School of Physics

Devi Ahilya Vishwavidyalaya

Vigyan Bhavan, Khandwa Road Campus,

Indore-452001,M. P. INDIA

Syllabus

Ph.D. Course Work

PHYSICS

2020 - 2021

Syllabus for Ph.D. Course Work inPhysics (2020-21)

S. No.	Name of Subject	Credits
1.	Review of related literature	03
2.	Research Methodology	04
3.	Computer applications	03
4.	Subject Specific-I	03
5.	Research and publication ethics	02
6.	Comprehensive viva Voce	03
	Total Credits	18

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:04**

Unit I- Structural studies 11Lectures

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 Electrical measurements 11Lectures

Transport measurements: Metal, Superconductors, Insulators and Semiconductors, Four probe and Van der Pauw techniques, Magnetoresistance, Hall measurements, Thermoelectric power, Thermal conductivity, Differential scanning calorimetry, Dielectric measurement.

Unit III Magnetic measurements 11Lectures

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 IV Mathematical Techniques. 11Lectures

Integral transforms. Fourier transform and inverse Fourier transforms. Convolution theorem. Laplace transforms. Laplace transforms of derivatives. Solving differential equations using Laplace transform technique.

Green's functions and solution of Non-homogenous boundary value problems.

Complex analysis: Cauchy Riemann equations, Cauchy integral theorem and formula. Taylor's and Laurent series. Residue Theorem and contour integration.

Books Recommended:

1. Mathematical Methods for Physicists: G. B. Arfken
2. Complex Variables, M R Spiegel, Schaum's Outline Series.
3. Laplace Transforms, M R Spiegel, Schaum's Outline Series.

Paper III: Computer Applications **Credits: 03**

35Lectures

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, interpolation and integration.

B. Microsoft Excel /OpenOffice 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.

Subject Specific- I Laser Applications: Credits: 03

35Lectures

Unit I: Laser application in fiber-optical communication and free electron laser

Introduction to waveguide: theory of electromagnetic waves in parallel plate and rectangular metal waveguide-concept of modes-Poynting vector calculation, optical fiber Propagation, Electromagnetic analysis of simple optical waveguide. Testing of fiber optic systems: attenuation, Numerical aperture, optical power, power measurement, fiber sensor

Free electron laser : introductory idea about undulator and small signal theory of free electron laser gain

Unit II: Laser application in plasma

Two-fluid description of plasmas. Plasma Oscillations, Electron Plasma wave and Ion Wave. Electromagnetic wave propagation in plasmas, propagation of obliquely incident light waves in inhomogeneous plasmas.

Unit III: Laser application in photonics

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

Books Recommended:

1. Photonic Crystals: Physics, Fabrication & Applications, K. Inoue & K. Ohtaka (Eds.), Springer-Verlag Berlin Heidelberg New York, 2004.
2. Practical fiber optics by bailey and wright, An imprint of Elsevier, Jordan Hill, Oxford in 2003.
3. G.Dattoli,L.Giannessi,M.Richeta,A.Torre,Phys.Rev.A, Vol. 45, (1992), 4023.
4. Y. Li, B. Faatz and J. Pflueger, Magnet sorting for the XFEL hybrid undulator comparative study, DESY Report, TESLA-FEL, August 2007.
5. Lectures on the Free Electron Laser Theory and Related Topics, by G. Dattoli.
6. Introduction to Plasma Physics and Controlled Fusion: F. F. Chen
7. Introduction to Plasma Theory: D.R. Nicholson
8. Laser Plasma Interaction by Willian L. Kruer, Addison-Wesley Publishing Company.

Research and publication ethics **Credits: 02**
22Lectures

THEORY

PHILOSOPHY AND ETHICS: Introduction to philosophy- definition, nature and scope, concept, branches. Ethics- definition, moral philosophy, nature of moral judgements and reactions

SCIENTIFIC CONDUCT: Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconducts -Falsification, Fabrication, and Plagiarism, Redundant publications- duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data.

PUBLICATION ETHICS: definition, introduction and importance. Best practices / standards setting initiatives and guidelines: COPE, WAME, etc. Conflicts of interest. Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types. Violation of publication ethics, authorship and contributorship. Identification of publication misconduct, complaints and appeals. Predatory publishers and journals

PRACTICE

OPEN ACCESS PUBLISHING: Open access publications and initiatives. SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies. Software tool to identify predatory publications developed by SPPU.
Journal finder / journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

PUBLICATION MISCONDUCT
Group Discussions on Subject specific ethical issues, FFP, authorship. Conflicts of interest
Complaints and appeals: examples and fraud from India and abroad.

