School of Physics
Devi Ahilya Vishwavidyalaya
Vigyan Bhavan, Khandwa Road Campus,
Indore-452001, M. P. INDIA

M.Sc. (Physics-Materials Science)

M. Sc. (Physics Materials Science)

Scheme of Examination for M. Sc. Programme

First Semester from July to December

COURSE CODE	COURSE TITLE	CREDITS
PHY-501	Classical Mechanics	4
PHY-503	Mathematical Physics	4
PHY-505	Quantum Mechanics-I	4
PHY-507	Electronics	4
PHY-509	Laboratory Course-I (Electronics)	4
PHY-511	CBCS- I Numerical techniques using C^{++}	4
	Comprehensive viva	4

Second Semester from January to June

COURSE CODE	COURSE TITLE	CREDITS
PHY-502	Statistical Mechanics	4
PHY-504	Solid State Physics-I	4
PHY-506	Classical Electrodynamics-I	4
PHY-508	Atomic and Molecular Physics	4
PHY-510	Laboratory Course-II (Optics)	4
	Comprehensive viva	4

Third Semester from July to December

COURSE CODE	COURSE TITLE	CREDITS
PHY-521	Classical Electrodynamics-II	4
PHY-523	Quantum Mechanics-II	4
PHY-525	Solid State Physics-II	4
PHY-527	Nuclear and Particle Physics	4
PHY-529	CBCS- II Numerical techniques using C^{++}	4
PHY-531	Research Project Work/ Laboratory Course-III (Computer oriented numerical methods)	2
	Comprehensive viva	4

Fourth Semester from January to June

COURSE CODE	COURSE TITLE	CREDITS
PHY-522	Research Project Work/ Laboratory Course-IV (Microprocessor)	6
PHY-524	Digital Electronics and Microprocessor	4
PHY-532	Materials Science	4
PHY-534	Nanomaterials	4
PHY-536	Transducers and characterization techniques	4
	Comprehensive Viva	4

Total Credits (102) = I Semester (28) + II Semester (24) + III Semester (26) + IV Semester (26)

After the end of each semester examination a comprehensive viva-voce of four virtual credits is conducted. *In addition to the theory and lab courses, there are seminars on course work and research topic given by faculty, students and visiting scientists through which students are encouraged to attend and participate. At the end of second semester, meritorious students will do summer training courses at IPR, Bhat Gandhinagar, PRL, Ahmedabad, NSC, New Delhi, CAT, Indore and IUC, Indore.*

M. Sc. (Physics Materials Science): SEMESTER– I

PHY-501   CLASSICAL MECHANICS   04 credits

Mechanics of a single particle and system of particles. Generalized coordinates. Principle of least action. Galileo's relativity principle. The Lagrangian for a free particle. The Lagrangian for a system of particles. Laws of conservation as derived from homogeneity and isotropy of space and homogeneity of mass. Principle of mechanical similarity. Virial theorem. Lagrangian Formulation. Constraint. Holonomic and non-holonomic constraints. D'Alembert's principle.

Reduced mass. Motion in a central field. Kepler's problem. Scattering in the central field. scattering cross section. Rutherford formula. Elastic and inelastic collision. Small oscillations. Forced oscillation. Normal coordinates. Frequency of molecular vibration. Damped oscillation. Parametric resonance. Motion of a rigid body. Euler's angles. Inertia tensors. Angular momentum of a rigid body. Precision Euler's equations. Symmetric and asymmetric top. Noninertial frame of reference. Rocket equation.

Canonical Equation, Hamilton's equations, Canonical transformations, Poisson brackets, Canonical invariance, Infinitesimal canonical transformations, Hamillton Jacobi theory, Action angle variables, Maupertuis principle, Adiabatic invariants.

Special theory of relativity: Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Books Recommended:
1.   Mechanics: Landau and Lifshitz (Pergamon Press)
2.   Classical Mechanics: H. Goldstein (Addison and Wesley)
3.   Introduction to classical Mechanics: Takwale and Puranik (Tata Mc Graw Hill)
4.   Schaum's Outline Series, Theory and applications of Theoretical mechanics, M. R. Spiegel
5.   Berkeley Physics Course: Mechanics, C. Kittel, W. D. Knight, and M. A. Ruderman.

PHY-503   MATHEMATICAL PHYSICS   04 credits

Special functions: Bessel functions of first and second kind, Hermite, Legendre, Associate Legendre and Laguerre polynomials. Their recursion relations, generating functions, and orthogonality. Curvilinear co-ordinate system with specific cases of Cartesian, Cylindrical, and Spherical coordinate systems.

Integral transforms. Fourier integral. Fourier transform and inverse Fourier transforms. Fourier transform of derivatives. Convolution theorem. Elementary Laplace transforms. Laplace transform of derivatives. Application to a damped harmonic oscillator.

