Bagalkot University,

(A State Public University of Govt. of Karanataka)

Jamkhandi

The Draft

SCHOOL OF BASIC SCIENCES

Department of Studies in Physics

M.Sc Physics Course

(CBCS)

STRUCTURE AND SYLLABUS

Adapted from RCU Belagavi applicable from the Academic Year 2023-24

Preamble for PG Syllabus of Bagalkot University

Bagalkot University Jamkhandi has been established by the Government of Karnataka and has started functioning from the academic year 2023-24. All the degree colleges other than engineering and medical colleges in the district of Bagalkote, are affiliated to this university as per the Karnataka State Universities Act 2000, as modified by the 26th Act of 2022. The students taking admission to any of the colleges in the district of Bagalkote, from the academic year 2023-24 will be students of Bagalkot University. The Chancellor of the university, the honorable Governor of Karnataka, has instructed the Vice chancellor and the university to adapt, the rules and regulations of the parent university, Rani Channamma University, Belagavi for the immediate activities (Vide letter from the office of the Governor GS 01 BGU 2023 dated 17/05/2023).

In this connection, Bagalkot University has adapted the postgraduate syllabus from RCU, Belagavi for all the 2 years degree PG programmes such as M.A.(English), M.A.(Political Science), M.S.W.,M.Com, etc. The syllabus follows the Choice Based Credit System introduced by University and provides flexibility to the students to choose their course from a list of electives and soft-skill courses, which makes teaching-learning student-centric. The higher semester syllabi will be published in due course. The syllabus is being published as one electronic file for each degree and is self-contained. Only the subject codes/ question paper codes are changed, whereas the subject syllabi remains the same. The subject code format is described in the following.

Subject Code Format for M.A. (History) and M.Sc. (Physics)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ver	Uni. Code		DEGREE			SEM		DISCIPLINE			SUB. TYPE			SL. NO. IN DISC. & S. TYPE		TH/ LAB /B/I NT.
1	2	6	M	S	C	0	1	P	H	Y	C	S	C	0	1	T
1	2	6	M	A	M	0	1	H	I	S	C	S	C	0	1	T

[1]The Ver information gives the version of the syllabus. It can take values 1,2..9,a,b,…

[2-3] The University UUCMS Code

[4-6] The PG degree codes to be provided as

Sl. No	Degree Code	Degree
1	MSC	Master of Science
2	MAM	Master of Arts
3	MCM	Master of Commerce
4	MBA	Master of Business Administration
5	MCA	Master of Computer Applications
6	MSW	Master of Social Work
7	MED	Master of Education
8	MPE	Master of Physical Education

[7-8]The Semester Information is provided as

Sl. No	Semester
1	‘01
2	’02
3	03
….	

[9-11]The Discipline Information to be provided as

Sl No	Degree	Discipline Code
1	MCM-MCOM	XXX
2	MCA	XXX
3	MBA	XXX
4	MSW	XXX
5	MAM	‘HIS’,POL’,’KAN’, ‘ENG’
6	MSC	‘PHY’,’CHE’, ‘MAT’,
7	MED-MEd	XXX
8	MPE-MPEd	XXX

[12-14]The Subject Type to be provided as

Sl. No.	TYPE	Description
1	HCC	Hard Core Course
2	CSC	Core Subject Course
3	SCC/SPC/OPC	Soft Core Course /Specialization Course/ Optional Course
4	OEC	Open Elective Course

[15-16] The Running Serial Number is to be provided for a particular subject type 01 to 99

[17] This character specifies the category of the subject namely, T=theory, L-Lab, P-Project, I-Internship, B- Bothe theory and Lab

Bagalkot University, Jamkhandi

Department of Physics (CBCS)

(w.e.f 2023-24)

Course Structure and Scheme of Examination

I SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	SubjectCode	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	126MSC01PHYCSC01T	Mathematical Methods of Physics	04	03	20	80	100	04
2	Core Subject	126MSC01PHYCSC02T	Classical Mechanics	04	03	20	80	100	04
3	Soft Core	126MSC01PHYSCC01T	Nuclear and Particle Physics(General)	04	03	20	80	100	04
4	Soft core	126MSC01PHYSCC02T	Condensed Matter Physics (General)	04	03	20	80	100	04
5	Soft Core Practi cal	126MSC01PHYSCC01L	Practical-I (Nuclear and ParticlePhysics)	04	03	20	80	100	04
6	Soft core Practical	126MSC01PHYSCC02L	Practical-II (Condensed MatterPhysics)	04	03	20	80	100	04
								Total Credits per Semester	**24**

