Board of Studies in Physics

FACULTY OF SCIENCE

GONDWANA UNIVERSITY, GADCHIROLI

Syllabus of

M.Sc. First Year (Semester Pattern)

SUBJECT - PHYSICS

Semester I &Semester II

Syllabus of M.Sc.(Physics) Semester Pattern

Syllabus for Each theory paper is based on 60 clock hours of teaching. Each lab will involve 15 clock hours per week.

M.Sc. Part I Semester I

1. Paper I: Mathematical Physics 75
2. Paper II: Classical Mechanics 75
3. Paper III: Solid State Physics I 75
4. Paper IV: Electrodynamics I 75

M.Sc. Part I Semester II

1. Paper I: Quantum Mechanics-I 75
2. Paper II: Numerical Methods 75
3. Paper III: Statistical Physics 75
4. Paper IV: Electrodynamics II 75

M.Sc. Part II Semester III

Compulsory Papers

1. Paper I: Quantum Mechanics-II 75
2. Paper II: Nuclear and Particle Physics-I 75

3. Any one of the Optional Papers from the following List

1. Materials science I 75
2. Atomic and Molecular Physics (Spectroscopy) I 75
3. Applied Electronics I 75
4. X-rays I 75
5. Nanoscience and Nanotechnology I 75

4. Any one of the following electives.

Note: Subject of Elective paper will be different from that of optional.

1. X-Rays 75
2. Materials Science 75
3. Numerical Methods and Programming 75
4. Spectroscopy elective I 75
5. Lasers, Fibre Optics and Applications elective I 75
6. Digital Electronics and Microprocessors. 75

M.Sc. Part II Semester IV

Compulsory Papers

1. Paper I: Solid State Physics II 75
2. Paper II: Nuclear and Particle Physics II 75

3. One of the Optional paper 2 for the subject same as that chosen in Semester III

1. Materials science II 75
2. Atomic and Molecular Physics (Spectroscopy) II 75
3. Applied Electronics II 75
4. X-rays II 75
5. Nanoscience and Nanotechnology II 75

4. Any of the following electives.

Note: Subject of Elective paper will be different from that of optional.

1. Nanoscience 75
2. Nonlinear Dynamics with Applications to Physics and other Sciences 75
3. Condensed Matter Physics 75
4. Electroacoustics 75
5. Spectroscopy elective and II 75
6. Lasers, Fibre Optics and Applications elective II 75

Board of Studies in Physics

FACULTY OF SCIENCE

GONDWANA UNIVERSITY, GADCHIROLI

Syllabus of

M.Sc. Final Year (Semester Pattern)

Semester III and IV

SUBJECT - PHYSICS

M.Sc. Part I Semester I

1. **Paper I: Mathematical Physics**
2. **Paper II: Classical Mechanics**
3. **Paper III: Solid State Physics I**
4. **Paper IV: Electrodynamics I**

M.Sc. Part I Semester II

1. **Paper I: Quantum Mechanics-I**
2. **Paper II: Numerical Methods**
3. **Paper III: Statistical Physics**
4. **Paper IV: Electrodynamics II**

M.Sc. Part II Semester III

Compulsory Papers

1. **Paper I: Quantum Mechanics-II**
2. **Paper II: Nuclear and Particle Physics-I**
3. **Any one of the Optional Papers from the following List**
    1. Materials science I
    2. Atomic and Molecular Physics (Spectroscopy) I
    3. Applied Electronics I
    4. X-rays I
    5. Nanoscience and Nanotechnology I

4. Any one of the following electives. Each one of equal Marks

Note: Subject of Elective paper will be different from that of optional.

1. X-Rays
2. Materials Science
3. Numerical Methods and Programming
4. Spectroscopy elective I
5. Lasers, Fibre Optics and Applications elective I
6. Digital Electronics and Microprocessors.

M.Sc. Part II Semester IV

Compulsory Papers

1. Paper I: Solid State Physics II

2. Paper II: Nuclear and Particle Physics II

3. One of the Optional paper 2 for the subject same as that chosen in Semester III

1. Materials science II
2. Atomic and Molecular Physics (Spectroscopy) II
3. Applied Electronics II
4. X-rays II
5. Nanoscience and Nanotechnology II

4. Any of the following electives. Each one of equal Marks

Note: Subject of Elective paper will be different from that of optional.

1. Nanoscience
2. Nonlinear Dynamics with Applications to Physics and other Sciences
3. Condensed Matter Physics
4. Electroacoustics
5. Spectroscopy elective and II
6. Lasers, Fibre Optics and Applications elective II

Semster III Paper I (Compulsory) Quantum Mechanics-II

Unit- I

Time independent perturbation theory, First order perturbation theory applied to non-degenerate states, second order perturbation extension to degenerate state, Application of perturbation theory to the ground state energy, He atom (calculation given in Pauling and Wilson), Normal and anomalous Zeeman effect, First order Stark effect in the ground and first excited states of H atom and second order Stark effect of H atom, an-harmonic oscillator.

Unit II

Time dependent perturbation theory, transition rate, Fermi Golden rule, constant perturbation harmonic in time, radiative transitions, absorption and induced emission, atomic radiation, dipole approximation, Einstein's atomic radiation, Einstein's A and b coefficients and their calculations.

Approximation methods: W. K. B. method and its application to barrier penetration.

Variational principle and its application to simple cases like ground state of He atom and deuteron in Yukawa potential.

Unit III

System of identical particles, exchange and transposition operators, totally symmetric and antisymmetric wave function and their expressions for a system of non-interacting particles, statistics of systems of identical particles, Relation of statistics with spin, Ortho and para states of the helium atom and their perturbation by Coulomb repulsion.