Green's functions: Non-homogenous boundary value problems, Green's function for one dimensional problems, Green's function for electrostatic boundary value problems and quantum-mechanical scattering problem.

Complex variables: Analyticity of complex functions. Cauchy Riemann equations. Cauchy theorem. Cauchy integral formula. Taylor's, Maclaurin, Laurent series. Residue Theorem, Simple cases of contour integration. Integrals involving multiple valued functions.

Books Recommended:
1.   Mathematics of Engineers and Physicists: L. A. Pipes
2.   Mathematical Methods for Physicists: G. B. Arfken
3.   Mathematical Physics: H. K. Dass, R. Verma
4.   Schaum's Outline Series.

PHY-505   QUANTUM MECHANICS I   04 credits

Foundation of Quantum mechanics: Wave-particle duality, wave packets, time independent Schrodinger equation, wave function, expectation values, continuity equation, Ehrenfest theorem, Heisenberg uncertainty principle.

Operators, Functions and Spaces: Linear operators, eigen functions and values, Dirac bra and ket notation and vectors, postulates of quantum mechanics, Hilbert Space, Hermitian Operators, properties of Hermitian Operators, position and momentum representation, time varying expectations, Ladder operators, the eigen values of ladder operators, the eigen functions of the orbital angular momentum operator.

One-dimensional problems: Free particle, potential step, rectangular barrier, tunneling, infinite square well, finite square well, periodic lattice, and linear harmonic oscillator.

Three-dimensional problems: Free particle (in Cartesian and Spherical coordinates), Three-dimensional Square well, three-dimensional linear harmonic oscillator (in Cartesian and in Spherical coordinates), rigid rotator, Hydrogen atom, and potential barrier.

Quantum approximations: Time-independent perturbation theory: Non-degenerate unperturbed states, Degenerate unperturbed states, Stark effect, The variational method, Helium atom (Using perturbation and variational method), WKB approximation and wave functions, connection formulae, application to bound states, transmission through a potential barrier.

Matrix Mechanics: The Schrodinger picture, The Heisenberg picture, The Interaction picture, linear harmonic oscillator (solution using the Schrodinger and Heisenberg Picture).

Books recommended:

1. Quantum Mechanics: Concepts and Applications, Nouredine Zettili, Jacksonville State University, Jacksonville, USA John Wiley and Sons, Ltd. 2009.
2. Quantum Mechanics: Fundamental and Applications to Technology, Jasprit Singh, University of Michigan, John Wiley and Sons, Ltd. 1997.
3. Quantum Mechanics, V. Devanathan, Narosa Publishing House, New Delhi, 2005.
4. Schaum's Outline Series: Quantum Mechanics, Y. Peleg, R. Pnini, E. Zaarur
5. Berkeley Physics Course: Quantum Physics, E. H. Wichmann.

PHY-507   ELECTRONICS   04 credits

Semiconductor devices: diodes, junctions, transistors, field effect devices, JFET, BJT, MOSFET and MESFET, device structure, working, I-V characteristics under different conditions.

Microwave Devices: Tunnel diode, transfer electron devices (Gunn diode), Avalanche Transit time devices, Impatt diodes.

Optoelectronic devices: LED, photodiode, device structure and working.

Amplifiers: Negative feed back and its advantages in amplifiers, various types of couplings in amplifiers. RC coupled, CE amplifier, its frequency response curve.

Differential amplifiers: Circuit configurations- dual input, balanced output differential amplifier- *dc* analysis- *ac* analysis, inverting and non-inverting inputs CMRR- constant, current bias level translator.

Operational amplifiers: Block diagram of a typical op-amp with negative feedback-voltage series feed back – effect of feed back on closed loop gain input persistence output resistance bandwidth and output offset voltage-follower. Practical op-amp input offset voltage – input bias current – input offset current, total output offset voltage, CMRR frequency response. DC and AC amplifier summing scaling and averaging amplifiers instrumentation amplifier, comparators, integrator and differentiator.

Oscillators: Positive feedback and Brakhausen Criteria of Oscillators, Oscillators principle – Oscillator types – frequency stability – response – The phase shift oscillator. Wein bridge oscillator – LC tunable oscillators – Multivibrators – Astable, Monostable and Bistable – Multivibrators – square wave and Triangle wave generators.

Voltage regulators – Transistor series pass regulator. IC regulator -fixed regulators, adjustable voltage regulators switching regulators.

Logic Gates: OR, AND, NOT, NOR, NAND Gates, NAND Gate as a universal building block.

