Faculty of Science

NORTH MAHARASHTRA UNIVERSITY
JALGAON

Syllabus

for

M.Sc. Physics

(W. E. From June 2005)

North Maharashtra University, Jalgaon
M.Sc. Physics Programme

Objectives of the programme

The objectives of this programme are to develop:

1. the students through high quality of education/study which enables them to succeed in career in which an understanding of physics is relevant;
2. the ability to think logically, to analyze problems and phenomena and to devise explanations or solutions;
3. an appreciation of the role of mathematical modeling of physical phenomena to produce predictions which can be tested against experimental observations;
4. an awareness of the importance of accurate experimentation in the understanding of natural phenomena;
5. the practical and technical skills required for physics experimentation;
6. an awareness of the value and the power of computer based techniques for experimentation, analysis and presentation and a familiarity in their exploitation;
7. an ability to communicate the concepts and discoveries of physics both orally and in writing;
8. an ability to organize time and meet deadlines;
9. an additional skills resulting from the experience of more extensive project work;
10. an ability to integrate 'Information Communication Technology' with basic concepts of physics to promote relevant education and training;
11. the qualities of adoptability, innovation and dynamism.

Important Instructions:

1. The T.Y.B.Sc. Physics pass students are eligible to offer this programme.
2. Two written tests, one oral test and one seminar (per semester) should be conducted for each course in addition to regular teaching schedule.
3. Faculty members are advised to use 'compact disks' and computers as teaching aids so as to ingrain the basic ideas of Physics.
4. Students are advised to borrow scientific information (published worldwide) from scientific websites on Internet.

5. A well-equipped computer laboratory with at least 5 computers and 5 Microprocessor kits is necessary to conduct related practicals.

6. Student should start the Project work soon after the commencement of third semester. Student should carry out the experimental work, keep record of the observations and results and should draw the conclusions of the project. Systematic project report should be prepared. Teacher should arrange oral examination to assign internal marks.

M.Sc. Physics Programme:Details

M.Sc.-Physics		
	Ist year	IInd year
No. of teaching days(weeks)/ year	180(30)	180(30)
No. of teaching days(weeks)/ semester	90(15)	90(15)
No of contact hours/ theory Course/week	4	4
No of contact hours/week/ practical courses	6	6+6* *Project
No of teaching hours theory course/ semester	48	48
No of contact hours/semester for tests, seminars, tutorials	12	12
No of contact hours/ theory course/ semester	60	60
Total contact hours/week	22	24
Total contact hours/ semester	342	372

M.Sc. Programme : Titles of the Courses

Semester	Course Number	Title of the course
I	PHY 101	Mathematical Methods for Physics
	PHY 102	Classical Mechanics
	PHY 103	Quantum Mechanics
	PHY 104.	Condensed Matter Physics-I
	PHY 105	General Practicals: Lab I
II	PHY 201	Statistical Mechanics
	PHY 202	Classical Electrodynamics
	PHY 203	Materials Synthesis Methods
	PHY 204	*Any one of the following*
	PHY 204(A)	Electronics Instrumentation
	PHY 204(B)	Materials Science
	PHY 204(C)	Physics of Semiconductor Devices
	PHY 204(D)	Biophysics
	PHY 205	General Practicals: Lab II
III	PHY 301	Atomic and Molecular Physics
	PHY 302	*Any one of the following*
	PHY 302(A)	Microprocessor and its Applications
	PHY 302(B)	Solar Energy Conversion
	PHY 302(C)	Communication Electronics
	PHY 303	*Any one of the following*
	PHY 303(A)	Systematic Materials Analysis
	PHY 303(B)	Physics of Nanomaterials
	PHY 303(C)	Acoustics and Entertainment Electronics
	PHY 303 (D)	Biomedical Instrumentation
	PHY 304	Special Practicals: Lab I
	PHY 305	Project Work-I
IV	PHY 401	Condensed Matter Physics-II
	PHY 402	*Any one of the following*
	PHY 402(A)	Computational Methods and Programming Using ' C ' Language
	PHY 402(B)	Renewable Energy Sources
	PHY 402(C)	LASER and its Applications
	PHY 403	*Any one of the following*
	PHY 403(A)	Microwaves: Theory and Applications
	PHY 403(B)	Nuclear and Particle Physics
	PHY 403(C)	Environmental Physics
	PHY 403(D)	Astrophysics and Astronomy
	PHY 404	Special Practicals :Lab II
	PHY 405	Project Work-II

M.Sc. Physics

PHY-101: Mathematical Methods for Physics

1. Vector Space:

Definition vector space, Subspace, linear combinations, Linear spans, Linear dependence, Basis & dimensions, linear transformation, Linear operator, Representation theory of operators, Hermitian operator.

Inner Product Space: Definition of Inner Product Space, Schwarz inequality, orthogonality, orthonormal sets, Gram Schmidt orthogenalization process, Orthogonal and unitary matrices. (H-8 M-15)

2. Matrices:

Definition, Types of matrices, Polynomials of matrices & Linear operators, Eigen values and Eigen vectors, Diagonalization, Caley-Hamilton theorem, Inverse of a matrix. (H-5 M-10)

3. Integral Transforms:

Definition, Linearity property , First and second shifting theorems, Change of scale property, Laplace Transform of derivaties, Laplace Transform of integrals, The multiplication by powers of t, Division by t, Laplace Transform of Laplace Transform, Problems on above all theorems. Proof of initial and final value theorems using Laplace Transform.

Inverse Laplace Transform:

Definition, Linearity property, First and Second shifting theorems, Change of scale property, Convolution theorem (statement only). Inverse Laplace Transform of partial fractions i.e. $P(x)/Q(x)$ of the form $A/(ax+b)^r$, $Ax+B/(ax^2+bx+c)^r$ where $r= 1,2,3....$

Applications of Laplace Transform:

(i) solution of differential equation [like $a(d^2x/dt^2)+dx/dt + f(t)$]

(ii) Evaluation of integrals like–$Y(t)= F(t) + \int k(u,t)Y(u)du$.

(H-12 M-20)

4. Fourier Services:

Definition, Determination of fourier coefficients, Dirichlet's condition, Fourier series of even and odd functions , Half range fourier sine and cosine series, Complex form of fourier series, Parseval's identity, Fourier integral, complex form of fourier integral. Fourier transforms, Fourier sine & cosine transforms, Fourier transform of dirac- δ function, Convolution theorem for fourier transforms. (H-8 M-10)

5. Special functions:

Revision of Legendre and Hermite polynomials and their orthogonality properties, Generation function, recurrence relations, Rodrigne's formula for $P_n(x)$, $H_n(x)$. Bessel's function of first kind, Integral representation, of $Jn(x)$. Laguerre function: Generating function, recurrence relations,Integral representation of $Ln(x)$ (H-7 M-10)

6. Tensor Analysis :

Definition, Rank of tensor, Contravarient & co-variant vectors, contravarient, covariant & mixed tensors, Kronecker- δ , tensors of a rank greater than two, Symmetric & Skew-symmetric tensor, Conjugate or reciprocal tensors, Associated tensors, length of a vector, angle between vectors, Riemann-Chrisfoffel tensor, transformation laws of Chrisfoffel symbols, Geodesics, Covariant derivaties, Permutation symbols, & tensors, The intrinsic or absolute derivative, Relative and absolute tensor. (H-8 M-15)

Reference Books:

1. Schaum's outline of theory & problems of linear Algebra: by Semour Lipschutz Lipsuitz, Schaum's Series, Mc Graw Hill.
2. Linear Algebra: by Sharma, Vasistha.
3. Vector analysis & an introduction to Tensor Anlysis : by Murrug R.Spiegel (Schaum's Outline series.)
4. Integral Transform : by Goyal and Gupta.
5. Mathematical methods for Physicist : G. Arifken, Academic Press,1985.
6. Mathematical methods for Physics : J.Mathew & R.L.Walker, Benjamin (IBH), 1979.
7. Mathematics for Physics and Chemistry : Vol.I, H.M.Margenau and G. M. Murphy, East-West Press.
8. Mathematical Physics: A.K.Ghatak, I.C.Goyal, S.J.Chua,, MacMillan India Ltd.,1995.
9. .Introduction to Mathematical Physics: Charlie Harper, Prientice Hall of India, 1993.
10. Mathematical Physics : P.K.Chattopadhyay, Wiley Eastern Ltd.,1990.

PHY-102: Classical Mechanics

1. Hamilton's Equation of Motion:

Introduction, Legendre's dual transformation, Hamilton's function and Hamilton's equations of motion, Properties of the Hamiltonian and Hamilton's equations of motion, Routhian, Configuration space, phase space and state space. (H-6 M-10)

2. Principle of Least Action and Hamilton's Principle:

Introduction, Principle of least action, Hamilton's principle, Comparison between Fermat's principle of least action in optics & Maupetul's principle of least action in mechanics, Derivation of Euler-Lagrange equations of motion from Hamilton's principle, Derivation of Hamilton's equations of motion from Hamilton's principle, Derivation of Hamilton's equation of motion for conomic systems from Hamilton's principle, Invariance of Hamilton's principle under generalized coordinate transformation, Hamilton's principle & characteristic function. (H-12 M-20)

3. Brachistochrones, Tautochroes and the Cycloid Family:

Introduction, Background and definition, Generating functions, properties of canonical transformations, Some examples of canonical transformations, Canonical transformations of the free particle Hamiltonian. (H-9 M-15)

4. The Poisson Bracket :

Introduction, Definition, Some useful identities, Elementary PBs, Possion's theorem, Jacobi-Possion theorem (or Poisson's second theorem) on PBs, Invariance of PB under canonical transformations, PBs involving angular momentum. (H-6 M-10)

5. Hamilton's-Jacobi Theory :

Introduction, solution to the time dependent Hamilton-Jacobi equation and Jacobi's theorem, connection with canonical transformation. How to find the complete integral of the HJ equation, Action-Angle variables. (H-6 M-10)

6. Small Oscillations :

Introduction, types of equilibria & the Potential at equilibrium study of small oscill- ations using generalized coordinates, Forced vibrations and resonance. (H-4 M-7)

7. Rigid Body Dynamics:

Degrees of freedom of a free rigid body, Euler's and Chasles' theorems, Frames of reference used to describe the motion of a rigid body, Kinetic energy of a rotating rigid body, Angular momentum, Transformations and theorems of the moment of inertia tensor. (H-5 M-8)

Reference Books

1. Introduction to classical Mechanics- Goldstein.
2. Principles of Mechanics-Synge Griffith
3. Introduction to classical mechanics – Takwale , Puranik
4. Classical Mechanics –Hauser
5. Mechanics-Franick Ayris.
6. .Classical Mechanics –N.C.Rana, P.S.Joag Tata MaGraw Hill 1991.

PHY-103: Quantum Mechanics

1. Linear vector spaces and operators:

A linear vector space and its properties, examples of linear vector spaces, norm of a vector, orthonormality and linear independence, bases and dimensions, completeness (closure property), Hilbert spaces, linear mainfolds and subspaces. (H-4 M-8)

2. Operators:

Definition, eigen values and eigen functions of an operator, orthonormal and orthogonal functions, Linear operator, Identity operator, Null operator, Hermitian operator and properties, Unitary operators, Projection operator, Reflection operator, Parity operator and properties, commutators (only idea).