Hamiltonian of a molecule, Born-Oppenheimer approximation, outline of Heitler-London theory of the hydrogen molecule.

Scattering theory, scattering cross-section in laboratory and centre of mass system, scattering by a central potential , Partial wave method, phase shifts and their importance, scattering by a square well; potential and a perfectly rigid sphere, resonance scattering.

Unit IV

Relativistic wave equation, the Klein-Gordon equation and initial difficulties in interpreting its solutions, Dirac's relativistic equation, Dirac's matrices, explanation of the spin of the electron, equation for an electron in an electromagnetic field and explanation of the magnetic moment due to the electron spin, spin-orbit interaction, solution for hydrogen atom in Dirac's theory, negative energy states and their qualitative explanations.

Text and References Books:

1. E. Merzbacher, Quantum Mechanics (Wiley and Sons-Toppon)
2. J. L. Powell and B. Crazemann, uantum mechanics (B I Publications)
3. L. I. Schiff, Quantum Mechanics (McGraw-Hill)
4. Quantum Mechanmics Aruldhas
5. Pauling and Wilson, Introduction to Quantum Mechanics
6. A.K. Ghatak and Lokanathan, Quantum Mechanics (Macmillan, India)

Semster III Paper II (Compulsory) Nuclear and Particle Physics-I

Unit-I

Basic nuclear properties: size, shape, charge distribution, spin and parity, nuclear mass, and binding energy, semi-empirical mass formula, Angular momentum, magnetic moment and electric quadrupole moment, Molecular beam resonance, and NMR Methods, Mossbaur effect and its applications.

The nucleon-nucleon interaction: Nucleon-nucleon interaction and hadron structure, phenomenological nucleon – nucleon potentials, Meson theory, derivation of Yukawa interaction, Electromagnetic properties of deuteron-polarization in nucleon- nucleon scattering, cross- sections in terms of partial wave amplitude, Effective range theory, spin dependence of Nuclear forces, charge independence and charge symmetry of nuclear forces, Isospin formalism, reciprocity theorem, optical model, Exchange forces.

Unit-II

Nuclear Models : Evidence of Shell structure, Magic numbers, Single particle shell model, it's validity and limitations, Spin- orbit coupling, Angular momenta and parities of nuclear ground states, Magnetic moments and Schmidt lines, Determinantal wave functions of the nucleus – single particle operator and their expectation values.

Collective Models of Nucleus: Deformable liquid drop and nuclear fission, Shell effects on liquid drop energy, Collective vibrations and exited states, Permanent deformation and collective rotations, Energy levels, Electromagnetic properties of even – even, odd-A deformed nuclei, Nilsson model and equilibrium deformation, Behaviour of nuclei at high energy liquid drop model, Collective model of Bohr-Mottelson.

Unit-III

Nuclear Reactions: Compound nucleus, Direct and compound nuclear reaction mechanisms, Relativistic kinematics, Coulomb excitation, Elementary approach to potential scattering theory, S-wave neutron scattering in the compound nuclear reaction model, Derivation and discussion of Breit-Wigner resonance formula, Discussion of direct reactions, Ground state deuteron, Magnetic moment, Quadrupole moment, Stripping in zero range approximation, Pick-up reaction.

Nuclear Deacay: Elementary ideas of alpha, beta and gamma decays, Fermi theory of beta decay, Angular momentum and Parity Selection rules, Allowed and forbidden transitions, Comparative half –lives, Parity violation of weak interaction, Gamma decay, Multipole transition in nuclei, Selection rules, Internal conversion, Nuclear isomerism.

Unit-IV

Nuclear Energy: Fundamentals of nuclear fission and extended liquid drop model, Bohr-Wheeler theory of fission, Neutron released in the fission process, Neutron chain reaction, Multiplication factor, Condition for criticality, Cross-sections, Fusion, Thermonuclear reactions, Energy production in stars.

Nuclear Reactor:– The fission reactors, Heterogeneous natural uranium reactor,Thermal reactor, Introduction to nuclear power, nuclear fuel moderators, coolants, control mechanism, different types of nuclear power reactors, Fast breeder reactor,dual purpose reactors,concept of fusion reactors.

Text and Reference books:

1. Introduction to Nuclear Physics: F.A.Enge, Addison-Wesley 1975
2. Atomic and Nuclear Physics: Ghoshal
3. Nuclear Physics: R.R. Roy and B.P.Nigam, Wiley-Eastern Ltd.1983

4. Introductory Nuclear Physics: Y.R.Waghmare, Oxford- IBH, Bombay,1981
5. Nuclear Structure: Bohr and B.R. Mottelson, Vol.1(1969), 2(1975) Benjamin Reading
6. Introductory Nuclear Physics: Kenneth S. Kiane, Wiley, New York 1988
7. Introductory Nuclear Physics: Burcham
8. Nuclear Physics: Kaplan, 2nd edition, Narosa 1989
9. Nuclear interaction: G.E.Brown and A.D.Jackson, North-Holland, Amsterdam, 1976
10. Nuclear Interaction: Benedetti, John Wiley & Sons, NY 1964
11. Atomic Nucleus: R.D.Evans,Mc-Grow Hill NY 1955
12. Nuclear Physics: B.L.Cohen, TMGH, Bombay
13. The Elements of Nuclear Reactor Theory: Glasston & Edulund
14. Physics and nuclei and particles P. Marmier and E. Sheldon, Vol I and II, Academic press, NY 1970/1971
15. Structure of the Nucleus M. A. Preston and R. K. Bhaduri, Addison Wesley, 1975
16. The Physical Theory of Neutron Chain Reactors: M. Weinberg and E. P. Wigner, University of Chicago Press, 1958
17. Introduction to Nuclear Reactions: Satchler
18. R. K. Bhaduri, Models of Nucleon, Addison-Wesley, Reading, MA, 1988

Semster III Paper III Materials Science – I (OPTIONAL)

Unit- I

Equilibrium and kinetics: Stability and metastability, Basic thermodynamic functions, Statistical nature of entropy, Kinetics of thermally activated process.