Software tools: Use of plagiarism software like Tumitin, Urkund and other open source software tools.

DATABASES AND RESEARCH METRICS
Databases: Indexing databases. Citation databases: Web of Science, Scopus, etc.
Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics

References

Bird, A. (2006). *Philosophy of science.* Routledge.
MacIntyre, Alasdair (1967) *A Short History of Ethics.* London.
P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978- 9387480865
National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On *Being a Scientist.' A Guide to Responsible Conduct in Research: Third EditfOn.* National Academies Press.
Resnik, D. B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences,* 1-10. Retrieved from
httos://www.nieiys.nih.gov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179—179. https://doi.org/10.1038/489179a
Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance(2019), ISBN:978-81-939482-1-7. http://www.insaindia res.in/pdf/Ethics Book.pdf

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M. Sc. (PHYSICS)

Session 2021-2023

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
PHY-526	Laser Physics	4
PHY-528	Plasma Physics	4
PHY-530	Materials Science	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. 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. 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**

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.

Equilibrium ensemble, classical statistical mechanics: 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 Classical Maxwell distribution function. Maxwell distribution function. Maxwell distribution of velocities. Doppler broadening of spectral lines.

Quantum Statistical Mechanics and phase transition: Indistinguishability and Quantum statistics. Symmetric and antisymmetric wave function. Quantum distribution function: Ensembles in Quantum Statistical mechanics. Bose Einstein and Fermi Dirac statistics, First and Second order phase transition, Clausius-Clapeyron equation, Order parameter, 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, Diffraction of x-rays by crystals, the Laue, Powder and Rotating crystal methods, Bragg's law, Reciprocal lattice, Brillouin zone, Ionic, Covalent, Molecular, Hydrogen bonded crystals.

Defects: Point defects, line defects and planer defects, expression for equilibrium concentration of point defects, role of dislocations in plastic deformation and mechanism of plastic deformation.

Magnetism: Types and origin of magnetism, Weiss molecular fields theory of ferromagnetism, Exchange interaction, Origin of magnetic domains, domain walls, Spin waves, Magnons, Nuclear magnetic resonance, electron spin resonence, Mössbauer effect.

Books Recommended:

1.Solid State Physics, Adrianus J Dekker, Macmillan India Limited, 2000
2. Solid State Physics, J. J. Quinn, K. S. Yi, Springer-Verlag Berlin Heidelberg 2009
3. Intermediate Quantum theory of Crystalline Solids, A. O. E. Animalu, Prentice−Hall of India private Limited, New Delhi 1977.

4. Crystallography for Solid State Physics, A. R. Verma, and O. N. Srivastava, New Age International (P) Ltd. 2001.
5. Introduction to Solid State Physics, C. Kittel, John Wiley and Sons, New York, 2005.
6. Solid State Physics, N. W. Ashcroft, and N. D. Mermin, Harcourt Asia (P) Ltd. 2001.
7.Physics of Magnetism, S. Chikazumi R.E.Krienger Publ Co.Inc,Florida 1978

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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^+ -molecule ion. Heitler-London theory of H_2 molecule. Covalent- and ionic- bondings. 2

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, Scattering Processes, Relaxation-time approximation, 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.

Superconductivity: Zero resistance, perfect diamagnetism, theory of superconductivity, Thermal properties, Isotope effect, Manifestations of energy gap, London theory, tunneling, *dc* and *ac* Josephson effect, High temperature superconductors.

Books Recommended:

1. Intermediate Quantum theory of Crystalline Solids, A. O. E. Animalu, Prentice−Hall of Indiaprivate 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 × 1 LCD Display Interfacing Module (IC-10)
8. 16 × 1 LCD Display with Matrix Keyboard module (IC-25)
9. 5 × 4 Key's Matrix Keyboard Interfacing module (IC-09)
10. Temperature measurement Interfacing Module. (IC-13)

PHY-524 DIGITAL ELECTRONICS AND MICROPROCESSOR 04 credits

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

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

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

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

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

PHY -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).

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 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.