(H-8 M-14)

3. Matrix representation in Quantum Mechanics:

Bra and Ket notations for vectors and their properties, Ket vector as a column matrix and bra vector as a row matrix, Defining equations for the operators a and a^+, Matrices for the operators: x, p, H, a, a^+ , Solution of 1-D harmonic oscillator using the ladder operators a and a^+, Derivation of Schrodinger's equation from a and a^+. The Schrodinger and Heisenberg pictures- Heisenberg equation of motion. (H-10 M-14)

4. Angular Momentum :

Angular momentum operator, linear momentum operator as generator of translation motion, Orbital angular momentum operator as generator of rotation, eigen values and eigen functions of L^2 and Lz, matrices for J^2 and Jz (J is general or total angular momentum vector), operators J+ and J- , Commutation releations between J^2 , Jz , J± , Addition of angular momenta and Clebesch-Gardon coefficients. (H-12 M-20)

5. Approximation Methods (time-independent problems):

b) Stationary Perturbation Theory: First order perturbation theory for non-degenerate and degenerate cases (evaluation of energy eigen values and eigen functions),

c) Variation Method: Ritz variational formula, Derivation of Schrodinger equation for steady-state, ground-state energy of hydrogen atom.

d) The WKB approximation: The principle of the method, the WKB wave function, theory of - decay. (H-14 M-24)

Reference Books:

1. Qunatum Mechanics (2nd Edition) , V.K.Thankapan. (New Age International P.Ltd.)
2. A text book of Quantum Mechanics : P.M.Mathews & K.Venkatesan (Tata Mc-Graw Hill P.co.Ltd.)
3. Quantum Mechanics: Chatwal & Anand (Himalaya Publishing House)
4. Quantum Mechanics : John L Powell & Bernd rasemann. (Narosa Publishing House)
5. Quantum Mechanics : A.K.Ghatak & S.Loknathan (The Macmillan company of India Ltd.)

PHY-104: Condensed Matter Physics-I

1. Classification of condensed matter:

Crystalline, noncrystalline, nanophase solids, liquids. (H-2 M-4)

2. Crystalline Solids:

Bravais lattices, crystal systems, point groups, space groups and typical structures: HCP, Diamond, Cubic & Hexagonal Zinc structures.

Diffraction of X-rays by crystals : Principle, interpretation of powder

photographs, analytical indexing, Accurate determination of lattice parameters-least-square method. (H-6 M-8)

3. Exotic solids:

Structure and symmetries of liquids, liquid crystals and amorphous solids, Aperiodic and quasi crystals, Fibonaccy sequence. Penrose lattices and their extension to 3-dimensions. Special carbon solids, Fullerence and tubules, formation and characterization of fullerences and tubules. Single wall and multi-wall carbon tubules. Electronic properties of nanostructurred materials. Methods of synthesis of nanostructured materials. Special experimental techniques for characterization of nanostructured materials. Quantum size effect and its applications. (H-8 M-12)

4. Band Theory of Solids:

Electrons in a periodic lattice: Bloch theorem, The Kronig-Penny model, wave mechanical interpretation of energy bands, origin of energy gap, Distinction between metals, semiconductor & insulators, concept of negative mass. (H-6 M-6)

5. Theory of Dielectrics:

Polarization-Dielectric constant, Local electric field, Dielectric polarizability, Clausius-Mossoti Relation, Sources of polarizability-Electronic, ionic and dipolar polarizability, Frequency dependence of dipolar polarizability, Measurement of dielectric constants, Piezoelectricity, Electrostriction, Application of Piezoelectric crystal, Propagation of elastic waves in crystals and measurement of elastic constants. (H-6 M-15)

6. Magnetism:

Origin of magnetic dipoles, classification of magnetic materials. Diamagnetism-Lagevin's classical theory of diamagnetism. Paramagnetism-Origin of permanent magnetic moments-The orbital magnetic moment, The spin magnetic moment. Langevin's classical theory of paramagnetism. Weiss theory of paramagnetism, comparison of experimental results with theory (Rare earth group ions, iron group of ions). Temperature dependence of spontaneons magnetism. Determination of magnetic susceptibility of para and diamagnetic materials by: Gouy method, Quinke's method.
Ferromagnetism, Antiferromagnetism and ferrimagnetism: Weiss theory of ferromagnetism, ferromagnetic domains, Neel's model of Anti ferromagnetism, Neel model of ferrimagnetism. (H-12 M-20)

7. Interatomic forces and lattice dynamics of simple metals, ionic and covalent crystals. Inelastic neutron scattering, Mossbauer effect, Debye-

Waller factor, Anharmonicity. Thermal expansion and thermal conductivity. Interaction of electrons and phonons with photons. Direct and indirect transitions. Absorption in insulators, polaritons. optical properties of metals. Skin effect and anomalous Skin effect. Organic conductors and polymers. (H-8 M-15)

Reference Books:

1. Handbook of Nanostructural Materials and Nanotechnology: (Vol.1 to 4) Ed. Hari Singh Nalwa.
2. The Physics of Quasicrystals : Eds. Steinhardt and Ostulond.
3. Condensed Matter Physics : Michel P. Marder
4. Elements of Solid State Physics : J.P.Shrivastava.
5. Solid State Physics : Springer International students edition. Harald bach and Hans Luth. Narosa Pub House (1991)
6. Crystal structure Analysis : Buerger.
7. Introduction to Solid State Physics : Charles Kittel, Wiley 5th edition 1976.
8. Solid State Physics : A.J.Dekker, Printice Hall 1957
10. Solid State Physics : N.W.Azaroff and N.D.Mermin, Saunder's College Pub 1976.

PHY-105: General Laboratory-I

Group A : Any six of the following:

1. Milikan's oil drop method.
2. Rayleigh Jeans scattering using constant derivation spectrometer.
3. Hall coefficient, conductivity and Hall mobility of given sample.
4. Coherence & width of spectral lines using Michelson interferometer.
5. Study of normal Zeeman effect using LG plate.
6. Determination of wavelength λ of monochromatic source by Febry – Perot Interferometer..
7. Determination of thickness of thin transparent sheet like mica using Michelson interferometer.
8. Study of the dispersion relation for the monoatomic lattice & diatomic lattice.

9. Verification of Inverse square law for gamma rays using G.M.Counter.
10. Design, build and test the phase shift oscillator using IC-741.
11. Design, build and test Schmidt trigger circuit using transistors.

Group B : Any six of the following:

1. G.M.Counter – Study of nuclear counting statistics
2. Determination of range of α / β particles emitted from given radioactive source.
3. Design, build & test first order low pass/high pass filter using IC-741.
4. Design, build & test voltage to frequency converter.
5. Study of characteristics of photo electrochemical solar cell.
6. Thermal testing of box type solar cooker. Determination of first and second figure of merit & cooking power.
7. Magnetic susceptibility of $FeCl_3$ solution at different concentrations.
8. Determination of ionic conductivity of salt NaCl/KCl.
9. Surface tension by Ripple method/any other method.
10. Study of I-V characteristics of solar cell (variation of intensity, variation of distance and load variation)

PHY-201: Statistical Mechanics

1. Basic principles of statistical mechanics:

Macroscopic and microscopic states, Liouville's theorem,ensembles-micro-cannonical ensembles(principle of equal priori probabilities) canonical ensembles-(Maxwell-distribution of velocities, Gibb's paradox equipartition theorem.)Grant canonical ensemble(thermodynamic functions) (H-6 M-9)

2. Various Statistical Theories:

Maxwell-Boltzmann, Bose Einstien, Fermi-Dirac, Quantum distribution functions, The Boltzmann limit of BE and FD gas. (H-6 M-9)

3. Ideal Bose system:

Ideal Bose gas, Bose Einstein condensation, Black body radiation,:the photon

gas, Debye's model of solids: phonons. (H-6 M-10)

4. Ideal fermi system:

Ideal Fermi gas: weakly degenerate, strongly degenerate, Free electron theory of metals, Relativistic degenerate electron gas, Neutron stars, Magnetic behaviour of ideal electron gas, Pauli paramagetism. (H-8 M-14)

5. Classical & Statistical Mechanics of interacting system.:

Deviations of imperfect gases from the ideal state: van der Waals equation of state, Cluster expansion for classical systems, Virial expansion of the equation of state, Equation of state for hard sphere fluid. (H-7 M-12)

6. Quantum Statistical Mechanics of Interacting System:

Cluster expansion for quantum systems, Virial expansion of the equation of state, Second virial coefficient at low temperature, Second virial coefficient at high temperatures, Quantum field theory for interacting systems. (H-7 M-12)

7. Kintetic theory of gases:

Boltzmann transport equation, Boltzmann's H theorem, Relation between H function and entropy, Maxwell- Boltzmann distribution, Validity of the Boltzmann equation,Mean free path, Transport properties. (H-8 M-16)

Reference Books:

1. Fundamentals of Statistical and Thermal Physics : F.Reif, McGraw Hill Publications, 1965.
2. Statistical Mechanics: Kerson Huang, Wiley Eastern Ltd.
3. Statistical Mechanics : :B.K.Agarwal and Melvin Eisner, New Age International Publishers
4. Statistical Mechanics: S. K. Sinha, Tata McGraw Hill Publications.
5. Statistical Mechanics: R.K.Patharia, Pergamon Press,1972.
6. Introduction to Statistical Mechanics and Thermodynamics : Keith Stowe, John Wiley and Sons,Inc.1984.
7. Introduction to Statistical Mechanics :- B.B.Laud, McMillan India Ltd. 1981.

PHY-202:Classical Electrodynamics

1. Maxwell's field equations :
Maxwell's equations in differential and integral form, Maxwell's equations in (a) free space (b) linear isotropic media (c) harmonically varying fields. (H-2 M-6)

2. Propagation of plane EM waves :
EM waves in free space : Wave equations for free space conditions, plane EM waves in free-space, energy flow due to plane EM wave.
Plane EM waves in matter: Plane EM waves in matter, relative orientation of E and H vectors in a plane wave.
Plane EM waves in isotropic dielectric: Equation of propagation of magnetic vector, equation of propagation of electric vector, E and H are transverse, intrinsic impedance of space speed of EM wave, refractive index of non-conducting media, the direction of flow of energy, the electrostatic energy density. (H-14 M-24)

3. EM fields and radiating systems :
Introduction, Lienard- Wiechart potential, method to derive LW potentials from retard potential, electric and magnetic fields of a charge in uniform rectilinear motion, radiation due to non-relativistic charges, electronic orbits in an atom, radiation due to relativistic charges, derivation of Lienard radiation formula and its applications (co-linear velocity and acceleration, circular accelerators) (H-14 M-22)

4. Relativistic (Co-variant) Electrodynamics:
Introduction, Lorentz variance and invariance, four vectors : Linear product of two four vectors, spatial and temporal components, velocity and acceleration, momentum and force four vectors, mass transformations, invariance of $E^2-P^2C^2$. Four vectors of charge and potential : invariant forms of continuity, equation and Lorentz, condition, invariance of Maxwell's field equations under relativistic transformation. Co-variant form of electric and magnetic field equations (EM field tensor), co-variance of Lorentz force law. (H-14 M-22)

5. Plasma Physics :
Definition of plasma, magnetohydrodynamics and plasma physics, Electrical neutrality in plasma (Debye screening distance), magnetohydrodynamic equations, magnetic pressure, plasma oscillations and hydromagnetic waves (idea only). (H-4 M-8)

Reference Books:

1. Electrodynamics : Dr. S.L.Gupta, Dr. V. Kumar, Dr. S.P. Singh, Pragati Prakashan 17th Ed.-2003 Meerut
2. Introduction of Electrodynamics (3rd Ed.): David .J.Griffith, Prentice Hall of India Pvt. Ltd., New Delhi.
3. Classical Electrodynamics : S.P.Puri , Tata McGraw Hill.
4. Classical Electricity and Magnetism : Panofsky and Philips, Indian Book Company Addision Wesley
5. Electromagnetic Theory and Classical Electrodynamics: Satya Prakash, Kedarnath Ram Nath & Co., .Merrut.
6. Introduction to Classical Mechanics: Corson and Lorain.
   Foundation of Electromagnetic Theory: Reitz and Milford, World Student series Edition.
7. Classical Electrodynamics: J.D.Jackson, 3rd Edition John Wiley
8. Electrodynamics: Sommerfield
9. Electromagnetics : B.B .Laud, Wiley Estern.

PHY-203: Materials Synthesis Methods

1. Nucleation and Growth of Thin Films:

Condensation, Langmuir-Frankel theory of condensation. Theories of nucleation: Capillarity model, Atomistic model. Various stages of growth.

