3. Separation of variables in Hamilton - Jacobi equation, 4.4. Action angle variable., 4.5. Kepler's problem in action angle variables.

5. **Small oscillations.**: 5.1. Formulation of problem. 5.2. The eigen value equation and the principal axis transformation., 5.3. Normal Co-ordinates and normal frequencies.

6. **Rigid bodies-Kinematics and Dynamics.**: 6.1. The Eulerian angles., 6.2. Euler's theorem on the motion of rigid body., 6.3. Infinitesimal rotation., 6.4. Rate of a change of vector. 6.5. The coriolis force., 6.6. Angular momentum and kinetic energy of motion about a point., 6.7. Inertia tensor and the moment of inertia., 6.8. Heavy symmetrical top with one point fixed.

7. **Lagrangian and Hamiltonian formulation for continuous systems and fields.**: 7.1. The linear chain., 7.2. The general variational problem., 7.3. The Hamilton method.

8. **Classical Statistical Mechanics:** 1.1 Postulates of Statistical mechanics., 1.2 Macro and Microstates., 1.3 Phase space., 1.4 Liouville's theorem., 1.5 Micro cannonical ensemble, 1.6 Connection between statistics and thermodynamics., 1.7 Equipartition theorem., 1.8 Classical Ideal gas., 1.9 Gibb's paradox., 1.10 Cannonical ensemble and grand - cannonical ensemble, 1.11 Energy and density fluctuations., 1.12 Equivalence of various ensembles., 1.13 Virial theorem., 1.14 Partition function., 1.15 Derivation of thermodynamic properties., 1.16 Ideal gas, classical harmonic oscillators, magnetic dipoles in magnetic field.

9. **Postulates of quantum statistical mechanics.**: 2.1 Postulates of Quantum Statistical Mechanics., 2.2 Ensembles in Quantum Statistical Mechanics, micro - cannonical, cannonical and grand - cannonical ensemble., 2.3 The density matrix., 2.4 Partition function with examples including (I) an electron in magnetic field (ii) a free particle in a box (iii) a linear harmonic oscillator., 2.5 Symmetric and anti - symmetric wave functions, ensemble of an Ideal Boltzmann, Bose and Fermi gases., 2.6 Derivation of Ideal Fermi - statistics, Bose - Statistics and Boltzmann statistics., 2.7 Grand - partition function of Ideal and Fermi gases, occupation number.

10. **Application of Ideal Bose and Fermi systems.**: 3.1 Thermodynamical behavior of Ideal Bose gas, condensation and Liquid Helium, Black body radiation and Planck's law of radiation., 3.2 Phonons in solid, specific heat of solids., 3.3 Thermodynamical behavior of ideal Fermi gas, statistical equilibrium of white dwarf, Neutron stars.

Text books:

1. Goldstein H. - **Classical Mechanics**, Narosa House, New Delhi (1985).
2. Huang K. - **Statistical Mechanics**, John Wiley (1987).

Reference books:

1. Patharia - **Statistical Mechanics**. Butter Worth Heinemann, New Delhi. India (1996)
2. Kibble T.W.B. - **Classical Mechanics**, ELBS and Mc Graw Hill, London (1970)
3. Takwale, R.G. and Puranik, P.S.- **Introduction to Classical Mechanics,** Tata Mc Graw Hill Pub.Com.Ltd. New Delhi (1979).
4. Mc qarrie. A. - **Statistical Mechanics**, Harper and Row, New York (1973).

Quantum Theory and Spectroscopy

Course No.: Phy 513
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : I

Course description:
This course is developed to extend the concept Quantum Mechanics and Spectroscopy that they learned in their Bachelor level.

Objectives:
The objective of this course is to provide the students with adequate knowledge of non-relativistic quantum mechanics and enable them to apply the knowledge to study the atomic, molecular and other quantum mechanical systems.

Course Contents:

Quantum Theory

1. **Introduction to quantum theory:** History, Schrodinger equation, superposition, uncertainty principle, simple problems.

2. **Postulates of quantum mechanics:** 2.1 Probability density, relation between the probability amplitudes in coordinate and momentum spaces, Operators and expectation values, 2.2 Conservation of total probability, probability current, equation of motion, principle of superposition, interference effect, time independent Schrodinger equation, Dirac notation, orthogonality of eigenfunctions, expansion in terms of eigenfunctions (discrete spectrum), continuous spectrum, simultaneously measurable quantities, uncertainty relation, 2.3 Linear operators, matrix element, integral form of the time independent Schrodinger equation, Hilbert space

3. **One dimensional barriers:** 3.1 Free particle, 3.2 The concept of potential, 3.3 Boundary condition, 3.4 Potential step, 3.5 Square potential barrier, 3.6 Ramsauer Townsend effect, 3.7 Smooth barrier, 3.8 Cold emission of electrons in a metal, 3.9 Alpha decay, 3.10 Virtual binding.

4. **Bound states in one dimension:** 4.1 Bound states, 4.2 Potential box, parity, 4.3 Potential with finite walls, 4.4 Box normalization, 4.5 Double well model of a molecule, 4.6 Kronig - Penney model for metals, 4.7 Linear harmonic oscillator, 4.8 Creation operators, Momentum representation for oscillators, 4.9 Coherent quasi classical states of oscillator, 4.10 Two coupled harmonic oscillators, 4.11 Infinite linear chain of coupled oscillators (phonons)

5. **Motion in three dimensions:** 5.1 Integrals of motion, 5.2 Special functions of eigenvalue problem, 5.3 Particle in a centrally symmetric

field, 5.4 Angular solutions, 5.5 Radial equation, 5.6 Orbital angular momentum, 5.7 Total angular momentum: general properties of spherical harmonics.

6. **Central potential problems:** 6.1 Two interacting particles, 6.2 Rigid rotator, 6.3 Hydrogen atom, 6.4 Free particle radial function, 6.5 Particle in a spherical box, 6.6 Spherical potential well of finite depth, 6.7 Isotropic harmonic oscillator, 6.8 General results for two particles bound states.

7. **Matrix representation:** 7.1 State vector, 7.2 Operators, 7.3 Continuous case, 7.4 Change of representations, 7.5 Eigenvalue problem, 7.6 Different representations, 7.7 Unitary transformations involving time, 7.8 Heisenberg matrix method: Harmonic oscillator.

8. **Spin and magnetic moment:** 8.1 Need for matrix representation of spin, 8.2 Pauli spin matrices, 8.3 Spinors and expectation values, 8.4 Pauli operators, 8.5 Magnetic moment of an electron, 8.6 Precession of an electron in a magnetic field, 8.7 Space inversion time reversal Isospin

9. **Addition of angular momenta:** 9.1 Addition of two spins, 9.2 Addition of two angular momenta: general method, 9.3 Vector operators: Wigner - Eckart theorem, 9.4 Identical particles and symmetry

Spectroscopy

10. **Atomic Spectra:** 1.1 Quantum mechanics of hydrogen atom, 1.2 Hydrogen like spectrum, 1.3 Fine and hyperfine structure, 1.4 Spin orbit interaction in one and two valence electrons, 1.5 Doublet splitting and intensity ratio, 1.6 Doublet, normal and inverted terms, 1.7 Zeeman effect of two valence electrons, 1.8 Paschen Back effect: intensity and polarization rules, 1.9 Different types of coupling, 1.10 Stark effect, 1.11 Width of a spectral line: Natural breadth and collisional broadening

11. **Molecular spectra of diatomic molecules:** 2.1 Structure and theory of pure rotation and pure vibration, 2.2 Anharmonic oscillator, 2.3 Vibration-rotation spectra and electronic spectra, 2.4 Intensity variation of spectra, 2.5 Frank Condon principle, 2.6 Fortrail diagram, 2.7 Vibrational Spectroscopy - IR and Raman spectra

12. **X - ray spectroscopy:** 3.1 X ray spectra, 3.2 Absorption spectra, 3.3 Energy levels, 3.4 Selection and intensity rules, 3.5 Fine structure, 3.5 Regular and Irregular doublet's law, 3.6 Multiple structure, 3.7 Satellites

Text Books:

1. Agrawal, B.K., and Prakash, H. - **Quantum Mechanics**, Prentic Hall of India, New Delhi (1997)
2. Schiff, - **Quantum Mechanics - (3rd ed)**, Tata Mc Graw Hill, India (1968)

3. White, H.E. - **Introduction to Atomic Spectra**, Tata Mc. Graw Hill, India

Reference:

1. Cohen - Tannoudji, C., Dui. B and Laloe, F. - **Quantum Mechanics, Vol 1 and Vol 2**, John Wiley (1977)
2. Merzbacher, E. - **Quantum Mechanics (2nd ed),** John Wiley, New York (1969)
3. Messiah, A. - **Quantum Mechanics**, John Wiley, New York (1963)
4. Thankappan, V.K. - **Quantum Mechanics**, Wiley Eastern Ltd, New Delhi (1993)

Electromagnetism and Electronics

Course No.: Phy 514
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : I

Course description:
This course has two sections: electromagnetism and electronics. The aim of this course is to provide skill and knowledge in the field of electromagnetism and electronics.

Objectives:
The objective of this course is to provide the students with adequate knowledge of electromagnetism and electronics. The course will enable the students to solve various problems in electricity and magnetism. The students will also acquire knowledge of electronics.

Course Contents:

Electromagnetism

1. **Electrostatic field in Vacuum.:** 1.1. The electric field.. 1.2. The divergence and curl of electric field., 1.3 Surface distribution of charges and dipoles., 1.4. Green's theorem., 1.5. Electrostatic potential and potential energy.

