DEVI AHILYA VISHWAVIDYALAYA, INDORE

School of Physics

1.1.1
Syllabus of all programs

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

M. Sc. (PHYSICS)

2017 - 2019

Rs. 25/-

M. Sc. (Physics)

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

Student is supposed to choose either stream A or stream B in IV semester.

COURSE CODE	COURSE TITLE	CREDITS
PHY-522	Research Project Work/ Laboratory Course-IV (Microprocessor)	6
PHY-524	Digital Electronics and Microprocessor	4
	Stream A	
PHY-526	Laser Physics	4
PHY-528	Plasma Physics	4
PHY-530	Optoelectronics	4
	Stream B	
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): 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.

Books Recommended:

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): 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): 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.

Books recommended:

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

Books Recommended:

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.

Books Recommended:

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.

Books Recommended:

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): 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 $\times$ 1 LCD Display Interfacing Module (IC-10)
8. 16 $\times$ 1 LCD Display with Matrix Keyboard module (IC-25)
9. 5 $\times$ 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.

Books Recommended:

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 -526 LASER PHYSICS 04 credits

Characteristics of lasers. Spontaneous and stimulated emission. Einstein A and B coefficients. Population inversion, Coherence, Laser amplification, Oscillation condition. Line broadening mechanisms: homogeneous and inhomogeneous broadening. Gain clamping. Spatial and spectral hole burning and their consequences, Power in Laser Oscillator, Optimum coupling.

Theory of optical resonators: Concept of cavity models, Stability criterion, Gaussian beams and their propagation. Quality factor, Geometry of resonators, Resonant frequency of resonators,

unstable resonators, Time dependence of laser emission, Rate equations for three and four- level systems. Normal mode oscillations, Q-switching and mode locking techniques of laser pulse generation.
Some specific laser systems: Ion lasers (Ar), Atomic and molecular gas lasers (He-Ne, CO2), Solid State lasers (Ruby, Nd: YAG and Nd: Glass). Dye lasers (with one example of dye).

Books Recommended:

1. Lasers: P.W. Miloni and J.H. Eberly, Wiley 2010
2. Principles of Lasers: O. Svelto, Edited D. C. Hanna, Plenum Publ. Corporation1998
3. Introduction to Quantum Electronic: A. Yariv, Oxford University Press 1997.
4. Lasers: Theory and Applications K. Thyagrajan and A. Ghatak Plenum Publ. Corporation1981

PHY 528 PLASMA PHYSICS 04 credits

Occurrence of Plasma in Nature: Criteria for plasmas, Single particle motion in uniform and non uniform electric (E) and magnetic (B) fields, Time varying E and B field. Adiabatic invariants magnetic mirrors, Fluid equation of motion. Fluid drifts parallel and perpendicular to B. Plasma Oscillations, Electron Plasma waves, Ion Waves, Validity of Plasma approximation.
Electrostatic electron and ion perpendicular to B, Electromagnetic waves with B_0=0. Propagation Vector (K) perpendicular and parallel to B_0. Alfven waves. Diffusion in weakly and fully ionized plasmas. Decay of Plasma by Diffusion.
Two stream instability, Gravitational Instability, Weibel instability, Equations of kinetic theory, Derivation of the Fluid equations Landau damping.
Ion acoustic shock waves. The pondermotive Force, Parametric Instabilities-Frequency matching, Instability threshold, Oscillating two stream instability, Plasma Echoes, The Problem of controlled Fusion, Magnetic confinement-Torous, Mirrors, Pinches, Plasma Heating Laser-induced Fusion.

Books recommended:

1 Introduction to Plasma Physics and Controlled Fusion: F. F. Chen
2 Introduction to Plasma Theory: D.R. Nicholson

PHY 530 OPTOELECTRONICS 04 credits

Reflection and transmission of plane waves at interfaces of non absorbing and absorbing media. Interference filters. Polarization and crystal optics. Optical activity and Faraday effect. Optics of liquid crystals. Basic concepts of Fourier Optics.
Introduction to fiber optics: Optical waveguide, rays and modes, principle of light guidance in optical waveguides, fiber types. Electromagnetic analysis of simple optical waveguide: Basic waveguide equation, propagation mode of symmetric step index planar waveguide, TE and TM modes of symmetric step index planar waveguide, mode cut-off condition.
Introduction to nonlinear optics: Basic Difference in Linear and Nonlinear optics, Wavepropagation in nonlinear media, Phase matching and second harmonic generation, Optical parametric oscillator. Third order effects- optical Kerr effect, Self-focusing.

Books Recommended:

1. Optics: A. K. Ghatak, Mc Graw Hill, 2014.
2. Fundamentals of Optics: F. A. Jenkins and H. E.White, McGraw Hill, 1981.
3. Fundamentals of Photonics: BahaaE. A. Saleh, Malvin Carl Teich, John Wiley and Sons 1991.
4. Non linear Optics: Baldwin, Springer, 1969.
5. An Introduction to Optical Fibres: A. H. Cherin, McGraw Hill, 1983.
6. Optical Electronics: A. Ghatak and K. Thyagrajan, Cambridge Univ. Press, 1989.
7. Optical fibre communication: G. Kaiser, McGraw Hill, 1989.

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.

Syllabus
M. Sc. (Physics-Materials Science)

Session 2017 - 2019

School of Physics
Devi Ahilya Vishwavidyalaya
Indore

Rs. 25/-

COURSES OF STUDIES:

First Semester from July to December –

COURSE CODE	COURSE TITLE	CREDITS
PHY-601	Classical Mechanics	4
PHY-603	Mathematical Physics	4
PHY-605	Quantum Mechanics-I	4
PHY-607	Electronics	4
PHY-609	Laboratory Course-I (Electronics)	4
PHY-611	CBCS- (IDC-I)	4
	Comprehensive viva	4

Second Semester from January to June -

COURSE CODE	COURSE TITLE	CREDITS
PHY-602	Statistical Mechanics	4
PHY-604	Solid State Physics-I	4
PHY-606	Classical Electrodynamics-I	4
PHY-608	Atomic and Molecular Physics	4
PHY-610	Laboratory Course-II (Optics)	4
	Comprehensive viva	4

Third Semester from July to December-

COURSE CODE	COURSE TITLE	CREDITS
PHY-621	Classical Electrodynamics-II	4
PHY-623	Quantum Mechanics-II	4
PHY-625	Solid State Physics-II	4
PHY-627	Nuclear and Particle Physics	4
PHY-629	CBCS (IDC-II)	4
PHY-631	Research Project Work/ Practicals	2
	Comprehensive viva	4

Fourth Semester from January to June -

COURSE CODE	COURSE TITLE	CREDITS
PHY-622	Digital Electronics & Microprocessor	4
PHY-624	Laser Physics	4
PHY-626	Material Science	4
PHY-628	Plasma Physics	4
PHY-630	Research Project Work/Practicals	6
	Comprehensive Viva	4

Total Credits= I Sem + II Sem + III Sem+ IV Sem
102 = 28 + 24 + 26 + 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-1:

PHY-601 CLASSICAL MECHANICS

Mechanics of a single particle and system of particlesGeneralized 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 and principle of mechanical similarity. Virial theorem, Lagrangian Formulation, Constraint, holonomic and non-holonomic, 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. 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. Non-inertial 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.

Books Recommended :

1. Mechanics : Landau & Lifshitz (Pergamon Press)
2. Classical Mechanics : H. Goldstein (Addison & Wesley)
3. Introduction to classical Mechanics : Takwali & Puranik (Tata Mac Graw Hill)

PHY-603 MATHEMATICAL PHYSICS

Special function: 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. Taylors, Maclaurin, Laurent series.

Residue Theorem, Simple cases of contour integration. Integrals involving multiple valued functions.

Books Recommended:

1. Mathematics of Engineers and Physicists :Pipes
2. Mathematical Methods for Physicists : Arfken

PHY. -605 QUANTUM MECHANICS I

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

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.

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.

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

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.