B.Sc. Hons. Syllabus

Course No.	Course Title	Credits
BS-101	Mechanics	04
BS-103	Waves and oscillation	04
BS-105	Mathematics	04
BS-107	English language	04
BS-109	Practical	04
BS-111	CV	04
BS-102	Mathematical Physics	04
BS-104	Electricity and Magnetism	04
BS-106	~~Computer Programming~~ Environmental Science	04
BS-108	Modern Physics	04
BS-110	Practical	04
BS-112	CV	04
BS-201	Thermal Physics	04
BS-203	Analog Electronics and Microprocessor	04
BS-205	Solid state Physics	04
BS-207	Optics-I	04
BS-209	Practical	04
BS-211	CV	04
BS-202	Electrodynamics -I	04
BS-204	Quantum Mechanics	04
BS-206	Statistical Mechanics	04
BS-208	Numerical analysis	04
BS-210	Practical	04
BS-212	CV	04
BS-301	Laser Physics	04
BS-303	Semiconductor Physics	04
BS-305	Optics-II	04
BS-307	Atomic and Molecular Physics	04
BS-309	Practical	04
BS-311	CV	04
BS-302	Nuclear Physics	04
BS-304	Digital electronics	04
BS-306	Experimental Techniques in Physics	04
BS-308	Electrodynamics -II	04
BS-310	Practical	04
BS-312	CV	04
	Total credits	144

BS-101 MECHANICS

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and nonconservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.

BS-103 WAVES AND OSCILLATIONS

Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition

Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different

frequencies (Beats).

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature- lubrication.

Sound: Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Reference Books:

- Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
- University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley
- Optics by Ajaoy Ghatak

BS-105 MATHEMATICS

Calculus:

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation.

Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor.

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.

BS-107 ENGLISH LANGUAGE

Listening: Listening to texts, listening to CDs, Trials of a good listener.

Pronunciation: Introduction to English phonetic Symbols consonants & Vowels with illustrations in use.

Listening & Comprehension: Interpretation of texts based on question-answer. Interaction among students.

Reading Skill Techniques of reading: Reading comprehension of unseen pages Identifying the context & the central idea.

Vocabulary & word formation: From different texts & dictionary

Basic Grammar: Prescriptive/descriptive approaches grammaticality acceptability –appropriateness- grammar in context grammar in spoken & written

Practice: 1) Exercise on the use of different grammatical constructions in context. 2) Identification of the use of the above given grammatical devices form different texts like newspapers, poems, stories etc.

Words & phrases used for conversation: Making statements, questions, order & suggestions – denying – rejecting-disagreeing-possibility-ability, permission, obligations etc. Unit-3 1. Dialogues 2. Public speech 3. Telephonic Conversation

Translation: From Hindi to English

BS-109 Practical
BS-111 CV

BS-102 MATHEMATICAL PHYSICS

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only).

Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

Orthogonal Curvilinear Coordinates: Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Dirac Delta function and its properties:Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Special functions : Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes.

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books

BS-104 ELECTRICITY & MAGNETISM

Electric Field and Electric Potential: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.

Magnetic Field: Magnetic force between current elements and definition of Magnetic FieldB. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and

(2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

Magnetic Properties of Matter: Magnetization vector (M). Magnetic Intensity(H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.

BS-106 COMPUTER Programming

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran

Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

BS-108 MODERN PHYSICS

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

BS 110 Practical
BS 112 CV
BS-201 THERMAL PHYSICS

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and

Adiabatic Processes, Compressibility and Expansion Co-efficient.

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press

BS-203 ANALOG SYSTEMS AND APPLICATIONS

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2- port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Coupled Amplifier: RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

BS-205 SOLID STATE PHYSICS

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law.

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical

Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India

BS 207 OPTICS -I

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit.

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Reference Books

- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

BS 209 Practical

BS-211 CV

BS-202 ELECTRODYNAMICS I

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media.

Wave Equations. Plane EM waves through vacuum and isotropic dielectric medium. Transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

Relativistic mechanics and electrodynamics :specia;l theory of relativity ,leorentz transformations ,four vector definition and relativistic mechanics ,Invariance

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

BS-204 QUANTUM MECHANICS

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition

Principles. Eigenvalues and Eigenfunctions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.particle in a box.

Time independent Schrodinger equation -Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wavepacket for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

- A Text book of Quantum Mechanics, P.M.Mathews & K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists and Engineers, D.A.B. Miller, 2008, Cambridge University Press

BS-206 STATISTICAL MECHANICS

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of

Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law.