Books recommended:
1. Semiconductor Devices, Physics and Technology, S. M. Sze, Wiley (1985).
2. Introduction semiconductor devices, M. S. Tyagi, John Wiley and sons.
3. Electronic Devices And Circuits; An Introduction, *Allen Mottershead.*
4. Electronics Principles: A. P. Malvino McGraw Hill, International edition.
5. Electronic Devices and circuits-J. Millman and C. Halkias,Tata McGraw Hill, Publishing Company Ltd.

PHY-509   LABORATORY COURSE-I (ELECTRONICS)   04 credits

1. To assemble Logic gates using discrete components and to verify truth table.
2. Perform mathematical operations using OPAMP and its use as analog computer: (a) Adder / Subtractor, (b) Divider / Multiplicator and (c) Design an analog computer.
3. Design of regulated power supply (transistorised).
4. Wave shaping circuit, clipping, clamping, differentiating and integrating circuits.
5. R C coupled amplifier-frequency response.
6. Emitter follower.
7. FET characteristics and calibration of FET Input voltmeter
8. R C phase shifts or Wien bridge (Transistor) Oscillator.
9. Use transistor BC 107 as astable multivibrator to a) Calculate its frequency and compare it with the observed value, and b) Convert it into Bistable multivibrators. Trace the output.
10. Measurement of Hybrid parameters of transistor.
11. Transistor Bias stability.
12. SCR characteristics and one application.
13. Operational amplifier (OP Amp) as integrator and differentiator.
14. Use OP Amplifier as a) Inverting amplifier, b) Non-inverting amplifier and c) Study the frequency response.

PHY-511   CBCS- I Numerical techniques using C^{++} 04 credits

Programming in C++: basic, loops and decisions, functions and arrays. Linear system of equations: Gaussian elimination, Gauss Jordan method, III conditioned matrix. Iterative solutions of linear equations: Jacobi and Gauss Siedel iterations. Real roots of nonlinear equations: Method of successive bisections, Regula falsi method, Newton Raphson method and secant method. Solution of simultaneous nonlinear equations.

List of computation problems:
1. Solving linear equations: i) Gauss elimination method; ii) Matrix inversion by Gauss Jordan method, iii) Jacobi iterative method, and iv) Gauss Siedel method.
2. Solving non linear equations i) Regula falsi method, ii) Newton Raphson method, iii) Secant method.

1. Programming with C++, Schaum's Outline Series: J. Hubbard
2. Object-oriented programming in Turbo C++: Robert Lafore.
3. Numerical mathematical analysis: J. B. Scarborough
4. First course in numerical analysis: A. Ralston
5. Numerical methods in Science and Engineering: S. Rajsekharan
6. Numerical methods for Science and Engineering: J.H. Mathews
7. Computer oriented numerical methods: V. Rajaraman
8. Teach yourself C++ in 21 days: Jesse Liberty.

M. Sc. (Physics Materials Science): SEMESTER II

PHY-502   STATISTICAL MECHANICS   04 credits

Elements of Thermodynamics: Laws of thermodynamics and their consequences, Thermodynamical potentials, Maxwell relations, chemical potential.

Fundamental of Statistical Mechanics: Phase space. Statistical ensembles. Fluctuations. Density of distribution in phase space. Postulate of equal a priori probabilities. Most probable distribution. Liouville's theorem. Density matrix.

Equilibrium ensemble: Micro Canonical, Canonical and Grand Canonical ensemble. Partition function, Thermodynamic function. Mean energy, pressure and free energy. Entropy in terms of probability. Gibb's paradox. Sakur-tetrode expression Equivalence of three equilibrium ensemble. Fluctuations in energy and particle number in Canonical and Grand Canonical ensemble.

Maxwell distribution: Maxwell distribution function. Maxwell distribution of velocities. Doppler broadening of spectral lines. Classical Statistical Mechanics: Evaluation of partition function for ideal gas.

Quantum Statistical Mechanics: Indistinguishability and Quantum statistics. Symmetric and antisymmetric wave function. Quantum distribution function: Ensembles in Quantum Statistical mechanics. Bose Einstein and Fermi Dirac statistics. Boltazman limit of Bose and Fermi gases. Bose Einstein condensation. Weakly and strongly degenerate Fermi gas.

Phase transition: First and Second order phase transition, Clausius-Clapeyron equation, critical indices, Order parameter, Landau theory of phase transition, Cooperative phenomena, Ising model, Bragg-Williams approximation, One dimensional Ising model, Mean field theory.

Books Recommended:
1. A treatise on Heat, M. N. Saha and B. N. Srivastava, The Indian Press Private Ltd. Allahabad (1969)
2. Statistical mechanics, B. K. Agarwal and M. Eisner.
3. Statistical Mechanics, K. Huang, John Wiley and Sons, New York (1987).
4. Introduction to Statistical Mechanics, S. R. A. Salinas, Springer (2001).
5. Introductory Statistical Mechanics, R. Bowley and M. Sanchez, Oxford (2000).
6. Schaum's Outline Series: Thermodynamics, M. M. Abbott, H. G. Van ness
7. Berkeley Physics Course: Statistical Physics, F. Reif.