(H-4 M-6)

2. Thin Films Deposition Techniques: Thermal evaporation, sputtering, chemical methods.

Thermal evaporation:

General considerations, evaporation methods: Resistance heating, Flash evaporation, Arc evaporation, Exploding wire technique, Laser evaporation, R. F. heating, Electron beam (e-beam) heating, Molecular Beam Epitaxy (MBE) (H-6 M-12)

Sputtering:

Cathodic sputtering- Sputtering process, glow discharge sputtering pressure, Deposit distribution, current and voltage dependence, cathode, contamination

problem, Deposition control, Sputtering variants, Low pressure sputtering: Magnetic field, Assisted (triode) sputtering, R.F. sputtering, Ion-beam sputtering. Reactive sputtering, sputtering of multicomponent materials.

(H-4 M-6)

Chemical Methods:

Chemical vapour deposition Techniques : Principle, chemical reactions used. Pyrolysis (Thermal decomposition), Hydrogen reduction, Halide disproportionation, Transfer reactions, polymerization. (H-4 M-6)

Chemical Bath Deposition Techniques: (a) Electodeless deposition - Mechanisms of chemical bath deposition. Introduction, Nuclean, Adhesion and film growth processes in Ion-by-Ion mechanism, Hydroxide cluster mechanism, complex decomposition mechanism. (b) Electrodeposition

(H-4 M-6)

Chemical Spray Method: Nucleation and growth process in film deposition. Ultrasonic spray pyrolysis to synthesize nanostructured films. (H-4 M-6)

Thick film deposition techniques: Fundamental aspect of the process, Design aids, Screens, Substrate materials, Screen printing, Firing process, Components and network: Passive components, active components, Assembly, packaging and testing: soldering methods for component attachment, wire bonding, packaging, testing. (H-4 M-6)

8. Single crystals:

Importance of growing single crystals and their uses. Thermodynamic principles and crystal growth equilibrium. Theory of crystal growth, Nucleation, Growth of single crystal by water solution method, growth by Gel method, growth by Flux method, Hydrothermal growth. (H-6 M-12)

3. Thickness measurements:

Optical interference technique, Multiple beam interferometry, Photometric method, Gravimetric method, Quartz crystal microbalance, Stylus (Talye step) method. Some aspects of physical structure of the films- crystalline size, surface roughness. (H-4 M-8)

4. Mechanical properties:

Adhesion and its measurements, hardness measurements, stress measurements. (H-2 M-4)

5. Electrical Properties:

Electrical conductivity of bulk, thin and thick films, Van-der Pauw and Four probe methods, Hall measurements, TEP measurements. (H-6 M-8)

Reference books:

1. Thin Film Phenomenan, K.L.Chopra, McGraw Hill,1969.
2. Hand book of Thin Film Technology L.I.Maissel & R.Glang, Mc Graw Hill,1970.
3. Thin Film Processes: J.L.Vossen and W.Kern, Academic Press,1978
4. Chemical Solution Deposition of Semiconductors Films : Gary Hodes-Weizmann Institute of Science, Rehorot, Iszael. New York-Basar.
5. The materials science of Thin Films: M.Ohring Academic Press,1992.
6. Active and Passive Thin Film Devices: T.J.Coutts, Acadmeic Press 1978.
7. An Introduction to Physics and Technology of Thin Films : A Wegendristel and Y.Wang, World Scientific 1994.
8. Handbook of Sensor and Actuators- Thick Film Sensors- Edited by M.Prudenziati, Elsevier (1994), Vol. I, Series editor S. Middelhoek

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PHY-204(A) : Electronic Instrumentation

1. Signal representation & generation:

Periodic signals, a periodic signals, modulated signals (A.M.,F.M.,P.M.), sampled data, pulse modulation (PWM,PAM,PPM) definition and their graphical representation. Generation of sine, square, triangular, linear ramp & saw tooth waveform. (H-6 M-12)

2. Measurement of electrical signals:

Meters: comparison of analog & digital meters, moving coil, moving iron, electrodynamics, induction meter, clamp on meter. CRO: Block diagram of general purpose CRO , detail study of CRT, How CRO displays waveform, various methods of measurements of voltage, current, resistance, frequency, phase, capacitance & inductance. (H-10 M-20)

3. Signal Processing Circuit :

Electronic amplifiers: Difference or balance amplifier, electrometer amplifier,

operational amplifier, Instrumentation amplifier, Charge amplifier, Power amplifier. Passive & active filters. Butter worth filter (low pass, high pass, band pass), notch filter. (H-9 M-14)

4. Data Acquisition conversion, processing & transmission system :

General DAS, signal conditioning of inputs, single channel DAS, multichannel DAS, R-2R ladder network, successive approximation type ADC, analog & digital multiplexer, sample and hold circuit. Data transmission system. Telemetry system- Block diagram, Characteristics, land line telemetry, radio telemetry, processing system. (H-9 M-14)

5. Applications of electronic system:

Frequency selective wave analyzer, spectrum analyzer, lock-in amplifier, fiber optic sensors. Measurement of Humidity, Hygrometers, measurement of pH, measurement of thermal conductivity (gas analyzer), Nuclear instrumentation-types of radiation, Geiger-muller tube , ionization chamber. Flow meters: Classification, working principle, electromagnetic flow meter, ultrasonic flow meter.

DFM- Block diagram, principle & working.

DMM – Block diagram, principle & working.

LUX meter : Block diagram, principle and working.

(H-14 M-20)

Reference Books:

1. Transducers & Instrumentation : D.V.S.Murthy.
2. Instrumentation-Devices & system.: C.S.Rangan, G.R. Sharma, V.S.V. Mani.
3. Principles of measurement and Instrumentation : Alan S.Morris.
4. Electronic Instrumentation : Kalsi
5. Electrical & electronic measurement Instrumentation : A.K.Sawhney.
6. Modern electronic instrumentation & measurement Technique : Helfrick Cooper.

PHY-204(B): Materials Science

1. Solid solutions:

Types of solid solutions, solid solution, Atomic size in solid solutions,

Vigard's law, Semiconducting intermediate phases, Hume-Rothery rules for formation of solids, Laue Phases and electron phases. (H-8 M-12)

2. Alloys:
Cu alloys-Brasses, bronzes , Pb-allows and rare-earth alloys, super alloys. (H-4 M-6)

3. Iron Carbon System:
Pearlite transformation, TTT diagram, hardening of steel, carbon and alloy steels, tool steels, cast iron. (H-4 M-8)

4. Ceramic Materials:
Ceramic Phases, ceramic crystals (Ax), ceramic crystals C(AmXp), multiple compound, silicates, mechanical behaviour of ceramics, processing of ceramic materials. (H-6 M-6)

5. Electric and Magnetic materials:
Ferrites-preparation and characterization, microstructure, substitution elements $BaTiO_3$ and its solid solutions, ferroelectric materials, piezoelectric materials. (H-8 M-12)

6. Non-crystalline solids:
Glasses, glass transition temperature, electrical and optical properties of glass, organometallic materials, metallic glasses. (H-4 M-12)

7. Solar energy materials:
Solar energy spectrum, photovoltaic conversion materials: Silicon, GaAs, CdS and $CuInSe_2$, fabrication of CbS/Cu_2S cell, Solar selective coatings: Black Nickel, Black chromium and semiconductor coatings. (H-8 M-12)

8. Composite Materials:
Types of composites, particulate composites, fibre composite, fabrication and applications, Theories of hardening of composites. (H-6 M-12)

Reference Books:

1. Structure and properties of Enginering materials, R.M.Brick, R.W.Pense, R.B.Gerden, International Students edition 1977.
2. Physical Metallergy Principles, R.E.Reed, Hiss East-West Press Pvt. Ltd. 1973.

3. Metallargy theory and Practice, D.K.Allies, American technical society sec.1969.
4. Modern Composite Materials, Broutman and Kroch, Addition Wesley Pub. Co. 1967.
5 .Oxide-Magnetic Materials, K.J.Standly Iare press (1962))
6. Ferro electric Materials, Jona & Shingane Pergaman Press (1973).
7. Superalloys, Sines and Hagel, John Wiley and Sons (1972)
8 .Introduction to Ceramics , W.D.Kingeri, John Wiley and Sons (1960)
9. Material Science in Energy Technology, Ed.G.D.Libowitz, M.S. Whiiingham (1979)
10. Elements of Material Science and Engineering, L.H.Van Vlack Addition Western Pub.Co,
11. First course in Material science and Engineering, V.Raghvan, Prentice Hall of India Pvt. Ltd. New Delhi.

PHY-204(C): Physics of Semiconductor Devices

1. Charge Carriers and Fermi Level in Semiconductors in Equilibrium: Equilibrium distribution of electrons and holes, Intrinsic carrier concentration and Fermi level position, Doping of semiconductors with impurities, Extrinsic semiconductors : Equilibrium distribution of electrons and holes, Degenerate and non-degenerate semiconductors, Impurity carrier concentration, Charge neutrality equation, Equilibrium electron and hole concentration and its temperature dependence, Position of Fermi level and its variation with temperature and concentration. (H-6 M-12)

2. Current Transport Phenomena and Continuity Equation:
Drift of carriers: Drift current, mobility and its temperature dependence. Diffusion current, Diffusion constant, Total current density, Non-uniform impurity distribution and induced internal field. Einstein's relation, Non-equilibrium excess carriers and Continuity equation. Excess carrier generation, recombination and injection and its mathematical analysis using continuity equation, Life-time and diffusion length of carriers, Concept of quasi fermi levels. (H-6 M-12)

3. Characterization of semiconductor solids:
Hall effect : Measurement of resistivity, mobility, carrier concentration, diffusivity, Hall coefficient and carrier types for majority carriers, Hall effect in intrinsic semiconductors. Haynes-Shockley experiment, Mobility, diffusivity and life time of minority carriers. (H-5 M-8)

4. P-N Junctions-Characteristics and Devices:

Junction in equilibrium, Continuity of Fermi level across the junction, Junction under forward and reverse bias, Zero bias, Built-in-potential, Electric field in depletion region, Space Charge width, Biased junction, Space charge width under electric field, Junction Capacitance, Diffusion capacitance, One sided junction, Non-uniformly doped junctions, Linearly graded, Hyper abrupt etc., Break down in P-N junction, Avalanche and Zener Breakdown.

a) PN Junction diode: Carrier distribution profile, Ideal P-N junction current, Small signal equivalent, Current voltage characteristics of junction diode.

b) Zener diode: Reverse bias breakdown, principle of operation, device design for particular breakdown voltage.

c) Varactor diode: Junction capacitance, principle of operation, circuit operation, application as an oscillator.

d) Tunnel diode: Degenerate semiconductors, principle of operation, circuit operation, applications.

e) Photovoltaic Cell: Principle of operation, forward and reverse bias characteristics, equivalent circuit, applications. (H-10 M-20)

5. Metal-semiconductor Junction Diode:

Structure, metal semiconductor contacts, energy band diagram for different cases, barrier formation, Schottky barrier diode, Non-ideal effects on barrier heights, Current voltage characteristics, Comparison of barrier diode and PN-junction diode, Metal Semiconductor Ohmic Contact, Ideal non-rectifying barriers, Heterojunction, Two dimensional electron gas. (H-8 M-10)

6. Bipolar Junction Transistor:

Structure, The basic principle of operation, Modes of operation, Carrier concentration profile in various regions in forward active mode, current gain and current gain factors, Equivalent circuit models: Ebers-Moll model, the dependense of Ebers-Moll parameters on the structure and operating point, Maximum transition current, Voltage and power rating, Transistor as a switch. (H-8 M-10)

7. Negative Conductance Microwave Devices:

IMPATT devices: Read diode, principle of operation, applications, other structures. Gunn devices : Two valley semiconductors, transferred electron mechanism, formation and drift of space charge domain, application to resonant circuit. (H-5 M-8)

Reference Books:

1. Semiconductor and electronic devices, Adir Bar-lev (1987), Prentice Hall of India.

2. Advanced Theory of Semiconductor Devices, Hess, K.(1988)Englewood Cliffs, N. J. , Prentice Hall of India
3. Semiconductor Fundamentals, Vol-1 of Modular Series on Solid State Devices, Pierrent, R.F.(1988)2nd edition, Reading, Mass; Addison-Wesley.
4. Physics of Semiconductor devices, Roy.D.K. (1992),Universities Press, India.
5. Physics of Semiconductor devices, Shur,M.(1990) Englewood Cliffs, N. J. Prentice Hall of India.
6. Solid State Electronic Devices, Streetman, B.G. (1990),3rd ed; Englewood Cliffs, N. J. Prentice Hall of India.
7. Semiconductor Devices; Physics and Technology, Sze, S.M. (1981) Wiley Eastern Ltd.
8. Physics of Semiconductor devices, Sze, S. M. (1985) Wiley Eastern Ltd.
9. Fundamentals of Semiconductor Theory and Device Physics, Wang, S. (1989) Englewood Cliffs. N.J., Prentice Hall of India.
10. Physical Properties of Semiconductors, Wolfe,C.F.N.Holonyak Jr., G.E.Stillman(1989) Englewood Cliffs.N.J., .Prentice Hall of India.
11. Semiconductor Devices, Zambuto, M .(1989), McGraw Hill.

