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

Semster IV Paper I *Solid State Physics*

Unit I

Defects: Vacancies, Point defects, line defects and stacking faults, Burgers vector and Burger circuit, presence of dislocation, dislocation motion, perfect and imperfect dislocations, slip planes and slip directions, dislocation reactions, experimental methods to observe dislocations, colour centres and their models.

Luminescence: types of luminescence, phosphors, concentration quenching, sensitization, characteristic (KCl:Tl type) and donor-acceptor (ZnS type) luminescence. Nonradiative and radiative transition, Mechanism of luminescence, configuration coordinate diagrams.

Unit II

Dielectric Properties: Dielectric loss and relaxation, ferroelectricity, classification, theories ferroelectricity, Devonshire and Cochran's theories, domains, antiferroelectrics. Lyddane – Sachs-Teller relation, Zeroes and poles of dielectric function. Dielectric response of an electron gas, plasmons, electron collisions.

Magnetic Properties:

Quantum theory of paramagnetism, magnetism of iron group and rare earth ions, crystal fields theory (elements) quenching of orbital moments. Ferromagnetism, Weiss theory, exchange integral, band model, Ising model, spin wave, magnons, domain walls, magnetostriction, anisotropy energy, thickness of domain walls. Antiferromagnetism, Neel's theory, susceptibility below Neel's temperature.

Unit III

Magnetic resonance and its applications in solids, experimental arrangements and basic principles of NMR, ESR and Mossbauer spectroscopies,

Unit IV

Superconductivity, occurrence, Type I and II super conductors, Meissner effect, isotope effect, microwave and infrared properties. Thermodynamics of transition. London equation, coherence length, elements of B. C. S. theory, tunnelling Josephson effect. Ginzsburg- Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Josephson junction. Vortices and type I & type II superconductors, high temperature superconductor (elementary).

Text and Reference books:

1. C. Kittle: Introduction to Solid State Physics (2nd and 4th Edition).
2. A. J. Dekker : Solid State Physics.
3. Kubo and Nagamiya : Solid State Physics.
4. Levrenz : Introduction to Luminescence of Solids.
5. Feynman Lectures: Vol. III.
6. Board and Huano : Dynamical Theory of Crystal Lattice.
7. Ferroelectricity Jona and Shirane

Semster IV Paper II Nuclear and Particle Physics-II

Unit-I

Elementary Particle Physics: Classification of fundamental forces, Strong, Weak and Electromagnetic Interactions between elementary particles, Hadrons, quarks, baryons, mesons and leptons, Symmetry and conservation laws, Baryons and mesons multiplets, Symmetry breaking, Gell-Mann-Okubo mass formula.

Unit-II

Spin and Parity assignment, isospin, Strangeness, Gell-Mann- Nishijima formula, C, P & T invariance and applications of symmetry, argument to particle reactions, Quark model, Charm, Bottom and top quarks, Spontaneous symmetry breaking and Higgs mechanism,Higgs bosons, Standard model for electro weak unification.

Unit-III

Particle Detectors:

Gas Counters: Ionization chambers, Proportional counters, Multiwire proportional counters, Geiger-Muller counters, Neutron detectors.

Solid state detectors: Semiconductor detectors, Integrating solid state devices, Surface barrier detectors.
Scintillation counters: Organic and inorganic scintillators- Theory, characteristics and detection efficiency.
High energy particle detectors: General principles, Nuclear emulsion, Cloud chambers, Bubble chambers, Cerenkov counter, Detection and properties of neutrino.

Unit-IV

Accelerators:

Historical Developments:Different types of accelerators, Layout and components of accelerators, Accelerator applications.

Transverse Motion: Hamiltonian for Particle motion in accelerators, Equation of betatron motion, Particle motion in dipole and quadrupole magnets, Linear betatron motion, Transfer matrix and stability of betatron motion, Effect of space – charge force on betatron motion. Synchrotron Motion: Longitudinal equation of motion, Synchrotron Hamiltonian.

Linear Accelerators: Historical milestone, Fundamental properties of accelerating structures, Particle acceleration by EM waves, Longitudinal particle dynamics in Linac, Transverse beam dynamic in a Linac.

Ion beam accelerator, ion beam optics, High energy accelerators (e.g. Large Hadron collider at Geneva) for particle physics research.