PHY- 504   SOLID STATE PHYSICS-I   04 credits

Crystal structure and binding: Crystalline state, Symmetry operations, point groups and crystal system, fundamental types of lattices, structure of NaCl, CsCl, Diamond and ZnS, Diffraction of x-rays by crystals, the Laue, Powder and Rotating crystal methods, Bragg's law, Properties of reciprocal lattice, Brillouin zone, Ionic, Covalent, Molecular and Hydrogen bonded crystals, Lattice energy of ionic crystals.

Crystal vibrations: Vibrations of monoatomic and diatomic linear lattices, acoustical and optical phonons, dispersion relation for three dimension crystals, inelastic neutron scattering, elastic properties of solids, specific heat of solids, Einstein and Debye theory of specific heat, anharmonic crystal interactions, thermal expansion, Raman effect, Mössbauer effect.

Defects: Point defects, line defects and planer (stacking) faults, the role of dislocations in plastic deformation and crystal growth, the observation of imperfections in crystals, X−ray and electron microscopic techniques.

Magnetism: Quantum theories of diamagnetism and paramagnetism, Paramagnetic susceptibility of conduction electrons, Weiss molecular fields theory of ferromagnetism, Exchange interaction, Origin of magnetic domain and domain walls, Collective magnetic excitations, Spin waves, dispersion of spin waves.

Books Recommended:
1. Solid State Physics, J. J. Quinn, K. S. Yi, Springer-Verlag Berlin Heidelberg 2009
2. Intermediate Quantum theory of Crystalline Solids, A. O. E. Animalu, Prentice−Hall of India private Limited, New Delhi 1977.

3. Crystallography for Solid State Physics, A. R. Verma, and O. N. Srivastava, New Age International (P) Ltd. 2001.
4. Introduction to Solid State Physics, C. Kittel, John Wiley and Sons, New York, 2005.
5. Solid State Physics, N. W. Ashcroft, and N. D. Mermin, Harcourt Asia (P) Ltd. 2001.

PHY-506 CLASSICAL ELECTRODYNAMICS-I   04 credits

Boundary value problems in Electrostatics: Elements of Vector analysis, methods of images, field due to a point charge outside a plane-conducting medium, field due to a point charge near a spherical conductor. Laplace's equation, separation of variables, Cartesian coordinates, spherical coordinates. Boundary value problems with linear dielectrics.

Boundary value problems in Magnetostatics: Biot and Savart Law, differential equations of magnetostatics and Ampere's law, vector potential and magnetic induction for a circular current loop, magnetic fields of a localized current distribution, magnetic moment, macroscopic equations, and methods of solving boundary value problems in magnetostatics.

Electromagnetic waves: E. M. waves in vacuum, linear and circular polarization, Poynting vector, refraction and reflection of EM waves at interface between two dielectrics, normal and oblique incidence, Brewster angle, total reflection, numerical problems.

Books recommended:
1. Elements of Electromagnetics: M. N. O. Sadiku.
2. Introduction to Electrodynamics: D.J. Griffith (Prentice Hall of India, N. Delhi, 2000).
3. Classical Electrodynamics: J. D. Jackson.
4. Classical Theory of Fields: L.D. Landau and E.M. Lifshitz (Pergamon Press).
5. Schaum's Outline Series: Theory and problems of Electromagnetics, J. A. Ediminister
6. Berkeley Physics Course: Electricity and Magnetism, E. M. Purcell.

PHY-508   ATOMIC AND MOLECULAR PHYSICS   04 credits

Quantum states of hydrogen like atomic systems. Fine structure: Relativistic correction, spin-orbit coupling and Darwin term. Spectroscopic terms and selection rules. Zeeman- and Paschen-Back effects. Hyperfine structure. Lamb shift.

Identical particles, spectra of two-electron atomic systems, Independent particle model, exchange effects.

Multi- electron atoms. Pauli principle and periodic table. Central field approximation, Hartree self consistent field method, Hartree-Fock method. Coupling schemes for many electron atoms, L-S and j-j coupling schemes, equivalent electrons. H^+_2 -molecule ion. Heitler-London theory of H_2 molecule. Covalent- and ionic- bondings. Van der waal interaction.

Molecular spectroscopy: Rotation. Rotation and Vibration spectra. Raman spectra. Frank-Condon principle.