Books recommended:

1/ Introductory Quantum Mechanics, R. L. Liboff, Pearson Education, India, 2003
2/ Quantum Mechanics, V. Devanathan, Narosa Publishing House, New Delhi, 2005
3/ Quantum Mechanics, B. H. Bransden, Pearson Education, Singapore, 2005
4/ Molecular Quantum Mechanics, Peter Atkins, Ronald Friedman, Oxford University Press, 2005

PHY-607 ELECTRONICS

Electronics Devices –

Transistors : JEET, BJT, MOSFET and MESFET : 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, Structure and working

Amplifiers:

Negative feed back & its advantages in amplifiers. Various types of couplings in amplifiers. RC Coupled common emitter amplifier, its frequency response curve. Differential amplifier- Circuit configurations- dual input, balanced output differential amplifier- DC analysis- AC Analysis, inverting and non inverting inputs CMRR- constant current bias level translator.

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 & 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 – Transistories 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, by S.M.Sze. Wiley (1985).
2.Introduction semiconductor devices, by M.S.Tyagi, John Wile & Sons.
3.Op amps & Linear Integrated circuits by Ramakant, A.Gayakwad, PH I, Second edition, 1991.
4.Electronics Principles – A.P.Malvino McGraw Hill, International edition.
5.Electronic Devices and circuits- J.Millman and C Halkias ,Tat McGraw Hill,Publishing Company Ltd.

PHY-609 LABORATORY COURSE-I (ELECTRONICS)

1. To assemble Logic gates using discrete components and to verify truth table.
2. Perform mathematical operations using OPAMP & its use as analog computer : (a) Adder / Subtractor, (b) Divider / Multiplicator and (c) Design an analog computer

3. 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.

(a) Calculate its frequency and compare it with the observed value.

(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 & differentiator.
14. Use OP Amplifier as a)Inverting amplifier, b) Non-inverting amplifier and c) Study the frequency response.

PHY-611 CBCS -I NUMERICAL TECHNIQUES USING C++ part 1

Programming in C++: , Basic, loops and decision, function, arrays.

Real roots of nonlinear equations: Method of successive bisections, Regula falsi method, Newton Raphson method and secant method.

List of computation problems :

1. Programs based on C++ basics, loops and decisions, functions and one dimensional arrays.
2. Solving nonlinear equations using

i. Bisection Method

ii Regula false method

Iii.Newton Raphson method

Books Recommended:

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

M. Sc. (Physics-Materials Science)

SEMESTER-1I

PHY-602 STATISTICAL MECHANICS

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.

Classical Maxwell distribution function. 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.

Correlation of time dependent fluctuations, fluctuations and transport phenomena, Brownain motion, Langevin theory, fluctuation dissipation theorem, Fokker-Planck equation.

Books Recommended:

1.Statistical Mechanics : K. Huang
2.Statistical Mechanics : B.K. Agarwal and M. Eisner
3.A treatise on Heat : M.N.Saha & B.N. Srivastava ,The Indian Press, Allahabad (1969)
4. Fundamentals of Statistical & Thermal Physics: McGraw-Hill, NewYork (1965)
5. Statistical Physics: L.D.Landau and L.M.Lifshitz, Pergamon Press, Oxford (1958)

PHY.- 604 SOLID STATE PHYSICS-I

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, Magnons.

Books Recommended:

Solid State Physics, Adrianus J Dekker, Macmillan India Limited, 2000
Crystallography for Solid State Physics, A. R. Verma, and O. N. Srivastava, New Age International (P) Ltd. 2001.
Introduction to Solid State Physics, C. Kittel, VIIIth Edition, John Wiley and Sons, New York, 2005.
Solid State Physics, N. W. Ashcroft, and N. D. Mermin, Harcourt Asia (P) Ltd. 2001
Physics of Magnetism, S. Chikazumi R.E.Krienger Publ Co.Inc,Florida 1978

PHY-606 CLASSICAL ELECTRODYNAMICS-I

Boundary value problems in Electrostatics- 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, seperation 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. Introduction to Electrodynamics: D.J. Griffith (Prentice Hall of India, N. Delhi, 2000)
2. Classical Electrodynamics : J.D.Jackson
3. Classical Theory of Fields : L.D. Landau and E.M. Lifshitz (Pergamon Press)

PHY-608 ATOMIC AND MOLECULAR PHYSICS

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.Principles of Lasers: Spontaneous and stimulated emission. Optical pumping. Population inversion. Coherence. Simple description of ammonia and He-Ne Laser.

Books Recommended:

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

PHY-610 LABORATORY COURSE II (OPTICS)

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. To determine the value of e/m specific charge ratio by Bush method.
7. Verification of Cauchy's formula.
8. Determine the B-H Curve.
9. Temperature variation of resistivity of semiconductor by four probe method and calculation of the band gap.
10. Determine Stefan constant.
11. Determination of velocity of ultrasonic waves.

M. Sc. (Physics-Materials Science)

SEMESTER-III

PHY-621 CLASSICAL ELECTRO DYNAMICS-II

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

Relativistic kinematics: 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, Numerical Problems & assignments.

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. Numerical Problems & assignments.

Books recommended :

1. Introduction to Electrodynamics : D.J. Griffith
2. Classical Electrodynamics : J.D. Jackson
3. Classical Theory of Fields : Landau and Lifshitz

PHY-623 QUANTUM MECHANICS – II

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.

Books recommended :

1. Quantum Mechanics : J. J. Sakurai.
2. Principles of Quantum Mechanics : P A M Dirac.
3. Quantum Mechanics : L I Schiff.
4. Quantum Mechanics : B.H. Bransden and C.J. Joachain.

PHY. - 625 SOLID STATE PHYSICS-II

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, electrical Conductivity, Peltier Coefficient, thermal conductivity, thermoelectric power, the transport and material properties.

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, quantum Hall effect.

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 and Sons, New York, 2005.
3. Solid State Physics, N. W. Ashcroft, and N. D. Mermin, Harcourt Asia (P) Ltd. 2001
4. Solid State Physics, J. D. Patterson, and B. C. Bailey, Springer Berlin Heidelberg New York, 2007
5. Solid State Physics, J. J. Quinn, K. S. Yi, Springer-Verlag Berlin Heidelberg 2009.

PHY-627 NUCLEAR & PARTICLE PHYSICS

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 nucle, 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.

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

Books Recommended:

1. Nuclear Physics : R.R.Roy & 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. Cohen
5. Introductory nuclear theory : L.R. B. Elton

PHY-629 CBCS -II NUMERICAL TECHNIQUES USING C++

Structure, objects and classes and Operative overloading

Linear system of equations:

Gaussian elimination , Gauss Jordan method, Iterartive solutions of linear equations: Jacobi and Gauss Siedel iterations.

Interpolation and curve fitting: Newton forward difference and Lagrange interpolation. Linear regression, data normalization

List of computation problems :

1. C++ programs based on Structure, objects and classes and Operative overloading.
2. Programs on

i. Gauss elimination method
ii. Matrix inversion by Gauss Jordan method
iii. Jacobi iterative method
iv. Gauss Siedel method

2. Programs based on principle of least squares
3. Programs based on Interpolation problems

Books Recommended:

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

PHY-631 Research Project Work/Practical (LABORATORY COURSE –III) (Part I)

Project work as decided by the committee of sos and approved by BOS. Laboratory course will be as per the decision made by the committee of sos and approved by BOS

Students opting for Research Project have to carry out research problem assigned to them by their supervisor

Students opting for Practicals have to follow the following:

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

Numerical integration: Trapozoidal rule, Simpsons' rule, Gaussian Quadratature. Formulas for numerical differentation.

Programs on

1. Numerical integeration with global errors

i. Trapazoidal rule
ii. Simpson's 1/3 & 3/8 rules
iii. Gaussian Quadratature

2. Numerical solutions of differential equations

i. Eulers method
ii. Runga Kutta second and fourth order methods.

Books Recommended:

1. Numerical mathematical analysis : J.B. Scarborough
2. First course in numerical analysis : A.Ralston
3. Numerical methods in Science and Engg.: 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-622 DIGITAL ELECTRONICS AND MICROPROCESSOR

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 & EPROM).

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.

Books Recommended:

1. Digital Principles and Applications : Malvino & Leech
2. Digital computer electronics and introduction to micro computers : Malvino
3. Introduction to microprocessors Software, hardware, programming : L.A. Leventhal.