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. Concept of Nuclear Physics: B.L.Cohen, TMGH, Bombay
13. Nuclear radiation detectors: S.S. Kapoor and V.S. Ramamurthy, Wiley –Eastern, New Delhi, 1986.
14. Nuclear radiation detection: W.J. Price, Mc Graw Hill, NY 1964
15. Quarks and Leptons: F. Halzen and A. D. Martin, John-Wiley & Sons, New York, 1984
16. Modern Elementary Particle Physics: G. Kane, Addision-Wesly, 1987
17. Unitary Symmetry and Elementary Particles: D. B. Lichtenberg, 2nd Edition, Academic Press
18. An introduction to particle physics: M. Leon, Academic Press, New York, 1973
19. Accelerator Physics: S. Y. Lee, World Scientific, Singapore, 1999
20. Theory of Resonance Linear Accelerators: M. Kapchinsky,Harwood Academic Publishers
21. Linear Accelerators: P. Lapostole and A. Septier, North Holland.
22. Particle Accelerators: P. Blewett, McGraw-Hill Book Co.
23. Particle Accelerators and Their Uses: W. Scharf, Harwood Academic Publishers

Semster IV Paper III Materials Science – II (OPTIONAL)

Unit –I

Mechanical response of Materials : Elasticity, model of elastic response, inelasticity, viscoelasticity, stress-strain curves, concept of various mechanical properties such as hardness, yield strength, toughness, ductility, yield toughness, ductility, brittleness, stiffness, young modulus, shear modulus, shear strength, Frenkel model, Peierls-Nabarro relation, Plastic deformation, importance of dislocation movements, sessile dislocations, relation of slip process and crystal structures, Franck reed source for dislocation etc, Creep, fatigue in materials, Fracture, Strengthening of materials.

Corrosion and degradation of materials – electrochemical considerations – passivity forms of corrosion – corrosion inhibition.

Unit – II

Dielectrics: Electronic, ionic and orientational polarizabilities for free atoms and molecules, Lorentz cavity, Clausius-Mossotti relation, static and frequency dependence of dielectric constant. Macroscopic theory of dielectric polarization and oscillating fields.

Spintronics and Photonics: Atomic origin of magnetism. Diamagnetism, paramgnetism, ferromagnetism and anti ferromagnetism, spin glass, magnetic bubbles, domain walls, magnetic multilayers, magnenites, GMR and CMR, DMS materials. Photonic band gap materials.

Unit – III

Materials Synthesis: Concept of equilibrium and nonequilibrium processing and their importance in materials science.

Synthesis of Bulk materials: Metallic and non metallic, Ceramics and other materials. Only basic elements of powder technologies, compaction, sintering calcination, vitrification reactions,with different

example, phenomenon of particle coalescence, porosity. Quenching : concept, glass formation,

Synthesis of nanostructured materials: Physical method – Bottom up: cluster beam evaporation, Ion beam deposition, Gas evaporation, Chemical method – Hydrothermal, combustion, bath deposition with capping techniques and top down: Ball milling. Solvated metal atom dispersion – thermal decomposition – reduction methods – colloidal and micellar approach.

Unit –IV

Microstructure characterization by direct & indirect methods

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

Microscopic techniques –TEM, SEM & STEM. AFM, XPS, EDX. Electron and neutron diffraction

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 approaches 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, 4th Edition, Chapman & Hall (1994).

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

7.Fuel Cells – A. Mcdougall, Macmillan 1976 Ch 3,5,7,8 and 11.

Experiments:

1. Crystal structure determination by powder diffraction.

2. Synthesis of semiconductor oxides by chemical route.

4. Crystal growth from slow cooling of the melt.

5. Thermal analysis of binary alloy.

6. Differential thermal analysis solid solution.

7. To study electrochemical method of corrosion control.

8. Dielectric behaviour of LiNbO3 and BaTiO3 in crystals and ceramics.

9. Electrical conductivity of ionic solids.

10. Testing of hardness of a material.

11. Band gap measurements of oxide film using UV-Vis Spectroscopy.

12. Multiple beam interferromentric study of surfaces.

13. Thermal conductivity of bad conductor.

14. Thermal expansion coefficient of metals.

15. Study of transport property in solid electrolytes.

16. Verification Nernst law/Oxygen sensor

17. Determination of Thermoelectricity Power.

Semster IV Paper IV X-ray spectroscopy and crystallography – II (Optional)

Unit I

Solids and symmetry elements: Crystalline state, Anisotropy, Symmetry, Self consistency of symmetry operations. Space lattice and unit cell of a crystal, Choice of a unit cell, Crystal systems, Bravais lattices, space groups and point groups.