2. **Boundary value problems in Electrostatics.:** 2.1. Method of image., 2.2. Point charge in the presence of a (a) grounded conducting sphere. (b) Charged insulated conducting sphere., 2.3. Conducting sphere in a uniform electric field by method of image, 2.4. Green function for the sphere, General solution, for the potential.. 2.5. Conducting sphere with hemisphere at different potentials, 2.6. Boundary Value problems with azimuthal symmetry, 2.7. Boundary value problems in cylindrical coordinates, 2.8. Expansion of Green function in spherical coordinates., 2.9. Expansion of Green function in Cylindrical coordinates.

3. **Multipoles, Electrostatics of macroscopic media, Dielectrics.:** 3.1. Multipole expansion, 3.2. Elementary treatment of electrostatics with ponderable media, 3.3. Boundary value problem with Dielectrics., 3.4. Molecular polarizability and electric susceptibility, 3.5. Models for the molecular polarizability, 3.6. Electrostatic energy in dielectric media.

4. **Magnetostatics.:** 4.1. Biot and Savart low, 4.2. Ampere's law, 4.3. Vector potential, 4.4 Magnetic fields of a localized current distribution, magnetic moment, 4.5. Force and Torque on the energy of a localized Current distribution in an external magnetic induction, 4.6 Macroscopic equations. Boundary conditions on B and H, 4.7 Method of solving boundary-value

problems in magnetostatics., 4.8. Uniformly magnetized sphere., 4.9. Magnetized sphere in an external field, permanent magnets.

5. **Maxwell equations.:** 5.1. Development of Maxwell equations., 5.2. Maxwell's displacement Current., 5.3. Vector and scalar potentials., 5.4. Gauge transformations., 5.5. Green functions for the wave equation., 5.6. Poynting's theorem and conservation of energy and momentum for a system of charged particles and electromagnetic fields., 5.7. Conservation laws for macroscopic media.

6. **Electromagnetic waves and wave propagation.:** 6.1. Plane waves in nonconducting medium., 6.2. Linear and circular polarization., 6.3. Reflection and refraction of electromagnetic waves at a plane interface between dielectrics, 6.4. Total internal reflection, 6.5. Waves in a conductive and dissipative medium., 6.6. Wave-guides.

7. **Introduction to scalar diffraction theory.**

Analog Electronics
Circuit Theory

8. **Network Transformation:** 1.1. Network definition., 1.2. Mesh and node network., 1.3. Principle of Duality., 1.4. Reduction of complicated network., 1.5. Conversion between T and Π sections., 1.6. The bridged T-network., 1.7. The lattice network., 1.8. The reciprocity theorem, 1.9. Brief revision of Thevnin's and Norton's Theorem., 1.10. The compensation theorem., 1.11. The driving Point impedance., 1.12. A.C bridge (Lattice network) Sensitivity in bridge measurement, 1.13. The Parallel - T networks and Network calculation using matrices.

9. **Resonance:** 2.1. Q - factor., 2.2. Series resonance and Band width of the series resonant circuit., 2.3. Parallel resonance circuit or antiresonance. Condition for maximum impedance, Current in antiresonant circuits, and Impedance variation with frequency., 2.4. Band width of antiresonant circuits., 2.5. The general case - resistance present in both branches and antiresonance at all frequencies., 2.6. Reactance curves, Foster's reactance network, and nondissipative network design using Foster's methods.

10. **Semiconductor circuit response and design:**

10.1. **Frequency response:** Definition and basic concepts., Decibels and Logarithmic plots., Series capacitance and low frequency response., Shunt capacitance and high frequency response., Transient response., Low and high frequency response of BJT amplifiers., Low and high frequency response of FET amplifiers

10.2. **Integrated, Differential and operational Amplifier Circuits:** Introduction., The ideal Differential amplifier (BJT and FET)., Common mode Parameters., Practical differential amplifier., Introduction to operational amplifiers and its circuit analysis.

10.3. **Operational amplifier theory:** The ideal operational amplifier. Feedback theory. Frequency response., Slew rate., Offset current and voltages.

10.4. **Application of Operational amplifiers:** Voltage summation. subtraction and scaling., Controlled voltage and current sources., Integration, differentiation and waveshaping., Instrumentation amplifiers., Oscillators (The Bark - hausen criterion. RC phase shift oscillator. Wien - bridge and crystal oscillator). Active filters and its design., Voltage comparators., Clipping. Clamping and rectifying circuits.

10.5. **Power supply and voltage regulators:** Introduction. Rectifiers and different types of filters. Voltage multipliers. Series and shunt voltage regulators., Switching regulators.. Different types Integrated circuit regulator (Three - terminal type and adjustable type)

11. **Digital electronics:**

11.1. **Digital circuit analysis and design:** Introduction., Boolean laws and theorem., Sum of Products method., Truth table to Karnaugh map., Pairs. quads and octates., Karnaugh's simplifications., Don't care conditions. Product of sums method and sums simplification.

11.2. **Data Processing circuits:** Multiplexers.. Demultiplexers 1 of 16 decoder. BCD to decimal decoders and Seven segment decoders., Encoders.. Exclusive OR gates. Parity generators- checkers and read only memory.

11.3. **Numbers, system and codes:** Binary numbers., Conversions of binary number to decimal number and vice versa., Octal numbers and their inter conversion., Hexadecimal numbers and conversion of hexadecimal to binary and vice versa., Different Codes (the ASCII code. the excess-3 code. the Gray code).

11.4. **Arithmetic Circuits:** Binary addition and subtraction. Unsigned binary numbers. Sign- magnitude numbers. 2's compliment representation and its arithmetic. Arithmetic building block. The adder subtracter., Binary multiplication and division.

11.5. **TTL Circuits:** Digital integrated circuits. 7400 Devices., TTL Parameters and TTL overview. gates. Open collector gates. Three state TTL devices. External drive for TTL loads and TTL driving external loads., Positive and negative logic.

11.6. **Flip - Flops:** Rs Flip - Flop (simple and clocked). D - Flip - flop.. Edge. triggered D - Flip - flop. Flip - flop switching time. JK Flip - flop. JK Master slave Flip - flop. Schmitt trigger.

11.7. **Clock and Timers:** Clock Waveforms. TTL Clock. Timer-Astable and Timer monostable. Monostable with impute logic. Contact bounce circuit and some applications.

11.8. **Shift Registers:** Types of registers. (Serial in - serial out. Serial in-Parallel out. parallel in-serial out. Parallel in-Parallel out). Ring counters.

11.9. **Counters:** Asynchronous Counters. Decoding Gates. Synchronous counters, MOD-3 and MOD-5 Counters, Presettable counters. Shift counters and A MOD-10 shift counters with decoding. A digital Clock.

Text Books:

1. Jackson, J.D. - **Classical Electrodynamics**, Wiley Eastern, India (1986)
2. Panofsky, W.K.H. and Philips - **Classical Electricity and Magnetism,** Addison - Wesley Publishing Company, Inc, USA or Indian Book Company, New Delhi (1970).
3. Born, Max and Wolf, E. - **Principle of optics**, Elsevier, Holland (1980)
4. Ryder. J.D. - **Network, Lines and Fields**, Prentice Hall of India (1955)
5. Bogart, T.F. - **Electronic Devices and Circuits**, Universal Book Stall, New Delhi (1995)
6. Malvino, A.P. and Leach, D.P. - **Digital Principles and Application**, Tata Mc Graw Hill Publishing Company, Ltd, New Delhi (1991)

References:

1. Reitz, J.R. and Milford, F.J. - **Foundation of Electromagnetic Theory Addison** - Wesley Publishing Company (1975)
2. Miah M.A. Wazed - **Fundamentals of electromagnetics (3rd eds)**- Tata Mc. Graw Hill Publishing Company Ltd. New Delhi (1982)
3. Malvino A.P. - **Electronic Principles**. Tata Mc Graw Hill Publishing Company, New Delhi (1984)
4. Strangio C.E. - **Digital Electronics: Fundamental Concepts and Application**, Prentice Hall of India Private Ltd.,New Delhi (1984)
5. Ryder, J.D. - **Electronic Fundamental and Application**, Prentice Hall of India Private Ltd, New Delhi (1979)
6. Gibson, J.R. - **Electronic Logic Circuits**, Edward Arnold (1980)
7. Jain R.P. - **Modern Digital Electronics,** Tata Mc. Graw Hill Publishing Company Ltd., New Delhi (1984)
8. Bonenbreak R.L. - **Practical Techniques of Electronic Circuit Design**, John Wiley and Sons (1982)

Physics Practical

Course No.: Phy 515
Nature of the course: Practical

Full Marks: 100
Pass Mark: 40
Year : I

Course description
This course consists of two sections. The first section deals with general laboratory covering experiments on Nuclear physics. Atomic and Molecular physics and Spectroscopy. The second section covers experiments on analog and digital electronics

In the M.Sc physics first year. students have to perform at least 15 general experiments and 15 electronics experiments: They have to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a separate sheet. and to keep them neat and properly filed.

Course objective
- To provide students with skill and knowledge in the experimental methods.
- To make them to be able to apply knowledge to practical applications.
- To make them capable of presenting their results/ conclusion in a logical order.