PHY 204 (D): Bio-Physics

1. Cellular Basis of Life :

Cell components-structure and function, plant and animal cells, Biomolecules- General idea about structure and functions-H_2O, Proteins, carbohydrates, fats and nucleic acids, Introduction to Biological energy, Energy consumption, Respiration, Energy production, photosynthesis, ATP synthesis. (H-10 M-16)

2. Protein structure:

4 levels, Ramachandran plot, Interpretations, classifications(by structure and function), Nucleic acids, Types of DNA , properties, RNA, Base pairing, Transcription and Translation. (H-8 M-15)

3. Confirmation Analysis:

Asymmetric carbon, Fisher conventions, L-D type systems, Torsion angle, Newmann projection, Cis-trans peptide. (H-6 M-8)

4. Membrane Biophysics & Transport :

A) Structure and function of membrane, membrane proteins.

B) Transport across membrane, processes, chemical potential, flux equation, Nernst equation, Using –Teorell unidirectional flux ratio, Osmotic pressure, Osmotic phenomenon in leaky membrane, The Donnan equilibrium – Goldmann equation. (H-12 M-16)

5. Bioenergetics:
Entropy in biological systems, Information processing, Photosynthesis pathways, Redox potentials, Glow curves, Orders of kinetics, Thermodynamics in photosynthesis, Thermo luminescence, Mitochondrial, Broenergetics. (H-8 M-15)

6. Enzyme Kinetics :
Classification of enzymes, Activation energy barrier, substrate concentration, Vmax, Km competitive inhibition, Allosteric enzymes. (H-4 M-10)

Reference Books:

1. Biophysics: A introduction by Rodney M.S., Colteril. John Willey and Sons Ltd.
2. Biophysics : Vasantha Pattabhi, M.Gantham, Narosa Publishing House.
3. Principles of Biochemistry: Lehninger
4. Biophysics & Physiology of excuitable membranes, Adleman, (Van-Nostrand Reehihod Co.1971).
5. Problems of Biological Physics. L.A.Blue monfeld (Springer-Verlag-Berlin 1979)
6. The structure and function of proteins. L Dickerson & J.Geis (Harpes & Reod 1975)
7. Biology, a human approach, I.W.Sherman and V.G.Sherman (Oxford University Press 1979).

PHY-205: General Laboratory II

Group A : Any six of the following

1. Design & build ERPS using IC 741 and study its line and load regulation.
2. To study FET characteristics and FET as VVR.
3. To study SCR characteristics and SCR as switch
4. Study of vacuum system and to measure the speed of rotary pump.

5. Study of magneto resistance in semiconductor and magnetics.
6. To investigate the characteristics of radiation emitted by bodies at elevated temperatures.(black body radiation) and to determine various constant.
7. To determine activation energy of KCl .
8. Study of phase diagram by direct cooling curves.
9. Study of Electro Spin resonance.
10. Thermal conductivity of Cu.
11. Seebeck measurement and conductivity measurement.
12. To measure share hardness of plastics and rubber sample.
13. To study the variation of β of transistor with frequency.

Group B : Any six of the following

1. Study of voltage control oscillator using IC 566.
2. Study of optocoupler MCT 2E & their applications.
3. Design build triangular, square and sign wave generator using IC-741.
4. Design, build and test transformerless class B push pull amplifier.
5. Design & build test log amplifier using IC-741.
6. Capacitance measurements with IC-555.
7. Radiation dosimetry.
8. Verification of Beer's and Lambert's law.
9. Adiometry.
10. Chlorophyll absorption.
11. Electroretinogram of cockroach.
12. Study of Creep behaviors of Sn-Pb alloy.
13. Skin depth of electromagnetic radiation in Al.
14. Determination of diffusion coefficient of cobalt atoms in Gel medium.
15. Determination of resonance frequency of piezoelectric element.

PHY-301: Atomic & Molecular Physics

1. Atomic Spectra:

Vector Atom models for two or more valence electrons.

Complex Spectra : Displacement law, Alternation law of multiplicities, Breits scheme for derivation of spectral terms, vector model for two, three and more valance electrons, Lande interval rule, inverted terms, Hund's rule, Zeeman effect & magnetic quantum numbers in complex spectra, magnetic energy and lande g factor, Paschen back effect in complex spectra.

Hyperfine structure: Introduction, Lande interval rule, hyperfine structure of two or more valence electrons, Zeeman effect in hyperfine structure, Back Groudsmit effect in hyperfine structure. (H-12 M-24)

2. Pure Rotation Spectra.:

Introduction to rotational spectra, Determination of moment of inertia & bond length from rotational spectra, relative intensities of spectral lines. (H-4 M-6)

3. Microwave Spectroscopy:

Rotational spectra of rigid and nonrigid molecules through microwave spectroscopy, Experimental techniques, Microwave spectrometer, Nuclear Hyperfine structure in molecular rotation spectra. (H-4 M-6)

4. Vibrational Spectra:

Anharmonic oscillator, deduction of molecular properties from vibrational spectra of diatonic molecules . (H-4 M-6)

5. Rotation-Vibrational Spectra:

Coupling of rotation and vibration, rotation-vibration spectra, selection rules and transitions for the vibrating rotator, intensities in rotation and vibration spectrum, parallel and perpendicular bands of linear molecules, Isotope effect-vibration, rotation. (H-4 M-8)

6. Electronic Spectra Diatomic Molecules :

Electronic energy curves, potential energy curve, stable & unstable molecular states, vibrational structure of electronic spectra, general formula, graphical representation, rotational structure of electronic spectra, P,Q,R branches of band, band head formation, shading of bands: Fortrat diagram, intensities in electronic bands –vibrational structure Frank Condon principle. (H-6 M-10)

7. Raman Spectra :

Raman effect –Quantum theory, Molecular polarisability, Pure rotational Raman spectra of diatomic molecules, vibration rotation Raman spectrum of diatomic molecule, intensity alterations in Raman spectra of diatomic molecules, Application of IR & Raman spectroscopy in the structure determination of simple molecules, polarization of Raman lines. (H-7 M-10)

8. NMR spectroscopy

Resonance Technique :

1) NMR – nuclear spin magnetic moment, interaction of nuclear magnet with external field. Quantum description of N.M.R., NMR spectrometer, Chemical shift, Spin–spin interaction, Application of NMR spectroscopy.

2) ESR – Electron spin interaction with external magnetic field, Thermal equilibrium & relaxation, A simple ESR spectrometer, ESR spectrum, Applications of ESR spectroscopy. (H-7 M-10)

Reference Books :

1. Molecular Spectra and Molecular Structure : G. Herzberq, Vol. I & II (Von Nostrand Co. Inc. 1965)
2. Spectroscopy and Molecular Structure : C.W. King Holt Reinhart and Winston Inc. 1964)
3. Introduction to atomic Spectra : H.E. White
4. Fundamental of Molecular Spectroscopy : C.B. Banwell
5. Basic Principles of Spectroscopy : Raymond Chang, McGraw Hill-Kogakusha Ltd, London 1971.
6. Introduction to IR and Raman Spectroscopy : Calthup, Daly & Wiberlay, Academic Press 1964.
7. Spectroscopy Vol I & II : Edited by B.P. Straughan & S. Walkar.

PHY-302(A): Microprocessor and its Applications

1. The 8086 Microprocessor:

Register organization of 8086, 8086 Architecture, Pin configuration, Physical Memory organization, General bus operation, I/O address capability, Special purpose activities, minimum and maximum mode of 8086 systems with timings. (H-12 M-25)

2. Instruction set of 8086 and programming:

Addressing modes of 8086, Instruction set of 8086, Assembler directives and operators. Simple programs like addition of two numbers, BCD addition, find the largest number, addition of two 3 x 3 matrices, move the string of data, find the number of positive numbers and negative numbers from, a given series of signed numbers etc. (H-17 M-25)

3. Special Architectural features:

Stack structure of 8086, Interrupts and interrupt service routine, Interrupt programming, Macros (Programming is not expected) (H-5 M-10)

4. Programmable Peripheral Devices and their Interfacing:

i] Programmable peripheral interface 8255.
ii] Programmable Communication interface 8251 USART.
iii] Programmable DMA interface 8257.
iv] Programmable interrupt Controller 8259. (H-10 M-15)

5. 32 bit Processor:

Features of 80386, 80486, 80586 (Pentium), MMX (Multimedia Extension) (H-4 M-5)

Reference Books:

1. Advance Microprocessor and Peripherals: A.K.Ray, K.M.Bhurchandi., Tata McGraw Hill ,New Delhi.
2. Microprocessor and Interfacing: Douglas V.Hall, McGraw Hill International Edition.
3. Architecture, Programming and Design: Yu Cheng Liu,G.A.Gibson,2nd Edition. PHI Publications.

PHY-302(B)- Solar Energy Conversion

1. Introduction :

Energy demand, Energy resources, Fossiel fuels, Hydroelectric power, Nuclear energy : utilization and limitations, Indian energy scenario, energy crisis, Nonconventional energy sources and their potential. (H-5 M-8)

2. Solar Energy :

Importance of Solar Energy; Solar Radiation; Sun as a fusion reactor; Spectral Distribution of Extraterrestrial Radiation; Estimation of extra-

terrstrial solar radiation; Variations in extra-terretrial solar radiation; Beam, diffuse and global radiation; Direction of beam radiation; Radiation on horizontal and tilted surfaces; Measurement of beam, diffuse and global radiation; Pyranometer, Pyrheliometer, Different routes to convert solar energy into different forms. (H-8 M-10)

3. Solar Thermal devices :
Basic Principles, Different types of solar collectors, Energy balance equation, Heat losses and efficiency of the solar collector, Solar cooker, Domestic hot water system, Industrial hot water system, Solar driers, Solar pond, Solar distillation, Solar furnace, Solar refrigeration, Solar power generation, Solar space heating and cooling. (H-6 M-12)

4. Flat Plate Collectors:
Construction; principle of operation; transmission of beam and diffuse radiation through the glass cover system; Transmittance- absorptance product; Energy balance equation; Evaluation of heat losses; Efficiency of solar thermal collectors; Liquid and air flat plate collectors. (H-4 M-8)

5. Selective Coating:
Selective coating; Ideal characteristics of selective coatings for various applications; Types of selective coatings; Materials and techniques for making selective absorbers; Effect of selective coating on the efficiency of solar collectors. (H-5 M-10)

6. Concentrating collectors:
Classification of solar concentrating collectors; Concentration ratio and second law limit of concentration ratio; Compound parabolic concentrator and its concentration ratio; Cylindrical parabolic concentrator and sizing of the absorber, Efficiency of solar concentrating collectors; Tracking of solar concentrators; Applications of solar concentrating collectors; Central receiver system. (H-8 M-14)

7. Energy Storage :
Sensible and latent heat storage system; Chemical energy storage systems; heat exchangers; hydrogen energy; storage, transportation and utilization of hydrogen, OTEC-concepts. (H-6 M-10)

8. Testing of Solar collectors :
Testing procedure for liquid flat plate collector and air flat plate collector. (H-6 M-8)

Reference Books:

1. Solar Engineering of Thermal Processes, Duffie, J. and W. Beckman(1991), John Wiley and Sons Inc.
2. .Solar Energy-Principles of Thermal Energy Collection and Storage, Sukahtme, S.P., .(1996) Tata McGraw Hill Co. Ltd.
3. Solar Energy Fundamentals and Applications, Garg, H. P. and Satyaprakash (1997), Tata McGraw Hill.
4. Solar Thermal Engineering Systems, Tewari, G.N. and Suneja,S .(1997) Narosa Publishing House.
5. Solar Power Engineering, Magal, B.S.(1990) Tata McGraw Hill.
6. A Text book on Energy Systems Engineering, Pandey, G.N. (1994), Vikas Publishing House.
7. Implementation of Solar Thermal Technology, Larson, Ronald and Ronald west (1996), MIT Press, ISBNO-262-12187-5.Part I,II,III,IV.
8. Energy Meteorology Part-I, Heineman, D.(1999) Solar Radiation, Carl V, Ossietzky Universitat, Germany.
9. Renewable Energy Sources and Conversion Technology, Bansal, N.K., M.K M. Meliss (1990) Tata McGraw Hill.