Morphology and angular relationships: Goniometry, Crystal faces and internal arrangement, Miller indices, Law of rational indices, Indices of a direction.

Perspective projections: Gnomonic projection, Stereographic projection, Orthographic projection.

Reciprocal lattice concept: Graphical construction, Relation to interplanar spacing, Interpretation of Bragg's law.

Unit II

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

Unit III

Physical Basis of X-ray Crystallography: Atomic and crystal structure factors, Structure factor calculations, The integrated intensity of reflection. Different factors affecting the intensity of diffraction lines in a powder pattern. The sources of systematic errors and methods of attaining precision.

Dynamical theory X-ray diffraction.

The Fourier series, Numerical applications, Fourier series in two and three dimensions. The Fourier Transform, electron density projections in crystals, Application to X-ray diffraction.

Unit IV

Experimental Methods of Structure Analysis: Laue method, Debye-Scherrer method, rotation Oscillation method, Weisenberg camera, Moving film method, Principles of energy dispersive and time analysis diffractometry.

Methods of detecting and recording diffraction patterns.

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

Other Diffraction Techniques: Electron and neutron diffraction techniques and their applications. Comparison with X-ray diffraction.

Small angle scattering, Gainer camera, SAXS and SANS, Applications in particle size determination,

Study of fibres, Study of submicroscopic heterogeneities in metals and other materials.

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 IV Paper V (OPTIONAL) Nanoscience and Nanotechnology – II

Unit – I:

Nanophotonics:

Fundamentals of photonics and photonic devices, Lasers, CFLs, LEDs, OLEDs, Wall paper lighting, Display devices, X-ray imaging nanophosphers, Photo therapy lamps and its applications, Nanomaterials for radiation, Dosimetery special for thermoluminescence. Optical stimulated luminescence, Luminescence solar concentration.

Unit – II:

Nanomagnetics:

Basics of Ferromagnetism, effect of bulk nanostructuring of magnetic properties, dynamics of nanomagnets, nanopore containment, giant and colossal magnetoresistance, applications in data storage, ferrofluids, Superparamagnetism, effect of grain size, magneto-transport, Magneto-electronics, magneto-optics, spintronics.

Unit – III:

Nanoelectronics:

Top down and bottom up approach, CMOS Scaling, Nanoscale MOSFETs, Limits to Scaling, System Integration, Interconnects;

NanoDevices: Nanowire Field Effect Transistors, FINFETs, Vertical MOSFETs, Other Nanowire Applications, Tunneling Devices, Single Electron Transistors, Carbon nanotube transistors, Memory Devices,

Unit – IV:

Nanocomposites:

Classification of nanocomposites, Metallic, ceramic and polymer nanocomposites, Tribology of polymeric nanocomposites, Nano ceramic for ultra high temperature MEMS, Optimizing nanofiller performance in polymers, Preparation techniques, Graphene/Fullerene/Carbon nanotube (CNT) polymer nanocomposites, One dimensional conducting polymer nanocomposites and their applications

Text and reference books:

1. H.S.Nalwa; Hand book of Nanostructure materials and nanotechnology; (Vol.1-5), Acad. Press, Boston, 2000
2. C.P.Poole Jr., F.J.Owens; Introduction to Nanotechnology, John Wiley and sons, 2003
3. C. Furetta; Hand book of thermoluminescence; World Scientific Publ.
4. S.W.S. McKEEVER; Thermoluminescence in solids; Cambridge Univ. Press.
5. Alex Ryer; Light measurement hand book; Int. light Publ.
6. M.J.Weber; Inorganic Phosphors; The CRC Press.

7. T.J.Deming; Nanotechnology; Springer Verrlag, Berlin, 1999

8. W.D.Kalister Jr., Materials Science and Engineering, 6th Eds, WSE Wiley, 2003

9. Gusev; Nanocrystalline Materials

10. C. Delerue, M.Lannoo; Nanostructures theory and Modelling

11. Fausto, Fiorillo ; Measurement and Characterization of Magnetic materials

12. Bhushan; Hand Book of Nanotechnology

13. Janos H., Fendler; Nanoparticles and Nanostructured Films

14. T.Pradip; Nano: The Essentials

15. Liu; Hand Book of Advanced Magnetic Materials (4 Vol.)

16. Lakhtakia; Nanometer Structure

17. Banwong, Anurag Mittal; Nano CMOS Circuit and Physical Design

18. G.W.Hanson: Fundamental of Nanoelectronics

19. Edward L. Wolf (2nd Ed.), *Nanophysics & Nanotechnology: An Introduction to Modern Concepts in Nanoscience*, WILEY-VCH, 2006