Books Recommended:
1. Physics of Atoms and Molecules: B. H. Bransden and C. J. Joachain
2. Molecular structure and spectroscopy: G. Aruldhas

PHY-510   LABORATORY COURSE II (OPTICS)   04 credits

1. Determination of wavelength by constant deviation prism.
2. Verification of Fresnel's formulas.
3. Determination of Young's modulus and Poisson's ratio of glass by Cornu's method.
4. Estimation of band energy gap of a semiconductor.
5. Hall effect and determination of type and number of carriers.
6. Determination of e/m specific charge ratio by Bush method.
7. Verification of Cauchy's formula.
8. Determination of the B-H Curve.
9. Determination of photoconductivity of semiconducting material.
10. Temperature variations of resistivity of semiconductor by four probe method.
11. Determination of Stefan constant.
12. Determination of velocity of ultrasonic waves.

M. Sc. (Physics Materials Science): SEMESTER -III

PHY-521   CLASSICAL ELECTRO DYNAMICS-II   04 credits

Electromagnetic waves in a conducting medium, complex refractive index, Boundary value problems in presence of metallic interface: reflection and refraction from metallic surface, wave guides: planar, rectangular and cylindrical, phase velocity and group velocity, cut off frequency, Poynting vector, modes, resonator.

Relativistic kinematics: Elements of Tensor analysis, Principle of relativity, Einstein's postulates, intervals, proper time, the Lorentz transformation, four vectors, four-velocity. Relativistic mechanics: charged particle motion in uniform and non-uniform fields, Relativistic electrodynamics: electromagnetic field tensor, Lorentz transformation of the filed, Invariants of the field. Maxwell equations in four-vector notation.

Radiation by relativistic particles Retarded potentials, Lienard-Wiechert potentials, spectral and angular distribution of radiation from a point charge, total power radiation, Larmor's formula its relativistic generalization, synchrotron radiation, radiation damping, dipole radiation, quadrupole and magnetic dipole radiation, Thomson scattering of high frequency waves.

Books recommended:
1. Elements of Electromagnetics: M. N. O. Sadiku.
2. Introduction to Electrodynamics: D.J. Griffith.
3. Classical Electrodynamics: J. D. Jackson.
4. Classical Theory of Fields: L.D. Landau and E.M. Lifshitz (Pergamon Press).
5. Schaum's Outline Series: Theory and problems of Electromagnetics, J. A. Ediminister

PHY-523   QUANTUM MECHANICS – II   04 credits

Time dependent potentials: The interaction pictures. Time dependent two state problems. Nuclear magnetic resonance. Rabi's molecular beam method, Ammonia molecule and maser. Time dependent perturbation theory, harmonic perturbation. Interaction of an atom with electromagnetic radiation. Absorption and stimulated emission. Electric dipole approximation. Sum rule. Photoelectric effect. Passage of charged particle through matter.

Scattering Theory: Scattering amplitude and cross section, Born approximation and its application to various potentials, Electron scattering from nuclei, form factor and nuclear radius, Validity of Born approximation, Partial wave analysis, Scattering by a rigid sphere and square well. Low energy nucleon-nucleon scattering.

Relativistic Quantum Mechanics: Klein-Gordon Equation and its non relativistic reduction. Dirac equation for a free particle and its solution. Interpretation of negative energy states. Nonrelativistic approximation to the Dirac equation. Existence of spin. Fine structure effects. Solutions of Dirac equation for hydrogen atom.

1. Quantum Mechanics: J. J. Sakurai.
2. Quantum Mechanics: L I Schiff.
3. Quantum Mechanics: B. H. Bransden and C.J. Joachain.

PHY. - 525   SOLID STATE PHYSICS-II   04 credits

Electron theory: Drude Model, Electrical and thermal conductivity, Wiedemann–Franz Law, Lorentz theory, Sommerfeld theory of Metals, Boltzmann differential equation, Scattering Processes, Relaxation-time approximation, Solution of the Boltzmann equation for metals. Materials transport properties. Peltier Coefficient. Thermoelectric power.

Electrons in a periodic lattice: Nearly free electron model, Bloch theorem, Kronig Penney model, Metals–Semimetals–Semiconductors–Insulators, Tight binding approach, Fermi surface, de Haas Van Alfen effect, Magnetoresistance.

Elementary excitations: Polarizability and dielectric function of the electron gas, collective excitations, Screening, metal Insulator transition, electron−electron interaction, polaritons, polarons, excitons, ferroelectric effects.

Superconductivity: Macroscopic electromagnetic properties, Thermal properties, Isotope effect, Manifestations of energy gap, London theory, Two fluid model, Flux quantization, single particle

tunneling, *dc* and *ac* Josephson effect, quantum interference, electron –phonon interaction, Cooper pair, BCS ground and excited states, High temperature superconductors.