II SEMESTER – MASTER OF SCIENCE IN PHYSICS

Sl. No	Subject	SubjectCode	Paper	Instruction Hours / Week	Duration of Examination	Marks			Credits
				Theory Practical	Hours	I.A. Marks	Theory/ Practical	Total Marks	
1	Core Subject	126MSC02PHYCSC03T	Quantum Mechanics-I	04	03	20	80	100	04
2	Soft Core	126MSC02PHYSCC03T	Atomic, Molecular & Optical Physics (General)	04	03	20	80	100	04
3	Soft core	126MSC02PHYSCC04T	Electronics (General)	04	03	20	80	100	04
4	Soft Core Practical	126MSC02PHYSCC03L	Practical-I (Atomic, Molecular & Optical Physics)	04	03	20	80	100	04
5	Soft Core Practi cal	126MSC02PHYSCC04L	Practical-II (Electronics)	04	03	20	80	100	04
6	Open Elective	126MSC02PHYOEC01T	Modern Physics	04	03	20	80	100	04
								Total Credits per Semester	**24**

M.Sc., PHYSICS SYLLABUS

I SEMESTER

Core Subject Code: 126MSC01PHYCSC01T

Paper Title : Mathematical Methods of Physics

Teaching hours per week : 4 No of credits : 4

Unit I

Special functions: Separation of the Helmholtz equation in Cartesian, circular cylindrical and spherical polar coordinates. **Legendre functions**: Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization;associated Legendre functions, spherical harmonics. **Bessel functions**: Bessel functions of the first kind, recursion relations, Orthogonality Hermite functions: Hermite polynomials, generating function, recursion relations; Orthogonality. Laguerre functions: Laguerre and associated Lauguerre polynomials, recursion relations; Orthogonality. Applications of special functions to problems in physics.

10 Hours

Unit II

Matrices: Vector spaces and subspaces, Linear dependence and independence, Basis and Dimensions, Gram-Schmidt orthogonalization procedure, Orthogonal, Hermitian, and unitary matrices, Eigenvalues and eigenvectors, diagonalization of matrices, Similarity transformations, applications to physical problems. **Integral Transforms**: Fourier transform: Definition, Fourier integral; inverse transform; Fourier transform of derivatives; convolution, Parseval's theorem; applications. **Laplace transform:** Definition, transform of elementary functions, Inverse transforms; transform of derivations; differentiation and integration of transforms; convolution theorem; solution of differential equations; problems in physics.

10 Hours

Unit III

Tensors: Coordinate transformation in linear spaces, curvilinear coordinates and their transformation; definition and types of tensors, contravariant and covariant tensors, symmetric and antisymmetric tensors, Tensor algebra : equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, lowering and raising of rank of tensors, the metric tensor**;** Christoffel symbols. Tensors in physics**.** 10 Hours

Unit IV

Group Theory: Groups, subgroups and classes; homomorphism and isomorphism, group representation, reducible and irreducible representation, Schur's Lemmas, orthogonlity theorem, haracter of a representation, character tables, decomposing a reducible representation into irreducible representations, construction of representations, lie groups, rotation groups SO(2) and SO(3). Application to molecular spectra.

10 hours

Unit V

Green's function: Non-Homogeneous boundary value problems and Green's function. Symmetry of Green's function for one-dimensional problems, Eigen function expansion of Green's function, Fourier Transform and Green's function in higher dimension, Some applications

10 hours

Text Books:

1. Mathematical Methods for physicists (4^{th} edition) : George Arfken & Hans J. Weber, Academic Press, San Diego (1995).
2. Mathematical Methods in Physical Sciences (2^{nd} edition): Mary L. Boas, John Wiley &Sons, New York (1983).
3. Mathematical Physics : P. K. Chatopadhyay, Wiley Eastern Ltd., New Delhi (1990).
4. Introduction to Mathematical Physics: Charlie Harper, Prentice-Hall of India Pvt. Ltd., New Delhi (1995)
5. Matrices and Tensors in Physics (3^{rd} edition): A.W. Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).
6. Elements of Group Theory for Phyicists (3^{rd} Edition): A.W.Joshi.,Wiley Eastern limited(1982).

Reference Books

1. Mathematical Methods for Physics and Engineering : K. F. Riley, M. P. Hobson and S. J.Bence, Cambridge Univ. Press Cambridge (1998).
2. Advanced Mathematics in Physics and Engineering : Arthur Bronwell, Mc Graw-Hill BookCompany, New York (1953).
3. Group theory and its Applications to Physical Problems: M.Hammermesh, Addision-Wesley,Mass (1962).
4. Schaum's Outline Series : Vector Analysis and Introduction to Tensor Analysis: M.R. Speigel, McGraw-Hill Company, Singapore (1983).

I SEMESTER
Core Subject Code: 126MSC01PHYCSC02T
Paper Title: Classical Mechanics

Teaching hours per week : 4 No of credits : 4

Unit I

Lagrangian Mechanics: Constraints, generalized co-ordinates, D'Alembert's principle, Lagrange equation from D'Alembert's Principle, Velocity dependent potentials and dissipation function. Applications of Lagrangian formulation: simple pendulum and Atwood machine. Hamilton's principle, Derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: momentum conservation, cyclic co-ordinates, angular momentum conservation and conservation of energy.