Phase diagrams: The phase rule, free energy composition diagram, correlation between free energy and phase diagram, calculation of phase boundaries, thermodynamics of solutions, single component system (water), two component system containing two phases and three phases, Binary phase diagrams having intermediate phases, Binary phase diagrams with eutectic system. Lever principle, maximum, minimum, super lattice, miscibility gap, microstructure changes during cooling, application to zone refining.

Unit - II

Phase transformations: Time scale for phase changes, peritectic reaction, eutectoid and eutectic transformations, order disorder transformation, transformation diagrams, dendritic structure in alloys, transformation on heating and cooling, grain size effect on rate of transformation at constant temperature and on continuous cooling, grain size effect on rate of transformation, nucleation kinetics, growth kinetics, interface kinetics leading to the crystal growth.

Diffusion in solids: Fick's laws and their solutions, the Kirkendall effect, mechanism of diffusion, temperature dependence of diffusion co-efficient, self diffusion, interstitial diffusion, the Snoek effect in diffusion, diffusion in ionic crystals, diffusion path other than the crystal lattice, thermal vibrations and activation energy, diffusion of carbon in iron.

Unit – III

Structure of materials

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

Classification of materials: Crystalline and amorphous materials, high T_c superconductors, alloys & composites, semiconductors, solar energy materials, luminescent and optoelectronic materials, Polymer, Liquid crystals and quasi crystals, Ceramics. Importance of oxides in metallurgy – Ionic and electronic conduction, application in sensors and electronic devices.

Unit-IV

Solid State Ionics: Definition, classification and characteristic properties of solid electrolytes. Complex impedance spectroscopy, Arrhenius theory of ionic conductivity. Chemical sensors: Nernst equation, potentiometer and amperometric sensors for various gases, electrochemical redox-reaction, advantages of electrochemical sensors.

Solid state battery and fuel cell: Primary and secondary solid state cells, advantages of lithium batteries, ion intercalation compounds for secondary cell, open circuit voltage and short circuit current, intercalation compounds for secondary cell, open circuit voltage and short circuit current, Energy density, power density. Fuel cells –advantages and disadvantages, classification, efficiency-emf of fuel cells, hydrogen/oxygen fuel cell, criteria for the selection electrode and electrolyte, methanol fuel cell, solid oxide fuel cells, phosphoric acid fuel cells, molten carbonate fuel cell, proton exchange membrane fuel cell, biochemical fuel cell.

Text and Reference books:

1. Vanvellak: Materials Science.

2. V. Raghvan: Materials Science.

3. D. Kingery: Introduction to ceramics.

4. R. E. Reedhil: Physical metallurgy.

5. Martin Start Sharger: Introductory materials.

6. Sinnot: Solid state for engineers.

7. Kelly and Groves: Crystal and defects.

8. Kittel: Solid state physics, Vth edition.

9. M. A. Azaroff: Elements of crystallography

9. Introduction to solid state theory: Modelung.

Semster III Paper IV X-rays I (OPTIONAL)

Unit I

Continuous and Characteristic X-rays: Various types of demountable and sealed X-ray tubes. Production of X-rays. Efficiency of X-ray production. Continuous and characteristic X-ray spectra. X-ray emission from thick and thin targets.

Basics of high-tension circuits and vacuum systems used for the operation of X-ray tubes.

Isochromats: Principles of Bremsstrahlung and characteristics isochromats

Synchrotron radiation: Production and properties of radiation from storage rings, Insertion devices. Pelletron as a source of X-rays.

Unit II

Absorption of X-rays and X-ray Fluorescence: Absorption of X-rays. Physical process of X-ray absorption. Measurement of X-ray absorption coefficients. Units of dose and intensity. Radiography.

Microradiography and their applications.

X–ray fluorescence. Auger effect. Fluorescence yield. X –ray fluorescence analysis and its applications. Techniques and applications of Auger electron spectroscopy, Photoelectron spectroscopy, Proton induced X-ray emission, Electron probe micro analyser.

Unit III

X-ray spectroscopy: Experimental techniques of wavelength and energy dispersive x-ray spectroscopy.

Bragg and double crystal spectrographs. Focussing spectrographs. Tangential incidence grating spectrographs. Dispersion and resolving power of spectrographs, Photographic and other methods of detection, resolving power of detectors.

X –ray emission and absorption spectra. Energy level diagram. Dipole and forbidden lines, Satellite lines and their origin, Regular and irregular doublets. Relative intensities of X-ray lines.

Unit IV

Chemical Effects in X-ray Spectra: Chemical effects in X-ray spectra. White line, Chemical Shifts of absorption edges, Fine structures (XANES and EXAFS) associated with the absorption edges and their applications. X-ray spectroscopy with synchrotron sources.

Dispersion Theory: Dispersion theory applied to X-rays, Calculation of the dielectric constant, Significance of the complex dielectric constant, Refraction of X-rays, Methods for measurement of refractive index

X-ray optics – X-ray microscopy and Telescopy. Design of beam lines for synchrotron applications. Applications in X-ray Astronomy.