PHY 624 LASER PHYSICS

Stimulated emission, Population inversion, Laser amplification, Oscillation condition, Characteristic of laser light, Line broadening mechanism, Spectral narrowing in a laser, Gain clamping. Spatial and spectral hole burning and their consequences, Power in Laser Oscillator, Optimum coupling.

Theory of optical resonators: Concept of cavity models, Stability criterion, Gaussian beams and their propagation. Quality factor, Geometry of resonators, Resonant frequency of resonators, unstable resonators, Time dependence of laser emission, Rate equations for three and four level systems. Normal mode oscillations, Q-switching and mode locking techniques of laser pulse generation.

Some specific laser systems. Ion lasers (Ar), Atomic and molecular gas lasers (He-Ne, CO_2), Solid State (Ruby, Nd:YAG & Nd:Glass). Dye lasers (one example).

Introduction to Nonlinear optics : Basic Difference in Linear and Nonlinear optics, Wave propagation in nonlinear media, Phase matching and second harmonic generation, Optical parametric oscillator. Third order effects- optical Kerr effect, Self focusing.

Elements of Optical communication.

Books Recommended:

1. Lasers: P.W. Miloni & J.H. Eberly
2. Principles of Lasers: Svelto
3. Introduction to Quantum Electronic: A. Yariv
4. Non linear Optics: Baldwin
5. Lasers: Theory and Applications by Ghatak & Thyagrajan.

PHY 626 MATERIALS SCIENCE

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, □E 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

1. Physical Chemistry of Polymers : A. Tager
2. Physics of Magnetism : S. Chikazumi

PHY 628 PLASMA PHYSICS

Occurrence of Plasma in Nature : Criteria for plasmas, Single particle motion in uniform and non uniform electric (E) and magnetic (B) fields, Time varying E and B field. Adiabatic invariants magnetic mirrors, Fluid equation of motion. Fluid drifts parallel and perpendicular to B. Plasma Oscillations, Electron Plasma waves, Ion Waves, Validity of Plasma approximation.

Electrostatic electron and ion perpendicular to B, Electromagnetic waves with B_0=0. Propagation Vector (K) perpendicular and parallel to B_0. Alfven waves. Diffusion in weakly and fully ionized plasmas. Decay of Plasma by Diffusion.

Two stream instability, Gravitational Instability, Weibel instability, Equations of kinetic theory, Derivation of the Fluid equations Landau damping .

Ion acoustic shock waves. The pondermotive Force, Parametric Instabilities-Frequency matching, Instability threshold, Oscillating two stream instability, Plasma Echoes, The Problem of controlled Fusion, Magnetic confinement-Torous, Mirrors, Pinches, Plasma Heating Laser-induced Fusion.

Books recommended :

1. Introduction to Plasma Physics and Controlled Fusion-Volume-I : F.F.Chen
2. Introduction to Plasma Theory : D.R. Nicholson

PHY 630 Research Project Work/Practical LABORATORY COURSE –IV)

Project work as decided by the committee of sos and approved by BOS. Laboratory course will be as per the decision made by the committee of sos and approved by BOS.

Syllabus

M.Tech.

(Laser Science & Applications)

Session 2016 - 2018

School of Physics

Devi Ahilya Vishwavidyalaya

Indore

M. Tech (Laser Science & Applications)

Course of Studies

Semester I

LA 701 APPLIED OPTICS	4
LA 703 LASER PHYSICS	4
LA 705 FIBRE OPTICS	4
LA 707 LASER APPLICATIONS	4
LA 709 PRACTICALS-I	6
COMPREHENSIVE VIVA	4

Semester II

LA 702 HIGH VOLTAGE ENGINEERING FOR LASERS	4
LA 704 LASER SYSTEMS AND APPLICATIONS	4
LA 706 SEMICONDUCTOR LASERS	4
LA 708 FREE ELECTRON LASERS	4
LA 710 PRACTICALS-II	6
CHOICE BASED PAPER I	
LA 712 OPTICAL COMMUNICATION AND OPTICAL SWITCHING	4
COMPREHENSIVE VIVA	4

Semester III

LA 721 PROJECT (Part I)	12
CHOICE BASED PAPER II	
LA 723 NUMERICAL TECHNIQUES BASED ON C++	4
COMPREHENSIVE VIVA	4

Semester IV

LA 722 PROJECT (Part II)	15
LA 724 SEMINAR	1
COMPREHENSIVE VIVA	4
Total Credits	96

M.Tech. Syllabus

M. Tech.(Laser Science & Applications)

SEMESTER-I

LA 701 APPLIED OPTICS:

Ray optics and matrix optics. Theory and practical examples of diffraction, interference, reflection and refraction of electromagnetic waves, wave propagation in anisotropic media, spatial frequency filtering, Fourier optics, spatial light modulators, charged coupled devices, speckle interferometry, polarized light, Jones matrices, crystal optics, electro-optics and electro-optic devices, acousto-optics, magneto optic effect and acousto-optic devices.

REFERENCES:

1. M. Born and E. Wolf, Principles of Optics, Macmillan, New York.

2. Fourier Optics by Joseph Goodman, Tata McGraw Hill, (II Edition).

3. A Yariv and P .Yeh, Optical Waves in crystals (Wiley, New York, 1984).

4. A.K. Ghatak and K. Thyagrajan, Optical Electronics (Cambridge Univ., Cambridge Press, 1989).

5. A Yariv, Quantum Electronics, 2nd edition (John Wiley 1975).

LA 703 LASER PHYSICS:

Properties of laser beams: Intensity, monochromaticity, coherence, directionality, and brightness. Interaction of radiation with matter: Absorption & stimulated emission, line broadening mechanism, transition cross section, absorption & gain coefficient, gain saturation (homogenous and inhomogeneous broadened line). Continuous wave and transient laser behaviour: Rate equations(Four level and three level laser). CW laser behaviour, power in laser oscillator, optimum output coupling, single mode oscillation, reasons for multimode oscillations, spatial hole burning, spectral hole burning, Lamb dip and active stabilization of laser frequency, Frequency pulling, relaxation oscillations in single mode lasers.

Optical resonator: Matrix formulation of geometrical optics, Fabry Perot interferometer, photon life time and cavity Q, plane parallel resonator, confocal resonator, Gaussian beam propagation and ABCD law, generalized spherical resonators, unstable resonators.

Gain switching and cavity dumping, Q-switching and mode locking.

REFERENCES:

I. K. Shimoda, Introduction to Laser Physics(Springer Verlag, Berlin, 1984)

2. M. Sargent III, M.O.Scully and W.E.Lamb. Jr. Laser Physics, Forth Printing. (Addison Wesley, Reading, 1982).

3. D.C.O.Shea. An Introduction to Lasers and Their Application (Addision -Wesley. Reading, 1978)

4. O.Svelto, Principles of Lasers, (Plenum, New York, 1982).

5. K. Thyagrajan and A.K.Ghatak, Laser: Theory and Applications. (McMillan India. New Delhi, 1984).

6. A.K.Ghatak and K.Thyagrajan, Optical Electronics,(Cambridge Univ. Press, 1989).

7. A.Yariv, Quantum Electronics, 2nd Edition (John Wiley, New York, 1975).

8. I. Marcuse, Principles of Quantum Electronics, (Academic, New York, 1980).

9. Laser Physics by P. W. Miloni, John Wiley and Sons.

10. Laser Fundamentals, W.T. Silfvast (Cambridge University Press 1999).

LA 705 FIBRE OPTICS:

Introduction to the optical fibre, comparison of optical fibre with other interconnectors. Concept of an optical waveguide, rays and modes, principle of light guidance in optical waveguides, fibre types. Electromagnetic analysis of simple optical waveguide: Basic waveguide equation, propagation mode of symmetric step index planar waveguide, TE and TM modes of symmetric step index planar waveguide, mode cut-off condition, mode theory for optical fibre waveguide, scalar wave-equation and modes of fibre, modal analysis for step index fibre, WKB analysis for multi mode fibre, fractional power in the core modal analysis of parabolic index medium.