14 hours

Unit II

Motion in central force field: Equivalent one body problem, motion in central force field, general features of motion, Equations of motion and first integrals. Motion in inverse square lawof force field. Equation of orbit. Elliptic orbits, hyperbolic orbits & parabolic orbits. Elastic scattering in central force field, laboratory and center of mass co-ordinate systems. Rutherford scattering formula for alpha particles. Differential scattering cross section and impact parameter.

10 hours

Unit III

Motion of Rigid body: Fixed and moving co-ordinate systems. Euler theorem. Euler angle, angular momentum and kinetic energy of a rigid body. Inertia tensor, Euler's equations of motion. Force free motion of a symmetric top. Motion of heavy symmetric top with fixed point – Nutational motion.

10 hours

Unit IV

Hamiltonian Mechanics and Brackets: Legendre transformation. Hamilton equations of motion: conservation theorem and physical significance of Hamiltonian. Derivation of Hamilton's equation from a variation principle: Integrals of Hamiltons' equations. Canonical transformations. Principle of least action. Lagrange and Poisson brackets, Equation of motion in Poisson bracket notation.

10 hours

Unit V

Hamilton-Jacobi Theory: Hamilton-Jacobi equation of motion for Hamilton's principle and characteristic functions, Harmonic oscillator problem as example of Hamilton-Jacobi method. Separation of variables in the Hamilton-Jacobi equation.

06 hours

Text Books

1. Classical Mechanics: Goldstein, Narosa Publishing Pvt. Ltd. (1998).
2. Introduction to Classical Mechanics: R. G. Takwale & P. S. Puranik.-Tata McGraw Hill, New Delhi (1997).

Reference Books:

1. Classical Mechanics: Goldstein, C.Poole & J.Safko. Third edition. Pearson Education Asia (2002).
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, New Delhi (1991).
3. Classical Dynamics of Particles and Systems: J. B. Marion, Academic Press (1964).
4. Classical Mechanics of Particles and Rigid Bodies: Kiran. C. Gupta, - New Age m International (1998).

I SEMESTER

Soft Core Code: 126MSC01PHYSCC01T

Paper Title : Nuclear and Particle Physics (General)

Teaching hours per week 4 Number of credits 4

Unit I

Basic Properties: Nuclear matter radius & charge radius, Nuclear radius by high energy electron, neutron scattering, X-ray of muonic atom. Nuclear binding energy and separation energy, spin and magnetic momentum of odd A nuclei.

Nuclear Spin & Magnetic Moment: Experimental determination of spin by hyperfine structure in optical spectra & magnetic moment by Rabi's atomic beam method. Systematics of spin & magnetic moment for odd nuclei.

10 hours

Unit II

Nuclear Models: Liquid drop model, Semi emperical mass formula, Stability against beta decay, Stability against spontaneous fission, Fermi gas model-Fermi energy and kinetic energy. **Alpha Decay:** Gamow's theory of alpha decay, relation between mean life and decay energy, Hindrance factor. **Beta decay**: Neutrino hypothesis, Fermi theory of beta decay. **Gamma decay:** Gamma transition in nuclei & classifications. Internal conversion (Qualitative).

10 hours

Unit III

Nuclear Reaction: Types of nuclear reactions. Conservation laws. Q-values of a nuclear reaction and relation between Q value and energy of outgoing particle, threshold energy Compound nucleus model and its experimental verification (Goshal experiment). Briet- Wigner formula (qualitative). **Reactor Physics:** Condition for chain reaction, four factor formula, Thermal reactors, Fast breeder reactor**.** 10 hours

Unit IV

Interaction of radiations with Matter: Interaction of gamma rays: Photo electric effect, Compton effect, Pair production, Mass attenuation co-efficient, attenuation co-efficient for mixture and additivity law. Resonance scattering of gamma rays, Mossbauer effect and its simple applications**.**

Interaction of Charged particles with Matter: Interaction of charged particles: Energy loss of heavy charged particles in matter, Bethe-Bloch formula, energy loss of fast electrons, Bremsstrahlung.

10 hours

Unit V

Nuclear Detector: Principle and working of Geiger-Muller (GM) Counter, Scintillation Detectors- NaI(Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li iondrifted detectors, relation between the applied voltage and the depletion region in junction detectors.

Particle Physics: Classification of elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness,etc.). Gell –Mann and Nishijima formula. Quark model, baryons and mesons. C,P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak reaction. Relativistic kinematics.