20. S. Sakka; Sol-gel science and technology processing, characterization and applications; Kluwer Acad. Publ.

21. Goser et al, "*Nanoelectronics & Nanosystems: From Transistor to Molecular & Quantum Devices"*

22. Supriyo Datta, "*From Atom to Transistor*"

23. John H. Davies, *The Physics of Low Dimensional Semiconductors: An Introduction",* Cambridge University Press, 1998.

24. Hari Singh Nalwa, "*Encyclopedia of Nanotechnology*"

25. A. A. Balandin and K. L. Wang, "*Handbook of Semiconductor Nanostructures & Nanodevices*"

26. Cao Guozhong, "*Nanostructures &Nanomaterials - Synthesis, Properties & Applications*"

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 IV Paper VI (Optional) Atomic and Molecular Physics (Spectroscopy-II)

Unit I

Time dependence in quantum mechanics, Time dependent perturbation theory, rate expression for emission, perturbation theory, calculation of polarizability. Quantum mechanical expression for emission rate.

time correlation function and spectral Fourier transform pair, properties of time correlation functions and spectral time shape,

Fluctuation dissipation theorem rotational correlation function and pure rotational spectra,

Re-orientational spectroscopy of liquids.

Unit II

Saturation spectroscopy, Burning and detection of holes in Doppler broadened two level systems, Experimental methods of saturation spectroscopy in laser, Ramsey fringes, Saturation techniques for condensed matter application,

Laser optogalvanic spectroscopy.Two photon absorption spectroscopy, Selection rules, Expression for TPA cross section –photo acoustic spectroscopy, PAS in gaseous medium, Roseneweig and Greshow theory, Thermally thin, thick samples, Typical experimental set up, Application in Spectroscopy,

Unit III

Stimulated Raman scattering, Quantum mechanical treatment, Raman Oscillation Parametric instabilities, Electromagnetic theory of SRS. Vibronic interaction, Herzberg Teller theory,

Fluorescence spectroscopy, Kasha's rule, Quantum yield, Non-radioactive transitions, Jablonski diagram, Time resolved fluorescence and determination of excited state lifetime.Light detectors, Single photon counting technique, Phase sensitive detectors.

Unit IV

Matrix isolation spectroscopy, Fourier transforms spectroscopy, Laser cooling. Molecular symmetry and group theory, Matrix representation of symmetry elementsof a point group, Reducible and irreducible representations, and character tables specially for C_{2v} and C_3 point group molecules, Normal coordinates normal modes, Application of group theory to molecular vibrations.

Text Book and References:

1. Molecular Quantum Mechanics: P. W. Alkins and R. S., Fridman.
2. Quantum electron – A. Yariv.
3. Introduction to non-linear laser spectroscopy – M. D. Levenson.
4. Photoacoustics and its applications, Roseneweig.
5. J. M. Hollas, High resolution spectroscopy.
6. Cotton, Chemical Applications of Group Theory.
7. Herzberg, Molecular spectra and molecular structure II and III.
8. Demtroder, Laser spectroscopy and instrumentation.
9. King, Molecular spectroscopy.
10. Lakowicz, Principles of fluorescence spectroscopy.
11. Molecular Quantum Mechanics: P. W. Alkins and R. S., Fridman.

Semster IV Paper VII Applied Electronics- II

Unit – I:

An Overview of Electronic Communication system ; block diagram of an digital electronic Communication system, Pulse modulation systems, sampling theorem, low-pass and band-pass signals,PAM channel bandwidth for a PAM signal, Natural sampling, flat top sampling, signal recovery throughholding, quantization of signals, quantization, differential PCM delta modulation, adoptive delta modulation CVSD. Digital modulation techniques: BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK, MSK.

Mathematical representation of noise, sources of noise, frequency domain representation of noise, Noise in Pulse Code and Delta modulation system, PCM transmission, calculation of quantization ofnoise, out pit signal power effect of thermal noise, outr signal to noise ratio in PCM, DM, quantization noise in DM, out put signal power, DM oput-put, signal to quantization noise ratio, effect of thermal noise in delta modulation, output signal to noise ratio in DM.