Transmission characteristics of optical fibers: Attenuation and dispersion, linear and nonlinear scattering losses, fiber bending losses, Intramodal dispersion losses. Dispersion shifted and dispersion modified fibers. Fabrication of fibers. Fiber alignment joint losses, coupling losses, splices and connectors. Beam connectors and expanders, couplers, wavelength division multiplexing couplers. Fiber Bragg grating. Fiber optic network and distribution.

REFERENCES:

1. A. H. Cherin: An Introduction to Optical Fibres,(McGraw Hill, 1983).

2. A. Ghatak and K. Thyagrajan, Optical Electronics,[(Cambridge Univ. Press 1989).
3. G. Kaiser: Optical fibre communication (McGraw Hill, Book Company, 1989).
4. D. Marcuse: Theory of Dielectric Optical waveguides, (Academic press New York: 1972).
5. N.S. Kapani: Fibre Optics (Academic Press, New York, 1967).

LA 707 LASER APPLICATIONS :

Laser in length measurement: Measurement of length; interferometry, surface topology & optical component testing, beam modulation telemetry, laser Doppler velocimetry, surface velocity measurement using speckle patterns, measurements of rate and rotation using laser gyroscope, LIDAR. Laser Plasma Interaction: Basic concepts and two-fluid description of plasmas, electromagnetic wave propagation in plasmas, propagation of obliquely incident light waves in inhomogeneous plasmas, collisional absorption of electromagnetic waves in plasmas, parametric excitation of electron and ion waves, stimulated Raman scattering, stimulated Brillouin scattering, heating by plasma waves, density profile modification, nonlinear feature of underdense plasma instabilities, electron energy transport, laser plasma experiments

Holography: The wavefront reconstruction process: Inline hologram, the off axis hologram, Fourier hologram, the lens less Fourier hologram, image hologram.

The reconstructed image: Image of a point, image magnification, orthoscopic and pseudoscopic images, effect of source size and spectral bandwidth. Thin hologram, volume hologram, volume transmission hologram and volume refraction holograms. Materials for recording holograms, holograms for displays, colour holography, holographic optical elements. Holographic interferometry: Real time holographic interferometry, double exposure holographic interferometry.

REFERENCES:

1. R.M. Measures, Laser Remote Sensing: Fundamentals and Applications (John Wiley, New York, 1984).
2. Laser Plasma Interaction by Willian L. Kruer, Addison-Wesley Publishingh Company.
3. W.O.N.Giummarres, C.T.Lin and A.Mooradian, eds, Lasers and Applications (Springer - Verlag, Berlin, 1981).
4. H. Moth, The Physics of Laser fusion (Academic, New York, 1979).
5. A K Ghatak and K. Thyagrajan, Optical Electronics, (Cambridge University Press, 1989).

6. A. Yariv, Quantum Electronics, 2nd Ed.(John Wiley, New York, 1975).
7. K. Iizuka, -.-Engineering Optics, Springer series in Optical Sciences Vol.35 (Springer Verlag, Tokyo, 1983).
8. R. J. Collier, Optical holography, (Academic Press, 1971).
9. P. Hariharan, Optical holography, (Cambridge University Press, 1984).
10. Laser Principles and Applications by J.Wilson and Hawkens.
11. Plasma Physics by F.F. Chen (Plenum Press).

LA 711 PRACTICALS-I

1. Verification of ray transfer matrix
2. Construction and Characterization of Beam expander
3. Determine the coherence length using Michelson's Interferometer
4. Comparison of geometrical and Gaussian optics
5. Measurement of thread angle, pitch, and diameter of a screw.
6. Virtual Experiments with ray trace
7. Determination of Gaussian beam parameters.
8. Experiments on spatial frequency filtering.
9. Understanding role of damping on lasing action.
10. Understanding the role of pumping and cavity parameters for lasing action.
11. Measurement of laser threshold and output power at CW laser operation.
12. Measurement of the relaxation time of upper laser level of Nd3+ : KGd(WO4)2 .

SEMESTER – II

LA 702 HIGH VOLTAGE ENGINEERING FOR LASERS

Power conditioning system (PCS) for lasers: Basics of PCS, components in PCS, L, transfer switches, Basic circuits, details of thyratrons, krypton etc., semiconductor switches, line type pulses, C-C charge transfer, LC inversion circuits, examples for gas lasers, Q-switching circuit, PCS for flash lamps, measurements, EMI & safety aspects. Comparison of linear & SMPS, magnetic materials & HF components, Basic topologies in SMPS, Bridge circuits, PWM and

resonant mode control, HF rectification, filtering & control circuits, need for MPC, Saturable inductor circuit, MPC theory, practical design example based on MPC.

Electrical discharge pumping for CW low power lasers: DC Discharge, RF Discharge, Longitudinal Discharge, Transverse Discharge, Segmented Electrodes, Ballast Resistors, Capacitive Coupling, Inductive Coupling. Electrical discharge pumping for pulsed high power lasers: Townsend Discharge, Modified Paschen Curves, E/P Criterion, Streamer Breakdown. Electron beam pumping for pulsed high power lasers: Electron Beam Generation, Interaction of Electron Beam in Gases. Excitation, Ionization, Attachment and Recombination. High voltage pulse techniques: Nanosecond & Microsecond pulse techniques: Marx generators, tesla transformers, pulse forming Lines, blumleins, sparkgap switches, equivalent circuits & analysis. Microsecond & Millisecond pulse techniques: Capacitor banks, switches, resistive charging, constant current and power chargings, equivalent circuits & analysis. High Voltage Pulse Measurement: Sparkgaps, crest voltmeters. resistive voltage dividers, capacitive voltage dividers, V-dot capacitive sensor, electro-optical techniques using Kerr & Pockel Effect.

High Current Pulse Measurement: Current shunts, rogowskii coils. inductive probes, current transformers, and Magneto-optical techniques.

REFERENCES:

1. Introduction to High Power Pulse Power Technology by S.T. Pai and Qi Zhang, World Scientific.

2. High Voltage Engineering by E. Kuffel and M. Abdullah, Pergamon Press.

3. Dr. P.H. Ron’s Notes on Pulse Power Technology.

LA 704 LASER SYSTEMS AND APPLICATIONS

Laser pumping requirement and techniques: Optical Pumping and Electrical discharge pumping. Optically and diode pumped solid state lasers: Properties of solid state laser materials, Ruby, Nd:YAG lasers, Er:lasers, Ti: Saphire laser . Dye laser, spectra of organic dyes, requirements for starting oscillation, cavity arrangement. FIR laser: CH3OH laser. Electrical discharge pumped laser: Ar+ ion, N2, He-Ne, CO2, Metal vapour, and excimer lasers. Gas dynamic CO 2 lasers Chemical lasers: HF, DF Laser Spectroscopy: High Resolution spectroscopy: Lamb dip or saturation spectroscopy, two photon absorption spectroscopy. Laser induced fluorescence

spectroscopy, opto acoustic spectroscopy, photothermal spectroscopy. Time resolved spectroscopy. Raman, SRS, CARS, Multiphoton spectroscopy.

Laser material processing: Laser matter interactions, mode of coupling energy from beam to the material. CW and pulsed heating and the resulting effect. Thermal processing of materials with lasers, Drilling, cutting, welding, heat treatment, glazing, alloying, cladding, hardening of surfaces, semiconductor annealing and trimming. Laser in Medicine & Biology: Laser light scattering, application in biomedicine. Light transport in tissue. Photochemical, photothermal, photomechanical effects and their therapeutic applications. Optical imaging and diagnosis.

REFERENCES:

1. O. Svelto, Principles of lasers (Plenum Press, New York, 1982).
2. Laser Fundamentals, W.T. Silfvast (Cambridge University Press 1999).
3. Solid State Laser Engineering, Walter Koechner
4. M.L. Wolbarshi, Ed. Laser Applications in Medicine & Biology, Vol.1, 2 & 3 (Plenum, New York, 1971,74,77).
5. Laser Material processing by W.M. Steen.
6. Lasers: Principles and Applications by J. Wilson and J.F.B. Hawkes, Printice Hall.
7. Laser Spectroscopy by Demtröder.

LA 706 SEMICONDUCTOR LASERS

Energy bands in solids, E-K diagram, Density of states in bulk and quantum well structures.