Books Recommended:

1. Intermediate Quantum theory of Crystalline Solids, A. O. E. Animalu, Prentice–Hall of India private limited, New Delhi 1977.
2. Introduction to Solid State Physics, C. Kittel, VIIIth Edition, John Wiley, New York, 2005.
3. Solid State Physics, J. D. Patterson, and B. C. Bailey, Springer, 2007
4. Solid State Physics, J. J. Quinn, K. S. Yi, Springer, 2009.

PHY-527   NUCLEAR and PARTICLE PHYSICS   04 credits

Nuclear sizes and shapes. Experimental methods of determining nuclear radius. Two-nucleon problem: Deuteron problem. Central and non central forces. Tensor forces.

Nuclear models: Semi empirical mass formula and isobaric stability. Nuclear shell structure. Magic numbers. Single particle model. Spin orbit coupling. Schmidt lines. Rotational and vibrational spectra and elementary idea of unified model.

Nuclear reactions: Q value. Compound nuclear reaction and direct reactions. Single level Breit-Wigner formula.

Nuclear fission: Liquid drop model. Multiplication factor and chain reaction. Concept of thermal, fast and breeder reactor. Elementary ideas of energy generation by fusion.

Radiative transition in nuclei, multipole transitions and selection rules.

Fermi theory of beta decay Kurie plot, ft value. Allowed and forbidden transitions. Determination of neutrino helicity. The τ - θ puzzle. Parity non conservation and it's experimental verification. Fundamental interactions classifications and properties of elementary particles. Conservation laws and it's violation in different types of interactions.

Hadron-Hadron interaction: Isospin of two nucleon and nucleon systems. Strangeness. Elements of group theory and symmetry.

Gell-Mann-Nishigima formula quark models, Baryon decuplet and octet, Meson monet, Colour, Elementary ideas of Quantum chromodynamics

1. Nuclear Physics: R. R. Roy and B. P. Nigam
2. Introduction to high-energy physics: D. H. Parkins
3. Introduction to nuclear physics: H. A. Enge
4. Concepts of nuclear physics: B. L. Cohen

PHY-529   CBCS- II Numerical techniques using C^{++} 04 credits

Data interpretation and analysis. Precision and accuracy. Error analysis, propagation of errors. Least square fittings.

Structure, objects and classes, Operative overloading, inheritance.

Interpolation and curve fitting: Newton forward difference and Lagrange interpolation. Linear regression, polynomial regression, data normalization. Numerical integration: Trapozoidal rule, Simpsons' rule, Gaussian Quadratature. Formulas for numerical differentation.

Numerical solutions of differential equations: Euler's method, Taylor series Heuns method, Runga Kutta method.

List of computation problems:
1. Numerical integeration with global errors: i) Trapezoidal rule, ii) Simpson's 1/3 and 3/8 rules, and iii) Gaussian Quadratature.
2. Problem based on principle of least squares.
3. Numerical solutions of differential equations i) Eulers, ii) Heuns, and iii) Runga Kutta method.
4. Interpolation problems.

1. Programming with C++, Schaum's Outline Series: J. Hubbard
2. Object-oriented programming in Turbo C++: Robert Lafore.
3. Teach yourself C++ in 21days: Jesse Liberty.
4. Numerical mathematical analysis: J.B. Scarborough
5. First course in numerical analysis: A. Ralston

6.   Numerical methods in Science and Engineering: S. Rajsekharan
7.   Numerical methods for Science and Engineering: J.H. Mathews
8.   Computer oriented numerical methods: V. Rajaraman

PHY-531 Research Project Work/Practical (LABORATORY COURSE –III)   02 credits

Research Project Work

Project work will be allocated to selected students as decided by the committee of School of Physics. Students opting research project have to carry out research problem assigned by concerned faculty.

Remaining students will undertake laboratory course-III as per the decision made by the committee.

LABORATORY COURSE-III (Computer oriented numerical methods)

Numerical solutions of differential equations: Euler's method, Taylor series Heuns method,

Runga Kutta method. Numerical integeration: Trapezoidal rule, Simpson's rule, and Gaussian Quadratature. Numerical differentiation.

List of programs:

1.   Numerical integeration with global errors: i) Trapezoidal rule, ii) Simpson's 1/3 and 3/8 rules, and iii) Gaussian Quadratature.
2.   Numerical solutions of differential equations: i) Eulers method, and ii) Runga Kutta second and fourth order methods.

1. Numerical mathematical analysis: J.B. Scarborough
2. First course in numerical analysis: A. Ralston
3. Numerical methods in Science and Engineering: S. Rajsekharan
4. Numerical methods for Science and Engineering: J.H. Mathews
5. Computer oriented numerical methods: V. Rajaraman

M. Sc. (Physics Materials Science): SEMESTER IV

PHY -522 RESEARCH PROJECT WORK/LABORATORY COURSE 06 credits Research Project Work

Students will continue six months project work allocated in the IIIrd semester.