Unit – II

Data transmission : base band signal receiver, probability of error, optimum filter, white noise, matchfilter, and probability of error, coherent reception, correlation PSK, FSK non-coherent detection of FSK,differential PSK, QPSK, calculation of error probability for BPSK, BFSK and QPSK.

Computer communication systems: Types of networks, design features of communication network,examples, TYMNET, ARPANET, ISDN, LAN.Mobile radio and satellite - time division multiplex access (TDMA) frequency division multiplex access(FDMA) ALOHA, Slotted ALOHA, Carrier sense multiple access (CSMA) Poisson distributionprotocols.

Unit – III

Microprocessor and Micro-computers: Microprocessor and architecture, Pin out and pin functions of 8086/8088 Internal microprocessor architecture, bus buffering and latching ,Bus timings, ready and wait states, minimum mode versus and maximum mode. Real and protected mode of memory addressing, memory paging, addressing modes, data addressing modes, programme memory addressing mode, stack memory addressing modes, instruction sets, data movement instruction, arithmetic and logic instruction, programme control instruction, clock generator (8284A),

Unit –IV

Memory and I/O Interface : Memory devices, ROM,RAM.,DRAM, SRAM, Address decoding , 3 to 8 line decoder 74LS138, 8086, and 80386(16 bits) Memory interface, ,

Introduction to I/O interface , Interfacing using 8255, Introduction to PIT 8254, Basic Communication device(UART) pin diagram and functioning of 16550

Interrupts: Basic interrupt processing, Hardware interrupt, expanding the interrupt structure, 8259A PIC.

Direct memory access: basic DMA operations, 8237 DMA controller, Shared bus operation

Text and Reference books.

1. Principles of communication systems : Taub and Schilling (ii Edn THM ,1994)

2. Principles of communication systems: Taub and Schilling Goutam Saha Third Edition

3. Communication systems : Simon Haykin (iii Edn John Wiley & Sons)

4. The intel microprocessors 8086/80188,80386,80486, Pentium and Pentium processor architecture,

programming and interfacing : Barry B. Brey (PHI iv Edn, 1999)

5. Microprocessor and interfacing ,programming and hardware : Douglas V. Hall (ii Edn, Mc GrawHill International edn. 1992)

6. The 80x86 IBMPC compatible computer: Muhammad Ali Maxidi and J .G. Mazidi (ii Edn.Prentice –Hall International.)

Semster IV Paper VIII Elective Condensed matter Physics – I

Unit – I

Lattice dynamics and optical properties of solids: Inter-atomic forces and lattice dynamics of simple metals, Ionic and covalent crystal, Optical phonons and dielectric constants, inelastic neutron scattering, Debye-Waller factor. Anharmonicity, thermal expansion and thermal conductivity.

Interaction of electrons and phonons with photons. Direct and indirect transitions. Absorption in insulators, Mossbauer effect,

Unit – II

Polaritons, one-phonon absorption, optical properties of metals, skin effect and anomalous skin effect.

Electron-Phonon Interaction: Interaction of electrons with acoustic and optical phonons.

Superconductivity: manifestations of energy gap. Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg- Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, macroscopic quantum interference. Josephson junction. Vortices and type I & type II superconductors, high temperature superconductor (elementary)

Unit – III

Principle of powder diffraction method, interpretation of powder photographs, Analytical indexing, Ito's method, Accurate determination of lattice parameters, least squares method, Application of powder method, Oscillations and Burger's precession methods, Determination of relative structure amplitudes from measured intensities (Lorentz and polarization factor), Fourier representation of electron density, The phase problem, Patterson function.

Unit – IV

Exotic solids: Structure and symmetries of liquids, liquid crystal and amorphous solids, aperiodic solids and quasicrystals, Fibonacci sequence, Penrose lattices and their extension to three dimensions, special carbon solids, Fullerenes, tubules, formation characterization of fullerenes and

tubules, Single wall and multi-wall carbon tubules, electronic properties of tubules, carbon nano-tubules, grapheme.

Text and Reference books:

1.X-ray crystallography: Azaroff.