Course Contents:

General Experiments
1. To study the Fresnel Biprism for the determination of the wavelength of a given monochromatic light and thickness of mica sheet.
2. To study Lloyds's mirror for the determinetim of wavelength of Hg light.
3. To study the working of fine beam tube for the determination of the specific charge of an electron.
4. To study the Michelson Interferometer to determine:
   i) the wavelength of monochromatic light and
   ii) the thickness of the mica sheet
5. To study the formation of fringe pattern by Wedge shape.
6. To study the variation of refractive index with concentration of sugar solutions using a hollow prism.
7. To study the phenomenon of Hysteresis of the magnetic material and to determine the Hysteresis loss of the material over a cycle.
8. To study the absorption of β-particle by the material to estimate the end-Point Energy of the β- particle.
9. To study the absorption of γ-ray by the material of lead to determine its linear absorption coefficient, μ.

10. To determine the half life of the radioactive source.
11. To study the working of CRT (Cathode Ray Tube) for the determination of specific charge of an electron.
12. To study the working of Magnetron for the determination of the specific charge of an electron.
13. To study the Lissajous pattern for the determination of the frequency of a given unknown source.
14. To use the Microwave source for studying the phenomenon of a) Refraction b) Interference c) Diffraction and d) Polarization.
15. To design and study the Series and Parallel LCR circuits for finding the quality factor of the elements.

Electronics

1. To construct CE amplifier for the determination of the voltage gain of the amplifier.
2. To design and construct CC amplifier for estimating input and output impedance.
3. To construct regulated power supply and to study its output input waveforms and to find the ripple factor.
4. To study the characteristics of a Zener diode and use it to construct the power supply.
5. To construct Monostable multivibrator and to study its functioning for the estimation of the repetition frequency.
6. To construct Bistable multivibrator and then study its performance.
7. To construct differential Amplifier and estimate it's CMRR (Common mode rejection ratio).
8. To study operational amplifier for its input - output waveform and use it as an integrator and differentiator.
9. To study the characteristic of a FET and construct it to work as an amplifier.
10. To construct a voltage doubler and study its characteristics.
11. To Construct and to study the characteristics of RS flip- flop
12. To construct and study the working of NOT, AND, OR, NAND and NOR gates.
13. To construct and to study the exclusive OR, NAND and NOR gates.
14. To construct D/A converter and to study its working.
15. To study the working of half adder and full adder.

Quantum Mechanics and Electrodynamics

Course No.: Phy 621 | Full Marks: 100
Nature of the course: Theory | Pass Mark: 40
Year : II

Course description

The aim of the course is to impart some fundamental knowledge of relativistic electrodynamics, and Quantum Mechanics. This is in continuation of the first year course on electromagnetism and Quantum Mechanics is based on the same textbook by Jackson.

Course objective

The objective of the course is to train the student in the methods of classical electrodynamics and Quantum Mechanics. At the completion of the course, the student should be able to solve problems in Electrodynamics and Quantum Mechanics.

Course Contents:

Quantum Mechanics:

1. **WKB approximation:** 1.1 Expansion in powers of h, 1.2 Turning point solutions, 1.3 Validity, 1.4 One dimensional barrier, 1.5 Bound states, 1.6 Radial wave equation, 1.7 Double well levels.

2. **Electron in the electromagnetic field:** 2.1 Maxwell's equations, 2.2 Uniform magnetic field, 2.3 Charged particle in magnetic field, 2.4 Flux Quantization, 2.5 Aharnov Bohm effects.

3. **Stationary Perturbation theory:** 3.1 Perturbation theory, 3.2 Nondegenerate case, 3.3 Simple applications, 3.4 Degenerate case, Simple cases of removal of degeneracy, 3.5 Exchange degeneracy, 3.6 Rayleigh-Ritz Variation Method

4. **Fine and Hyperfine Structures of Hydrogen atom :** 4.1 Mass correction, 4.2 Spin orbit interaction, 4.3 Fine structure of Hydrogen atom in an electric field : Stark effect, 4.4 Hyperfine structure.

5. **Helium atom:** 5.1 Normal Helium atom, 5.2 Excited states, 5.3 Autoionization.

6. **Many electron atom:** 6.1 Central field approximation, 6.2 Thomas- Fermi atom, 6.3 Hartree method of self consistent fields, 6.4 Hartree Fock method, 6.5 Koopmans theorem

7. **Molecules:** 7.1 Born Oppenheimer method, 7.2 H_2^+ ion, 7.3 Hydrogen molecule, 7.4 Main features of bonding, 7.5 Quantum resonance.

8. **Time dependent perturbation:** 8.1 Method of variation of constants, 8.2 Constant perturbation coupling between two discrete States, Fermi golden rule discrete states, 8.3 Periodic perturbation, 8.4 Coupling with a continuum of final states, 8.5 Adiabatic and sudden approximations

9. **Scattering Method of partial waves:** 9.1 Scattering of a wave packet, 9.2 Elastic scatting of plane waves, 9.3 Scattering by a weak potential: Born approximation, 9.4 General finite potentials, 9.5 Square.well potential, 9.6 Coulomb Scattering, 9.7 Screened Coulomb potential

10. **Relativistic single particle theory: Zero spin:** 10.1 Uncertainty principle. 10.2 Klien Gordon equation and its interpretation, 10.3 Charged spin zero free particle. Engenvalues of operators. 10.4 Interaction with electromagnetic field.

11. **Relativistic single particle theory: Half spin:** 11.1 Dirac equation, 11.2 Spin of a Dirac particle, 11.3 Free particle solutions approximate Hamiltonian Solution of central potential problems, negative energy and significance of negative energy states, hydrogen atom

Electrodynamics

1. **Special Relativity:** 1.1 Postulates of relativity, 1.2 Lorentz Transformations, 1.3 Light cone, Proper time, time dilation and Doppler shift, 1.4 Four velocity and momentum, 1.5 Thomas precession, 1.6 Covariance of electromagnetic fields

2. **Relativistic electrodynamics:** 2.1 Lagrangian and Hamiltonian of relativistic charged particle in external Electromagnetic field, 2.2 Motion in uniform static magnetic field and uniform static Electromagnetic field, 2.3 Adiabatic invariance of flux through orbit of particle, 2.4 Lagrangian for electromagnetic field. Stress tensors and Conservation laws, 2.5 Solution of wave equation in covariant form

3. **Scattering:** 3.1 Energy transfer in Coulomb collision, 3.2 Energy transfer to harmonically bound charge, 3.3.Density effects in collision, energy loss, 3.4 Elastic scattering of fast particles by atoms.

4. **Radiation by moving charge:** 4.1 Lienard – Wiechert potentials and Fields for a point charge, 4.2 Total power radiated by an accelerated charge, 4.3 Angular distribution of radiation emitted by an accelerated charge, 4.4 Radiation from extremely relativistic charge, 4.5 Frequency and angular distribution of energy, 4.6 Frequency spectrum of Radiation by relativistic charges in circular motion, 4.7 Thomson scattering, 4.8 Bremsstrahlung in Coulomb collisions

Text Books

1. John David Jackson - **Classical Electrodynamics**, John Wiley and Sons, New York (1975).
2. Panofsky W. K. H. and Phillips M. - **Classical Electricity and Magnetism**, Addison-Wesley, Reading Mas(1962).
3. Agrawal B. K. and Hari Prakash – **Quantum Mechanics**, Prentice Hall of India, New Delhi (1997).

References

1. Cohen Tannoudji, C. Dui B. and Laloe F. - **Quantum Mechanics**, John Wiley, New York (1977).
2. Ghatak A. and Lokanathan S.– **Quantum Mechanics**, Macmillan India Limited.

Physics of Nuclei, Particles and Solids

Course No.: Phy 622
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

This course is divided in to two sections. Section one consist of Nuclear Physics and section two consist of Solid State Physics This course is designed to meet the following objectives.

Course objective:

i) To provide the student with the knowledge of fundamental of Nuclei and particles
ii) To provide students with knowledge of the theory of Solids

Course Contents:

1. **Nuclear forces:** 1.1 Ground state of deuteron, 1.2 Magnetic moment, 1.3 Quadrupole moment tensor, 1.4 Interaction nucleon – nucleon scattering, 1.5 Single and triplet Parameters, 1.6 Charge independence, 1.7 Isospin, 1.8 Meson theory of forces.

2. **Nuclear models:** 2.1 Liquid drop model, 2.2 Nuclear fission, 2.3 Bohr Wheeler theory, 2.4 Shell model, 2.5 Spin orbit coupling, 2.6 Spins of nuclei, 2.7 Magnetic moments.

3. **Nuclear reactions:** 3.1 Cross sections, 3.2 Compound nucleus, 3.3 Scattering matrix, 3.4 Reciprocity theorem, 3.5 Breit Wigner one level formula, 3.6 Resonance scattering, 3.7 Continuum theory, 3.8 Optical model, 3.9 Absorption cross-section at high energies.

4. **Radioactivity:** 4.1 Beta decay – energy spectrum, 4.2 Fermi's theory., 4.3 Fermi Curie plot, 4.3 Fermi and Gamow – Teller selection rules, 4.4 Decay rates-non conservation and selection rules, 4.5 Nuclear isometrics, 4.6 Angular correlation in Successive gamma emissions.

5. **Nuclear reactors:** 5.1 Elementary ideas, 5.2 Neutrino cross sections, 5.3 Fission production and energy release chain reactions, 5.4 Multiplication factors and criticality conditions, 5.5 Uranium reactor, 5.6 Moderator.