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

BS-208 NUMERICAL ANALYSIS

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of

Errors. Standard and Probable Error.

Methods for solution of Algebraic and Transcendental equations: Bisection, Newton Raphson and Secant methods

Interpolation methods: Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation.

Numerical differentiation and Integration: Forward and Backward difference formula. Trapezoidal and Simpson rules.

Referred Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw---Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn. , 2 0 0 7 , Wiley India Edition.

BS 210 Practical

Basics of C++

List of practicals:

1) Write a C++ program showing 'switch' usage.
2) Write a C++ program showing 'if' and 'if – else' implementation.
3) Write a C++ program for 'while' and 'for' loop.
4) Write a C++ program showing usage of 'function'.
5) Write a C++ program that arranges N integers in ascending order.
6) Write a C++ program for Bisection method.
7) Write a C++ program for Newton Raphson method.
8) Write a C++ program for Secant method.
9) Write a C++ program for Lagrange Interpolation.
10) Write a C++ program for Numerical differentiation.
11) Write a C++ program for Trapezoidal rule.
12) Write a C++ program for Simpson rules 1/3 rule.
13) Write a C++ program for Simpson rules 3/8 rule.

BS 212 CV

BS-301 LASER PHYSICS

Introduction to Laser and laser systems :Ruby laser,He-Ne laser,optical Resonators,Einstein coeficients and stimulated emmission,Line shape function,Properties of laser: coherence,dibvergence and monochromaticity
Lasers in instrumentation: introductory idea or measurement of cohehence length and refractive index in Michelson set up
Laser applications : applications of lasers in material processing ,Biology and various metrologicak applications

BS-303 SEMIDONDUCTOR PHYSICS

Semiconductor Diodes: P and N type semiconductors. Barrier Formation in PN Junction Diode. Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode. PN junction and its characteristics. Static and Dynamic Resistance. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line & Q-point. Active, Cutoff & Saturation regions. Voltage Divider Bias Circuit for CE Amplifier. h-parameter Equivalent Circuit. Analysis of single-stage CE amplifier using hybrid Model. Input & output Impedance. Current, Voltage and Power gains. Class A, B & C Amplifiers.

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metalsemiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop and closedloop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting Amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Zero crossing detector.
Sinusoidal Oscillators: Barkhausen's Criterion for Self-Sustained Oscillations. Determination of Frequency of RC Oscillator

Instrumentations: Introduction to CRO: Block Diagram of CRO. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers Calculation of Ripple Factor and Rectification Efficiency, Basic idea about capacitor filter, Zener Diode and Voltage Regulation.

Timer IC: IC 555 Pin diagram and its application as Astable and Monostable Multivibrator.

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic devices & circuits, S. Salivahanan & N.S. Kumar, 2012, Tata Mc-Graw Hill
- Microelectronic Circuits, M.H. Rashid, 2nd Edn., 2011, Cengage Learning.
- Modern Electronic Instrumentation and Measurement Tech., Helfrick and Cooper, 1990, PHI Learning
- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed.,2011, Tata McGraw Hill
- Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
- OP-AMP & Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

BS-305 OPTICS - II

Polarization and Double refraction

Introduction,Production of p[olarized lioght,interference of polarized light,Analysis of polarized light,Wollaston prism,Rochonprism.Nicol Prism,Optical cavity,,theory of optical cavity

Optical fibres and their properties

, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Step and Graded Indices, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

BS-307 ATOMIC AND MOLECUAR PHYSICS

Atomic models: The nuclear atom, Rutherford scattering formula, nuclear dimensions, The planetory model of atoms and its failure, Electron orbits, Fundamental concepts of Atomic spectra,Absorption and Emission spectra, Spectral series, Ritz combination principle. Correspondence principle. Nuclear motion, atomic excitation, Frank Hertz experiment.
Many electron atoms:Electron spin, Spin angular momentum, Stern Gerlach experiment, Symmetric and antisymmetric wavefunctions, Fermions and Bosons, Mny electron atoms, Periodic table, organizing elements, Atomic strycture with shells and subshells of electrons, Ionization energy, Transition elements, Hund's rule.
Spin Orbit coupling :Angular momentum link magnetically. Total angular momentum, LS coupling, Term symbols, X-ray spectra, Magnetic splitting of spectral radiationPaschen- Back effect, Stark effect.
Molecules:The molecular bond . Electron sharing. Hydrogen molecular ion, rotational and vibrational energy levels, Hydrogen molecule, Electronic spectra of molecules.Franck- Condon principle,Origin of fluorescence and phosphorescence, Isotope effect in molecular spectra,Raman effect.