PHY-302(C): Communication Electronics

1. Modern Electronic Communication:
Block diagram of communication system, function of each block, modulation, necessity of modulation, types of modulation. (H-2 M-4)

2. Amplitude modulation & detection:
Theory and mathematical expression for AM, AM modulation factor (importance & derivation), Frequency spectrum, power relation in carrier and side bands, idea of SSB, SSBSC, DSB, DSBSC, AM circuits, Class C modulator, FET reactance balanced modulator, methods for SSB generation, Block diagram of AM transmitter and function of each block, diode as AM detector. (H-4 M-8)

3. Frequency Modulation & Detection:
Theory and mathematical expression for Fm, frequency deviation, modulation index, difference between AM & FM.

F.M. generation system – Different types, FET reactance modulator, varactor diode modulator.
Transmitter- Block diagram and explanation, FM detection- phase shift, Foster seller discriminator.

(H-4 M-8)

4. Antenna :
Antenna parameters- power gain, isotropic radiator, radiation resistance, directivity, directional gain, radiation parameter, polarization, effective apparatus, effective length, front to back ratio. Types of antenna- Half wave dipole (without mathematical derivation), Yagi & dish antenna. (H-4 M-5)

5. Elements of T.V. System :
TV fundamentals, sound transmission, picture transmission, sound transmission, sound reception, picture reception, front panel control of TV, TV standards. (H-4 M-5)

6. Scanning:
Horizontal, vertical and progressive interface scanning, synchronizing and blanking pulses, composite video signals. (H-2 M-4)

7. T.V. Camera Tube:
Detail explanation of Videocon tube, T. V. transmitter –Block diagram and function of each block., T.V. receiver- Block diagram and function of each block. (H-4 M-6)

8. Colour T.V.:
Compatibility, colour perception three colour theory (mixing of colours), colour TV camera, luminance signal, chroma signal, (colour difference signal of colour), colour TV picture tube, Trintron colour picture tube, simplified block diagram colour TV receiver and function of each block. (H-6 M-8)

9. Telephone Network :
Elemental phone system, public telephone network, central switching, hierarchy of switching offices, switched lines and leased lines, crossbar switch, common control, mobile telephone communication, celtular concept.

(H-4 M-8)

10. Remote control of receiver function :
Remote transmitter (diagram of remote IR transmitter and explanation), remote control receiver (Block diagram and its explanation). Pulse Modulation – Idea of pulse modulation, sampling theorem, analog pulse modulation, digital pulse modulation- PCM (Introduction and quantization), Analog pulse modulation-PAM, PWM, PPM. (H-6 M-10)

11. Optical fiber Communication:
Block diagram of optical fiber communication, function of each block, construction, single mode, multi mode, graded mode, step index and advantages. (H-4 M-6)

12. Satellite communication:
Elements of satellite communication systems, geostationary satellite, geostationary orbit, uplink, downlink, TV broadcast via INTELSAT & DOMSAT, Areas of application of satellite. (H-4 M-8)

Reference Books:

1. Electronic communication- Sanjeeva Gupta (Khanna Publication, Delhi)
2. Electronic communication system : Fundamentals through advances Wame Tomdsi (Prentice Hall Publication)
3. Basic Electronics – D.C.Tayal
4. T.V.Fundamentals – Anil Maini
5. Electronic communication system – Kennedy.
6. Electronic communication- Roddy & Coolen.
7. Electronic communication – Deshpande & Deshpande.
8. Satellite communication – Giglardi Robert M.
9. Antenna – K.D.Prasad.
10. Electronic communication, modulation & transmission – Robert J. Schoenback (Universal Book Stall Delhi)
11. Modern Satellite & Cable T.V.Manual – Manohar Lolia.
12. Monochrome & Colour T.V. – R.R.Gulati
13. Colour T.V.Trouble shooting – R.C.Vijay (B.P.B.publication)
14. Colour TV Principle & Practice – R.R.Gulati (New Age international Publications)
15. Electronic Communication systems- IInd edition, Blake Thomson, Delmar Publishers.
16. Electronic Communication systems- IIIrd edition, Dungan Delmar Publishers.

PHY-303(A): Systematic Materials Analysis

1. Characterization Techniques:
Importance of materials characterization, Classification of characterization techniques, Destructive and non-destructive techniques, Electromagnetic spectrum, Properties of electromagnetic radiation. (H-6 M-8)

2. Infrared Spectroscopy:
Range of IR absorption, Requirements for infrared radiation Absorption, Theory of IR absorption Spectroscopy, Linear molecules, Symmetric top molecules, Asymmetric molecules, Spectrophotometers, Application of IR Spectroscopy, Limitation of IR Spectroscopy. (H-8 M-10)

3. Raman Spectroscopy:
Characteristic properties of Raman Lines, Differences between Raman spectra and infrared spectra, Mechanism of Raman effect, Instrumentation, Intensity of Raman Lines, Application of Raman spectroscopy, Laser Raman spectroscopy. (H-8 M-10)

4. Ultra Violet & Visible Spectroscopy:
Colour and light absorption, The chromophore concept, Theory of electronic spectroscopy - orbital involved in electronic transitions, Laws of light absorption-Beer's and Lambert's laws, Instrumentation. UV spectrometer, Sample and reference cells, Vacuum ultraviolet, Applications of UV visible spectroscopy. (H-8 M-14)

5. X-Ray Diffraction:
Crystalline state, X-ray diffraction processes, Preliminary discussion of powder and single crystal pattern and their information content, Structure determination, Particle size determination, Crystallography by diffraction of radiation other than X-ray. Applications of X-ray diffraction measurements. (H-6 M-14)

6. Surface Spectroscopy:
X-ray Photoelectron Spectroscopy, Auger electron spectroscopy, Loss spectroscopy, adsorption and desorption, Different energy analyzers. (H-6 M-12)

7. Electron Microscopy:
Optical microscopy, Scanning electron microscopy, Electron diffraction. Secondary electron emission, electron microprobe analysis, EDAX. (H-6 M-12)

Reference Books:

1. Elements of X-ray diffraction, B. D. Cullity, Addision-Wesely Publishing Co. Inc., USA.
2. SEM microcharacterization of semiconductors, D.B.Holt, and D.C.Joy, Academic Press, New Delhi.
3. Fundamentals of Molecular Spectroscopy, C.N.Banwell, Tata McGraw-Hill Publ. Co. Ltd. New Delhi.

4. Instrumental methods of Analysis (Seventh Edition), H.H. Willard, L.L. Merritt, John A Dean, F.A. Settle, CBS Publishers and Distributors, New Delhi-110002.

PHY-303(B): Physics of Nanomaterials

1. Introduction:
Idea of crystalline, microcrystalline and nanocrystalline materials. Free electron theory[qualitative idea] and its features, Idea of band structure, metals, insulators and semiconductors, Density of states in bands, variation of density of states with energy, variation of density of states and band gap with size of crystal. (H-4 M-8)

2. Properties of nanomaterials:
Mechanical, thermal, structural, optical, magnetic and electrical. (H-6 M-8)

3. Synthesis of nanomaterials:
Physical, chemical, biological, arc deposition, cluster beam, laser deposition, MBE, MOCVD, glasses, Zeolites, polymer media, chemical, self assembly. (H-8 M-16)

4. Analysis of nanostructures:
Microscopies-TEM, SEM, AFM, XRD, optical: UV-VIS, IR, XPS. (H-8 M-12)

5. Photonics and Magnetomics:
GMR, CMR, Spintronics, photomics. Determination of particle size, Increase in width of XRD peaks of nanoparticles, shift in photoluminescence peaks, variations in Raman spectra of nanomaterials. (H-8 M-16)

5. Applications:
LED, SET, GMR, Display panels, sensors, medical. (H-6 M-4)

6. Quantum dots:
Electron confinement in infinitely deep square well, confinement in two and one dimensional well, Idea of quantum well structure, Quantum dots, Quantum wires. (H-8 M-16)

Reference Books:

1. Quantum Dots: L.Jacak, P.Hawzylak, Wojs Springer (1997)
2. Optical properties of semiconductor nanocrystals: S. V. Gaponenko Cambridge Press (1997).

3. Semiconductor Quantum Dots: L.Banjaj and S.W.Koch.
4 Low dimensional semiconductors.: M.J.Kelley Clarenden.
5. Physics of low dimensional structures : J.H.Davis Cambridge (1998).
6. Physics and applications of semiconductor microstructures:- M.Jaross Clarendon (1989).

PHY-303(C): Acoustics and Entertainment Electronics

1. Basic Principles:

Sound Wave propagation, plane and Spherical waves, Plane wave equation (No derivation),Acoustic Intensity, Energy density, Acoustic impedance, Decibel Scales: Intensity level, Sound Pressure level, Sound power level, Loudness level, Equivalent continuous sound level, Laeqt, Perceived noise level LEPN, Noise pollution level, LNP.

Human Speech and hearing mechanism, Threshold of audibility and feeling, Analogy among Electrical, Mechanical and Acoustical systems.

(H-8 M-12)

2. Architectural Acoustics:

Reverberation time, Decay of sound in a live room, Sabine Equation, Decay of sound in a dead room, Eyring's Journals, Optimum reverberation time, Coefficient of absorption and its measurement. Methods of measurement of reverberation time, Synthetic reverberation, Acoustical evaluation of Theatre/ auditoria/ studios, Requirements for good acoustics of Theatre/Studios/ auditoria. Sound reinforcement systems for auditoria. Amplifier power requirements, Audio delayers. (H-8 M-18)

3. Loudspeakers:

Direct radiator dynamic loudspeakers, Horn loudspeakers, Directional characteristics, Equivalent circuits, Efficiency of loudspeakers, Special Purpose loudspeakers, Loudspeaker systems, woofer, midrange/squankes, tweeter, Crossover, networks, Loudspeaker Cabinets. (H-6 M-10)

4. Microphones:

Carbon, Condenser. Moving coil dynamic and ribbon microphones. Microphone sensitivity, directional characteristics and applications. Calibration of microphones. (H-6 M-8)

5. Sound Recording and Reproducing systems:

Basic requirements of a system for good quality recording and reproduction.