LABORATORY COURSE-IV (Microprocessor)

1. 8085 Based Microprocessor: With elevator simulator interfacing module IC 05.
2. 8085 Based Microprocessor: With traffic light controller interfacing module IC 12.
3. 8085 Based Microprocessor: With ADC 0809 interfacing module IC 01.
4. 8085 Based Microprocessor: With DAC 0800 interfacing module IC 02.
5. 8085 Based Microprocessor: With stepper motor controller interfacing module IC 08.
6. Seven Segment Display & matrix Keyboard Module (IC-24)
7. 16×1 LCD Display Interfacing Module (IC-10)
8. 16×1 LCD Display with Matrix Keyboard module (IC-25)
9. 5×4 Key's Matrix Keyboard Interfacing module (IC-09)
10. Temperature measurement Interfacing Module. (IC-13)

PHY-524   DIGITAL ELECTRONICS AND MICROPROCESSOR   04 credits

Concepts of Digital Electronics: Boolean laws and Theorem. Binary, decimal, octel and hexa decimal number and inter conversion. Simple combinational circuits. Karnaugh map pairs, Quads and octets. Karnaugh simplications. Don't care conditions. The ASCII code. Excess III code. Gray code. Binary addition, Subtraction, unsigned binary numbers. Sign magnitude numbers. 2's compliment representation. 2's compliment arithmetic. Arithmetic building blocks. The adder and subtractor.

Multiplexers, Demultiplexer. 1-of-16 decoder. BCD to decimal decoder. 7 segment decoders. Encoders. Exclusive OR gates. Parity generators-checkers. 7400 devices. A-01 gates. Positive and negative logic. 74C00 devices. CMOS logic gates. Flip flop. Shift registers, counters.

A/D and D/A converters. A/D and D/A accuracy and resolution. Semiconductor memory, (RAM, ROM and EPROM).

Microprocessor architecture: Basic architecture of intel 8085 microprocessor. Microprocessor and its architecture-data. Address and control buses. ALU registers, program counters. Flow chart and assembly language. Writing some programs in assembly language for 8085 microprocessor.

1. Digital Principles and Applications: A. P. Malvino and Leech
2. Digital computer electronics and introduction to micro computers: A. P. Malvino
3. Introduction to microprocessors Software, hardware, programming: L. A. Leventhal.
4. Microprocessor Architecture, Programming, and Applications with the 8085: R. S. Gaonkar

PHY 532   MATERIALS SCIENCE   04 credits

Binary alloys: Interstitial and substitutional solid solution, Factors governing solid solubility, Statistical stability of alloys, Temperature dependence of solubility, phase diagrams, Superlattices, Equilibrium between two phases. Two component systems containing two phases. The phase rule. Binary phase diagrams: Isomorphous alloy systems, The Lever rule, Eutectic systems, The equilibrium microstructure of eutectic systems, applications, Peritectic transformation, Iron-Carbon phase diagram, Austenite, pearlite, Bainite and Martensite phases, TTT diagram, Heat treatments, Intermatallic compounds, Hume-Rothery electron compounds.

Polymers: Classification of polymers, homo- and co-polymers, Linear, branched and crosslinked polymers, Organic, Elemento-organic and Inorganic polymers, Synthesis of polymers, chain polymerization, step polymerization, thermodynamics of the process, Effect of various factors on polymerization rate, Synthesis of graft and block copolymers, Crosslinking reactions, Vulcanization of rubbers, Hardening of plastics, Degradation of polymers, effect of high temperatures, Light and ionizing radiation, Chemical degradation.

Ceramics: Short range order, Coordinated polyhedron and ionic radius, crystalline and glassy states, Glasses, Whitewears and refractories, Cement and Concrete.

Magnetic materials: Magentocrystalline anisotropy, Induced magnetic anisotropy, Magnetostrction, Magentoelastic energy, Magnetoelastic coupling, Volume changes in magentostriction, Villari effect, Wiedemann effect, Inverse Wiedemann effect, Matteucci effect, ΔE effect, Barkhausen effect, Magentization process, Technical magnetization, Magnetic after effect, Soft and hard magnetic materials, Ferrites their structure and uses.

Environmental effects: Corrosion, Oxidation, Thermodynamics oxidation, Oxidation resistance, Acquaous corrosion, Anodic dissolution, Corrosion prevention.