Text and Reference Books:

1. A. H. Compton and S. K. Allison: X-rays in Theory and Experiment

2. G. L. Clark: Applied X-rays.

3. Sproull: X-rays.

4. J. A. Nielsen and D. Mc. Morrow: elements of Modern X-ray Physics.

5. A. G. Michette and C. J. Buckley: X-ray Science and Technology.

6. M. A. Blokhin: X-ray Spectroscopy.

7. B. K. Agarwal: X-ray Spectroscopy.

8. E. P. Bertin: Principles and Practice of X-ray Spectrometric Analysis.

9. L. V. Azaroff: X-ray Spectroscopy.

10. C. Bonnelle and C. Mande: Advances in X-ray Spectroscopy.

11. D. C. Koningsberger and R. Prins: X-ray Absorption Principles, Applications, Techniques of EXAFS, SEXAFS and XANES.

12. N. F. M. Henry, H. Lipson and W. A. Wooster: The interpretation of X-ray Diffraction Photographs

13. K. Lonsdale: Crystals and X-rays.

14. B. D. Cullity: Elements of X-ray Diffraction.

15. M. M. Woollfson: X-ray Crystallography.

16. M. J. Buerger: X-ray Crystallography.

17. C. Kunz: Synchrotron Radiation.

18. Bacon: Neutron Physics.

Semster III Paper V (OPTIONAL)

Nanoscience and Nanotechnology – I

Unit I:

Introduction to Nanoscience:

Free electron theory (qualitative idea) and its features, Idea of band structure, Density of states for zero, one, two and three dimensional materials, Quantum confinement, Quantum wells, wires, dots, Factors affecting to particle size, Structure property relation, Size dependence properties. Determination of particle size, Increase in width of XRD peaks of nano-particles, Shift in photoluminescence peaks, Variation on Raman spectra of nano-materials.

Unit II:

Synthesis of Nanomaterials:

Physical methods**:** High energy Ball Milling, Melt mixing, Physical vapour deposition, Ionised cluster beam deposition, Laser ablation, Laser pyrolysis, Sputter deposition, Electric arc deposition, Photolithography.

Chemical methods**:** Chemical vapour deposition, Synthesis of metal & semiconductor nanoparticles by colloidal route, Langmuir-Blodgett method, Microemulsions, Sol-gel method, Combustion method, Wet chemical method

Unit III:

Nanomaterials Characterizations:

X-ray diffraction, UV-VIS spectroscopy, Photoluminescence spectroscopy, Raman spectroscopy, Transmission Electron Microscopy, Scanning Electron Microscopy, Scanning Tunnelling Electron Microscopy, Atomic Force Microscopy, Vibration Sample Magnetometer, Spintronics

Unit IV:

Special Nanomaterials and Properties:

Carbon nanotubes, Porous silicon, Aerogels, Core shell structures. Self assembled nanomaterials. Metal and semiconductor nanoclusters

Mechanical, Thermal, Electrical, Optical, Magnetic, Structural properties of nanomaterials

Text and Reference books:

1. Nanotechnology: Principles & Practicals. Sulbha K. Kulkarni ,Capital Publishing Co.New Delhi.

2. Nanostructures & Nanomaterials Synthesis, Properties & Applications**.** Guozhong Cao, Imperials College Press London.

3. Nanomaterials: Synthesis, Properties & Applications**.** Edited by A.S. Edelstein & R.C.Commorata. Institute of Physics Publishing, Bristol & Philadelphia.

4. Introduction to Nanotechnology. C.P. Poole Jr. and F. J.Owens, Wiley Student Edition.

5. Nano: The Essentials. T.Pradeep , McGraw Hill Education.

6. Handbook of Nanostructures: Materials and Nanotechnology. H. S. Nalwa Vol 1- 5, Academic Press, Bostan.

7. Nanoscience and Technology: Novel Structure and Phenomena. Ping and Sheng

8. Hand Book of Nanotechnology, Bhushan

List of experiments:

1. Synthesis of metal oxide nanoparticles by wet chemical method.
2. Synthesis of inorganic nanomaterials by combustion method.
3. Synthesis of nanomaterials by sol-gel method.
4. Synthesis of conducting polymer nanofibres by interfacial polymerization.
5. Synthesis of conducting polymer nanotubes by self assembly.
6. Synthesis of conducting polymer nanocomposites by in-situ polymerization.
7. Synthesis of metal oxide nanoparticles by hydro-thermal method.
8. Study of optical absorption of nanomaterials.
9. Deposition of thin films by spray pyrolysis technique.
10. Determination of particle size of nanomaterials from x-ray diffraction.
11. Study of photoluminescence of well known luminescent nanoparticles.
12. Deposition of thin films by spin coating method.
13. Thermoluminescence study of nanomaterials.
14. Deposition of thin films by dip coating technique.
15. Study of particle size effect on luminescence.
16. Electrical characterization of nanostructured materials.
17. Deposition of thin film in vacuum.
18. Electrical resistivity of nanomaterials using four probe method
19. Photoluminescence study of prepared red/blue/green luminescent nanomaterials.
20. Characterization of nanomaterials using SEM/TEM.

Semster III Paper VI Atomic and Molecular Physics (Spectroscopy-I)

Unit I

Quantum states of an electron in an atomic Electron spin, spectrum of hydrogen, Helium and alkali atoms, Relativistic corrections for energy levels of hydrogen; Basic principles of interaction of spin and applied magnetic field.

Concepts of NMR spectroscopy concepts of spin-spin and spin-lattice relaxation, chemical shift; spin-spin coupling between two and more nuclei; chemical analysis using NMR.