Occupation probability, carrier concentration and Fermi level. Semiconductor materials and their heterostructures. Lattice matched and strained layers in quantum well structures.

Band gap engineering, Heterostructure p-n junction. Fermi level in doped and undoped, biased and unbiased semiconductor junctions.

Interaction of photons with electrons and holes in semiconductors. Optical joint density of states.

Rate of emission and absorption in semiconductors. Amplification by stimulated emission. Absorption spectrum of semiconductors.

Semiconductor laser device structure, output characteristics, single frequency lasers.

Quantum well lasers. Gain in quantum well lasers, multiquantum well lasers, Distributed feedback lasers, Distributed Bragg reflectors. Vertical cavity surface emitting lasers.

REFERENCES:

1. Y.R. Shen, The principles of Nonlinear Optics (Wiley, New York, 1984).
2. A. Yariv, Quantum Electronics, 2nd edition (Wiley, New York,1975').
3. C. Flytzanis and J.L. Oudar, Nonlinear Optics, Device and Application (Springer. Berlin, 1986).
4. D.C. Hanna, M: Yuratich and D.Cotter. Nonlinear Optics of free atoms and free molecules (Springer- Verlag, Berlin. 1979).
5. Harry: Industrial Lasers and their applications (McGraw Hill, 1974).
6. H. Koebner, Industrial application of Lasers (John Wiley, New York, 1984)
7. Physics of Semiconductor laser Devices, By G.H.P. Thompson (John Wiley & Sons 1980).
8. Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics (John Wiley & Sons, Inc. 1991)

LA 708 FREE ELECTRON LASERS:

Emission in undulator magnets, spectral properties of undulator radiation for linearly polarized and helically polarized undulator. Dependence of undulator on transverse coordinate. Inhomogeneous broadening effects in undulator magnets. FEL pendulum equation. Energy equation energy interchange between EM fields and e-beam, gain saturation mechanism in FEL. FEL operating regimes; Electron dynamics, dynamics of the loss field, FEL equations. FEL integral equations. Other concepts: Cherenkov free electron laser, Smith Purcell radiation, BWO, Plasma based accelerator concepts. Accelerator for free electron laser. Design and fabrication of undulators for FEL.

REFERENCES:

1. Lectures on FEL theory and related topics. G.Datoli, A. Renier, and A. Tore..
2. Introduction to FEL by Charles Brau.
3. Free Electrón Lasers by T.C. Marshall.

LA 710 PRACTICALS:

1. Determination of numerical aperture of a glass fibre.
2. Determination of fibre attenuation.
3. Measurement by connector/alignment losses.
4. Identification of mode loses.
5. Measurement of threshold current of a semiconductor laser.
6. Measure the mode field intensity of the given single mode fibre.
7. Construct Mac-Zender Interferomer using single mode fiber and use it as a temperature/pressure sensor.

Choice Based Paper I(Offered by this or any other M.Tech. offering Schools/ departments/ Institutes of the University)

LA 712 OPTICAL COMMUNICATION AND OPTICAL SWITCHING

Optical sources: ILD & LED, emission, semiconductor materials, .efficiency, gain guided and index guided lasers, structures, numerical aperture loss, LED structures & characteristics.

Optical detectors and fiber systems: Detection principles, quantum efficiency responsivity, semiconductor photodiodes with and without internal gain, noise, receiver noise and structures, optical amplification and integrated optics.

Design considerations of a fiber optic communication system: BER, system design, power budget, rise time budget.

Origin of Optical nonlinearity, General description of wave propagation of in nonlinear media. Degenerate and nondegenerate four wave mixing phenomena. Nonlinear refraction, Nonlinear absorption, Self focusing and defocusing phenomena, experimental techniques for determination of nonlinear refraction and absorption, Optical bistability, Dispersive and absorptive optical bistability, Fabry Perot etalon. Applications of optical bistability in switches and memory elements. Photonic Switches, All-Optical Switches, Bistable Optical Devices, Optical Interconnections Optical Computing.

REFERENCES:

1. Bahaa E. A. Saleh, Malvin Carl Teich, Fundamentals of Photonics (John Wiley & Sons, Inc. 1991).
2. A K Ghatak and K. Thyagrajan, Optical Electronics, (Cambridge University Press, 1989).
3. Amnon Yariv, Quantum Electronics, 2nd Ed.(John Wiley, New York, 1975).
4. Yariv, "*Optical Electronics in Modern Communications*", (Oxford University Press, New York, 1997).
5. G.P. Agrawal, Fiber optic communication systems, (Wiley series in microwave and optical engineering) (John Wiley & Sons, 2002) (ISBN 9-8141-2660-8)
6. Optical fiber Communications, Principles & Practice, M. Senior, Prentice Hall of India.
7. Optical fiber Communications, G.Kaiser, Mc Graw Hill Book Company.
8. Fiber optic Communications, J.C.Palais, Prentice Hall of India.

Choice Based Paper II(Offered by this or any other M.Tech. offering Schools/ departments/ Institutes of the University)

LA 723 NUMERICAL TECHNIQUES BASED ON C++:

Introduction to C++ language- Fundamentals, expressions and statements, structures, functions, classes, objects and arrays.

Solving Simultaneous linear equations, algebric nonlinear equations, least square line fitting, Interpolation techniques, integration and differentiation, and ordinary differential equations.

REFERENCES:

1. Turbo C++ Robert Lafore
2. Numerical Methods for Mathematics, Science and Engineering by J.H. Mathews.
3. Computer Oriented Numerical Methods by V. Rajaraman.

School of Physics

Devi Ahilya Vishwavidyalaya

Vigyan Bhavan, Khandwa Road Campus,

Indore-452001,M. P. INDIA

M. Phil. (PHYSICS)

2018-2019

M. Phil. (Physics)

Scheme of Examination for M. Phil. course
(As per UGC Regulation and Guidelines– 2016)
University ordinance-13 (NEW)

SEMESTER I:

S. No.	Name of Subject	Credits
1.	Review of related literature	04
2.	Research Methodology	04
3.	Computer applications	04
4.	Subject Specific-I	04
5.	Synopsis work- Subject Specific-II	04
6.	Comprehensive viva Voce	04
	Total Credits	24

SEMESTER II:

S. No.	Name of Subject	Credits
1.	Seminar	04
2.	Term paper/ Assignment	04
3.	Mid term Dissertation/ Project Presentation	12
4.	Comprehensive viva Voce	04
	Total Credits	24

TOTAL CREDITS OF SEMESTER I+ SEMESTER II = 48

FIRST SEMESTER

COURSE CODE	COURSE TITLE	CREDITS
PHY-801	Review of related literature	**04**
PHY-803	Research Methodology	**04**
PHY-805	Computer applications	**04**
PHY-807	Subject Specific-I: (any one) *Stream A: Nanostructures and nanotechnology* *Stream B: Condensed Matter Physics* *Stream C: Nano-photonics* *Stream D: Physics of bulk and nano-materials*	**04**
PHY-809	Synopsis work -Subject Specific-II: (any one) *Stream A: Advanced Materials Science* *Stream B: Vacuum and thin film technology* *Stream C: Fibre-optics* *Stream D: Quantum Electronics and Lasers*	**04**
PHY-811	Comprehensive Viva **(Virtual Credits and Compulsory)**	**04**
Total Credits		**24**

For subject specific 1 and 2, opt anyone from a, b, c and d stream course with same combination.

SECOND SEMESTER

COURSE CODE	COURSE TITLE	CREDITS
PHY-802	Seminar	**04**
PHY-804	Term paper/ Assignment	**04**
PHY-806	Dissertation/ Project	**12**
PHY-808	Comprehensive viva Voce **(Virtual Credits and Compulsory)**	**04**
Total Credits		**24**

SEMESTER I:

PHY-801: Review of related literature Credits: 04

First step is the allotment of supervisor by Research advisory committee. As a next step student and supervisor decide the topic of studies to work for in first six months of the course work. Student is supposed to review the literature in the topic allocated. As per the examination scheme, student shall submit (in his own hand writing two to five pages) the review from the peer reviewed and published papers of international repute (Number of papers reviewed is two to five) as assignment I, II, and III each of 20 marks. For term end examination, student shall review one peer reviewed published review article/ monograph/ chapter in book and submit (in his own hand writing two to five pages). It will account for 60 marks.