6. **Elementary particle physics:** 6.1 Types of interactions between elementary particles, 6.2 Hadrons and leptons, 6.3 Symmetry properties of interactions, 6.4 Continuous and discrete symmetries, 6.5 Conservation laws, 6.6 CPT theorem, 6.7 Classification of hadrons, 6.8 Quark model SU (2), SU(3) multiplets, 6.9 Gellmann Okubo mass formula for octet and decuplet hadrons, 6.10 Phenomenology of weak interactions of hadrons

and leptons. 6.11 Universal Fermi interaction. 6.12 Elementary concepts of V-A theory of weak interactions.

Physics of Solids

1. **Crystal Structure:** 1.1 Translation symmetry. 1.2 Simple lattices. 1.3 Reciprocal lattice. Brillouin zone. 1.4 Crystal diffraction. 1.5 Structure factor. 1.6 Crystal binding: a) Vander Waal's crystals. b) Ionic crystals. c) Metals. d) Covalent crystals. e) Hydrogen bonded crystals . 1.7 Elastic constants and their determination

2. **Lattice Vibration:** 2.1 Vibration of a one dimensional monoatomic chain. 2.2 Vibration of a diatomic linear chain, 2.3 Optic modes in ionic crystals, 2.4 Quantization of elastic waves, 2.5 Phonon momentum, 2.6 Inelastic Scattering by phonons, 2.7 Thermal properties of solid : Density of states in one, two and three dimensions, 2.8 Phonon heat capacity: Debye and Einstein's model, 2.9 Conductivity, 2.10 An harmonic crystal interaction: Thermal expansion.

3. **Electrons in bands:** 3.1 Nearly free electron model, 3.2 Bloch theorem, 3.3 Kronig – Penny model, 3.4 Wave equation of electron in periodic potential, 3.5 Number of orbitals in a band., 3.6 Tight binding approximation, 3.7 Fermi surface, 3.8 Dynamics of electrons and holes. 3.9 Electrons in magnetic field

4. **Semiconductor:** 4.1 Band diagram of semiconductor, 4.2 Intrinsic carrier concentration, 4.3 Impurity conductivity: Thermal ionization of donors and acceptors.

5. **Dielectric properties:** 5.1 Dielectric Constant and polarizability, 5.2 Electronic ionic and orientational polarizabilities, 5.3 Complex dielectric constant and dielectric losses, 5.4 Dielectric losses and relaxation time.

6. **Magnetism:** 6.1 Diamagnetism and Paramagnetism, 6.2 Quantum theory of Diamagnetism of Mononuclear systems, 6.3 Quantum theory of Paramagnetism, rare earth and iron group ions, 6.4 Magnetic ordering, 6.5 Curie point and exchange integral Ferromagnetic domain, Bloch wall, Temperature dependence of magnetization at and near absolute zero magnetization at and near absolute zero, Magnons. Thermal excitation of Magnons, 6.6 Ferromagnetic order; Curie temp susceptibility of Ferrimagnet. 6.7 Antiferrimagnet, susceptibility below the Neel Temperature

Text books

1. Roy and Nigam - **Nuclear Physics: Theory and Experiment**, New age International Private limited, New Delhi 539.7 R812n
2. Marmier and Sheldon- **Physics of Nuclei and Particles, Vol I and Vol II**
3. Kittel C. - **Introduction to Solid State Physics**, John Wiley and Sons, India. ✓

4. N.L.W. Ashkroft and Mermin - **Solid State Physics** , Holt Rinehart and Winston, New York (1976)

References

1. Perskin - **Elementary Particle Physics,** Addison Wesley Publishing Company Inc.
2. Ibach Luth - **Solid State Physics**, Narosa Publishing House, New Delhi
3. Elliot R.J. and Gibson A.F. - **An introduction to Solid State Physics and its application**, ELBS
4. Hall H.E. - **Solid State Physics**, ELBS
5. Walter A. Harrison - **Solid State Theory**, Tata McGraw Hill, India
6. Dekker A.J. - **Solid State Physics**, Macmillan, Student Edition
7. Ziman J.M. - **Principles of Theory of Solids** ,Cambridge University Press
8. Azaroff - **Principle of Solids** ,Tata McGraw Hill, India

Practical and Project work

Course No.: Phy 623 | Full Marks: 100
Nature of the course: Practical | Pass Mark: 40
Year : II

Course objective

- To give students the skill of experimental technique
- To develop students ability to verify theoretical aspect of physics experimentally
- To provide student skill and knowledge of independent thinking to pursue research work.

Course description

The main aim of this course is to provide skill in the experimental technique and strengthen the theoretical basis. It also provides skill to apply knowledge for the practical purposes. The project work included here is to develop student's skill in carrying out research independently

Phy 623 is a practical oriented course offered in the M. Sc. second year physics. It consists of two parts: general practical carrying 50 mark and project work carrying 50 mark or general practical work of full mark 50 and electronics practical of full mark 50. In the general practical laboratory a student will perform experiments covering Practical work on nuclear physics, solid state physics, electronics and atomic and molecular physics. There will be minimum of fifteen general/electronics experiments to be performed by each student. Once the student completes his laboratory work in the allotted period of time, it is expected that he/she clearly states the problem and objective of the experiment, write a brief outline of the procedure, makes a table of data he collects from the experimental work and interpret the results of his/her data. It also is expected that the data is well processed and appropriately error analyzed. The results must be presented in the logical order and concluded in a systematic way. The final write up must clearly be typed wherever possible or neatly written. The external examiner appointed by the university will conduct the final practical examination. The final practical examination of full mark 100 will be of six hours. The marking scheme is as follows.

1.	Note book	-	20%
2.	Oral (Viva)	-	20%
3.	Final examination	-	60%

Course Contents:

List of the Practical

1. To study the absorption of X-ray by the materials.

2. To study the phenomenon of X-ray diffraction to determine the wavelengths of X(X(, X(radiation
3. To study the (-ray spectrum of a radio active source using a single channel analyzer
4. To study the phenomenon of Back- Scattering using a thin radioactive source
5. To study the Hall effect for the determination of Hall Coefficients of N-type and P-type materials.
6. To determine the specific heat capacity of the materials using Calorimetric method.
7. To study the ultrasonic wave through a liquid for the determination of the velocity of ultrasonic wave.
8. To study the thermal expansion of the material for the determination of linear expansion coefficient of the material using interferometric method.
9. To study the functioning of constant deviation spectrometer and hence use it to determine the wavelengths of light sources.
10. To study the Zeeman splitting of spectral line by the applied magnetic field and to determine the ratio of the charge 'e' of an electron to it mass m (e/m).
11. To study the behavior of dielectric constant of liquid mixtures.
12. To study the phenomenon of electron diffraction for the determination of interplaner spacing 'd' of a given crystal
13. To use (-ray spectrometer to analyze energy of a given radioactive source
14. To study the phenomenon of quantization of energy levels using Frank Hertz experiment.
15. To study the current- voltage characteristics of a photocell and hence use photoelectric method to determine the value of Planck's constant
16. To study the paramagnetic and diamagnetic susceptibilities of materials.
17. To study the temperature dependence of resistance of a given Semiconductor.
18. To design, Construct and study the Colpitt's oscillator.
19. To design, Construct and study the pulse amplifier

Project Work

The second part of this course is a project work. In this course, a student can opt for theoretical project work or experimental project work. In either case, a student must demonstrate his ability to carry out either theoretical calculation or experimental technique independently and at the end of his/her work, he/she must produce a write up. The work must be presented orally. The external examiner appointed by the department examines his/her project write up and the department, in an appropriate time, will conduct oral presentation. A marking scheme is as follows.

1.	Project write up	-	10
2.	Oral Presentation	-	10
3.	Final Examination	-	30

Solid State Physics

Course No.: Phy 624
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

This course aims at providing students with basic knowledge and skill in theoretical as experimental aspects of Solid State Physics.

Course objective

- To acquaint student with the theoretical and experimental methods in Solid State Physics.
- To prepare them in developing skill to pursue further study and research in this field of physics

Course Contents:

1. **Transport Phenomena:** 1.1 The Boltzmann transport equation, 1.2 Relaxation time approximation, 1.3 Electrical conductivity, 1.4 Thermal and thermoelectric effects, 1.5 General transport coefficients, 1.6 The Hall effect and magetoresistance, 1.7 Effects in strong magnetic fields

2. **Optical properties:** 2.1 General discussion of interaction of radiation and a solid, 2.2 Penetration of light in a metal, 2.3 Optical conductivity in simple metals, 2.4 Interband absorption, 2.5 Hagen-Rubens relation, 2.6 Optical properties in the infrared

3. **Magnetism and magnetic resonance:** 3.1 Magnetic relaxation and Resonance phenomena, 3.2 The Bloch equations and the complex susceptibility, 3.3 Ferromagnetic resonance, 3.4 Spin waves

4. **Superconductivity:** 4.1 The phenomena of superconductivity, 4.2 Thermodynamic properties, 4.3 Flux exclusion and Meisner effect, 4.4 London equation, 4.5 Coherence length, 4.6 Flux quantization in a super conducting ring, 4.7 Ginzbrg -Landau theory, 4.8 Type I and Type II superconductors, 4.9 Cooper pairs and BCS theory of superconductor, 4.10 Superconducting energy gap, 4.11 Giaever and Josephson tunneling, 4.12 High temperature superconductors, 4.13 Critical fields and critical currents

5. **Imperfection in solids:** 5.1 Classification of imperfection and irregularities in atomic arrays, 5.2 Phonon, Vacancies and Interstitial atoms, 5.3 Foreign atoms, 5.4 Dislocations and crystal growth