Mossbauer effect-Recoil less emission of gamma rays, chemical shieft, magnetic hyperfine interaction,

Unit II

electron spin resonance, experimental setup, hyperfine structure and isotopic shift,width of spectral lines, LS & JJ coupling, Zeeman, Paschen Back & Stark effect. Spontaneous and Stimulated emission, Einstein A & B Coefficients; LASERS, optical pumping, population inversion, rate equation, modes of resonators and coherence length, Role of resonant cavity, three and four level systems, Ammonia MASER, ruby, He-Ne, CO2, dye and diode lasers, Lasers applications

Unit III

Rotational, vibrational and Raman spectra of diatomic molecules, Quantum theory, Molecular polarizability, Intensity alteration in Raman spectra of diatomic molecules, Experimental setup for Raman spectroscopy in the structure determination of simple molecules. polyatomic molecules, symmetric top asymmetric top molecules. Hunds rule.

Unit IV

Electronic spectra of diatomic molecules, Born Oppenheimer approximation, Vibrational Coarse structure of electronic bands, intensity of electronic bonds, Franck Condon principle, and selection rules,dissociation and pre dissociation, dissociation energy, rotational fine structure of electronic bands. General treatment of molecular orbitals, Hund's coupling cases.

Text Book and References:

1. Molecular Spectroscopy: - Jeane L. McHale.

2. Mossbauer spectroscopy –M. R. Bhide.

3. NMR and Chemistry – J. W. Akitt.

4. Structural Methods in inorganic chemistry, E.A V.Ebsworth, D. W. H.Rankin, S.Crdock.

5. Introduction to Atomic Spectra – H. E. White.

6. Fundamental of Molecular Spectroscopy – C. B. Banwell.

7. Spectroscopy Vol. I, II and III, Walker and Straghen.

8. Introduction to Molecular Spectroscopy – G. M. Barrow.

9. Spectra of diatomic molecules – Herzberg.

10. Molecular spectroscopy – Jeanne L. McHale.

11. Molecular spectroscopy – J. M. Brown.

12. Spectra of Atoms and Molecules – P. F. Bemath.
13. Modern Spectroscopy – J. M. Holkas.
14. Laser spectroscopy and instrumentation- Demtroder

Semster III Paper VII (OPTIONAL)

Applied Electronics- I

Unit – I

Operational Amplifiers, Block diagram of a typical operational amplifier, analysis, open loop configuration, inverting and non-inverting amplifiers, operational amplifier with negative feedback,voltage series feedback, effect of feedback on close loop gain, input resistance output resistance bandwidth and output offset voltage, voltage follower.

Practical operational amplifier, input offset voltage, input bias current, input off set current, total output off set voltage, CMRR, frequency response, dc and ac amplifier, summing, scaling and averaging amplifier, instrumentation amplifier, integrator and differentiator.Application of Op-Amp as fixed and variable voltage regulator.

Oscillators principles- Barkhausen criterion for oscillations, The phase shift oscillator, Weinbridge oscillator, LC tunable oscillator, multi-vibrators, mono-stable and astable, comparators, square wave and triangular wave generators

Unit – II

Communication electronics: Amplitude modulation , generation of AM waves, demodulation of AM waves, DS BSC modulation, generation of DSBSC waves, coherent detection DSBSC wave, SSB modulation, generation and detection of SSB waves, Vestigial sideband modulation, frequency division multiplexing (FDM).

Microwave communication: Advantage and disadvantage of microwave transmission, loss in free space propagation of microwaves, atmospheric effect on propagation, Fresnel zone problem, ground refection,fading sources, detector components, antennas used in microwave communication systems

Unit – III

Digital Electronics: Various logic gates ;OR, AND NOT, NOR and NAND gates Exclusive OR gate, Boolean algebra, De Morgan’s theorem, , Decoder/demultiplexer, Dataselector/ multiplexer, Encoder Sequential logic: Flip flops, 1 bit memory, the RS flip flop, JK flip flop, JK master slave flip-flop, T flipflop,D, Flip-flop, Shift registers, synchronous and asynchronous counters, Cascade counters.

Microprocessor: Introduction to microcomputers, Memory. Input-output devices, interfacing devices.8085 CPU, architecture, bus timing, de-multiplexing, the address bus, generating control signals,instruction set, addressing modes, illustrative programmes, assembly language programmes, looping, counting and indexing, counters and timing delay, stack and sub routings. read only memory (ROM) and applications. Random access memory (RAM) and applications,

Digital to analogue converters. Ladder and weighted register types, analog to digital converters, ,successive approximations and dual slop converters, application of DAC and ADC,

Unit – IV

Microwave devices: Klystrons, magnetrons, and travelling wave tubes, velocity modulation, basic principle of two cavity klystrons and reflex klystrons, principle of operation of magnetrons, Helix travelling wave tubes, wave modes, transferred electron devices, gunn effect, principle of operation,modes of operation, read diode, IMPATT diode, TRAPATT diode..

Text and Reference Books:

1. Electronic devices and circuit theory: Robort Boylested and L. Nashdsky (PHI, New Delhi).
2. OP-Amps and linear integrated circuits: Ramakanth A. Gayakwad (PHI 2nd Edn).
3. Digital principles and Applications: A. P. Malvino and D. P. Leach (Tata Ma-Graw Hill).
4. Microprocessor architecture, programming and Application with 8085/8086, Ramesh S. Gaonkar (Wiley-Estern).
5. Microelectronics: Jacob Millman (Mc-Graw Hill Interna).
6. Optoelectronics: Theory and Practices: Edited by Alien Chappal (Mc Graw Hill).
7. Microwaves: K. L. Gupta (Wiley Ester New Delhi).
8. Advanced electronics communication systems: Wayne Tomasi (Phi Edn).
9. Fundamentals of microprocessors and Micro-computers: B. Ram. (Dhanpat Rao and Sons.).