2. X-ray crystallography: Cullity

3. C. Kittel: Introduction to Solid State Physics (2nd and 4th Edition).

4. Liquid crystals Chandrashekhar

7. The physics of quasicrystals: Editors. Steinhardt and Ostulond.

8. Handbook of Nanostructured materials and nanotechnology (Vol 1 to 4) : Editor Hari Singh Nalwa.

Semster IV Paper IX (Elective) Nonlinear Dynamics with Applications to Physics and other Sciences

Unit I

Flows on a line, fixed points and their stability, Population growth, Linear Stability Analysis, Existence and Uniqueness, Impossibility of Oscillations, Potentials, Bifurcations, Saddle-node, Transcritical, Pitchfork, Examples, Imperfect Bifurcation.

(Chapter 2 and 3 of Ref. 1)

Unit II

Flows on a circle, Uniform and Nonuniform Oscillator, Over damped Pendulum, Superconducting Josephson Junction, Fireflies, Examples of Linear System, Classification of Linear System.

(Chapter 4 and 5 of Ref. 1)

Unit III

Phase portraits, Existence and Uniqueness, Fixed points and their Linearization, Conservative Systems,

Reversible Systems, Index theory, Limit Cycles, Ruling out Closed Cycles, Poincare-Benedixon theorem, Lienard Systems, Relaxation Oscillations, Weakly Nonlinear Oscillators.

(Chapter 6 and 7 Ref. 1)

Unit IV

Bifurcations in detail, Saddle-node, transcritical, pitchfork, Hopf, Global Bifurcations, Hysteresis in Driven pendulum, Coupled Oscillators and Quasiperiodicity

(Chapter 8 of Ref. 1)

Reference books:

1. S. W. Strogatz : Nonlinear Dynamics with Applications to Physics, Biology, Chemistry and

Engineering. (Perseus)

2. Edward Ott : Chaos in Dynamical Systems (Cambridge University Press)

Semster IV Paper X Elective ElectroAcoustics

Unit – I:

Fundamentals of ultrasonic, Acoustics interaction with liquids, Velocity in fluids, Absorption due to heat conduction and viscosity, single relaxation, internal degrees of freedom, Relaxation in binary mixtures, Normal and associated liquid essential difference in low and high amplitude ultrasonic wave propagation of low amplitude waves, ultrasonic generators piezoelectric effect. Propagation in Solids Attenuation due to electron phonon interaction; Phonon-Phonon interaction, Measurement Techniques, optical method, interference method, Pulse method, Sign-around method. Applications of ultra-sound in industrial and medical fields.

Unit - II

Architectural Acoustics, Classical ray theory. Decay of sound in live and in dead rooms, Measurement of reverberation time. Effect of absorption on reverberation, Sound absorption coefficient, absorbing materials and their uses. Fundamentals of musical scales. Physics of musical instruments. Public address system and music sound system for auditoria. Instruments used for acoustical tests. Underwater acoustics, Velocity of Sound in Sea-water, sound transmission loss in sea-water. Refraction Phenomena, Masking by noise and by reverberation, Passive detection hydrophone systems.

Unit – III

Loud Speakers, idealized direct radiator, Typical cone Speaker, Effect of voice coil parameters, Horn Loudspeakers, pressure response, Woofer, midrange and tweeter, Crossover net works, Fletcher Munsion Curves, Baffles; Infinite type, vented type and acoustic suspension type, Microphones, Moving coil type, Carbon microphones, condenser microphones, Cardiod type, Polar response, Rating of microphone responses. Reciprocity theorem and calibration. RIAA equalization Preamplifiers, Tone control circuits, Equalization amplifiers, Noise filters, Dolby Noise Reduction, High Fidelity Stereo amplifiers, Recording and reproduction of sound.

Unit – IV

Noise Decibels and levels, dB Scales in acoustics, Reference Quantity for acoustic Power, intensity and pressure, Determination of overall levels from band levels, Basic sound measuring system using sound level meter. Octave band analyzer. Acoustic Calibrator, Definition of Speech interference levels (SIL), Noise criteria for various spaces. Nomogram relating SPL in octave bands to loudness in Tones, Computation of LL and SIL.

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Text and Reference books:

1. Fundamentals of Acoustics: Kinsler and Fry, (Wiley Eastern).

2. Acoustics: Leo L. Beranek (John Wiley and Sons.).

3. Noise Reduction: L. L. Beranek.

4. Fundamentals of Ultrasonic: J. Blitz.

5. Ultrasonic Absorption: A. B. Bhatia.

6. Acoustical Test and Measurements: Don Davis.

Semester IV Paper XI (Elective) NANOSCIENCE

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

Semster IV Paper XII (Elective) Spectroscopy

Unit –I:

Electronic spectra of diatomic molecules, Resolution of total regen-function of total energy. Vibrational structure of electronic transitions. Progressions, Sequences Vibrational analysis. Deslander's table. Rotational Structure of electronic bands P. O. R. branches.