6. **Semiconductors:** 6.1 General properties of semiconductor, 6.2 Carrier statistics in thermal equilibrium, 6.3 Intrinsic and extrinsic

semiconductors, 6.4 Thermal equilibrium carrier density of impurity semiconductors, 6.5 Mobility of charge carriers, 6.6 Effects in magnetic fields, 6.7 Thermoelectric effects, 6.8 Excess carriers in semiconductors, 6.9 Transport behaviour of excess carriers

Text books

1. J.M. Ziman – **Principles of theory of Solids**, Cambridge University Press, London.
2. J.M. Ziman – **Electrons and Phonons**, Clarendron Press, Oxford

References:

3. Ashcroft N.W., Mermin N.D. - **Solid State Physics**, Holt, Rinehart and Winston, New York, 1976.
4. Callaway J. - **Quantum theory of Solid State, Volume I & Volume II** Academic press, New York & London, 1974.
5. Animalu A.O.E. - **Intermediate Quantum theory of Crystalline Solids**, PrenticeHall of India,New Delhi, 1978.
6. Christman J.R. - **Fundamentals of Solid State Physics**, John Wiley & Sons, New York, 1988.
7. Kittel C. - **Quantum theory of solids**, John Wiley & Sons, New York, 1967.
8. Seitz F. and Turnbull D. - **Solid State Physics, Advances in Research and Applications** (complete set), Academic Press, New York.
9. **Springer Series in Solid State Science**, (complete set), Springer Verlag, Berlin,
10. Harrison W.A - **Solid State Theory,** Tata McGraw Hill, India.

Condensed Matter Physics

Course No.: Phy 625
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

The main aim of this course is to provide the knowledge of physics of Condensed Matter and to prepare student for the higher studies and research in this field. The course is designed with the following objectives.

Course objectives

- To provide students with basic theoretical knowledge in this field
- To prepare students for research work

Course Contents:

1. **Mean field theory:** 1.1 Symmetry and ordered parameters, 1.2 Landau theory, 1.3 Bragg- William theory, 1.4 The Ising model, 1.5 The liquid – gas transition, 1.6 The liquid – solid transition, 1.7 Variational mean field theory

2. **Scaling and Renormalization:** 2.1 Critical exponent, 2.2 Scaling, 2.3 Renormalization group, 2.4 Fixed point

3. **The behaviour of electron systems:** 3.1 Fermi liquid theory, 3.2 Dielectric function and plasmons, 3.3 Long-distance impurity effect in metals, 3.4 Hubbard and Anderson models

4. **Electron Correlation:** 4.1 Correlation energy, 4.2 Electron – hole droplets, 1.3 Heavy fermions system

5. **Two dimensional and Quasi one dimensional systems:** 5.1 Realization of two dimensional electron systems, 5.2 Phase transitions in two dimensional electron system, 5.3 Squeezing two dimensional systems, 5.4 One dimensional conductors

6. **Hopping and Localization:** 6.1 Hopping conduction, 6.2 Anderson localization, 6.3 Weak localization, 6.4 Spin glasses

7. **Superconductivity and Superfluidity:** 7.1 Low Tc Superconductivity, 7.2 B.C.S. Theory, 7.3 High Tc Superconductivity, 7.4 Superfluidity of liquid ^{4}He, 7.5 Energy dispersion and vortex motion, 7.6 Sound in liquid Helium, 7.7 Superfluidity of ^{3}He, 7.8 Spin dynamics and vortices, 7.9 Solid ^{3}He

Text Books

1. Chaikin P.M. and lubensky T.C. – **Principles of Condensed Matter Physics**, Foundation Books, New Delhi 1998.
2. Isihara A. - **Condensed Matter Physics**, Oxford University Press, New York, 1991.

References

1. M. Toda, R Kubo and N. Saito - **Statistical Physics I**, Springer Verlag, Berlin, 1983

Microelectronics and Optoelectronics

Course No.: Phy 626 | Full Marks: 100

Nature of the course: Theory | Pass Mark: 40

Year : II

Course description

This course contains two sections. The first section deals with Microelectronics and second section deals with Optoelectronics. The course is designed to fulfil the following objectives

Course objective

- To give the adequate knowledge in designing digital electronics circuits
- To give the principle of architecture of the microprocessor and its application
- To introduce the Optoelectronics theory and devices together with their application in modern communication system.

Course Contents:

1. **Integrated circuit Fabrication and Design:** 1.1 Monolithic Integrated circuit Technology, 1.2 Fabrication of Bipolar transistor, FET, IC Diodes, Metal-semiconductor contacts, IC resistors, Capacitors and inductors, 1.3 Logic Gate Characteristics, 1.4 NMOS Logic Gates, 1.5 CMOS Logic Gates, 1.6 BJT Inverters, 1.7 TTL Logic gates, 1.8 TTL output stages, 1.9 Emitter coupled Logic Circuits, 1.10 Comparison of Logic Families

2. **Signal Processing and Data Conversion:** 2.1 Signal and signal processing, 2.2 Sample – and hold system, 2.3 Analog Multiplexer and demultiplexer, 2.4 D/A Converters, 2.5 A/D Converters

3. **Combinational Digital Circuits:** 3.1 Standard gate Assemblies, 3.2 Binary adders, 3.3 Arithmetic functions, 3.4 Decoder – Demultiplexers, 3.5 Data selector Multiplexers, 3.6 Encoder, 3.7 Read only Memory (ROM), 3.8 Programable logic arrays

4. **Very large scale integrated system:** 4.1 Dynamic MOS shift registers, 4.2 CMOS Domino LOGIC, 4.3 Random Access Memory (RAM), 4.4 Read write memory cells

5. **Microprocessor system:** 5.1 Introduction, 5.2 Central Processing Unit (CPU), 5.3 Arithmetic logic Unit (ALU), 5.4 General Purpose Registers, 5.5 Control Registers, 5.6 Instruction Registers and Decoder, 5.7 Timing and control unit, 5.8 Read and write, 5.9 Architecture and organization of 8085 microprocessor

Optoelectronics

6. **Optical Fiber waveguides:** 6.1 Introduction, 6.2 Optical Fiber waveguides, 6.3 Losses in Fibers, 6.4 Fiber Joining, 6.4 Measurement of Fiber characteristics, 6.5 Fiber materials and Fiber cables

7. **Optical communication system:** 7.1 Modulation schemes, 7.2 Free space communication, 7.3 Fiber optical communication systems, 7.4 Operating wavelength, 7.5 Emitter characteristics and emitter design, 7.6 Detector characteristics and Detector design, 7.7 Choice of Fibers, 7.8 System design consideration, 7.9 Local area network, 7.10 Future development

Text Books

1. Millman J., Grabel A. - **Microelectronics**, McGraw Hill International edition.
2. Wilson J., Hawkes J.F.B. - **Optoelectronics**, Prentice Hall, India.

References

3. Wakherly J.F. - **Digital Design, Principles and Practices, 2nd edition,** Prentice Hall International edition, 1994
4. Franco S. - **Design with Operational Amplifier and Analog Integrated Circuit**, McGraw Hill Book Company, 1988
5. Yu- Cheng Liu and Gibson G.A. - **Microcomputer Systems, the 8086/8088 Family,** Printice Hall of India.

Physics of Liquid State, Liquid crystals and Polymers

Course No.: Phy 627 Full Marks: 100
Nature of the course: Theory Pass Mark: 40
Year : II

Course description
This course is divided into two sections, one deals with the physics of liquid state and the other deals with the physics of liquid crystals and polymers. This course is designed to meet the following objectives

Course objective

- To introduce the Statistical theory of liquids and liquid metals
- To provide the knowledge of liquid crystals
- To provide the knowledge of polymers, polymer synthesis, its characterization and some physical properties.

Course Contents:

1. **General Properties of Liquids:** 1.1 Introduction, 1.2 Methods of studying the liquid states, 1.3 Molecular distribution functions, 1.4 Cluster and virial expansion of the equation of state

2. **Non-conducting Liquids and Liquid metals:** 2.1 Pair potential function for non-conducting liquids, 2.2 Dipolar attraction and repulsive terms, 2.3 Atom – Atom Scattering experiments, 2.4 Evaluation of the constants of the model potential, 2.4 Idealized model for metals, 2.6 The effective inter - atomic potential and pair potential in a metals, 2.8 Resistivity of liquid metals

3. **Relation Between Pair Distribution Function and Pair Potential Function:** 3.1 The Yvon-Born-Green equation, 3.2 Hypernated chain (H-C) equation, 3.3 The Percus Yevick (P-Y) equation, 3.4 Cluster expansion, 3.5 Solution of PY equation for hard spheres, 3.6 Cell theory and Pair distribution function, 3.7 Relationship between g (r) and u (r)

4. **Measurements of the Pair Distribution Functjon and Equilibrium Properties:** 4.1 Measurement of pair distribution functions by neutron, X-ray and electron scattering methods, 4.2 Determination of Structure factors, 4.3 The equation state for dilute gas, P-Y hard sphere fluid, 4.4 Calculation of pressure, energy and specific heat for a liquid

5. **Space and Time Dependent Correlation Function:** 5.1 The Van- Hove distribution function, 5.2 The measurement of dynamic correlation function by neutron and by X-ray scattering, 5.3 Structure factor, 5.4 Relation between Macroscopic properties and structure factors

6. **Long Period and Short Period Modes of Single Particle Motion;** 6.1Einstein's random Walk theory, 6.2 Langevin equation for Brownian motion, 6.3 Velocity Correlation function, 6.4 Relation between velocity Correlation function and diffusion constant, 6.5 Velocity Correlation function for Brownian motion

7. **Liquid Crystals:** 7.1 The nematic mesophase, 7.2 Cholesteric liquid crystal, 7.3 Smetic liquid crystal, 7.4 The Smetic A – nematic isotropic phase transition, 7.5 The Smetic – C and Smetic A transition

8. **Synthesis of Polymers:** 8.1 Basic definition, nomenclature and classification of polymers, 8.2 Molar mass and degree of polymerization, 8.3 Synthesis of Polymers : Condensation polymerization, : Addition polymerization, 8.4 Ionic polymerization and copolymerization, 8.5 Stereoregular polymerization

9. **Characterization and Structure of Polymers:** 9.1 Macromolecules in Solution, 9.2 Flory – Huggin's theory, 9.3 Number average molar mass, 9.4 Light Scattering, 9.5 Transport measurement, 9.6 Spectroscopic analysis of polymers, 9.7 Crystalline, semi-crystalline and amorphous polymers, 9.8 Crystallization and melting

10. **Mechanical Properties:** 10.1 Viscoelasticity and Rubber elasticity, 10.2 Yield in polymer, 10.3 Deformation mechanism, 10.4 Fracture

Text books

1. Egelstaff P.A. - **An Introduction to the Liquid State**, Academic Press, London, 1967.
2. Young R.J. - **Introduction to Polymer**, Chapman and Hall, London, 1989.