10 hours

Text Books:

1. Nuclei and Particles: E. Serge -The Benjamin Publishing, Pvt. Ltd (1977)
2. Introductory Nuclear Physics: K.S. Krane- John Wiley & Sons(1987)
3. Atomic and Nuclear Physics : Vol.II S.N.Goshal –S.Chand and Company(1996)
4. Nuclear Physics: D.C.Tayal – Himalaya Publishing House (2009)

References Books:

1. The Atomic Nucleus : R.D.Evans – Tata Mc Graw Hill New Delhi (1992)
2. Physics of Nuclear Reactors: S. Garag, F.Ahmed and L.S.Kothri.- Tata Mc Graw Hill New Delhi (1986)
3. Introductory of Nuclear Physics: Samuel Wong –Prentice Hall (1996)
4. Fundamentals of Nuclear Physics : N.A.Jelly –Cambridge University Press (1990)
5. Introduction to Nuclear Physics: Harald A. Enge- Addison – Wisely (1996)

Semester-I
Soft Core Code: 126MSC01PHYSCC02T
Paper Title : Condensed Matter Physics (General)

Teaching hours per week 4 umber of credits 4

Unit I

Crystal Structure: Lattice translational vectors and lattices, basis and crystal structure, primitive an d non-primitive cells, Wigner-Seitz cell construction; fundamental types of lattices, Miller indices, Crystal planes and directions. Symmetry elements, point groups an d space groups (qualitative). Examples of simple crystal structures, NaCl, CsCl, HCP structure, Diamond, cubic ZnS and Hexagonal ZnS (Quartzite) structure.

Crystal diffraction: Production and properties of X rays. Continuous and characteristic X rays. X ray diffraction: Braggs law. Braggs X ray spectrometer. Experimental methods of x-ray diffraction, powder XRD method: Intensity versus theta plot and Debye –Scherer powder method.

12 Hours

Unit II

Crystal binding: Inter atomic forces, types of bonding: covalent, ionic, metallic, hydrogen and van der Waals; cohesive energy, compressibility and bulk modulus. Ionic Crystals: Madelung-energy, Born-Mayer Model, evaluation of Madelung constant for an infinite line of ions.

Lattice vibrations and thermal properties: vibrations of one-dimensional monatomic and diatomic lattices, properties of lattice waves, phonons. Einstein and Debye models of lattice heat capacity. Lattice thermal conductivity.

10 Hours

Unit III

Free electron model of metals: Free electron Fermi gas in three dimensions, Fermi surface. Fermi-Dirac distribution. Heat capacity of electron gas. Electrical conductivity and Ohm's law, Mattheissen's rule. Thermal conductivity, Weidman Franz law. Hall effect in metals.

Energy bands in solids: Origin and Magnitude of energy gap. Bloch functions. Kronig- Penney model. Number of states in a band. Distinction between metals, insulators and semiconductors, Concept of holes. The dynamic effective mass of electrons and holes.

10 Hours

Unit IV

Semiconductors: Intrinsic and extrinsic semiconductors. Expression for Intrinsic carrier concentrations, position of Fermi level. Electrical conductivity and mobility and their temperature dependence. Energy gap determination by four probe method.

Superconductivity: Occurrence of superconductivity. Destruction of superconductivity by magnetic field. Meissner effect. Type I and Type II superconductors. Qualitative idea about BCS theory.

10 hours

Unit V

Magnetic properties: Review of basic formulas, Magnetic susceptibility, Classification of materials, Diamagnetism, Langevin theory of diamagnetism, Classical and quantum theory of paramagnetism.

Defects in solids: Types of imperfections, Schottky and Frenkel defects and their concentrations. Edge and screw dislocations, Burgers vector construction. Colour centers.

08 hours

Text books

1. Introduction to Solid State Physics: C.Kittel.Wiley Eastern Ltd., Bangalore (1976).
2. Elementary Solid State Physics : M.A. Omar.Addison-Wesley Pvt.,Ltd.,New Delhi (1993).
3. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
4. Solid State Physics : F.W.Ashcroft & N.D. Mermin. Saunders College Publishing, NewYork (1976).

Reference Books

1. Introduction to Solids : L.V. Azaroff. McGraw-Hill inc, New york (1960).
2. Solid State and Semiconductor Physics: J.P.McKelvey. Harper and Row, Newyork (1966).

Semester -I

Soft Core Code : 126MSC01PHYSCC01L

Title : Practical-I (Nuclear and Particle Physics)

Each practical is of 4 hours per week and with 4 Credits

1) To study the characteristics of G M counter and determination of operating voltage and plateau length.

2) To verify the inverse square law relationship between distance and intensity of radiation.

3) To determine the dead time of a GM tube using the double source method.

4) To determine the mass absorption co-efficient of gamma and Beta rays using G M tube for aluminum, lead and copper foils.

5) Study of the performance of G. M. Counter and measurement of dead time by variable area method.

6) Study of characteristics of nuclear statistical counting for β-source using G M counter.

7) NaI (Tl) Scintillation detector-energy calibration, resolution and determination of gamma ray energy.

8) Beta ray absorption-end point energy of beta particles.

9) Life time of a short lived radio source.

10) Calculation of binding energy for different nuclei using semi-empirical mass formula. (assignment)

11) Calculation of coulomb energy for mirror nuclei. (assignment)

12) To determine Rutherford scattering of α-particle. (assignment)

13) Mott scattering (assignment).