PHY-803: Research Methodology Credits: 04

Unit I- Structural studies 16 Lectures

Basic Materials Characterization Techniques: Principle, instrumentation and applications of the following techniques- X ray based techniques: X-ray diffraction (XRD) and X-ray absorption fine structure (XAFS), Optical Spectroscopy: UV-VIS and FTIR Spectroscopy, Photoelectron spectroscopy: X-ray photoelectron spectroscopy.

Unit II Magnetic measurements 17 Lectures

Magnetic and structural characterization using - Mössbauer spectroscopy, magnetic hysteresis measurements making use of conventional induction technique and vibrating sample magnetometer technique, determination of magnetic anisotropy using torque magnetometer and, magnetostriction measurements using stress dependence of hysteresis loop and small angle magnetization rotation method.

Unit III Free Electron Laser related measurement Techniques. 11 Lectures

Introduction of free electron laser, types of undulator, fabrication of undulator, field measurement of undulator, method for undulator field measurement.

Testing of fiber optic systems: optical power, power measurement, optical and electrical bandwidth, wavelength measurement, dispersion measurement bandwidth measurement, phase measurement, polarization measurement.

Books Recommended:

1. Practical fiber optics by bailey and wright, An imprint of Elsevier, Jordan Hill, Oxford in 2003.
2. Y. Li, B. Faatz and J. Pflueger, Magnet sorting for the XFEL hybrid undulator comparative study, DESY Report, TESLA-FEL, August 2007.
3. Lectures on the Free Electron Laser Theory and Related Topics, by G. Dattoli.
4. Elements of X-ray Diffraction: B. D. Cullity, Addison Wesley Publishing Company Inc.
5. X-ray Spectroscopy, An Introduction: B. K. Agarwal, Springer Verlag, Berlin.

6. Applied Electron Spectroscopy for Chemical Analysis: H. Windawi and Floyd F. L. Ho, Wiley Interscience Publications.
7. Mössbauer Spectroscopy, V. G. Bhide.
8. Physics of Ferromagnetism: S. Chikazumi, Second Edition, Clarendon press, Oxford, 1997

PHY-805: Computer Applications Credits: 04 (24 T + 30 P)

Unit I

Programming using C++. Numeric data type expression input /output, logical expression, selection control structure, loops, if, for, while and do-while.

Unit II

A. Matlab / Scilab.The basic features of Matlab / Scilab, viz., variables, function & arrays, scripts, and operations. Visualization, programming, problems based on interpolation, integration, and initial value problems.

B. Microsoft Excel /Open Office Calc The basic features of spreadsheets, arithmetic operations on grid cells, inbuilt mathematical and statistical functions, display of data as line graphs, histograms and charts. Applications in using numerical methods.

Unit III

Application of various software's including-graphics software, such origin etc. Data analysis software's and their application in research, linear and polynomial regression.

Books Recommended:

1. Turbo C++, Robert Lafore, Galgotia Publications Pvt. Ltd, ISBN 81-85623-22-8.
2. Programming and Problem Solving with C++, N. Dale and C. Weems, Jones and Bartlett Publication, ISBN 978-93-80108-50-6.
3. Numerical mathematical analysis: J. B. Scarborough.
4. First course in numerical analysis: A Raltson.
5. Numerical methods in Science and Engg: S Rajsekharan.
6. Numerical methods for Physics, Science and Engineering: J. H. Mathews, Tata McGraw Hill Publishers 1984.
7. Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canale, McGraw-Hill Book Company, ISBN-0-07-100412
8. Matlab by Rudra Pratap.

PHY-807: Subject Specific- I Credits: 04

Title of the paper: Nanostructures and Nanotechnology:

Overview and properties of nanoparticles: Size Dependence of Properties, Crystal Structures, Face-Centered Cubic Nanoparticles, Tetrahedral Bonded Semiconductor Structures, Lattice Vibrations, Energy Bands, Localized Particles, Excitons. Metal Nanoclusters, Magic Numbers, Geometric Structure, Electronic Structure, Magnetic Clusters, Semiconducting Nanoparticles, Optical Properties, Coulomb Explosion, Molecular Clusters.

Methods of Measuring Properties of nanostructures: Structure, Atomic Structures, Crystallography, Particle Size determination, Surface Structure, Microscopy, Transmission Electron Microscopy, Field Ion Microscopy, Scanning Microscopy, Infrared and Raman Spectroscopy, Photoemission and X- Ray Spectroscopy, Magnetic Resonance. Method of Synthesis: RF Plasma, Chemical Methods, Thermolysis, Pulsed Laser Methods.

Vibrational and Electronic properties: Ionic, Covalent, inert gas solids, metals, Experimental observations of phonon modes, Vibrational, Raman, Infrared spectroscopy, Phonon confinement, Effect of dimension on lattice vibration and density of states, Effect of size on Debye frequency, melting temperature, specific heat, plasmons, phase transition, Effect of lattice parameter on electronic structure, measurements of electronic structure of nanoparticles.

Mechanical and magnetic properties: Mechanical and dynamical properties of nanosized devices: Nanopendulum, Nanometer string, Nanospring, Clamped beam. Magnetism in Nanostructures: Basics of Ferromagnetism, Effect of Bulk Nanostructuring of Magnetic Particles, Dynamics of Nanomagnets, Nanopore Containment of Magnetic Particles, Nanocarbon Ferromagnets, Giant and Colossal Magnetoresistance, Ferrofluids.

Quantum Wells, Wires, and Dots: Fabrication of Quantum Nanostructures, Size and Dimensionality Effects, Size 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, Excitons, Single-Electron Tunneling, Infrared Detectors, Quantum Dot Lasers.

Books Recommended:

1. The Physics and Chemistry of Nanosolids: Frank J. Owens, and Charles P. Poole Jr., Wiley Interscience, 2008.
2. Introduction to Nanotechnology, Charles P. Poole Jr., and Frank J. Owens, Wiley Interscience, 2006.
3. Chemistry of Advanced Materials, Edited L. V. Interrante, and M. J. Hampden-Smith Wiley – VCH, U. S. A 1998.
4. Transport in Nanostructures, D. K. Ferry and S. M. Goodnick, Cambridge University Press, 1997.

PHY-807: Subject Specific- I Credits: 04

Title of the paper: Condensed Matter Physics

Electron structure: Classification and bonding in solids, Free electron model, Drude Model, Sommerfeld model, Electron states in a periodic potential, Tight binding theory, Pseudo potentials, screening, band structure methods, Fermi surface, Surface effects, related experimental methods.

Lattice vibration: Introduction to lattice vibrations; lattice vibrations as collective motions of ions around their equilibrium positions. Dispersion relation: monoatomic and diatomic case; acoustical

and optical branches; extension to the general case (3D solids) Phonon specific heat in solid: Dulong-Petit law, Einstein model and Debye model. Thermal Conductivity as Elastic waves; Phonon gas Model, Thermal Expansion in Solids.

Magnetism: Magnetism in isolated ions, ions in crystals, and ions in magnetic fields. Diamagnetism, Paramagnetism, Pauli paramagnetism, ordered magnetic states, metastable magnetic states. Magnetic transitions. Superconductivity.

Phase Transitions: Ideal and interacting systems. Cooperative phenomenon. Symmetry/order-structure correspondence. Equilibrium vs. instability. Order parameter. Discontinuous and subtler phase transitions. Cross-transition continuity-behaviors of thermodynamic-functions and thermodynamic-potential. Latent heat. Specific heat jump. Superheating/super cooling and phase-coexistence. Lattice gas model. Dimensional constraints. Effects of an external field. Correlation lengths. Fluctuations of order parameter and critical behavior. Landau phenomenology and scaling.

Quantum nature of condensed Heliums and their melting curves; manifestation of Bose and Fermi statistics in ^{4}He and ^{3}He. Superfluidity due to Bose condensation and due to pairing. Mixtures of ^{3}He and ^{4}He. Novel mechanisms for cooling.