Semster III Paper VIII (Elective) Numerical Methods and Programming

Unit I

Errors in Numerical Calculation, General Error Formula, Errors in Series approximation (1.3, 1.4, 1.5 of ref.1) Representation of numbers in memory (2.4 of ref. 2), floating point arithmetic (2.3,2.4, 2.5 of ref. 3) Advanced methods of solution of non-linear equations, ,Newton Raphson method, successive approximation, Bairstow's method, Ramanujan's method, Graeffe's root squaring method, Quotient difference method (ref. 1 and 2)

Unit II

Matrices: Determinant, consistency of equations, vector and matrix norms,

Solution of linear equations: direct methods a) matrix inversion b) Gaussian elimination,

partial pivoting, Gauss-Jordan method, matrix inversion using Gaussian elimination,

LU decomposition, Iterative methods (Jacobi and Gauss-Seidel methods) (Ref. 1 and 2)

Eigenvalue problem: power method (ref. 2) , Jacobi method (ref. 4)

Unit III

System of differential equations, higher order differential equations (ch. 10 of ref. 2) Numerical methods of partial differential equations ADI method, (9.2.4), parabolic equations, hyperbolic equations (8.4, 8.5 ref. 1) Introduction to finite element method (10.1)

Unit IV

C programming (Ch 1, 2, 3, 4, 5 of ref. 5 and 7.1, 7.2)

Text and Reference books:

1) S. S. Sastry Introductory methods of Numerical Analysis 4th Ed.

2) R. S. Salaria A textbook on Computer oriented numerical methods 4th ed.

3) V. Rajaraman : Computer oriented numerical methods 3rd ed

4) F. Scheid: Schum's outlines in Numerical Analysis 2nd ed

5) B. Kerningham and D. M. Ritchie : The C Programming Language 2nd ed.

6) Y. Kanetkar: Let us C

Semster III Paper IX Elective X-rays

Unit – I

Production of X-rays and Physical Crystallography: Various types of demountable and sealed X-ray tubes. Production of X-rays. Efficiency of X-ray production. Continuous and characteristic X-ray spectra. X-ray emission from thick and thin targets. High tension and vacuum techniques.

Synchrotron radiation : Production and properties of radiation from storage rings, Insertion devices. Pelletron as source of X-rays.

Absorption of X-rays and X-ray Fluorescence: Absorption of X-rays. Physics process of X-ray absorption. Measurement of X-ray absorption coefficients.

Unit - II

X-ray Spectroscopy: Experimental techniques of wavelength and energy dispersive x-ray spectroscopy. Bragg and double crystal spectrographs. Focussing spectrographs. Tangential incidence grating spectrographs. Methods of detection and measurement, Resolving power of detectors.

X –ray emission and absorption spectra. Energy level diagram. Dipole and forbidden lines, Satellite lines and their origin, Regular and irregular doublets. Relative intensities of X-ray lines.

Chemical Effects in X-ray Spectra: Chemical effects in X-ray spectra. Fine structures (XANES and EXAFS) associated with the absorption edges and their applications. X-ray spectroscopy with synchrotron sources. Soft X-ray spectroscopy of the solid state.

X-ray fluorescence. Photoelectron spectroscopy, Auger effect. Fluorescence yield. X-ray fluorescence analysis and its applications.

Unit-III

Scattering and Dispersion of X-rays: Scattering of X-rays. Thomson scattering. Polarisation of X-rays. Compton scattering. Wave mechanical treatment of scattering. Scattering by a pair of electrons. Scattering by a helium atom. Scattering by many electrons. Raman's theory of X-ray scattering. Experiments on scattering by monatomic and polyatomic gases, liquids and amorphous solids.

Dispersion theory applied to X-rays. Calculation of the dielectric constant. Refraction of X-rays. Methods for measurement of refractive index. X-ray optics and X-ray microscopy.

Unit – IV

Classification of crystals. Symmetry elements. Crystal systems. Point groups. Space groups. Reciprocal lattice.

Diffraction of X-rays: Diffraction of X-rays by crystals. Atomic and crystal structure factors. Amplitude of scattering by a crystal. Different factors affecting the intensity of diffraction lines.

The integrated intensity of reflection. Temperature effect. Debye-Waller factor.

Experimental methods of structure analysis. Laue method. Debye Scerrer method. Rotation oscillation method. Weisenberg camera.

Principles of energy dispersive and time analysis diffractometry.

Structures of metals and alloys. Phase transformations. Order-disorder phenomenon. Super lattice lines. Determination of grain size. Study of nano-particles.

Use of synchrotron radiation in structural studies.

Electron and neutron diffraction techniques and their applications. Comparison with X-ray diffraction.

Text and Reference Books

1. A. H. Compton and S. K. Allison: X-rays in theory and Experiment.

2. G. L. Clark: Applied X-rays.

3. Sproull : X-rays.

4. J. A. Nielsen and D. Mc. Morrow: Elements of Modern X-ray Physics.

5. A. G. Michette and C. J. Buckley: X-ray Science and Technology.

6. M.A. Blokhin: X-ray Spectroscopy.

7. B. K. Agarwal: X-ray Spectroscopy.

8. E. P. Bertin: Principles and Practice of X-ray Spectrometric Analysis.

9. L. V. Azaroff: X-ray Spectroscopy.

10. C. Bonnelle and C. Mande: Advances in X-ray Spectroscopy.

11. D. C. Koningsberger and R. Prins: X-ray Absorption Principles, Applications, Techniques ofEXAFS, SEXAFS and XANES.

12. N.F.M. Henry, H. Lipson and W. A. Wooster: the interpretation of X-ray Diffraction Photographs.

13. K. Lonsdale: Crystals and X-rays.

14. B. D. Cullity: Elements of X-ray Diffraction.

15. M. M. Woollfson: X-ray Crystallography.

16. M. J. Buerger: X-ray Crystallography.

17. C. Kunz: Synchrotron Radiation.

18. Bacon: Neutron Physics.

Semster III Paper X Materials Science (Elective)

Unit – I:

Phase diagrams: The phase rule, free energy composition diagram, correlation between free energy and phase diagram, calculation of phase boundaries, thermodynamics of solutions, single component system, two component system containing two phases and three phases, Binary phase diagrams of Cu-Ni and Sb - Bi systems, lever principle, maximum, minimum, super lattice, miscibility gap, microstructure changes during cooling, application to zone refining.