Reference Books:
1.Concepts of Modern Physics, A.Beiser, S. Mahajan, S. Raichoudhury, Sixth edition, Tata Mcgraw- Hill 2009.
2. Atomic and Nuclear Physics, third edition, K Gopala Krishnan, Macmillan India, 2006
3. ,Physics of Atoms and molecules, B.H.Brandsen, C.J. Joachain, Second edition, Pearson education, 2004.
4. Fundamentals of Molecular spectroscopy,C.N. Banwell, E.M. McCash, Fourth edition, McGraw- Hill Education, 2017
5. Introduction to nuclear and particle Physics, A.Das, T. FerbelWorld Scientific, second edition, 2003

BS 309 Practical

BS 311 CV

BS-302 DIGITAL SYSTEMS AND APPLICATIONS

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

BS-304 NUCLEAR PHYSICS

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) □ -decay: energy kinematics for □-decay, positron emission, electron capture, neutrino hypothesis. (c)Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of

particle, for ionization chamber and GM Counter. Basic principle of Scintillation

Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators: Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

BS-306 EXPERIMENTAL TECHNIQUES

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution.

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise.

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference.

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric.
Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector.

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement.

Impedance Bridges and Q-meter: Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge.

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system-Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization).

Reference Books:

- Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
- Experimental Methods for Engineers, J.P. Holman, McGraw Hill
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
- Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
- Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
- Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
- Electronic circuits: Handbook of design & applications, U.Tietze, Ch.Schenk, Springer

BS-308 ELECTRODYNAMICS II

Maxwell's equations and EM waves-A review, EM wave propagation through conducting media, relaxation time, skin depth. EM waves in confined spaces. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

Motion of charges in E and B fields, EM potentials from a moving charge (Lienard-Wiechert), EM fields from a uniformly moving charge, Cherenkov radiation.

Radiation from an accelerating charge, Radiation from linear motion, Radiation from circular orbits, Radiation reaction force, EM radiation passing through matter

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

BS-310 Practical
BS-312 CV

Syllabus

M.Tech.

(Laser Science & Applications)

Revised w.e.f 01-09-2021

(Session 2021 – 2023)

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 -I	4
LA 709 CHOICE BASED-I*(NUMERICAL TECHNIQUES BASED ON C++)	4
LA 711 PRACTICALS-I	6
COMPREHENSIVE VIVA	4

Semester II

LA 702 HIGH VOLTAGE ENGINEERING FOR LASERS	4
LA 704 LASER SYSTEMS	4
LA 706 LASER APPLICATION-II	4
LA 708 CHOICE BASED-II* (QUANTUM OPTICS)	4
LA 710 SEMINAR	2
LA 712 PRACTICALS-II	6
COMPREHENSIVE VIVA	4

Semester III

LA 721 PROJECT (Part I)	11
LA 723 Project presentation	4
COMPREHENSIVE VIVA	4

Semester IV

LA 722 PROJECT (Part II)	11
LA 724 Project presentation	4
COMPREHENSIVE VIVA	4

Total Credits	96

* Choice Based Papers: Student can opt these papers or any other Choice based paper(s) from other M.Tech. offering Schools/ departments/ Institutes of the University)

M.Tech. Syllabus

M. Tech.(Laser Science & Applications)

SEMESTER-I

LA 701 APPLIED OPTICS:

Ray optics and matrix optics.

Polarized light, Jones matrices.

Theory and practical examples of diffraction, interference, reflection and refraction of electromagnetic waves.

Fourier optics, spatial frequency filtering, spatial light modulators, charged coupled devices, speckle interferometry

Wave propagation in anisotropic media, crystal optics, electro-optics and electro-optic devices, acousto-optics, magneto optic effect and acousto-optic devices.

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 and Optical bistability.

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, 3rd edition , Wiley, New York-1989.
6. R.W. Boyd, Nonlinear Optics, 2nd edition, Academic, San Diego- 2003.
7. Y.R. Shen, Principle of Nonlinear Optics, John Wiley, New-York, 1984.
8. G.P. Agrawal : Nonlinear fibre optics, Academic Press, 1989.

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.

Fiber Optic sensors: Optical fiber sensor systems. Intrinsic and extrinsic fiber optic sensors. Fiber based sensors: Phase modulated, frequency modulated and polarization modulated fiber optic sensors.