Unit - II:

Band head formation, fortran diagram. Evaluation of rotational constants. Intensities in electronic bands. Frank Condone Principle. Condone parabola, General treatment of molecular orbitals, Hund's coupling cases.

Unit – III:

Polyatomic molecules- symmetry consideration. Symmetry operation. Point groups Symmetry potential and Kinetic energy. Outline of group theory. Mathematical methods of studying vibrations, internal coordinates and atomic displacement .

Unit – IV

Bond, stretching. Bending, torsion, G. matrix for a linear triatomic molecules. Kinetic energy for linear triatomic molecule. Symmetry of Benzene molecules its vibrational modes, in-plane and out of plane modes, selection 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 IV Paper XIII Elective Lasers, Fiber Optics and Applications

Unit – I

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 – II

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.

Unit-III Numerical aperture, Coherence bundle, Attenuation in optical fiber, Pulse dispersion in step index optical fiber, Loss mechanism.

Unit – IV

Splice loss, Petermann-2 spot size, Far field patter. Graded index fiber: Model analysis of parabolic index fiber, LPl m modes, Multimode fibers with optimum profiles.

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 and IV **(List of Recommended Experiments.)**

Electronics

1. Pulse amplitude modulation / demodulation.
2. Pulse position / Pulse width modulation / demodulation.
3. FSK modulation / demodulation using timer / PLL.
4. Microwave characterization and measurement.
5. PLL circuits and applications.
6. Fibre optics communication.
7. Design of active filters.
8. BCD to seven segment display.
9. A/D and D / A conversion.
10. Experiments using various types of memory elements.
11. Addition, subtraction, multiplication and division using 8085 / 8086.
12. Waveform generation and storage oscilloscope.
13. Frequency, voltage, temperature measurements.
14. Motor speed, temperature control using 8086.
15. Trouble shooting using signature analyzer.
16. Assembler language programming on PC.
17. Experiments based on computer aided design.

Materials Science

1. Crystal structure determination by powder diffraction.
2. Study of microstructures of metal alloys.
3. Dislocation in alkali halide crystals.
4. Crystal growth from slow cooling of the melt.
5. Thermal analysis of binary alloy.
6. Differential thermal analysis of $BaTiO_3$-$PbTiO_3$ solid solution.
7. To study electrochemical method of corrosion control.
8. Dielectric behaviour of $LiNbO_3$ and $BaTiO_3$ in crystals and ceramics.
9. Electrical conductivity of ionic solids.
10. To test hardness of a material by Brinell hardness tester.
11. Photo elasticity study.
12. Multiple beam interferromentric study of surfaces.
13. Thermal conductivity of bad conductor.
14. Thermal expansion coefficient of metals.
15. Study of transport property in solid electrolytes.
16. Verification Nernst law/Oxygen sensor.
17. Determination of Thermoelectricity Power.

X-Rays

1. Study of Crystal Models.
2. X-ray Diffraction Photograph of a Metal Foil by transmission (Hull Method).
3. X-ray Diffraction Photograph of a Metal Foil by Back Reflection.
4. Powder Photograph by Debye Scherrer Method, Computer Analysis.
5. Laue Photograph and Gnomonic Projection.
6. Rotation oscillation Photograph.
7. Diffraction of X-rays by Liquids.
8. Bragg's Spectrometer: Uhler and Cooksey's method.
9. Bent Crystal (Cauchois) Transmission Type Spectrograph: Study of K and L Absorption Edges.
10. Bent Crystal (Cauchois) Transmission Type Spectrograph: Study of K and L emission Spectra.
11. Measurement of Intensities of Emission Lines, Computer Analysis.
12. Study of Satellite Lines.
13. Analysis of XANES Spectrum, Computer Analysis.
14. Analysis of EXAFS Spectrum, Computer Analysis.
15. Determination of Planck's constant by X-rays.
16. X-ray Fluorescence Spectrum Analysis.
17. Absorption Coefficient for X-rays by G. M. / Scintillation Counter.
18. Characteristics of G. M. tube.
19. Compton Effect.
20. Operation of a Demountable X-ray Tube.

Nanoscience and Nanotechnology

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