References

3. Hansen J.P and McDonald I.R. - **Theory of Simple Liquids**, Academic Press, London, 1986.
4. Croxton A. - **Introduction to Liquid State Physics**, John Wiley and Sons, New York, 1975.
5. Chandrashekhar S. - **Liquid Crystal**, Cambridge University Press, London 1977.
6. McQuarrie D.A. - **Statistical Mechanics**, Harper and Row Publishers, New York, 1976.
7. Rice S.A. and Gray P. - **The Statistical Mechanics of Simple Liquids**, Wiley Interscience, New York.
8. Perepechko I.I. - **An Introduction to Polymer Physics**, Mir Publisher, Moscow, 1981.
9. Rodriguez F. - **Principles of Polymer Systems**, Tata McGraw Hill, New Delhi, 1970.
10. Utraki L.A. - **Polymer blend and alloys**, Hanser, New York, 1990.

11. Cheremisinoff N.P (Eds) – **Handbook in Polymer Science and Technology**. (Complete set). Marcel Dekker. New York.
12. Paul D.R. and Newman S.– **Polymer blends, Vol. 1**. Academic Press. New York. 1978.
13. Olabisi O., Robeson L.M. and Shaw M.T. - **Polymer- Polymer Miscibility**. Academic Press New York, 1988.
14. Billmeyer F. W. - **Textbook of Polymer Science**. John Wiley and Sons (Asia) Pt. Ltd. (1994).
15. Eisele U. - **Introduction to Polymer Physics**. Springer-Verlag. Berlin (1990).

Seismology

Course No.: Phy 628
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

This course consists of various topics starting from the theory of elasticity. It explains how the elastic waves are being generated and propagated. Ray theory approach will also be dealt with. The boundary value problems for the potential in the layer boundary will be solved. Various types of waves propagated inside the earth as a result of earthquake have been discussed. Moreover, important earthquake parameters will be discussed in order to focus on the seismic hazard and risk with special reference to Nepal.

Course objective

The main objective of the course is to make the student familiar in the field of earthquake Seismology. On completion of this course, one will be able to understand the theoretical basis of seismology. The course gives insight on the seismic studies in Nepal.

Course Contents:

1. **Elasticity theory :** 1.1 Analysis of stress and strain, 1.2 The equation of conservation, 1.3 Stress strain relation for a perfectly elastic isotropic material, 1.3 Equation of motion in terms of displacement, 1.4 Energy in a perfectly elastic body, 1.5 Theorems on elastic equilibrium, 1.6 Departures from perfect elasticity due to time effects : Kelvin-voigt model, Maxwell model

2. **Vibration and waves:** 2.1 Vibrations of systems with one degree of freedom, 2.2 Vibration of systems with more than one degree of freedom, 2.3 Fourier analysis of plane waves, 2.4 Polarisation and dispersion of waves, 2.5 Energy in plane wave motion, 2.6 Two dimensional wave motion, 2.7 Scattering and Diffraction, 2.8 Energy in plane wave motion

3. **Body elastic waves:** 3.1 P and S waves, 3.2 Inclusion of the seismic source in infinite media: Spherical source, Green function, representation for point sources, Reciprocity theorem, 3.3 Form of ground motion in an earthquake, 3.4 The effect of gravity fluctuations, 3.5 The effects of elastic imperfections , 3.6 Linear models and Jeffrey's power law, 3.7 Damping of harmonic waves, the quality factor Q

4. **Surface elastic waves and eigen vibrations of a sphere:** 4.1 Waves guided along a plane boundary, 4..2 Rayleigh waves, Stonley waves, Love waves, 4.3 Surface waves in the presence of multiple layers and sources, 4.4 General idea about normal oscillations of an elastic sphere, 4.5 Seismic waves in a linear viscoelastic media

5. **Reflection and Refraction of elastic waves:** 5.1 Laws of reflection and refraction, 5.2 General equation for the two media, 5.3 Special cases: Case of incident SH waves, P wave incident against a free plane boundary, SV wave incident against the free plane boundary, 5.4 Curved boundaries and head waves, 5.5 Scattered seismic waves.

6. **Seismic rays in a spherically stratified earth model;** 6.1 The parameter p of a seismic ray, 6.2 Rays in inhomogeneous media, the eikonal equation, 6.3 Relations between p, (, T for a given family of rays, 6.4 Special velocity distribution; curvature of a seismic ray, rays in a homogenous medium, circular rays, Mohorovicic's law, 6.5 Theory of travel times in near earthquakes.

7. **Amplitudes of the surface motion due to seismic waves in a spherically stratified earth model:** 7.1 Energy per unit area of wavefront in an emerging wave and the relation between energy and amplitude, 7.2 Movements of the surface due to an incident wave: amplitude as a function of (, 7.3 Loss of energy during transmission through the medium: gradual variation in properties, single discontinuity, 7.4 Amplitude corresponding to cusps in (T, ( ) curves, 7.5 Amplitude of surface seismic waves

8. **Seismometry: 8.1** Simple seismographs: horizontal component and vertical component seismographs, 8.2 The indicator equation, 8.3 Damping of seismographs, 8.4 Solution of the indicator equation for: simple harmonic ground motion, impulsive ground motion and general ground motion, 8.5 Displacement and velocity meters and accelerometers, 8.6 The dynamic ranges of seismic ground motion, 8.7 Modern seismographs : The electromagnetic type, short period, long period and broad band instruments, strong motion accelerometers, 8.8 Portable seismographs, Telemetry

9. **Construction of travel time table:** 9.1 Calculation of parameters of earthquake location epicentral distance, azimuth and focal depths, 9.2 Tomography, 9.3 Travel time tables, 9.4 Notation used for phases read on seismograms, 9.5 Travel time tables for body waves and surface waves, 9.6 The Jefferys-Bullen, 9.7 Seismological tables, 9.8 Tables for PKP, 9.9 Interpretation of seismograms: determination of hypocenters and earthquake size, 9.10 Major discontinuities within the earth: existence of a crust, existence of a central core, discontinuities in the mantle, discontinuities in the central core, division of the earth's interior into shells.

10. **Earthquake statistics and prediction:** 10.1 Energy released in earthquakes, 10.2 Earthquake magnitude, 10.3 Magnitude and energy and magnitude- frequency of occurrence relation, 10.4 Seismicity : foreshocks and aftershocks, 10.5 Earthquake prediction

11. **The earthquake source;** 11.1 Elastic rebound model: causes of earthquakes, strain energy before an earthquake, faults and fracture, 11.2 Double couple model, 11.3 Source mechanism estimation, 11.4 Moving dislocation source, 11.5 Kinematics and dynamics, near field and far field, 11.6 Radiation patterns and directivity, 11.6 Synthetic seismograms : seismic moment, moment tensor

12. **Strong motion seismology;** 12.1 Effects of earthquakes: intensity of earthquake effects, 12.2 Isoseismal curves and acceleration, 12.3 Fault rupture correlation, 12.4 Near field parameters, 12.5 Peak ground accelerations, velocity and displacement, 12.6 Attenuation

13. **Seismicity of the Himalayas and Himalayan tectonics:** 13.1 Seismicity of the Himalayas : Himalayan tectonics, plate tectonics view, 13.2 Seismicity of the Nepal Himalaya, 13.3 Major earthquakes in the Himalayas and in Nepal, 13.4 Seismic Network in Nepal

14. **Earthquake Hazard and Risk:** 14.1 Earthquake hazards and risks, 14.2 Mitigation of earthquake risk, 14.3 Seismic zoning and microzoning, 14.4 Earthquake resistant design

Text books

1. Bullen K. E. and Bolt B.A. - **An introduction to the theory of seismology,** Cambridge University Press

References

2. Richter C.F. - **Elementary Seismology** , Narosa publishing house, India.
3. Aki K. and Richards P.G. - **Quantitative Seismology**, W.H. Freeman and Company, New York.
4. Officer C.B. - **Introduction to theoretical Geophysics,** Springer – Verlag, Berlin.
5. Stacey F.D. - **Physics of the Earth**, John Wiley and Sons, New York.