Books recommended:

1. Physical Metallurgy: Read-Hill
2. Introduction to properties of Materials: Resenthal Asimow
3. Elements of Materials Science: Von Vlack
4. Science of Engineering Materials: C. M. Srivastava
5. Physical Metallurgy: V. Raghavan
6. Physical Chemistry of Polymers: A. Tager
7. Physics of Magnetism: S. Chikazumi

PHY-534   NANOMATERIALS   04 credits

Size, Confinement and Oxidation Effects: Basic concepts, Interatomic trapping, Interatomic bonding, Intercluster coupling, Hamiltonian and energy band, Atomic cohesive energy and thermal stability, Barrier confinement. Quantum uncertainty, Atomic coordination reduction, Surface-to-volume ratio, Bond order-length and bond length-strength correlation, Densification of mass, charge, and energy, Oxide long-range interaction, Shape-and-size dependency, Bond–band–barrier correlation, Surface potential barrier, Bond geometry, Valence density of states, Lone-pair interaction, Bond-forming kinetics.

Quantum Wells, Wires, and Dots: Preparation of quantum nanostructures, Size and dimensionality effects, Conduction electrons and dimensionality, Fermi gas and density of states, Potential wells, Quantum wells and quasi–two–dimensional systems, Coupled wells and superlattices, Doped heterojunctions, Nanolithography partial confinement, Properties dependent on density of states.

Mechanical and electronic properties: Stress-strain behaviour, Mechanical and dynamical properties of nano pendulum, Nanometer string, Nanospring. Bindings in solids, Elastic constants, Lattice vibrations, Density of states, Specific heat, Thermal expansion, Thermal conductivity, Vibrational, Raman, Infrared spectroscopy, Phonon confinement, Effect of dimension on lattice vibration and density of states, Effect of size on Debye frequency, Melting temperature, Plasmons, Phase transition, Effect of lattice parameter on electronic structure, Measurements of electronic structure of nanoparticles.

Nanostructured magnetism: Magnetic variables, Magnetic materials, Magnetic phenomena, Quantum effects, Band theory effects, Magnetic anisotropy, Magnetocrystalline anisotropy, Shape anisotropy, Magnetic domains, Hysteresis, Small particle magnetism, Single-domain particles, Coercivity of single-domain particles, Coherent rotation of magnetization, Curling, Fanning, Superparamagnetism, Coercivity of small particles.

Books Recommended:

1. Synthesis, properties and applications of oxide nanomaterials, J. A. Rodriguez, and M. F.] Garcia, Wiley Interscience 2007.
2. Introduction to Nanotechnology, Charles P. Poole Jr., and Frank J. Owens, Wiley Interscience, 2006.
3. The Physics and Chemistry of Nano solids: Frank J. Owens, and Charles P. Poole Jr., Wiley Interscience, 2008.
4. Nanoscale materials in Chemistry, Edited by Kenneth J. Klabunde, Wiley Interscience 2001.
5. Foundations of Nanomechanics, A. N. Cleland, Springer 2005.

PHY-536   Transducers and characterization techniques   4 credits

Basic concepts of measurements: Measurement system performance, static characteristics, errors in measurements, reproducibility and drift, accuracy and precision, sensitivity, efficiency, linearity.

Units, systems and standards: Fundamental and derived units, International standards, primary standards, secondary standards, working standards, standards for mass, length, time, temperature and luminous intensity, electrical standards EMF-standards.

Transducers: Primary and secondary transducers, various sensing elements, active and passive transducers, general principles used in transducers, magnetic transducers, strain gauges, load cells, linear variable differential transformer (LVDT), displacement, pressure, force, torque, electric transducers, temperature, flow measurements.

Basic material characterization techniques: Principle, instrumentation and applications of the following techniques: X-ray diffraction (XRD), conventional induction technique and vibrating sample magnetometer (VSM), Mössbauer spectroscopy, measurement of resistivity, differential scanning calorimetry (DSC).

Books Recommended:

1. Measurement Systems Application and Design, E. O. Doebelin, Fifth Edition McGraw-Hill, New York, 2004.
2. Experimental Physics; Modern Methods, R. A. Dunlap, Oxford University Press, 1988.
3. Handbook of Analytical Instruments, R. S. Khandpur, *Second Edition,*. US: McGraw-Hill Education, 2006.
4. Instrumentation: Devices and System, C. S. Rangan, G. R. Sharma and V. S. V. Mani. Tata McGraw-Hill, New Delhi, 1983.
5. Elements of X Elements of X-ray Diffraction 2nd Edition, B. D. Cullity Addison Addison-Wesley 1978.
6. Instrumentation measurement and analysis: C. Nakra and K. K. Choudhry, Tata McGraw-Hill, New Delhi, 2009.
7. P. Gütlich, R. Link, A. Trautwein, Mössbauer Spectroscopy and Transition Metal Chemistry, Springer Verlag, Berlin-Heidelberg-New York, 1978.