Hi-Fi system, volume compressors. Viviters and expanders, Graphic equalizers. Monophonic and stereophonic sound reproducing systems. Magnetic tape sound recording and reproducing systems, Basic principles Analogue recording, Digital Audio tape, recording (DAT), Noise reduction in sound reproducing system-(I) Dolby A., B. System, Basic principles of compact Disc (CD), audio systems. (H-8 M-16)

6. Music:

Characteristics of musical notes: Vibratio, tremolo, portamento, waveforms of typical musical tones, Basic principles of musical instruments, Electronic musical instruments, Computer music, MIDI and applications. (H-6 M-8)

7. Ultrasonic and underwater acoustics:

Ultrasonic transducers-Principles and applications, Under water acoustics-Principles and applications of underwater transducers, underwater communication, SONAR. H-6 M-8)

Reference Books:

1. Fundamentals of acoustics (2nd Ed.)-Kinsler and Frey.
2. Acoustics-W.W.Sets (Schwm series)
3. Music Physics and Engineering-HIF Olson
4. Acoustics Measurement-L.L.Bernek
5. Basic Acoustics-D.E.Hall
6. Technical Ascepts of sound-(Vol.I)Richardzen
7. Noise reduction-L.L.Bernk
8. Audio Cyclopedia-H.Tremanic
9. Hand book of sound Enpineors (New Audio cyclopedia)-G.M. Balloh (Ed.)
10. Acoustic techniques for the Home and Studio-F Alton Everest.
11. Design for good acoustics and noise control- J.E.Moore.
12. Acoustics sourcebook-S. Parker(Ed).

PHY-303(D): Biomedical Instrumentation

1. Bioelectric Signals And Electrodes :

Origin of Bioelectric Signals, Recording electrodes, Skin Contact Impedance, Electrodes for ECG, Electrodes for EEG, Electrodes for EMG, Electrical Conductivity of Electrode Jellies and Creams, Microelectrodes. (H6 M-10)

2. Cardiovascular System :

Physiology of Heart and Cardio vascular System, ECG Lead Configuration,

ECG Recorders, Vector Cardiograph, Phonocardiograph, Characteristics of Blood Flow and Blood Pressure, Measurement of Cardiac-output.

(H-7 M-10)

3. The Nervous Systems :

The anatomy of the Nervous System, Neuronal Communication, Neuronal Receptors, The Somatic Nervous and Autonomic Nervous System and Spinal Reflexes, Neuronal Firing Measurement, EEG Measurements, Recorder for EEG and EMG.

(H-7 M-10)

4. Therapeutic Equipment :

Cardiac Pacemakers, Cardiac Defibrillators, Short Wave, Diathermy Machine, Microwave Diathermy Machine, Ultrasonic Therapy Unit.

(H-8 M-16)

5. Medical Imaging System :

Instrumentation for Diagnostics X-Ray – Properties, X-ray Units, X-Ray Machines and Generation of X-ray, X-ray image intensifier, Television System, C.T. Scan (X-ray Computed Tomography).

Ultrasonic Imaging System- Physics of ultrasound, Basic Mode of Transmission,

Ultrasonic Display Modes – A Scan, B Scan and m Scan, Biological Effects of Ultrasound.

(H-9 M20)

6. Patient Monitoring System :

System Concepts, Measurement of Heart Rate, Blood Pressure Measurement, Measurement of Temperature, Measurement of Respiration Rate. (H-7 M-8)

7. Electrical Safety Of Medical Equipment :

Physiological effects of electrical current, Electric Shock Hazards, Methods of Accident Prevention.

(H-4 M-6)

Reference Books:

1. Handbook of Biomedical Instrumentation- R.S.Khandpur, Tata McGraw Hill Publishing Company Ltd.
2. Biomedical Instrumentation and Measurements – 2nd Edition, Leslie Cromwell, F.Weibell, C.A.Pfeiffer, Prentice Hall of India.
3. Medical Medical Instrumentation- Application and Design- 3rd Edition, John.G.Webster, Editor- John, Wiley and Sonc. Inc.
4. Biomedical Instrumentation and Measurements: Leslie Cromwell, Fred.J.Weibell, Erich A Pfeiffer .(2nd edition)
5. Handbook of Biomedical Instrumentation: R. S. Khandpur,. TMH Publishing Company.

6. Introduction to Biomedical Equipment Technology: Carr and Brown (John Wiley and Sons 1981)
7. Principles of Neural Science: Kandel and Schwart, (Elservier. North Holland 1981).

PHY-304 Special Practicals: Lab I

Group A: Any six of the following:

1. Analysis of given compound by Thermogravimetric analysis (TGA).
2. Analysis of given compound by Differential thermal analysis (DTA).
3. Deposition by spray pyrolysis and thickness measurement by gravimetric method.
4. Synthesis of CdS thin film by chemical bath deposition (CBD) method.
5. Study of dielectric behavior of $BaTiO_3$ sample.
6. PAM, PWM and PPM using IC-555
7. Design, build and test Half and Full substractor.
8. Design and study Notch filter using IC-741.
9. Design, build and test up-down counter.
10. Design, build and test code converter circuit.
11. To study the Horn antenna characteristics using microwave bench.

Group B: Any six of the following:

Microprocessor

1. Square, Triangular and Ramp wave generator using microprocessor.
2. Interfacing an eight bit ADC with microprocessor.
3. Write a program for four digit hexadecimal counter. The counter should stop and resume counting by pressing a key.
4. Temperature measurement using ADC.
5. Read data through thumb wheel switches and display it on monitor and 7-segment display.
6. Write a program to control relay switches with a delay of 1 second.
7. Average the given set of data and display the result in decimal form.
8. Stepper motor speed control using microprocessor.
9. Read string through keyboard which is terminated by any specified character and reverse the string.

10. Read two digit hexadecimal number through key board and convert it into binary form.
11. Interrupt driven clock. (Ref. Ramesh S.Gaonkar Page No.376)

Solar energy :

1. Determination of Calorific value of Wood/Cow dung
2. Study of Optical Properties of Selective Coatings.
3. Study of I-V Characteristics of Solar Cell (Variation of Intensity, Distance between Source and Solar Cell, and Load variation)
4. Study of Power versus Load Characteristics of Solar Photovoltaic Systems and Study of Series and Parallel Combination of Solar Photovoltaic Panels.
5. Study of Solar Photovoltaic Systems such as street light, water pumping system, domestic lighting system, Solar lantern etc.(Any two system)
6. Study of Solar Flat Plate Collector. Plot of Efficiency versus delta T/I curve
7. Study of Hot Water System.
8. Determination of Heat Loss Coefficients in Flat Plate Collector.
9. Study of Solar Dryer (Hot Air Collector)
10. Study of Solar Still.
11. Performance Evaluation of Box Type solar cooker (Finding F1 and F2)
12. Performance evaluation of Concentrating Type Solar Cooker-SK14..

Biomedical Instrumentation

1. ECG preamplifer- instrumentation amplifiers design & testing.
2. Active filters for biosignals-design & testing.
3. Waveshaping circuits for cardiac pacemaker
4. Acostic impedence mesurement
5. Recording of action potentials with extra cellular electrodes.
6. ECG signal recording with structure electrodes.
7. Blood pressure measurement with transducer/pressure differentiation circuits.

PHY-305 (IIIrd Semester): M. Sc. Project

Activities:

1. To display the list of "project titles" on notice board.
2. To organize a meeting of project supervisors and students to discuss.
3. To finalize the project titles as far as to match student's particular interest.
4. To survey the Literature.
5. To set the experiment/to start Preliminary Experimental work.
6. Internal oral examination(20 Marks).

PHY-401: Condensed Matter Physics-II

1. Charge carriers and Fermi level in semiconductor in Equilibrium:
Intrinsic carrier concentration, and Fermi level position, Impurity carrier concentration, Equilibrium distribution of electron and holes and its temperature dependence, Position of Fermi level and its variation with temperature and concentration. Temperature dependence of minority carriers. (H-6 M-10)

2. Imperfection in atomic packing:
Classification of imperfections: Point defect-Schottky defect, Frekel defect and their concentration in equilibrium. Line defect: Origin of edge and screw dislocations, mechanism of plastic deformation in solids, stress and strain fields of screw and edge dislocations. Elastic energy of dislocations. Various methods to estimate density of dislocations. Experimental method of observing dislocations. Dislocation and Growth of crystals. Motion of dislocation, creep, Frank and Read source (multiplication of dislocation). Colour centers : F-centres, V-centres. (H-8 M-15)

3. Characterization of semiconductor solids :
Measurement of resistivity, mobility, carrier concentration, diffusivity, Hall coefficient and carrier types for majority carriers, Hall effect in intrinsic semiconductors, Haynes-Schockley experiment: Mobility, diffusivity and life time of minority carriers. (H-8 M-12)

4. Luminescence:
Types of luminescence, Excitation and emission, Decay mechanism, Thallium activated alkali halides, sulphide phosphors. (H-6 M-8)

5. Mossbaur effect:
Elementary considerations. Theory of Mossbaur spectroscopy, Instrumentation, Application of Mossbaur spectroscopy. (H-4 M-8)

6. Photoconductivity:

Historical survey, Photoconducting materials, Electronic transitions, Photoconductors, Absorption and Excitation, Trapping and capture, Recombination, Life time, Photoconductivity, Capture cross section, Simple model of photoconductor, Excitation, Absorption. Excitation across the gap, Trapping and its effects. (H-8 M-12)

7. Superconductivity:

Basic concept, Occurrence, Miessner effect, Critical field, type-I, type-II superconductors, Critical currents, Thermodynamics of super conducting transitions, London equations, Coherence length, London penetration Depth, BCS theory of superconductivity, High Tc super conducting materials. (H-8 M-15)

Reference Books:

1. Semiconductor and Electronic Devices : Adir Bar-Ler (1987), Prentice Hall India.
2. Physics of Semiconductor Devices : Roy, D.K. (1992), University's Press.
3. Solid State Electronic devices: Streetman, B.G. (1990),3rd Ed. Englewood cliffs, N. J., Prentice Hall India.
4. Introduction to Solids: L. V. Azaroff.
5. The Physics of Engineering Solids :T. S. Hutchison and D. C. Baird.
6. Solid State Physics : R. L. Singhal
7. Fundamentals of Solid State Physics : Saxena and Gupta.
8. Mossbaur Effect.: G. K. Wertheim.
9. Introduction Mossbaur Effect : V. G. Bhide.
10. Crystal Growth and Characterization: R. Ueda, J. B. Mullin.
11. Photoconductivity of Solids : Richard H. Bube, John Wiley and Sons, Inc.
12. An Introduction of Luminescence of Solids: Leverenz H.W., John Wiley and Sons, New York (1950)
13. Solid State Physics: A.J. Dekkar, McMillan students Ed.
14. Introduction to Solid State Physics: C. Kittle, Wiley Eastern Ltd; Editions.
15. Solid State Physics: C. M. Kachhara, Tata Mc Graw Hill Eds.

PHY-402(A): Computational Methods and Programming using 'C' Language

1. 'C' Language :

a) Review of C language for preparing and running 'C' programs. (H-5 M-8)

b) **Pointers:** The concepts of pointers, The address operator, pointer arithmetic, pointers as function parameters, pointers and arrays, Dynamic storage allocation. (H-3 M-5)

c) **Structures and Unions:** Declaration and period operator, structure initialization, structure and arrays, structure and functions, structure and pointers, structure within structure, Unions, Rules to use unions. (H-3 M-6)

d) **File handling:** Opening and closing a data file, creating a data file, processing a data file. (H-3 M-5)

2. Numerical methods:

In the following topics on numerical methods, students are expected to be able to write programs using "C" language as well as perform numerical calculations using electronic calculators and mathematical tables.

a) **Iterative methods to obtain roots of equations:** The method of successive bisection, false position method, Newton-Raphson method. Derivation of formula and advantages as well as limitations of these methods over each other. (H-8 M-12)

b) **Interpolation:** Definition of interpolation and extrapolation, finite differences, Interpolation with equally spaced and unevenly spaced points. Lagranges interpolation, curve fitting,, polynomial least squares and cubic spline fitting. (H-8 M-12)

c) **Numerical Integration:** Derivation and application of Trapezoidal, Simpson 1/3 and Simpson's $3/8^{th}$ rule. (H-7 M-12)

d) **Solution of simultaneous linear equations:** Gauss elimination method, pivotal condensation, Gauss Seidal method. (H-7 M-12)

e) **Solution of first order differential equation:** Eulers method, Runge-Kutta methods. (H-4 M-8)

Reference Books:

1. The 'C' Programming Language: Kernighan B.W. & Ritchie D.M. (Prentice Hall India Pvt. Ltd.)

2. Let us 'C': Yashwant Kanetkar (BPB Publications)
3. Schaum's outline of theory and problems of programming with 'C': Gottfried B.S. (Tata McGraw Hill Publishing Co. Ltd.)
4. Programming in ANSI C (II[nd] Edition): E.Balagurusamy (Tata McGraw Hill Publishing Co.Ltd.)
5. The C language Trainer with C graphics and C[++] : J. Jayasri (New Age International Pvt. Ltd. New Delhi.)
6. The spirt of 'C' : Mullish Cooper (Jaico Publishing Co.New Delhi)
7. Programming in ANSI C : Ramkumar (Tata McGraw Hill)
8. Introductory methods of Numerical Analysis: S.S.Sastry.
9. Numerical Analysis : Goel and Mittal (Pragati Prakashan, Merrut)
10. Numerical methods for engineers with programming and software applications : Steven C. Chapra, Raymond, P.Canale (McGraw Hill)
11. Numerical Methods problems and solutions : M.K. Jain, S.R.K. Iyengar, R.K. Jain (Wiley Eastern Ltd)
12. Numerical methods for Mathematics, Science and Engineering: John Mathews (Prentice Hall India Pvt Ltd)
13. Numerical Receips in C : Willam Press & Teukolsky (Cambridge University Press)
14. Computer Oriented Numerical Methods : V. Rajaraman (Prentice Hall India Pvt Ltd)

PHY-402(B):Renewable Energy Sources

1. Conventional Sources of Energy:
Fossil fuels, coal, oils and natural gas. Hydro power, Nuclear power, Electrical power, limitations, Indian Energy scenezio (Sukhatme).
Renewable Energy Sources: Solar, wind, bromass, Tidal, Geothermal, Hydrogen as source of energy. Their potential (Sukhatme)
(H-6 M-12)

2. Solar Energy:
Fundamentals of photovoltaic energy conversion, Principles of solar cell, materials and fabrication technologies of solar cell, P. V. Systems, street lights, water pumps, radio/TV, small capacity power generation, energy storage through charged batteries. (H-10 M-16)

3. Biomass Energy Conversion Technologies:
Types of biomass energy conversion processes, photosynthesis, generation of biogas, digesters and their designs, pyrolysis and gasification, fermentation process, waste as source of energy. (H-8 M-10)

4. Wind Energy:
Origin and classification of winds, relation between wind velocity and power, principles of wind machine and its performance, horizontal and vertical axis wind mills, merits and limitations of wind energy conversions. (H-8 M-16)

5. Ocean Energy:
Ocean as the potential energy resource, origin of ocean temperature, difference and its use as the energy resource, Ocean waves, energy and power from ocean waves, origin of tidal energy and tidal energy schemes. (H-6 M-10)

6. Hydrogen Energy Technology:
Hydrogen as clean source of energy, sources of hydrogen Thermodynamics of water splitting, photoelectrolysis of water, Direct thermal decomposition of water, Thermochemical production of hydrogen. Use of hydrogen as fuel, use in vehicular transport, Hydrogen for electricity generation, Fuel Cells. (H-10 M-16)

Reference Books:

1. Solar Energy Utilisatio: G.D.Rai, Khanna Publishers (1996)
2. Solar Energy Conversion: S. P. Sukhatne(2nd editions)
3. Terrestrial solar photovoltaics: Japan Bhattacharya, Naros Publication House New Delhi(1998)
4. Energy Technology: S.Rao, Br.B.B.Parulekar, Khanna Publisher (1995)
5. Solar Cells : M.A.Green
6. Solar Thermal Engineering: J.A.Duffie
7. Hydrogen as an Energy carrier Technologies systems Economy: Winter & Nitch
8. Solar Energy Conversion: A. E. Dixnon & J. D. Leslie.
9. Power plant Technology: M. M. El. Wakil.
10. Solar Energy and Rural Development: S.H.Pawar, C.D.Lokhande & R.N.Patil
11. Wood Energy Systems : O.P.Vimal & M.S.Bhatt.
12. Biomass Energy : S.H.Pawar, L.J.Bhosale, A.B.Sabale, S.K.Goel.
13. Energy through solar Hydrogen alternatives : J.O.M.Bocksis.
14. Cryogenics and its Applications : S.H.Pawar, V.N.Shinde, K.G.Narayan, Khedkar.

PHY-402(C): Lasers and its Applications

1. Basic of Lasers:
Interaction of radiation with matter: Absorption, Spontaneous and Stimulated emission, Einstein's coefficients, Population inversion for amplification of light. (H-5 M-8)

2. Theory of Laser Oscillator:
Two level system (Ammonia maser- Physical separation of excited species from those in ground state). Three and four level system, Rate equations for three and four level system, Threshold pump power, Relative merits and de-merits of three and four level systems. (H-6 M-10)

3. Optical resonators:
Resonator configurations, Stability of resonators, Characteristics of Gaussian beam, Transverse and longitudinal modes, Mode selection techniques (at least two techniques in each case), Losses in resonator, Hardware design-laser support structure, Mirror mounts, Optical coatings etc. (H-8 M-10)

4. Solid State Lasers:
The Ruby laser, Nd: YAG laser, Nd: Glass lasers, Characteristics of semiconductor lasers.
Gas and Dye Lasers: Excitation in gas discharge, Collisions of 1st and 2nd kind, Electron impact excitation-its cross section, Different types of gas lasers: He – Ne, N_2, CO_2, Metal vapour lasers, Excimer and chemical lasers, Dye laser.
Gas Lasers: Process of excitation and de-excitation in gas lasers, Neutral-Atom gas laser, Lamb-dip phenomenon and construction.
Metal vapour lasers: He-Cd and He-Se lasers, construction of metal vapour lasers.
Molecular Gas Lasers: Energy levels of molecules, Vibrational-Rotational lasers: CO_2-laser system, Construction and working of CO_2-Laser, Different types of CO_2 lasers.
Vibronic Lasers: Construction and working of N_2-Laser, excimer laser.
Dye Lasers: Characteristics of dye lasers, Rate equations for dye lasers.
Chemical Lasers: H_2, F_2 mixture and DF, CO_2 mixture lasers.
(H-14 M-24)

5. Laser parameter measurements:
Measurements of Laser power, energy-wavelength, frequency, line width. Detectors and their operational mechanism including specific properties like rise time spectral response etc. (H-7 M-12)

6. Applications of Lasers:
Optical communication, Holography, Laser Spectroscopy, material processing: welding, hardening, drilling, cutting. Medical applications, Laser range finding, Laser fusion, Military applications. (H-8 M-16)

Reference Books:

1. Principles of Lasers: O.Suelto-Plenum, 1982.
2. Laser Fundamentals: W. T. Silfrart.
3. An introduction to lasers and their applications: D.C.O.Shea, W. Russell and W.T.Rhodes (1977) Addition , Welslay Pub.Co.
4. Laser Applications: Ed. Monte Ross, Vol.III (1977) Academic Press.
5. Principles of laser and their applications: by Callen, O'shea, Rhodes.
6. Laser guide book: J.Hechr.
7. Lasers: A.G.Sigman, Oxford University Press 1986.
8. Lasers and non linear opticals: B.B.Laud (2nd edition).

PHY-403(A): Microwaves : Theory and Applications

1. Prerequisite:
Electron motion in electric field, magnetic field and electromagnetic field, Electric and magnetic wave equations, Poynting theorem, plane wave propagation in free space, poor conductor, good conductor and lossy dielectric. (H-6 M-8)

Passive Elements:

2. Transmission Lines:
Introduction to microwaves and its applications, Skin effect, Transmission line theory, TL equations and their solutions, Open and terminated transmission lines, Line impedances, Line admittance, reflection coefficient, transmission coefficient, standing wave ratio, Impedance matching, Smith chart, Single stub matching and double stub matching. (H-6 M-10)

3. Wave Guides:
Rectangular and Circular wave guides, Solution of wave equation in rectangular co-ordinates, TE and TM modes in rectangular wave guide, Power transmission, Power losses and excitation modes in rectangular wave guides. (H-6 M-10)

4. Wave-guide components:

Attenuators, filters, junctions, rectangular cavity resonator, circular cavity resonator, E-plane (series tee), H-plane (shunt tee), magic tee (Hybrid tee), directional couplers, hybrid rings (Rat-Race), wave guide corners, bends, loads, Microwave circular isolators, Hybrid couplers. (H-6 M-10)

Active Elements:

5. Microwave Generators:

Microwave generation problems and principles, Tubes: Two cavity klystron and Reflex-klystron. Klystron operations amplifiers and oscillators, velocity modulation, bunching process, output power and beam loading efficiency of klystron.

Reflex Klystron: Velocity modulation, power output efficiency, electronic admittance.

Magnetron, Traveling wave tube amplifier : construction and operation.

Microwave transistors: Principle of operation, microwave characteristics-cutoff frequency, current gain, power gain.

Variable diode : Principle of operation, use of varactor diode for frequency multiplication. Microwave Tunnel diode: Principle of operation, Gunn diode, MOSFET, PIN diode: Principle of operation, microwave characteristics.

(H-9 M-16)

6. Measurements:

Smith chart: Derivation, use of chart for solving various problems in wave guide/ transmission lines,

Microwave measurements: Measurement of impedance, power, frequency, attenuation, SWR, dielectric constant, quality factor.

(H-6 M-10)

7. Applications:

- Radar: Block diagram of pulsed Radar and its working.
- Microwave ovens: Design requirements, sizes available, application areas.
- Medical applications.
- Satellite: Active, passive, design requirements, payload, launching sequence.
- Microwave link
- Masers & Lasers

(H-9 M-16)

Reference Books:

1. Foundation of microwave engineering . Colin R.E. McGraw Hill 1969.

2. Introduction to microwaves: Atwater, McGraw Hill 1962-63.
3. Introduction to microwave: Wheeler McGraw Hill 1962-63.
4. Microwave semiconductor devices and their circuit application: Watson McGraw Hill 1962-63.
5. Microwave circuits and elements: M.L.Sisodia
6. Electromagnetic fields and waves: Jorden
7. Microwave: K.C.Gupta
8. Electronic communication: Sangeeva Gupta
9. Introduction to microwave theory & Measuremebnt : Lance PUB McGraw Hill
10. Introduction to Radar: McGraw Hill,1962.
11. Electronics & Radio Engineering: McGraw Hill 1954.

PHY-403(B): Nuclear and Particle Physics

1. Basic concepts of general properties of nuclei:
Masses and relative abundance, Mass defect, size and shape, binding energy, angular momentum, magnetic dipole moment and electric quadrupole moment. Nuclear radius , Radioactivity, Units & radiation, Alpha, Beta and Gamma rays decay. (H-4 M-8)

2. Nucleon-Nucleon Interaction:
The deuteron problem, Radius of deuteron, Nature of interactions-Electromagnetics, weak interactions and Hadronic interactions. Nucleon-nucleon scattering, scattering cross section, Low-energy neutron-proton scattering, and proton-proton scattering, High energy neutron-proton and proton-proton scattering, antinucleus. Theory of nuclear forces, Measurement of nuclear parameters, Mossbaur effect. (H-8 M-10)

3. Interaction of electromagnetic radiation with matter:
Absorption geometrics, Absorption coefficients, The photoelectric process: general features, variation of cross section with Z and with hν, directional distribution of photoelectrons, average forward momentum, The compton process: general considerations, absorption cross section, angular and energy distribution of scattered photons and Compton electrons, The pair production process: theoretical basis, angular and energy distribution of pair electrons, screening, pair cross section, pair production in the field of an electron. (H-10 M-16)

4. Interaction of charged particles with matter:
Energy loss of heavy charged particles: stopping power, range and straggling, Cerenkov radiation: specific mechanism, radiative cross section, technical

importance, Bremsstrahlung: classical and quantum mechanical considerations, angular distribution, radiative cross section. (H-6 M-10)

5. Nuclear Models:
Liquid drop model, Fermi Gas model, shell model, collective model, single particle model of nucleus, magic numbers, spin orbit coupling, prediction of angular momenta of nuclear ground states, Nuclear energy levels and their applications. (H-6 M-12)

6. Reaction dynamics:
The Q of nuclear reactions, Compound nucleus formation and breakup, Nuclear fission and heavy ion induced reactions, Fusion reactions, types of nuclear reactors. Theory of stripping reactions. Basic principles of (i) electron accelerator and (ii) ion accelerator. Linear accelerator, cyclic accelerator, Pelletron Electron gun; Radiation detector, Gas detectors, NaI(Tℓ) detectors, Semiconductor detectors, Bubble chamber, cloud chamber, spark chamber. (H-8 M-14)

7. Elementary particle Physics :
Introduction, classification of elementary particles, Particle interactions, conservation laws, Invariance under charge, Electrons and Positrons, Protons and antiprotons, Neutrons and antineutrons, Neutrinos and antineutrinos, Mesons: Muon, Pion, k-meson, n-meson, Resonance. states, Quark theory, Electromagnetic structure of nucleons. (H-6 M-10)

Reference Books:

1. Concepts of Nuclear Physics: B.L.Choen Tata McGraw Hill
2. Subatomic Physics: Franenfelder and Hanley Prentice Hall
3. Nuclei and Particles : E. Segre.
4. Atomic Nucleus : R. C. Evans
5. Basic Nuclear Physics: B.N. Shrivastava
6. Introduction to Nuclear Physics: David Halliday.
7. Introduction to Nuclear Physics : Herald Enge.
8. Nuclear Physics: Irving Kaplan
9. Elements of Nuclear Physics: M.L.Pandya and Yadav
10. An Introduction to Nuclear Physics : Bhide & Joshi
11. Nuclear Physics : D.G.Tayal.