(Minimum of 80% of the listed experiments per paper should be performed).

Semester-I

Soft Core Practical: 126MSC01PHYSCC02L: Practical-II

(Condensed Matter Physics)

Each practical is of 4 hours per week and with 4 Credits

1) Analysis of X-ray diffraction Pattern (Powder XRD analysis, assignment).
2) d-spacing calculations using Debye Scherrer powder pattern (assignment)
3) Thermistor characteristic and its energy gap determination.
4) Determine the plank's constant with different wavelengths by reverse photo electric effect using photodiode.
5) Measurement of Hall coefficient in semiconductor and estimation of charge carrier concentration, carrier density mobility and type of semiconductor.
6) Determination of energy gap by reverse saturation current in a pn-junction.
7) Structure factor calculation of simple crystal structure (assignment).
8) Determination of Fermi energy and Fermi temperature of copper and silver.
9) Determination of e/k_b .
10) Defect formation energy in metals.
11) Electrical conductivity of ionic solids (NaCl) and determination of vacancy formation energy.
12) Determination of energy gap of a given semiconductor by determining its resistivity at various temperature by four probe method.

II SEMESTER

II SEMESTER

Core Subject Code : 126MSC02PHYCSC03T

Paper Title: Quantum mechanics – I

No. of hours per week: 4 No. of credits: 4

Unit I

Basic Principles: Wave-particle duality, de Broglie hypothesis, Wave packets, Heisenberg uncertainty principle for position and momentum. electron diffraction, Hermitian operators, Eigen functions, eigen values and ortho normalization of eigen functions, completeness. State functions as probability amplitude and the principle of superposition. Momentum, Hamiltonian and energy operators, Schrodinger equation: time dependent and time independent. Probability density and probability current density, expectation values,
Ehrenfest theorem; basic postulates of quantum mechanics. 12 hours

Unit II

Simple Applications:. Eigenvalues and eigen functions of free particle, Dirac delta function and its properties; particle in a square well; simple harmonic oscillator by polynomial method. Tunneling phenomena: barrier transmission, leakage of free particle through a thick rectangular potential barrier, transmission and reflection coefficients for infinite and finite square well potential.

10 hours

Unit III

Hydrogen atom: Reduction of two-body problem to a single particle problem.
Center-of-mass and relative motions; eigenvalues and eigen functions. Hydrogen- like atom, eigenvalues of energy and eigen functions, parity of eigen functions; angular momentum, expression for the three Cartesian components and the square of the angular momentum, their commutation relations, expression for the operators in polar coordinates, eigenvaluesand eigen functions in terms of polar coordinates; eigenvalues and eigen functions of the square and z-component of angular momentum.

10 hours

Unit IV

Time-Independent Perturbation Theory: Eigenvalue of energy and eigen function in the first order approximation (the case of a system with non- degenerate energy levels). Application to anharmonic oscillator and to the ground state of Helium atom.
Time-Dependent Perturbation Theory: First order perturbation, Transition from one discrete level to the other, to continuum states, Fermi Golden rule, another discrete level through an harmonic perturbation, to resonance transitions. Interaction of radiations with a system of atoms, transition dipole moment, Einstein A and B coefficients.

10 hours

Unit V

Elastic Scattering: Differential and total cross-section, phase analysis.
Significance of the partial waves and phase shifts, S-wave scattering from a square well

potential. The Born approximation, derivation of the expression for differential scattering cross-section, condition for validity of the approximation: application to square well potential and screened coulomb potential. 08 hours

Text Books

1. Quantum Mechanics – Theory & Applications (3rd Ed): A.K. Ghatak & Loknathan, MacMillan India Ltd. 91984)
2. A Text of Quantum Mechanics: P.M. Mathews &K. Venkatesan, Tata McGraw-Hill, New delhi (1982)
3. Quantum Mechanics (2nd ed.), G. Aruldhas, Prentice Hall India Pvt.Ltd., New Delhi (2009).

Reference Books:

4. Quantum Mechanics (2nd Ed): V.K. Thankappan, new Age International (P) Ltd. (1993)
5. Introduction to Quantum Mechanics: L. Pauling & E. Bright Wilson, McGraw-Hill, N.Y.(1935)
6. Quantum Mechanics(3rd ed): L.I. Schiff, McGraw-Hill, N.Y.(1968)
7. Quantum Mechanics: E. Merzbacher, 2nd ed., Wiley, N.Y.(1970).