Phase transformations: Time scale for phase changes, peritectic reaction, eutectoide and eutectic transformation, order-disorder transformation, transformation diagram, dendritic structure of alloys, transformation on heating and cooling, grain size effect on rate of transformation at constant temperature and on continuous cooling , grain size effect on rate of transformation, nucleation kinetics, growth kinetics, interface kinetics leading to the crystal growth.

Unit – II:

Diffusion in solids: Fick's laws and their solutions, the Kirkendall effect, mechanism of diffusion, temperature dependence of diffusion co-efficient, self diffusion, interstitial diffusion, the Snoek effect diffusion, diffusion in ionic crystals, diffusion path other than the crystal lattice, thermal vibrations and activation energy, diffusion of carbon in Iron.

Solid electrolytes: Theory of solid electrolytes, solid state batteries, solar cells and their applications.

Unit – III:

Preparative methods: Solid State reaction, epitaxy, topotaxy, examples of solid state reactions, Li_4SiO_4, $YBa_2Cu_3O_7$, Na β/ β' alumina.

Sol-gel methods – synthesis of MgAl2O4 – synthesis of silica glass – spinning of alumina fibers, preparation of indium tin oxide (ITO) and other coating – Fabrication of YSZ ceramics- preparation of alumina based abrasives. Use of homogeneous, single source precursors- Hydrothermal synthesis – Intercalation and deintercalation – vapor phase transport- Combustion sunthesis – Crystal growth techniques – High pressure methods.

Film deposition techniques and processes: Introduction, vacuum systems – Evaporation – Molecular beam apitaxy – Sputter deposition – Chemical vapour deposition – Laser ablation – Electroplating.

Unit – IV:

Solid state characterization techniques: X-ray diffraction - Introduction – basic principles – experimental considerations – applications, structure determination, phase analysis, grain size analysis. Microscopic techniques: SEM, AFM and STEM.

Thermal analysis – Principle and applications of thermo-gravimetric analysis – differential thermal analysis – differential scanning calorimetry.

Spectroscopic techniques – Photoacoustic spectroscopy – principle – instrumentation – applications.

Photoelectron spectroscopy – Instrumentation – solid state surface studies – surface charging and calibration problems – valence energy level studies – surface charging and calibration problems – Valence energy level studies – UV photoelectron spectra – X-ray photoelectron spectra – Auger electron spectroscopy.

Text and Reference Books:

1. Basic solid State Chemistry, 2nd Edition, Anthony R. West, John Wiley & Sons, 1996.

2. New Directions in Solid State Chemistry, C. N. R. Rao and J. Gopalkrishnan, Cambridge University Press, Cambridge, 1986.

3. Chemical Approach to the synthesis of inorganic materials, C. N. R. Rao Wiley Eastern Ltd. 1994.

4. Materials Science and Engineering – an Introduction, W. D. Callister Jr. John Wiley & Sons,1991.

5. Materials Science, J. C. Anderson, K. D. Leaver, R. D. Rawlings and J. M. Alexander, 4thEdition, Chapman & Hall (1994).

6. Encyclopedia of Materials Characterization by C. Richards Brundle, C. A. Evans. Jr and S. Wilson, Butterworth, 1992.

7. Spectroscopy Vol 3. B. P. Straughn and S. Walker, Chapman and hall, 1976.

8. Spectroscopy in Catalysis, J. W. Niemantsverdriet, VCH, 1995.

9. Instrumental Methods of analysis, Willard, Merritt, Dean and Settle, CBS Publishers, New Delhi, Sixth Edition, 1986.

10. P. Ganguly and C. N. R. Rao. “Photoacoustic spectroscopy of solids and surfaces: Proc. Indian Acad. Scie. (Chem. Sci)99(1981)153-214.

11. Chemistry of Advances Materials an overview, Leonard V. Interrante and mark J. Hampden-Smith (Ed) Wiley – VCH, 1998.

12. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press (1998).

13. Environmental photochemistry with semiconductor nanoparticles by P. v. Kumar and K.Vinodgopal in Organic and Inorganic Photochemistry edited by V. Ramamurthy and Kirk S.Schanze, Marcel Dekker Inc (1998).

Semster III Paper Paper – XI (Elective) Spectroscopy I

Unit – I:

Spectra of alkaline, earth elements, penetrating and non-penetrating orbits, Coupling schemes, Zeeman effect, Paschen Back effect in two electron systems, Stark effect. Normal and inverted terms

Unit - II:

Width of special lines, Natural and Doppler broadening. Asymmetric and pressure shift intensity rules. Hyperfine structure, Complex spectra. Wave equation for many electron atom. Saha's theory of ionization.

Unit –III:

Quantum mechanical treatment of vibration and rotation spectra. Mass potential. Infra-red and Raman spectra of vibrating and rotating diatomic molecules, Vibration-rotation interaction. Anharmonic oscillator and non-rigid rotator energy levels.

