SCHEME OF EXAMINATION
&
SYLLABUS
of
M.Sc. (PHYSICS)

UNDER

FACULTY OF SCIENCE

Approved by Board of Studies in Physics

EFFECTIVE FROM JULY 2023

(Valid for 2 Years 2023-2025)

School of Studies in Physics & Astrophysics
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Approved by Board of Studies in Physics on 16, January 2023
PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

M. Sc. - PHYSICS

M.Sc. in Physics is a full time 2-year (4-semesters course). There will be four theory papers in each semester, two laboratory courses in semester I, II, III and one project in semester IV. In each semester, there will be two internal examinations/assessments**. Each paper contains employability and skill development.** Semester-wise course structure along with distribution of marks is given below:

Semester I

Name of the Paper	Marks					Credits
	Theory		Internal		Total	
	Max	Min	Max	Min		
1. Mathematical Physics	80	16	20	04	100	4
2. Classical Mechanics	80	16	20	04	100	4
3. Electrodynamics & Plasma Physics	80	16	20	04	100	4
4. Electronics	80	16	20	04	100	4
Laboratory Course I-A: General & Optics (Professional Ethics)	-		-		100	2
Laboratory Course I-B : Electronics -I (Professional Ethics)	-		-		100	2
Total Marks					600	20

Total Marks for Semester I = 600 & Credit = 20

Semester II

Name of the Paper	Marks					Credits
	Theory		Internal		Total	
	Max	Min	Max	Min		
1. Quantum Mechanics-I	80	16	20	04	100	4
2. Statistical Mechanics	80	16	20	04	100	4
3. Electronic & Photonic Devices and Optical Modulators	80	16	20	04	100	4
4. Computational Physics & Computer Programming	80	16	20	04	100	4
Laboratory Course II-A : Numerical Analysis & Computer Programming (Professional Ethics)	-		-		100	2
Laboratory Course II-B : Electronics-II (Professional Ethics)	-		-		100	2
Total Marks					600	20

Total Marks for Semester II = 600 & Credit = 20

Programme outcome:

The students will be able to:

- Apply theoretical knowledge and concepts of Physics to practical problems.
- Use mathematical techniques and interpret mathematical models of physical behavior.
- To acquire the skills in handling scientific instruments, planning and performing in laboratory experiments. Analyze the given scientific data critically and systematically.
- Develop subject expertise, confidence, communication skills and scientific discussions to perform in National and International platform.
- Continue research at the higher degree (Ph D) level.
- Obtain employment in research and development in the scientific labs and engineering industries.
- Develop necessary skills and ability to opt more general carrier choices such as public services, banking, IT, government and private sectors etc.

Programme specific outcome: M.Sc. Physics

- Understanding the basic concepts of Physics i.e. classical mechanics, quantum mechanics, statistical mechanics and electrodynamics and plasma physics through logical and mathematical reasoning.
- Understand the basic concepts of other fields such as nuclear and high energy physics, atomic and molecular physics, solid state physics, astrophysics, general theory of relativity.
- Develop experimental skills in front line areas of Physics such as solid state physics, nanoscience, lasers, electronics, astronomy and astrophysics.
- Gain expertise to work in applied fields.
- Study of Physics develops a critical attitude and logical reasoning that can be applied to various fields.

Learning outcome of M. Sc. Physics

S. No.	Paper Code	Name of Papers	Outcomes The students will be supervised, experienced and be able to:
1.	PHY 101	Mathematical Physics	• Understand the basic ideas, tools and methods of Mathematical Physics. • Use of Vector Space, Matrices and complex variables in different areas of Physics. • Solve Differential equations and learn their applications. • Familiar with in Physical Sciences, Special functions and their applications. • Utilize Series Expansion and Fourier transform in Physical problems.
2.	PHY 102	Classical Mechanics	• Understand the Newtonian Mechanics, Lagrangian and Hamiltonian Formulation. • Have a deep understanding of the central force problem and rigid body dynamics. • Use of Mechanics to solve various Physical problems.
3.	PHY 103	Electrodynamics & Plasma Physics	• Understand Maxwell equations and its implication to Electromagnetic fields and waves. • Learn the production of Electromagnetic radiations through various radiation processes. • Understanding the plasma state, concepts of Debye screening and collective behavior. • Get knowledge of Plasma Kinetic Theory, MHD and confinement scheme.
4.	PHY 104	Electronics	• Get knowledge of Operational Amplifier circuits, frequency response and its applications. • Understand the combinational and sequential logic circuits and their various applications in digital electronics. • Have understanding of 8085 Microprocessor and its programming.
5.	PHY 201	Quantum Mechanics-I	• Gain knowledge of non-relativistic quantum mechanics. • Solve time dependent and time independent Schrodinger Equations for simple potentials. • Apply time independent perturbation theory to solve simple problems. • Understand the concept of angular momentum and central force problems.
6.	PHY 202	Statistical Mechanics	• Develop concept of macroscopic, microscopic states