II Semester

Soft Core Code : 126MSC02PHYSCC03T

Paper Title : Atomic, Molecular & Optical Physics (General)

Teaching hours per week: 4 No. of Credits:4

Unit I

Atomic Spectroscopy Quantum states of an electron in an atom. LS and JJ coupling schemes. Terms for equivalent and nonequivalent electron atom. Spectra of one electron systems. Qualitative idea of: Electron spin, spin orbit interaction, fine structure, relativity correction and radiation correction (Lamb Shift). Electric dipole selection rules. Intensity rules. Penetrating and non-penetrating orbits, quantum defect. Alkali type spectra. Spectrum of helium. Normal and anomalous Zeeman effect. Paschen-Back effect. Stark effect. Hyperfine structure and isotopic shifts, Shape and width of spectral lines: mechanisms; Natural, Doppler, Collision broadenings.

12 hours

Unit II

Electronic Spectroscopy: Born-Oppenheimer approximation. Electronic spectra of diatomic molecules. Hund's cases. Vibrational structure of electronic transition. Selection rules. Franck-Condon principle. Intensity of bands in absorption and emission. Isotopic effect.

Microwave Spectroscopy: Microwave spectra (Far IR Spectra); Diatomic molecule as a rigid rotator, non-rigid rotator & symmetric top. Rotational spectra of diatomic molecules. Intensity distribution.

08 hours

Unit III

Infrared Spectroscopy: Diatomic Molecule as a harmonic oscillator, anharmonic oscillator, vibrating rotator. Vibrational spectra of diatomic molecules. Rotation-Vibration spectra of diatomic molecules.

Raman Spectroscopy: Scattering of light. Rayleigh scattering. Blueness of ocean. Raman effect: Classical & Quantum theory of the Raman effect, Pure rotational & vibrational Raman Spectra. Difference between IR and Raman spectroscopy with examples.

Spectroscopic Techniques: Fluorescence Spectroscopy, Fourier transform infrared spectroscopy, Emission spectroscopy, Mossbauer Spectroscopy.

12 hours

Unit IV

Laser Physics: Absorption, spontaneous and stimulated emission. Einstein coefficients, Transition probability and lifetime of an atom in an excited state. Population inversion. Laser rate equations: The three level and four level systems. He-Ne laser. CO2 laser. Semiconductor laser. Properties of laser beam: directionality, monochromacity, intensity, coherence (temporal and Spatial). Applications of lasers.

10 hours

Unit V

Fiber optics: Types of fibers – single mode and multimode with different refractive index profiles. Ray theory of transmission, total internal reflection, acceptance angle, numerical aperture, skew rays. Optical fiber connectors, fiber alignment and joint loss, bending loss, fiber splices.

08 hours

Textbooks:

1. Introduction to Atomic Spectra : H.E. White, McGraw – Hill, Tokyo (1934)
2. Physics of Atoms and Molecules – 2nd Ed., Brans den B.H. and JoachainC.J., Pearson Education, India (2006)
3. Elementary Atomic Structure (2nd ed.) : G. K. Wood gate, Clarendon Press, Oxford (1980)
4. Molecular Spectra & Molecular Structure – Vol I : Herzberg, D. Van Nostrand Co. Princeton, J. J. (1945)
5. Spectroscopy – Vol. 3:S. Walker & B. P. Strauhghan, Chapman & Hall, Lon (1976)
6. Fundamentals of Molecular Spectroscopy : C. N. Banwell and E.M. McCash, Tata Mc Graw-Hill Co., 4th revised edition, (9th reprint, 2000)
7. Lasers and Non-Linear Optics : B. B. Laud, Wiley Eastern Ltd., New Delhi (1991).
8. An Introduction to Lasers & their Applications : Donald C. O' Shea, W. Russell Callen & William T. Rhodes, Addison-Wesley, N. Y. (1977).
9. Optical Fiber & Communications Principles & Practice : John M. Seniors, Prentice Hall Intl. Ltd. London (1992)

Reference Books:

1. Fundamentals of Spectroscopy (2nd ed): B. Narayan, Allied Publishers Ltd., New Delhi (1999).
2. Principles of Lasers : O. Svelto, Plenum Press, N. Y. (1982).
3. Laser Electronics : Joseph T. Verdeyen, Prentice-Hall of India Pvt. Ltd. NewDelhi (1989).
4. Lasers : Theory & Applications : K. Thyagarajan & A. Ghatak, MacMillan India, New Delhi (1981).
5. Laser Principles & Applications : J. Wilson & J.F.B. Hawkes, Prentice-Hall Intl. Inc. (1983)
6. Fiber Optics Sensors : D. A. Krohn, Instrument Soc. Am. (1988).
7. Encyclopedia of Lasers & Optical Technology : Robert A. Meyars, Academic Press, Cal. (1991).
8. Fiber Optic Communication : D. C. Agarwal, Wheeler Pub. (1993).
9. Optoelectronics – An Introduction : J. Wilson & J.F.B. Hawkes, Prentice – Hall Intl. Inc. (1983).
10. Laser Fundamentals : W.Q. Silfvast.