Atmospheric Physics

Course No.: Phy 629
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

The main aim of this course is to provide basic knowledge of the atmosphere. It is an elective paper meant for students who are interested to pursue higher study in the field of atmospheric physics. This course is offered to students to provide them with solid foundation in this particular field

Courses objective

- To provide knowledge in the field of atmospheric physics
- To provide students with adequate knowledge and skill to pursue further study in the area of atmospheric physics.

Course Contents:

1. **The atmosphere:** 1.1 Atmospheric Compositions, 1.2 Temperature profile, 1.3 Barometric law, 1.4 Atmospheric thermodynamics, 1.5 Transport of atmospheric masses, 1.6 Green House effect

2. **The sun:** 2.1 Sun as a source of energy, 2.2 Solar constant and its determination, 2.3 Solar radiation outside the terrestrial atmosphere

3. **Absorption and scattering of solar radiation:** 3.1 Photo chemical Processes, 3.2 Formation of ionospheric layers, 3.3 D,E,F_1,F_2 and sporadic E layers, 3.4 Absorption of visible and infrared radiation, 3.5 Solar heating rates, 3.6 Representation of polarized light and Stokes parameters, 3.7 Rayleigh scattering, 3.8 Mie scattering

4. **Atmospheric Ozone:** 4.1 Absorption of UV – radiation, 4.2 Formation of ozonosphere, 4.3 Tropospheric and stratospheric ozone layers and its measurement, 4.4 Ozone depletion, 4.5 Biological and Chemical effects of Ozone, 4.6 Protection of ozone layer, 4.7 Measurement of UV-B radiation on the earth's surface, 4.8 Surface level ozone, 4.9 Total ozone concentration and its measurement

5. **Infrared radiation transfer in the atmosphere:** 5.1 The thermal infrared spectrum and atmospheric effect, 5.2 Characteristic of infrared absorption spectra of atmospheric gases, 5.3 Infrared transfer by plane-parallel atmospheres, 5.4 Transmission function and band models, 5.5 Curtis-Godson approximation for inhomogeneous atmosphere, 5.6 Infrared cooling rates, 5.7 Infrared flux in terms of Stefan-Boltzmann law, 5.8 Carbon Dioxide and Climate

6. **Light scattering by particulates in the atmosphere:** 6.1 Electromagnetic wave and its solution, 6.2 Formal scattering solution, 6.3 Far field solution, 6.4 Extinction parameters, 6.5 Scattering phase matrix, 6.6 Ray optics, 6.7 Light scattering by non-spherical particles

7. **Multiple scattering in plane-parallel atmosphere:** 7.1 Scattering of sunlight in plane-parallel atmosphere, 7.2 Approximations for radiative transfer, 7.3 Discrete-ordinates method for radiative transfer, 7.4 Principles of invariance, 7.5 Surface reflection, 7.6 Adding method for multiple scattering, 7.7 Multiple Scattering including polarization, 7.8 Multiple Scattering by non-spherical particles, 7.9 Equations for multiple scattering in three- dimensional-spaces

8. **Application of radiative transfer:** 8.1 Scattering sunlight as means of remote sensing, 8.2 Infrared sensing from satellites, 8.3 Microwave sensing from satellites, 8.4 Radar Back scattering

9. **Radiation Measurements:** 9.1 Thermal detectors, 9.2 Quantum detectors, 9.3 Radiation scales, 9.4 Pyrheliometers, 9.5 Pyranometers, 9.6 Pyradiometers and pyrgeometers, 9.7 Photospectrometers, 9.8 Nephelometer

10. **Data Processing:** 10.1 Quality control and validation, 10.2 Missing data, 10.2 Data Archive, 10.3 Statistics and Graphs

Text Books

1. Goody R.M., walker C.G. - **Atmosphere** Prentic Hall Inc, (1972)
2. Liou K.N. - **An Introduction to Atmospheric Radiation**. Academic Press Inc. New York (1980)
3. Ratcliffe J.A. - **An Introduction to the Ionosphere and Magnetosphere**, Cambridge University Press (1972)
4. Chandrasekhar S. - **Radiative Transfer** , Oxford Press (1960)
5. Ilyas M. - **Ozone Depletion**. University of Science, Malaysia, Penang, Malaysia
6. Fro hlich C. and London J. - **Instruction Manual on Radiation Instruments and Measurements**, Pergmon Press (1986)

Plasma Physics

Course No.: Phy 630
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description

The main aim of this course is to provide basic working knowledge of plasma physics and develop skill in pursuing research work in fusion energy application.

Course objectives

The objective of this course is to apply the knowledge and to lay the foundation on the fundamental study/ research in plasma physics.

Course Contents:

1. **Introduction:** 1.1 Plasma and its applications, 1.2 Concept of plasma temperature, 1.3 Debye shielding

2. **Single Particle motions:** 2.1 Single particle motion in gravitation field, and in uniform and non – uniform time varying electric and magnetic fields, 2.2 Drifts, 2.3 Adiabatic invariants

3. **Plasmas as fluids:** 3.1 Fluid equation of motion, convective derivatives, stress tensor, collision, equation of continuity, equation of state, complete set of fluid equations, 3.2 Fluid drifts, 3.3 Plasma approximations

4. **Waves in plasma:** 4.1 Plasma oscillations, 4.2 Electron and ion plasma waves in electrostatic and electromagnetic fields: Alfven waves, magnetosonic waves, hybrid frequency modes, whistler, 4.3 Faraday rotation, 4.4 Validity of plasma approximation

5. **Diffusion and resistivity;** 5.1 Diffusion and mobility in weakly ionized gases, collision and diffusion parameters, 5.2 Decay of plasma by diffusion in slab and cylinder, 5.3 Steady state solution with plane and line sources, 5.4 Recombination, 5.5 Coulomb collision, resistivity, 5.6 Single fluid MHD equation, 5.7 Diffusion in fully ionised plasma and its solutions : Bohm and Neo classical diffusion

6. **Equilibrium and stability:** 6.1 Hydromagnetic equilibrium, concept of (, 6.2 Diffusion of magnetic field into a plasma, 6.3 Classification of instabilities, two-stream instability, gravitational instability, 6.4 Resistive drift waves

7. **Kinetic Theory:** 7.1 Velocity distribution function and the Boltzmann equation, Vlasov equation and Fokker- planck equation, 7.2 Derivation of

the fluid equations. 7.3 Plasma oscillations and Landau damping : BGK and Van Kampen modes

8. **Nonlinear effects:** 8.1 Sheaths and related equations. Bohm sheath criterion. 8.2 Child- Langmuir law. 8.3 Ion acoustic shock waves. 8.4 Sagdeev potential. 8.5 Critical Mach number and wave steepening. 8.6 Parametric instabilities. instability threshold. plasma echos. Landau nonlinear damping

9. **Confinement of plasma for energy applications:** 9.1 Importance of confinement. Lawson criterion. 9.2 Magnetic confinement fusion. Tokamak. 9.3 Inertial confinement fusion. laser energy deposition. transport of energy in the corona. magnetic field generation in corona. compression. 9.4 Problems and prospects of controlled fusion.

Text books

1. Chen F.F. - **Introduction to Plasma Physics**, Plenum Publishing Co. New York. 1974.
2. Chakraborty B. - **Principles of Plasma Mechanics**. Wiley Eastern. New Delhi.1990.

References

3. Krall N.A. and Trivelpicec A.W. - **Principles of Plasma Physics**. Plenum Publishing Co. New York, 1974.
4. Duderstadt J.J. and Moses G.A. - **Inertial Confinement Fusion**. John Wiley and Sons. 1982.

Biomedical Physics

Course No.: Phy 631
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description
This course is aimed at giving fundamental knowledge in the field of Biophysics and Medical Physics. The first section deals with Biophysics and the second section with Medical Physics.

Course objective
The objective of this course is to train students in the fields of
i) Bio- physics and
ii) Medical physics

Course Contents:

Biophysics

1. **Physics of Macromolecules;** 1.1 Physics and Biology, 1.2 Scope and Methods of Biophysics, 1.3 The Macromolecule as a cooperative system, 1.4 Atomic and molecular forces, 1.5 Bond energies, 1.6 Dipole – Dipole interactions, 1.7 Behavior of macro molecule

2. **Physics of Protein:** 2.1 Conformation of polypeptide chains, 2.2 The Hydrogen Bond, 2.3 Helix coil transition, 2.4 Structure and stability of the Globule, 2.5 Antigens and Antibodies.

3. **Physics of Enzyme;** 3.1 Chemical Kinetics and catalysis, 3.2 Conformational properties of enzymes, 3.3 Enzyme-substrate interactions, 3.4 Myoglobin and Hemoglobin.