Books Recommended:

1. J. S. Blakemore, Solid State Physics, 2nd Ed., Saunders (1974).
2. C. Kittel, Introduction to Solid Stat Physics 1st ed. (Willey Eastern, 1953).
3. A. O. E. Animalu, Intermediate Quantum Theory of Crystalline Solids, (Prentice-Hall of India) (1978).
4. O. Madelung, Introduction to Solid State Theory, (Springer-Verlag 1978).
5. G. Grosso, and G. P. Parravicini, Solid State Physics (Elsevier, 2004).
6. G. D. Mahan, Many Particle Physics, (Plenum Press, 1990); L. Kantorovich, Quantum theory of the Solid State: An Introduction, (Kluwer, 2004).
7. N. W. Ashcroft and N. D. Mermin, Solid State Physics,

PHY-807: Subject Specific- I Credits: 04

Title of the paper: Nano-photonics

Photonic crystals and resonators, Photonic bandgap, Defects in photonic crystals, Surface plasmons, Surface plasmons in noble metals, Surface plasmon polaritons at plane interfaces.

Introduction to Quantum computation from bits to Qbit, Multiple Qbits, Single Qbit gates, Multiple Qbit gates, Quantum circuits, Bell states, Quantum teleportation.

Quantum wells and Superlattices, Quantum well lasers, Vertical cavity surface emitting lasers, Quantum dot lasers.

Books Recommended:

1. Lukas Novotny & Bert Hecht, Principles of Nano-Optics, Cambridge University Press, New York, 2006.
2. P.N. Prasad, Nanophotonics, John-Wiley, New Jersey, 2004.

3. Photonic Crystals: Physics, Fabrication & Applications, K. Inoue & K. Ohtaka (Eds.), Springer-Verlag Berlin Heidelberg New York, 2004.
4. Micheal A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2002.
5. Dirk Bouwmeester, Artur Ekert, Anton Zeilinger (Eds.), The Physics of Quantum Informations, Quantum Cryptography, Quantum Teleportation, Quantum Computation, Springer-Verlag Berlin Heidelberg New York, 2001.

PHY-807: Subject Specific- I Credits: 04

Title of the paper: Physics of bulk and nano-materials

Lattice structure: Crystalline and amorphous state, Symmetry operations, Point groups, Crystal system, Types of lattices, Size Dependence of Properties, Lattice structure of bulk and Nanomaterials, Diffraction of x-rays by crystals, Bragg's law, Reciprocal lattice, Brillouin zone, Ionic, Covalent, Molecular and Hydrogen bonded crystals, Lattice energy of ionic crystals. Synthesis of bulk and Nanomaterials: Solid State reaction, Chemical Methods, Pulsed Laser Methods. Particle Size determination.

Lattice vibrations: Vibrations of lattices (mono, dia and polyatomic), acoustic and optical phonons, dispersion relation for one, two and 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, Thermal conductivity, Effect of size on Debye frequency, melting temperature, specific heat, Raman effect, Energy Bands, Localized Particles, Excitons, Metal Nanoclusters, Magic Numbers, Geometric Structure.

Novel properties: Quantum Nanostructures, Size Effects, Dimensionality Effects, Density of States, Potential Wells, Quantum wells, Coupled wells and superlattices, Nanolithography, Partial Confinement, Plasma oscillations, Screening effects, Polaritons, Polarons, Optical and Dielectric Properties, Single-Electron Tunneling. Flux quantization, Para, Dia and ferro elasticity, electricity and ferromagnetism, High temperature superconductors, Giant and Colossal Magnetoresistance, Multi Ferroelectric materials.

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. Introduction to Solid State Physics, C. Kittel, VIIIth Edition, John Wiley and Sons, New York, 2005.
4. Introduction to Nanotechnology, Charles P. Poole Jr., and Frank J. Owens, Wiley Interscience, 2006.
5. Solid State Physics, J. D. Patterson, and B. C. Bailey, Springer Berlin Heidelberg New York, 2007.

PHY-809: **Synopsis / Subject Specific- II** **Credits: 04**

Title of the paper: Advanced Materials Science

Magnetic Ordering: An overview, Magentocrystalline anisotropy, Induced magnetic anisotropy, Magnetostrction, Magnetization process, Technical magnetization, magnetization curve and domain theory, Soft and hard magnetic materials.

Magnetic behavior and structure of materials: Magnetism of metals and alloys, Magnetism of Ferrimagnetic Oxides, Magnetoelasticity, Magentoelastic energy Magnetoelastic coupling, Wiedemann effect, Inverse Wiedemann effect, Matteucci effect.

Engineering applications of magnetic materials: Principle of various applications, specific requirements of magnetic properties for them and application areas.

Experimental techniques for characterizing magnetic materials: An overview of various experimental techniques, their principal and information obtained from them about various magnetic materials.

Books recommended:

1. Physics of Ferromagnetism: S. Chikazumi, Second Edition, Clarendon press, Oxford, 1997
2. Ferromagnetism: R. M. Bozorth, IEEE Press, Piscataway, NJ, 1993
3. Modern Magnetic Materials Principles and applications: R. C. O'Handley, John Wiley and Sons Inc., NY2000.
4. Magnetic domains The analysis of magnetic Microstructures: A. Hubert and R. Schafer, Springer Verlag, Berlin Heidelberg, 1998.
5. Magnetism in condensed matter: S. Blundell, Oxford University Press, 2001.
6. Constitution and magnetism of Iron and its alloys, W. Pepperhoff, M. Acet, Springer Verlag, Berlin Heidelberg, 2001.

PHY-809: **Subject Specific- II** **Credits: 04**

Title of the paper: Vacuum and thin film technology

The fundamental nature of gases and gas flow, vapour pressure, the concept of conductance in a vacuum system, Conductance effect on pump speed, Combined conductance, Aperture conductance, mean free path, Degrees of vacuum. Operational principles of various mechanical pumps as well as limitations; Operating principle of Turbo molecular Pumps, Design parameters, Matching forepumps, Compression ratio considerations, System operation, Molecular Drag principle; Operating principle of Diffusion Pumps, Critical forepressure and inlet pressure, Limitations to base pressure, Backstreaming and Backmigration, Use of baffles and traps, Fluids, Matching backing pump, Small system operation; Operating principle of Cryopumps and ion pumps, Cryogenic processes, Pump configuration, Cryopump system operation.

Pressure measurement gauges, Thermal Conductivity gauges - Pirani gauge, Thermistor gauge, Thermocouple gauge, Calibration of thermal gauges**.** Ionization gauges**,** Principle of ionization, Discharge tube, Hot filament gauge, Cold cathode Penning gauge, Range, limitations and features of Penning gauge. Leak detection and Residual Gas Analyzers, design and operation of a practical vacuum system, construction of vacuum systems including materials and couplings, identify sources of contamination and leaks in a typical vacuum system.

Thin films and their need; Steps in thin film growth process- sticking coefficients, surface bombardment rate; Thin film growth models- adsorption, thermal accommodation, Van der Waals forces, lifetime of adsorbed species, surface diffusion, chemisorption; Film growth modes- capillary theory of nucleation and growth, coalescence processes; Epitaxy; Environment for Film Growth- Real surfaces, surface passivation, vacuum requirements for film growth. Techniques to grow thin films at atomic scale and to fabricate multilayers/superlattices at nanoscale. Evaporating alloys and compounds, difficulties with evaporation; Molecular beam epitaxy (MBE), Sputter deposition- sputtering process, sputtering yield, Magnetron sputtering, advantage of sputtering, Ion Beam Sputtering, Pulsed laser ablation, and Chemical vapor deposition (CVD); Relationships between deposition parameters and film properties; Defects in thin films; Thin film superlattices; Applications and emerging technologies: optical coatings, photodetectors, smart sensors, switching devices, solar cells, superconducting and GMR devices.

Books Recommended:

1. The physical basis of ultra high vacuum, P A Redhead, J P Hobson, E V Kornelsen, AIP, New York.
2. High vacuum technology- a practical guide, Marsbed H. Hablanian, Marcel Dekker, Inc.
3. Thin film phenomena, K. L. Chopra, Robert E Krigger publishing company, Huntington, New York 1979.
4. An introduction to the thin film state: preparation, structure and basic characteristic of thin film, B Damodar Das, Aparna Publication, Mysore 1992.