Unit – IV:

Thermal distribution of quantum states. Intensities of rotational and vibrational and vibration – rotational spectra of diatomic molecules, Isotope effect in rotational and vibrational spectra. Rotations and vibrations of polyatomic molecules, symmetric top asymmetric top molecules. Hund's rules

Text and Reference books:

1. Gupta, Kumar and Sharma: Elements of spectroscopy.

2. 2. White, H. E. : Introduction to Atomic Spectra.

3. Herzberg : Spectra of Diatomic Molecules.

4. Banwell: Fundamental of Molecules.

5. S. Walker and Straw : Spectroscopy, Vol. I and II.

6. Wilson, Decius and Gross :Molecular Vibrations.

7. Gans (Chapman and Hall): Vibrating Molecules.

Semster III Paper Paper – XII (Elective) Lasers, Fiber Optics and Applications

Unit – I

Laser characteristics**:** Gaussian beam and its properties, Stable two minor optical resonators Longitudinal and transverse modes of laser cavity, Mode selection, Gain in the regenerative laser cavity,

Unit – II

Threshold for 3 and 4 levels laser systems, mode locking pulse shortening pico-second and femto second operations, Spectral narrowing and stabilization. Ruby laser, Nd YAG Laser, Semiconductor lasers,

Unit – III

Laser System**:** Diode pump solid state lasers, Nitrogen laser, Carbon dioxide laser, Excimer laser, Dye laser, high power laser systems and industrial applications.

Unit – IV

Laser Specroscopic techniques and other applications**:** Laser fluorescence and Raman scattering and their use in pollution studies, nonlinear interaction of light with matter, Laser induced multi-photon processes and their applications, Ultra high resolution spectroscopy with lasers and its applications.

Text and Reference books:

1. Laser: Svelto.
2. Optical electronics: Wariv.
3. Laser spectroscopy: Demtroder.
4. Non-linear spectroscopy: Etekhov.
5. Introduction to fiberoptics, A.Ghatak and K.Thyagarajan,Cambridge Univ.Press.

Semester III Paper XIII (elective) Digital Electronics and Microprocessor

Unit – I:

Logic gates: Characteristics of TTL, ECL, CMOS circuits with reference to fan in / out noise, speed, power dissipation with suitable examples.

Simplyfying logic circuits: Algebric method – SOP (minterm) and POS (maxterma) forms. Karnaugh mapping – Fundamental products, pairs, gaurds, octats, Don't's care conditions. Complementary

Karnaugh map. Diagonal adjacencies. NAND-NAND and NOT-NOR networks. Applications of K maps to half adder, full adder.

Arithmetic circuits: Number representation. Binary point, negative numbers, sign and magnitude. 1s and 2 s complement adder, parallel binary adder, BCD addition, parallel BCD adder, binary multiplication and division. Circuits using 7483 and 7486 be discussed. ALU with emphaisi on IC 74181 in details. TTY, Video display, TVT sweep, dotmatric, encoding, decoding.

Unit – II

Multiplexers, demultiplexers : IC 74150 multiplexer and IC 74154 demultiplexer. Tristate buffers, their use in bus organization. Key board encoders, BCD, octal, Hex and scanned matrix keyboard.

Communication in Analog and Digital Domains: Modulation and demodulation in analog (AM FM, PM SSB – SC etc.) Pulse modulation systems. (PAM, PWM, PDM). Pulse code modulation, coding, FDM and TDM, Code noise immunity, Code transmission and bands and speeds, ASK, FSK, PSD, computer and digital communication: Modems, DART, URSI, Local area networks, Radio telemetry.

Unit – III:

A/D and D/A converters: Weighted resistor and R-2R ladder D/A converters. A/D converter – parallel comparator and Application. ADC 0808, 08116/08117, DAC 0800, look up table, measurement of electrical and physical quantities. Introduction to architecture, pin configuration etc. of 8086, 80286, 80486 (Intel)

Memories Allied Devices: Design consideration of Bipolar RAM, MOS memory and dynamic RAM, ROM, EXROM and CCD. Read/Write operation. Expanding memory sizewordsize and word capacity. FIFO and LIFO. Study of 7489 RAM and 745370 RAM and other chip. Magnetic bubble memories. Floppy disks-track and sector organization, data format Winchester disk (hard disk).

Unit – IV:

Microprocessor Architecture: The parts of up. CPU, memory requirements, numerical data, representation of characters, microprocessor instructions, program storage, instruction execution fetch and execute cycles, addressing modes including simple memory paging, direct scratch and pad addressing.

The instruction set including memory reference, immediate conditional jump-shift, change control, stack and program counter, subroutines, flow charts, masking, simple programs.

I/O Systems: Program interrupts including multiple interrupt priorities. Interfacing memory mapping, memory mapped and I/P mapped I/O. Use of decoders, I/O posts. ic 8212. simple programs, program looping serial and parallel looping time delay, program for scanned matrix keyboard, IC 8155 and IC8255 (with block diagram of internal circuits) Typical programs using these ICS.

Text and Reference Books:

1. Design of Digital Systems : P. C. Pitman (Galgotia Pub).

2. Digital Computer Electronics :A. P. Malvino (TMH).

3. Digital Fundamentals: T. L. Floyd (Universal Book Stall).

4. Theory and Problems of Digital Principles : R. L. Tokheim (TMH).

5. Modern Digital Electronics : R. P. Jain (TMH).

6. Introduction to UP : A. K. Mathur (PHL).

7. Up and Small Digital Computer Systems for Scientist and Engineers L G. A. Korn, (McGraw Hill).

8. An Introduction to Micro-computer: Adam Osborne(Galgotia).

9. Introduction top 4 bit and 8 bit UP : Adam Osborne.