4. **Physics of Nucleic Acid:** 4.1 Structure of Nucleic Acid, 4.2 Interaction of Double Helix with small molecules, 4.3 Replication of DNA, 4.4 Genetic code, 4.5 Protein Biosynthesis, 4.6 Transcription and reverse Transcription, 4.7 Transfer RNA, 4.8 Deciphering of the Genetic code

5. **The Cell and the Cell membrane:** 5.1 Organization of cell, 5.2 Mitochondria, 5.3 Membrane and its structure, 5.4 Passive Transport, 5.5 Electrodiffusion, 5.6 Active Transport in red blood cells, 5.7 Lysosome and Ribosomes

6. **Physics of Nerve Impulse:** 6.1 The axon and Nerve impulse, 6.2 Propagation of Nerve impulse: Hodgkin and Huxley Theory, 6.3 Generation of Nerve impulses, 6.4 E EG and EMG

7. **Blood Flow/Heart action:** 7.1 Blood flow. 7.2 Mechanics of the Heart. 7.3 Electrical activity: ECG

8. **Vital organs: 8.1** Physics of Hearing. 8.2 Physics of vision. 8.3 The molecular Mechanism of Photoreceptor

9. **Biological Evolution and Development: Stochastic and Dynamical Regulation:** 9.1 Origin of life. 9.2 Modeling of pre-biotic evolution. 9.3 Biological evolution

Medical Physics

10. **Review of Radioactivity:** 10.1 Radioactive Nuclides 10.2 Attenuation of a Beam of X and γ rays: Mixture Rule. Coherent Scattering. Photo electric absorption. Compton. pair Production and Photo-disintegration. 10.3 Interaction of heavy charged Particles. 10.4 Interaction of fast electron. 10.5 Interaction of X-rays and (rays. 10.6 Interaction of Neutrons and Neutron activation analysis

11. **Radiation Intensity and exposure:** 11.1 Radiation Intensity. 11.2 Radiation Exposure. 11.3 Energy and photon fluence per Roentgen. 11.4 Ionisation measurements. 11.5 Free air Ionisation chambers and Thimble chambers. 11.6 Condenser Chambers and Electrometer

12. **Radiation Dose:** 12.1 Units of Radiation dose. 12.2 Quality factors for different Radiation. 12.3 Measurement of Radiation Dose. 12.4 Calorimetric Dosimetry. 12.5 Photographic Dosimetry. 12.6 Chemical Dosimetry. 12.7 Scintillation Dosimetry. 12.8 Thermo luminescence Dosimetry. 12.9 Solid State Dosimetry

13. **Radiation Quality:** 13.1 Half Value layer. 13.2 Tube Voltage. 13.3 Effective Energy. 13.4 Variation in Quality across an X-ray Beam. 13.5 Special Distribution of an X-ray Beam. 13.6 Factors influencing Radiation Quality

14. **Interaction of x-ray and Gamma Ray in the Human Body:** 14.1 F-factor. 14.2 Attenuation of X- and (rays in: i) Fat ii) soft tissues iii) bone and iv) Cavities. 14.3 Contrast media

15. **Signal from Radiation detectors:** 15.1 Statistics of counting systems. 15.2 Precision and Accuracy. 15.3 Precision count rate. 15.4 Accumulation of error. 15.5 Precision of Rate Measurements. 15.6 Electron Microscopes (Transmission and Scanning Electron Microscopes)

16. **Imaging Techniques:** 16.1 Gamma Camera. 16.2 CT Imaging. 16.3 PET (Positron Emission Tomography) Imaging. 16.4 NMR Imaging. 16.5 Ultrasound Imaging. 16.6 R Imaging. 16.7 Whole body counting

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17. **Radiation Therapy:** 17.1 Radio-analytical methods in vitro and in vivo. 17.2 Linear accelerators and their use in radiotherapy. 17.3 Absorption studies of Radio-nuclides and metabolic investigations. 17.4 Isotope Therapy units and various accelerators. 17.5 Depth Dose and filters. 17.6 Treatment Planning. 17.7 Simulators. 17.8 Neutron Therapy

18. **Protection form Radiation sources:** 18.1 Protection from external and internal sources of radiation. 18.2 Risk Evaluation. 18.3 Dose limits and ALARA (As low as Radiation Absorption). 18.4 Effect of Radiation at sub-cellular and cellular level. survival curves repair. 18.5 Fractionalization of R.B.C and Q.C. 18.6 Effects on organs and Tissues including skin Genetic and somatic effect. 18.7 Radiation Hazards and its control. 18.8 Assessment of personal dose and dose commitment. 18.9 Protection of patients

Text Books

1. VolkenshteinM.V.– **Biophysics**, Mir Publishers, Moscow
2. William Hughes - **Aspects of Biophysics,** John Wiley & sons, New York
3. William R. Hendee - **Medical Radiation Physics,** Year book Medical Publishers Inc., London
4. **Medical Physics Hand Books**, Adam Hilger Ltd. Birstol in collaboration with the Hospital physicist's Association

Gravitation and Cosmology

Course No.: Phy 632
Nature of the course: Theory

Full Marks: 100
Pass Mark: 40
Year : II

Course description: The aim of the course is to impart the fundamental knowledge of general relativity and cosmology.

Course objective: The objective of the course is to introduce the student to the theory of general relativity and cosmology. After the completion of this course, the student will have a grasp of the fundamentals of the theory of gravitation to pursue higher studies and research in this field.

Course Contents:

1. **Introduction :** 1.1 Physics and geometry, 1.2 Riemannian Geometry, 1.3 Tensor algebra, 1.4 Vector transplantation, 1.5 Affine connection, 1.6 Christoffel symbols, 1.7 Geodesic equation, 1.8 Gaussian co-ordinates

2. **Tensor Analysis:** 2.1 Covariant differentiation, 2.2 Symmetric and anti-symmetric tensors, 2.3 Closed and exact tensors, tensor densities, 2.4 Symmetry and Killing vectors, 2.5 Maxwell's equation in tensor form, 2.6 Relativistic mechanics, 2.7 Fluid dynamics, 2.8 Gravity as a metric phenomenon, 2.9 Equivalence principle, 2.10 Mach's principle, 2.11 Red shift

3. **Field equations in free space:** 3.1 Riemann curvature tensor, 3.2 Ricci tensor, 3.3 Bianchi identities, 3.4 Integrability and Riemann tensor, 3.5 Pseudo Euclidean and flat space, 3.6 Einstein field equation for free space, 3.7 Einstein tensor.

4. **Schwarzschild solution:** 4.1 Schwarzschild solution, perihelia shift, 4.2 Null geodesic and bending of light, 4.3 Schwarzschild coordinates and Kruskal co-ordinate,

5. **Linearized field equations:** 5.1 Linearization of the field equations, 5.2 Time independent and spherically symmetric field, 5.3 Solution of the linearized equation, 5.4 Gravitational waves

6. **Field equation in nonempty space:** 6.1 Energy momentum tensor, 6.2 Electromagnetic field, 6.3 Field equation in non empty space, 6.4 Classical limit of gravitational equations, 6.5 Equation of motion, 6.6 Conservation law in General relativity

7. **Stellar equilibrium and gravitational collapse:** 7.1 Relativistic stellar structure, 7.2 Interior Schwarzschild solution, 7.3 Stellar stability, 7.4 Gravitational collapse

8. **Cosmology:** 8.1 Cosmological Principle. 8.2 Isotropy and homogeneity. 8.3 Cosmic microwave background radiation. 8.4 De Sitter space. 8.5 Robertson Walker metric. 8.6 Kinematics in RW space. 8.7 Friedmann equation. 8.8 Expansion age. 8.9 Critical density and dark matter. 8.10 Equilibrium thermodynamics. 8.11 Entropy

References

1. Steven Weinberg, **Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity**: John Wiley & Sons. New York.
2. Adler, Bazin, Schiffer - **Introduction to General Relativity**. McGraw Hill Inc, New York.
3. Kolb and Turner - **Early Universe**. Addison Wesley.
4. Misher, Thorne and Wheeler - **Gravitation**, W.H. Freeman and Company, New York.

Dissertation

Course No.: Phy 650
Nature of the course: Dissertation

Full Marks: 100
Pass Mark: 40
Year : II

Course description

Phy 650 is a thesis paper of full mark 100 offered in the curriculum of the M.Sc. second year physics. A student opting for thesis prepares a proposal under the supervision of a thesis devisor and defends his/her proposal in the Department. Once accepted by the Department, a student can start his/her research work under the guidance of his/her supervisor

Course objective

- To provide student with skill and knowledge in conducting research on fundamental and application aspect of physics
- To train student in developing analytical as well as argumentative skill.

A student who completes and passes all his/her first year course can opt for this course in lieu of one of the elective courses prescribed in the M.Sc. physics second year syllabus. The number of students accepted for the thesis work will be limited on the basis of resource persons and the materials available in the department. A student must complete this course within the academic year. However, a grace period of three months may be extended to complete it beyond the academic year.

A student's M.Sc. thesis must embody the results of guided research, preferably, be an original contribution to knowledge, and include materials worthy of publication, if possible. It is expected that the student learns and applies some theoretical or experimental techniques, not prescribed in text books, and demonstrates his ability to conduct an investigation to abstract principles upon which predictions can be made, to interpret the results of his research work in a logical manner and to present this results clearly in writing. To be acceptable to the department, the thesis, upon completion, must be recommended by his/her supervisor. Three spirally bound copies must be presented to the office of the Head of the Department to facilitate his/her final oral examination. Once these formalities are completed, a date of final oral examination will be fixed as per rule. The thesis should be submitted to the department after the inclusion of the comments made by the following examiners.

The thesis evaluation committee consists of four members. The committee members are Head of the Physics Department, the thesis supervisor, an internal examiner and an external examiner. They will evaluate the student's thesis write up and oral presentation. They will grade the thesis individually. An average of four-member evaluation will be the final mark on this paper. If the grade is not exactly divisible by four, it will be rounded off to the next higher number. The thesis will be graded on the basis of the following marking scheme:

1.	Oral presentation	-	20
2.	Over all thesis write up	-	30
3.	Abstracting the principles	-	10
4.	Analysis of the results	-	10
5.	Tables, charts, graphs and figures/captions	-	10
6.	Conclusion	-	10
7.	References	-	10
			100

Please note that the thesis submitted to the Department is the partial fulfillment of the requirement for the degree of Master of Science in physics at Tribhuvan University