II Semester

Soft core Code : 126MSC02PHYSCC04T

Paper Title : Electronics (General)

Teaching hours per week 4 Number of credits 4

Unit I

Semiconductor Devises: Basic principles of transistor operation; Biasing; Characteristics of BJT. **JFET:** The junction field effect transistors (JFET), basic structure and operation, characteristics, parameters, biasing, voltage divider biasing. JFET as an amplifier, common-source, common-drain and common-gate. **MOSFET:** Metal Oxide semiconductors **(**MOSFET), inversion layer, the enhanced MOSFET and depletion MOSFET and their characteristics, PMOS, NMOS & CMOS (qualitative).

10 hours

Unit II

Operational Amplifier: Ideal Op-Amp and practical O-Amp, Input modes and parameters, open loop Op-Amp configuration. Op-Amp with negative feed-back, inverting, non-inverting and differential amplifiers. Feedback configurations – voltage series feedback amplifier, voltage shunt feedback amplifier and differential amplifier. Summing, scaling and averaging amplifier, instrumentation amplifier, integrator and differentiator. **Op-Amp Applications**:Comparator, summing, integrator differentiator, instrumentation amplifiers, isolation amplifiers, and Operational Transconductance Amplifiers, Log and Antilog amplifiers, Converters, Introduction to OPAMP based active filters; Oscillators-basic principles, types, phase shift oscillator, Wien bridge oscillator, triangular wave generator .

10 hours

Unit III

Digital Electronics: Number systems and Boolean algebra: Introduction to number system and Boolean algebra; Boolean identities, basic logic functions, standard forms of logic expressions, simplification of logic expressions. Karnaugh map: Reduction using Karnaugh map, Product of sums (POS) and sum of products (SOP) simplification. Implementation of Boolean Expressions.

10 hours

Unit IV

Logic families: Brief overview of Transistor as a switch; Logic gate characteristics – propagation delay, speed, noise margin, fan-out and Power dissipation; Standard TTL and static CMOS gates. **Combinational Logic circuits**: Arithmetic circuits: Adder, substractors. Decoders, encoders, Multiplexers, de-multiplexers.

10 hours

Unit :V

Sequential circuits: Latches and Flip Flops (SR, D, JK, T);Timing in sequential circuits; Shift register; Counters – synchronous, asynchronous; Sequential circuit design examples in VHDL and simulation. Memory units, random access memory (RAM). **A/D and D/A conversion circuits:** Introduction, filtering and sampling, quantization, quantization error, flash converter and dual slope converter, conversion errors. Binary weighted converter, R-2R ladder converter, characteristic properties.

10hours

Text Books:

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).

2. Op-Amps and linear Integrated Circuits :R Gayakwad, PHI publications, New Delhi (2000).

3. Digital Principles and Applications: A.P. Malvino and D. Leach, TM H Publications (1991).

4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003)

Reference Books:

12 Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).

2. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).

3. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).

4. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).Mano M.M., Ciletti M.D., "Digital Design", Pearson India, 4th Edition. 2006

5. Katz R.H., Borriello G., "Contemporary Logic Desing", Prentice Hall India, 2nd 2008 Edition.

6. Kohavi Z., Jha N.K., "Switching and Finite Automata Theory",Cambridge University Press, India, 2nd 2011Edition.
7. Wakerly J.F., "Digital Design: Principles and Practices," Pearson India, 4th 2008 Edition.

II Semester

Soft Core Practical Code : 126MSC02PHYSCC03L

Paper Title : Practical I (Atomic, Molecular& Optical Physics)

Each practical is of 4 hours per week and with 4 Credits

1) Study of Zeeman Effect: Determination of e/m for an electron.
2) To study the numerical aperture and bending loss of an optical fiber.
3) Determination of unknown wavelength of a laser source using grating and a laser source of known wavelength.
4) Study of interference and diffraction using single and double slits using He-Ne/semiconductor laser source.
5) Study of interference and diffraction using reflection grating and He-Ne/semiconductor laser source
6) Measurement of wavelength of sodium D line/wavelength separation of sodium D doublet lines using Michelson Interferometer.
7) Verification of Beers law. Determination of absorption coefficient.
8) To measure the wavelength of absorption bands of $KMnO_4$ and calculate it's Hartmann's constant using constant deviation spectrometer.
9) To find wavelength of prominent lines of the emission spectra of copper, iron and brass using constant deviation spectrometer.
10) Determine the spectral terms of sp and pd configuration for 'LS' and 'JJ' coupling (assignment).
11) Determine the spectral terms for equivalent electrons in L-S coupling and show splitting of energy levels with diagram for each term i) d ii) sp iii) pp, iv) pd, v) ppd (assignment).
12) Determine the spectral terms for non-equivalent electrons in L – S coupling and show splitting of energy levels with diagram for each term term i) d ii) sp iii) pp, iv) pd, v) ppd (assignment).

(Minimum of 80% of the listed experiments per paper should be performed).