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).
6. Optical Fiber sensing and signal processing y B. Culshaw, Peter peregrinus Ltd., London (UK),1984.
7. Optical Fiber Communications: Principles and Practice, John M. Senior and M. Yousif Jamr, Prentice Hall, Third edition, 2009.

LA 707 LASER APPLICATION-I :

Laser instrumentation:

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:

Introduction to plasma Physics ,Basic concepts and two-fluid description of plasmas, electromagnetic wave propagation in plasmas, Kinetic theory of plasma ,Landau damping and its application to plasma based Laser accelerator

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 Publishing 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 709 Choice Based Paper : NUMERICAL TECHNIQUES BASED ON C++:

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

Solving Simultaneous linear equations, algebraic 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.

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

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 CO2 lasers Chemical lasers: HF, DF and Free electron lasers

Semi Conductor 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, multi quantum well lasers, Distributed feedback lasers, Distributed Bragg reflectors. Vertical cavity surface emitting lasers.

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

LA 706 Laser Application –II

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.

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.

REFERENCES:

1. Solid State Laser Engineering, Walter Koechner
2. M.L. Wolbarshi, Ed. Laser Applications in Medicine & Biology, Vol.1, 2 & 3 (Plenum, New York, 1971,74,77).
3. Laser Material processing by W.M. Steen.
4. Lasers: Principles and Applications by J. Wilson and J.F.B. Hawkes, Printice Hall.
5. Laser Spectroscopy by Demtröder.
6.A. Yariv, Quantum Electronics, 2nd edition (Wiley, New York,1975').
7.Harry: Industrial Lasers and their applications (McGraw Hill, 1974).
8.H. Koebner, Industrial application of Lasers (John Wiley, New York, 1984)

LA 708 Choice Based Paper II: Quantum Optics

Introduction to quantum optics

Quantum mechanics: Formalism of quantum mechanics, The Schrodinger equation, Properties of wave functions, Measurements and expectation values, Angular momentum and Dirac notation.

Quantized states in atoms, Fine and hyperfine structure, The harmonic oscillator, Stern–Gerlach experiment and the band theory of solids.

Radiative transitions in atoms: Einstein coefficients, Radiative transition rates, Selection rules, Width and shape of spectral lines, broadening, Laser oscillation, modes and properties.

Photons: Photon statistics, Photon-counting statistics, Poissonian photon statistics, Classification of light by photon statistics.

Photon antibunching: Introduction, Hanbury Brown–Twiss experiments and classical intensity fluctuations, The second-order correlation function $g(2)(\tau)$, and Photon bunching and antibunching.

Coherent states and squeezed light: Light waves as classical harmonic oscillators, Phasor diagrams and field quadratures, Light as a quantum harmonic oscillator, The vacuum field, Coherent states, Squeezed states, and Detection of squeezed light 139

Photon number states: Operator solution of the harmonic oscillator, The number state representation, Photon number states and Coherent states.

Resonant light–atom interactions: Preliminary concepts, The two-level atom approximation, Coherent superposition states, The density matrix, The time-dependent Schrodinger equation, The weak-field limit: Einstein's B coefficient, and the strong-field limit: Rabi oscillations.

Atoms in cavities: Optical cavities, Atom–cavity coupling, Weak coupling, Free-space spontaneous emission, Spontaneous emission in a single-mode cavity: the Purcell effect,

Strong coupling, and Cavity quantum electrodynamics.

Cold atoms: Introduction to Laser cooling, Basic principles of Doppler cooling, Optical molasses, Sub-Doppler cooling, Magneto-optic atom traps, Experimental techniques for laser cooling, Cooling and trapping of ions, and Bose–Einstein condensation.

REFERENCES:

1.Quantum Mechanics: J. J. Sakurai.
2.Quantum Mechanics: B. H. Bransden and C.J. Joachain.
3.Quantum Electronics, 3rd edition , A. Yariv, Wiley, New York-1989.
4.Nonlinear Optics, 2nd edition, R.W. Boyd, Academic, San Diego- 2003.
5.Principle of Nonlinear Optics, Y.R. Shen, John Wiley, New-York, 1984.
6. Quantum Optics an Introduction, Max Fox, Oxford University Press, 2006.

LA 710 SEMINAR

A seminar on topic of your choice relevant to Laser Science and Applications.

LA 712 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.