PHY-809: Subject Specific- II Credits: 04

Title of the paper: Fibre-optics

Basic electromagnetic theory: Maxwell equations, electromagnetic waves, Reflection and refraction from dielectric interface, Total internal reflection, Poynting vector, Dielectric waveguide, dielectric symmetric slab waveguide, Numerical aperture, TM and TE even and odd modes, Phase and Group velocity, power flow in slab waveguide.

Introduction to optical fibers: Optical fiber, step index and graded optical fiber, single mode and multimode optical fiber, attenuation and dispersion in optical fibers, waveguide

dispersion, material dispersion, multimode dispersion, dispersion shifted and dispersion flattened fibers.

Source to fiber coupler, fiber-fiber coupler, connectors, misaligned losses in single and multimode fibers, experimental methods in optical fibers: determination of Numerical aperture, determination of attenuation, OTDR, determination of core cladding refractive indices, Optical fiber applications in Networking and optical communication.

Books Recommended:

1. A. H. Cherin: An introduction to optical Fibres (McGraw Hill, 1983).
2. A. Ghatak and K. Thyagrajan, Optical Electronics (Cambridge Univ. Press 1989).
3. G. Kaiser: Optical fiber communication (McGraw Hill, Book Company 1989).
4. D. Marcuse: Theory of Dielectric Optical waveguides: (Academics press New York: 1972).
5. N. S Kapani: Fiber Optics (Academics Press New York, 1967).

PHY-809: Subject Specific- II Credits: 04

Title of the paper: Quantum Electronics and Lasers:

Basics of Quantum mechanics, Time dependent perturbation technique, Atom-field interaction, Induced Resonant Transitions, Exact Rabi solution.

Coherent transient effects: Optical nutation, Free induction decay, Photon echo. Nonlinear optical effects, Self-focusing, defocusing effects, and optical switching.

Basics of electromagnetic wave propagation in anisotropic medium and optical resonators. Properties of lasers, Einstein's A and B coefficients, Gain in Lasers, power output from laser. Homogeneous/Inhomogeneous broadening, Q- switching and Mode locking in Lasers.

Books Recommended:

1. Yariv, "Quantum Electronics", John Wiley & Sons, USA, (1988).
2. M. Sargent III, M.O. Scully, W.E. Lamb, "Laser Physics", Addison-Wesley Publishing Company, USA, (1974).
3. Yariv, "Optical Electronics in Modern Communications", Oxford University Press, New York, (1997).

SEMESTER II:

PHY-802: Seminar Credits: 04

Students are supposed to give three seminars [time duration 10 minutes; maximum marks of each seminar is 20] and one colloquium [time duration 30 minutes; maximum marks is 60] in the second semester as per examination ordinance 31 of the Devi Ahilya University. The topics of seminar are related with the project work. Supervisors are requested to complete the process in time.

PHY-804: Term paper/ Assignment Credits: 04

Students are supposed to undertake the term paper related with the project. As per the examination scheme, student shall submit (in his own hand writing two to five pages) the review from the peer reviewed and published papers of international repute (Number of papers reviewed is two to five) as assignment I, II, and III each of 20 marks as per ordinance 31 of the Devi Ahilya University. For term end examination, student shall review one peer reviewed published monograph/ review article/ chapter in book and submit (in his own hand writing two to five pages). It will account for 60 marks.

PHY-806: Dissertation/ Project Credits: 12

Students are supposed to undertake the dissertation on the topic of investigation related with the project.

School of Physics

Devi Ahilya Vishwavidyalaya

Vigyan Bhavan, Khandwa Road Campus,

Indore-452001,M. P. INDIA

Syllabus
Ph.D. Course Work
PHYSICS

2018-2019

S. No.	Name of Subject	Credits
PHY-801	Review of related literature	03
PHY-803	Research Methodology	04
PHY-805	Computer applications	03
PHY-807	Subject Specific-I	03
	Comprehensive viva Voce	03
	Total Credits	16

PHY-801: Paper I: Review of related literature Credits: 03

1.Selection of topic for literature.
2.Chronological development of the topic.
3.Current trends and Future scope.

Paper II: **Research Methodology Credits: 03**

PHY-803:

Unit I- Structural studies 16 Lectures

Basic Materials Characterization Techniques: Principle, instrumentation and applications of the following techniques- X ray based techniques: X-ray diffraction (XRD) and X-ray absorption fine structure (XAFS), Optical Spectroscopy: UV-VIS and FTIR Spectroscopy, Photoelectron spectroscopy: X-ray photoelectron spectroscopy.

Unit II Magnetic measurements 17 Lectures

Magnetic and structural characterization using - Mössbauer spectroscopy, magnetic hysteresis measurements making use of conventional induction technique and vibrating sample magnetometer technique, determination of magnetic anisotropy using torque magnetometer and, magnetostriction measurements using stress dependence of hysteresis loop and small angle magnetization rotation method.

Unit III Free Electron Laser related measurement Techniques. 11 Lectures

Introduction of free electron laser, types of undulator, fabrication of undulator, field measurement of undulator, method for undulator field measurement.

Testing of fiber optic systems: optical power, power measurement, optical and electrical bandwidth, wavelength measurement, dispersion measurement bandwidth measurement, phase measurement, polarization measurement.

Books Recommended:

1. Practical fiber optics by bailey and wright, An imprint of Elsevier, Jordan Hill, Oxford in 2003.
2. Y. Li, B. Faatz and J. Pflueger, Magnet sorting for the XFEL hybrid undulator comparative study, DESY Report, TESLA-FEL, August 2007.
3. Lectures on the Free Electron Laser Theory and Related Topics, by G. Dattoli.
4. Elements of X-ray Diffraction: B. D. Cullity, Addison Wesley Publishing Company Inc.
5. X-ray Spectroscopy, An Introduction: B. K. Agarwal, Springer Verlag, Berlin.
6. Applied Electron Spectroscopy for Chemical Analysis: H. Windawi and Floyd F. L. Ho, Wiley Interscience Publications.
7. Mössbauer Spectroscopy, V. G. Bhide.
8. Physics of Ferromagnetism: S. Chikazumi, Second Edition, Clarendon press, Oxford, 1997

Paper III Computer Applications Credits: 03 (24 T + 30 P)

PHY-805:

Unit I

Programming using C++. Numeric data type expression input /output, logical expression, selection control structure, loops, if, for, while and do-while.

Unit II

A. Matlab / Scilab.The basic features of Matlab / Scilab, viz., variables, function & arrays, scripts, and operations. Visualization, programming, problems based on interpolation, integration, and initial value problems.

B. Microsoft Excel /Open Office Calc The basic features of spreadsheets, arithmetic operations on grid cells, inbuilt mathematical and statistical functions, display of data as line graphs, histograms and charts. Applications in using numerical methods.

Unit III

Application of various software's including-graphics software, such origin etc. Data analysis software's and their application in research, linear and polynomial regression.

Books Recommended:

1. Turbo C++, Robert Lafore, Galgotia Publications Pvt. Ltd, ISBN 81-85623-22-8.
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5. Numerical methods in Science and Engg: S Rajsekharan.
6. Numerical methods for Physics, Science and Engineering: J. H. Mathews, Tata McGraw Hill Publishers 1984.
7. Numerical Methods for Engineers, Steven C. Chapra and Raymond P. Canale, McGraw-Hill Book Company, ISBN-0-07-100412
8. Matlab by Rudra Pratap.

PHY-807: Subject Specific- I Credits: 03

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4. Micheal A. Nielsen & Isaac L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press, 2002.
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Lattice vibrations: Vibrations of lattices (mono, dia and polyatomic), acoustic and optical phonons, dispersion relation for one, two and 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, Thermal conductivity, Effect of size on Debye frequency, melting temperature, specific heat, Raman effect, Energy Bands, Localized Particles, Excitons, Metal Nanoclusters, Magic Numbers, Geometric Structure.

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5. Solid State Physics, J. D. Patterson, and B. C. Bailey, Springer Berlin Heidelberg New York, 2007.