II Semester

Soft core Code : 126MSC02PHYSCC04L

Paper Title : Practical I(Electronics)

Each practical is of 4 hours per week and with 4 Credits

1). Construction of Astable and Monostable Multivibrator using IC- 555 timer and calculation of frequency.

2) Construction of adder, subtractor, differentiator and integrator using Op-Amp 741.

3) FET- as an amplifier.

4) MOSFET characteristics and application as an amplifier.

5) SCR- characteristics and its applications as a switching device.

6) Construction of decoder and encoder using NAND and NOT gates and verification of truth tables.

7) Construction of Karnaugh map for three and four variables.

8) R-2R ladder network D/A converter and its characteristics.

9) Design of low pass, high pass and band pass active filters using Op-Amp 741, and calculation of cut off frequency. Study of triggered SR, JK and D-flip-flops.

10) Construction of Wein bridge oscillator using Op-Amp 741 and comparison of its theoretical and practical values.

11) Simplification of Boolean expression and implementation using 2-input NAND gate IC7400.

12) Asynchronous & Synchronous Counters

(Minimum of 80% of the listed experiments per paper should be performed).

References:

12 Microelectronics Circuits : Adel S. Sedra and Kenneth C.Smith, OxfordUniversity Press (1991).

2. Electronic devices and circuits: R.Boylsteadand Nashalsky: PHI publications (1999).
3. Electronics Principles: A.P.Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op-Amps and Linear Integrated Circuits : R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid Satte Physics : M.A.Omar, Addison Wisley Pub.Ltd. New Delhi (1993).
7. X-ray Diffraction : B.D.Cullity, Addison-Wisley Ltd. New York (1972).
8. Introduction to Solid State Physics: C.Kittel, Wiley Eastern Ltd. Bangalore, (1976).

10. Advanced Practical physics : (9^{th} Edition) B.C.Worsnop & H.T. Flint Methuen & Co.Ltd.Lond (1951).

11. Instrumental Methods of Analysis : (6^{th} Edition) H.H. Willard, L.L.Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).

12 .Experiments in Modern Physics: A.C. Melissions academic press (NY)(1966).

II Semester

Open Elective Code : 126MSC02PHYOEC01T

Paper Title : Modern Physics

Teaching hours per week 4 Number of credits 4

Unit I

Blackbody Radiation: Nature of Blackbody spectrum; classical radiation laws & their limitations; Planck's radiation law & quantum hypothesis. **The Photoelectric Effect:** Photoelectric Effect experiment; laws of Photoelectric Effect; Einstein Photoelectric Equation. **X- rays: P**roduction and properties of X- rays. Continuous and Characteristic spectrum of X rays. **The Compton Effect:** X-ray Compton scattering from an electron; expression for wavelength shift (no derivation). Experimental set-up for Compton Scattering. Simple problems.

10 hours

Unit II

Atomic Physics: Hydrogen spectrum; the Bohr model; experimental measurement of the Rydberg Constant; Franck Hertz Experiment. **Matter Waves:** The de Broglie wavelength & its relation with the Bohr Model; Davisson – Germer experiment. Heisenberg Uncertainty Principle. Momentum – position & energy – time relations. **Quantum Physics:** Idea of wave function & probability. One-dimensional time independent Schrodinger wave equation.

10 hours

Unit III

Molecular structure: Bonding Mechanisms: ionic bonds; Covalent bonds; the Hydrogenbond; Van-der Waal's Bonds. Molecular vibration & rotation Spectra. **Lasers:** Absorption, Spontaneous & Stimulated emissions; Population Inversion; Two level and three level energy system. Condition for laser action. Ruby laser energy level diagram and working.

10 hours

Unit IV

Solid State Physics: Crystal structure. Space lattice, building block of crystals. Primitiv and non primitive unit cells. Miller indices (qualitative). Seven crystal systems. X ray diffraction, Bragg's law; Bragg's X-ray spectrometer; **Magnetism:** Magnetic Moment; Magnetization. Classification of Magnetic Materials: Diamagnetic, Paramagnetic & Ferromagnetic materials.

10 hours

Unit V

Nuclear Structure: Nuclear properties: Charge, mass, size & structure; Binding Energy & nuclear forces. Radioactivity: Decay constant, half-life. **Nuclear Fission:** Fission – basic process; a simple model; a typical nuclear reactor. **Semiconductor Physics:** Intrinsic and extrinsic semiconductors. Doping: p type and n type semiconductors. Types of carriers. pn junction. Junction potential, depletion region. Forward bias and reverse bias. pn junction diode. VI characteristics.

10 hours

Textbooks:

1. Modern Physics (2nd Ed) Serway, Moses & Moyer, Saunders College Pub,1997.
2. Fundamentals of Physics extended with Modem Physics (4^{th} Ed) Halliday, Resnick & Walker, John Wiley, 1993.
3. Concept of Modern Physics, (6^{th} edition) Aurther Beiser, McGraw Hill Publishing company.
4. Modern Physics, Kenneth Krane, Wiley India limit.