PHY-403(C): Environmental Physics

1. Introduction:
Environmental science & overview, definition, concept & scope, types of environmental approaches, Nomenclature, environmental segments, natural cycles (hydrologica, oxygen, nitrogen cycle). (H-6 M-10)

2. Atmosphere:
Composition of atmosphere, its structure, evolution of atmosphere, earth's radiation balance, chemical & photochemical reactions in the atmosphere. (H-8 M-10)

3. Environmental Resources:
Forest-Utilization, degradation & conservation water-water cycle, degradation & conservation Soil-utilization degradation & conservation. (H-6 M-10)

4. Pollution & environmental problems:
Meaning of pollution, sources, causes elementary fluid dynamics, factors governing air, water and noise pollution Green house effect/Global warming ozone hole. El Nino phenomenon. Acid Ran. (H-8 M-12)

5. Water Pollution:
Acquatic environment, water pollutant, waste water treatment, water quality parameters & standards, sampling, preservation, monitoring techniques pH dissolved oxygen, chemical oxygen demand, total oxygen demand, analysis of water quality parameter. (H-8 M-14)

6. Air Pollution:
Air pollutant, air quality standard, sampling, monitoring, sampling, analysis. Gaseous and particulate matter. (H-4 M-10)

7. Global & Regional Climate:
Elements of weather and climate, stability and vertical and horizontal motion of air and water, viscous force, inertia force, Raynolds number, energy balance, pressure gradient force, global climate model and climate of India. (H-8 M-14)

Reference Books:

1. Environmental Chemistry: A.K.De
2. Physics of atmosphere: J.T.Hougtion (Cambridge Uni.Press:1977)
3. Renewable Energy Sources: Elbs.1988.J.T.Widell & J.Weir.

4. The Physics of Mansoons: R. N. Keshavmurthy & M. Shankar Rao Allied Publishers,1992.
5. Solar Energy: S.P.Sukhatme.
6. Solid State Energy Conversion: S.H.Pawar, V.H.Shinde.
7. Environmental Physics:Egbert Boekar and Rienk Van Groundelle(John Willey)
8. An Introduction to Solar Energy for Scientists and Engineers: Sol-Wieder John Wiley,1982.
9. Numerical Weather Prediction : G.J.Haltiner and R.T.Williams John Wiley,1980.

PHY-403(D): Astrophysics and Astronomy

1. Astronomical Instruments:
Optical telescopes-refracting and reflecting -(Newtonian & Cassegrain). Radio telescopes. Hubble's space telescope, spectroscopes, photometry, spectro-photometry, Detectors & image processing. (H-8 M-8)

2. Message from starlight:
Electromagnetic spectrum, Radiation from heated object, Doppler effect, Stellar spectra, determination of abundance of elements from stellar spectra. (H-6 M-10)

3. The Hertzsprung - Russel diagram:
Brightness and luminosity, population of stars, H-R diagram, variable and binary stars. (H-4 M-8)

4. Stellar Evolution:
Nuclear Fusion, Fusion reactions in stars formation of Helium, Carbon Oxygen and other reactions, Equation of state for stellar interior, Mechanical and thermal equilibrium in stars stellar evolution, white dwarfs red giants, pulsars, neutron stars, black holes. (H-10 M-14)

5. Galaxies:
Types of galaxies, evolution of galaxies, radiogalaxies, seyfert galaxies, quasars, milky way galaxy. (H-6 M-12)

6. General theory of relativity:
Space time & gravitation, vectors & tensors-contravariant & covariant vectors, symmetric and antisymmetric tensors, contraction, space time curvature, Geodesics, Principle of equivalence. (H-8 M-14)

7. Cosmology:

Big bang theory, steady state universe, oscillating universe, Hubble's law, experimental evidences for big bang, open and close universes. (H-6 M-14)

Reference Books:

1. Astronomy-Fundamentals and Frontiers-Robert Jastow and Malcolm H. Thompson (Pub. John Wiley & Sons)
2. An Introduction to Astrophysics-Baidyanath Basu (Pub. Prentice Hall India Pvt. Ltd.)
3. Introduction to Cosmology – J. V. Naralikar (Pub: Cambridge University Press)
4. An Introduction to the study of stellar structure- S. Chandarashekhar (Pub: Dover)
5. Measure of the universe- T.D. North (Pub: .Oxford University Press).

PHY-404 Special Practicals: Lab II

Group A: Any six of the following:

1. Photosensitivity of CdS / copper doped CdS thick film samples.
2. Study of TEP measurement of thick/thin film sample and type of semiconductor.
3. To determine the transition temperature and the heat of transition of the given sample of $BaTiO_3$ solid solution.
4. To study of magnetic susceptibility of given sample by Guoy method.
5. Structural investigation of a given sample by using X-ray diffraction spectrum.
6. Measurement of thickness of thin film by Tolansky method.
7. Determination of band gap energy of a given sample by using absorption/transmission spectra.
8. To study of beam divergence and determination of beam diameter.
9. Instrumentation amplifier with thermocouple or any other transducer.
10. Inductance simulation using IC-741.
11. Design and build duel power supply using 3-Pin regulator: 78XX & 79XX series.

Group B: Any six of the following:

(Use 'C' Language for programming)

1. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Bisection method.
2. Draw a flowchart and write a program to find the root of the equation f(x)=0 by Newton Raphson method.
3. Draw a flowchart and write a program to find the root of the equation f(x)=0 by False position method.
4. Draw a flowchart and write a program to integrate the given function using Trapezoidal rule.
5. Draw a flowchart and write a program to integrate the given function using Simpson's 1/3 rule.
6. Draw a flowchart and write a program to integrate the given function using Simpson's 3/8 rule.
7. Draw a flowchart and write a program for fitting of a polynomial of degree n using Lagrange's Interpolation formula.
8. Draw a flowchart and write a program to solve given set of simultaneous equations using Gauss Elimination method.
9. Draw a flowchart and write a program to solve given set of simultaneous equations using Gauss Seidal method.
10. Draw a flowchart and write a program to solve given differential equation using Euler's simple method.
11. Draw a flowchart and write a program to solve given differential equation using Runge-Kutta method.
12. Draw a flowchart and write a program for finding the inverse of a given matrix./transpose of a matrix.
13. Impliment strlen ( ), Strcat ( ), Strcpy ( ), Strcmp ( ) using pointers.
14. Write a menu driven program to create, list, modify and calculate the student record details. Assume the following file structure.

    Register No.
    Subject 1 mark
    Subject 2 mark
    Subject 3 mark

Renewable Energy Sources

1. Determination of calorific value of wood/cowdung.
2. Determination of wind power.
3. Wind data analysis of a given site.

Microwave

1. Study of passive components
2. Study of various loads
3. Determination of constants of transmission line, striplines.
4. Study of cavity resonator.
5. Study of ring resonator and rejection filter .
6. To design, fabricate and test a stripline resonater.
7. To prove Bragg's law using microwave diffraction spectrometer apparatus.
6. To study reflection of microwaves.
7. Refraction of microwaves by Lucile and Paraffin wax prisms.
8. Diffraction from multiple slits
9. Determination of dielectric constant of materials.
10. Polarization of microwaves with grating.

Astronomy-Astrophysics

1. To estimate the temperature of an artificial star by photometry.
2. To study characteristics of a CCD camera.
3. To study the solar limb davening effect
4. To polar assign an astronomical telescope.
5. To estimate the relative magnitudes of a group of stars by a CCD camera.

Laser

1. Power distribution within He-Ne Laser.
2. Determine the spot size of He-Ne laser beam.
3. Diameter of a given wire by diffraction.
4. Determination of Brewster's angle and estimation of refractive index of given transparent material.
5. Determination of bandwidth of a given optic1 fibre.

Material Science:

1. Phase equilibrium diagram for a binary Sn-Pb alloy.
2. Study of phase transmormation in a ferroelectric crystals.
3. Thermoluminescence of alkali halides.

4. Skin depth of electromagnetic radiation in Al.
5. Stress measurement of transparent conducting oxides (Newton's ring method)
6. Determination of diffusion coefficient of cobalt atoms in Gel medium.
7. Determination of direct and indirect band gap of a given materials by UV-visible spectroscopy.
8. Determination of inter atomic bond length in a diatomic molecule by studying rotational vibrational IR spectra.
9. Study of hysteresis of hard and soft ferrites.
10. Determination of resonance frequency of piezoelectric element.
11. Synthesis of conducting oxide films by pyrolysis method.

Refereaces Books :

1. Experiments in Material Science.: Prof. F. C. Subbarao, L. K. Singhal et al. Tata Mc Graw Hill Publishing Co. Bombay
2. Experiments with He-Ne laser : Sirohi
3. Experimental Physics: Warsnop & Flint.
4. Experimental Nuclear Physics : Pearson.
5. Solid State Manual : Pune University Publications.
6. Experiments with He-Ne laser : R.S.Sirotri, ,IIT Madras.

PHY-405 (IVth Semester) M.Sc.Project

Activities:

1. To complete the experimental work.
2. To carryout the measurements.
3. To characterize the samples.
4. To obtain the results.
5. To draw the conclusions.
6. To write the project report.
7. To appear for Internal oral examination (20 Marks).

Project Report:

1. Students have to write a 'project report'.
2. A report should be a concise account of project work containing full descriptions of the aims, method and outcomes.
3. Length of report should not normally exceed 40 pages.

Assessment Criteria of the project:

The following criteria are to used in assessing the project work:

(i)The conduct of project work:

The following questions are considered in assessing how well students have carried out the project work.

1. How difficult was the project?
2. How well did the student understand the scientific principles behind the project?
3. How well did the student plan the project work?
4. How much effort was put into the project?
5. Was an interium report presented on time?
6. Was the student's project logbooks adequate?
7. How much initiative and/or originality did the student contribute to the project?
8. How well did the student cope with problems that arose during the course of the project?
9. Did a project reach a stage of completion where meaningful results were obtained and definite conclusions could be drawn?

(ii) The Project Report:

1. How well did the report set out the background?
2. How well did the report describe the underlying them?
3. Was the report a reasonable length?
4. How well was the report structured?
5. How understandable was the written content?
6. How well did the report describe the execution of the project?
7. Did the report have an adequate summary or conclusions?

(iii) Oral Examination:

1. Did the student adequately describe what he/she had done in their project?
2. Did the student have a clear interpretation of his/her results?
3. What was the clarity and overall standard of the presentation?
4. How well was the talk/presentation structured?
5. Did the student cover all the relevant material in a reasonable time?