			and ensembles in statistical mechanics. • Formulation of classical and quantum Statistics i.e. MB, BE and FD. • Implication of statistics in various Physical problems.
7.	PHY 203	Electronic & Photonic Devices and Optical Modulators	• Understand unipolar and bipolar devices and their applications in various fields. • Develop special microwave devices and their applications in many fields. • Gain the knowledge of Photonic Devices, Optical Modulators and Display Systems.
8.	PHY 204	Computational Physics & Computer Programming	• Get knowledge of computational methods in Physics. • Learn the FORTRAN Language. • Use FORTRAN Programming to solve various equations. • Perform Interpolation and curve fittings through various tools.
9.	PHY 301	Quantum Mechanics-II	• Use the variation method, WKB approximation and Time dependent Perturbation theory to solve questions in atomic Physics. • Learn the principle of scattering processes. • Gain knowledge of relativistic quantum mechanics, explain the Dirac equation and it's free particle solutions.
10.	PHY 302	Atomic & Molecular Physics	• Learn one electron and two electron atomic systems. • Understand role of Pauli's exclusion principle and coupling mechanism of angular momentum. • Learn the effect of electric and magnetic fields on atomic system, its energy levels and spectral lines. • Understand the interaction mechanism of molecules with radiation. • Learn to explain IR, Microwave and Raman Spectroscopy.
11.	PHY 303	Solid State Physics-I	• Develop theoretical and experimental approach to give fundamental insights into Solid State Physics. • Gain knowledge of characteristic behavior of electrons in solids and its consequences. • Understand the Fermi Surfaces and Lattice Dynamics. • Get basic ideas of superconductivity and semiconductor crystals.
12.	PHY 304 (A)	Astronomy & Astrophysics-I	• Understand the various astrophysical parameters and get elementary ideas of astronomy and astrophysics. • Formulate basic equations of stellar structure to understand stellar interiors. • Learn the process of stars' formation; understand their evolution and study of their end products i.e. white dwarfs, neutron starts and Black hole. • Get a deep insight into Solar Physics and related

			phenomena. • Learn and perform the measurement techniques used in astronomy and astrophysics.
13.	PHY 304 (C)	Physics of Nano-material-I	• Get basic ideas of Nano structure materials and carbon nano tubes. • Learn methods of preparing nanostructure using different techniques. • Understand Structural and chemical characterization of nano structure.
14.	PHY 401	Nuclear & Particle Physics	• Understand the nucleon-nucleon interaction through Deuteron and scattering theory. • Able to understand nuclear reactions and energetics. • Study of nuclear decays and related Physics. • Develop nuclear models to explain nuclear properties. • Understand the fundamental interactions, elementary particles, Quarks and standard models.
15.	PHY 402	Laser Physics and Applications	• Learn the working mechanism of Laser and its applications. • Develop knowledge of population inversion, Q-factor and threshold conditions. • Gain knowledge of different types of lasers. • Understand the production of giant laser, multi photon process and their applications.
16.	PHY 403	Solid State Physics -II	• Gain the basic knowledge of Physics of plasmons and polaritons. • Understand the dielectric and ferroelectric properties of solids. • Have quantum mechanical exemplification of the diamagnetic, paramagnetic, ferro and anti-ferromagnetic properties of solids. • Develop knowledge of optical process and defects in solids.
17.	PHY 404 (A)	Astronomy & Astrophysics-II	• Learn various types of galaxies through Hubble Sequence and get detail knowledge of Milky Way galaxy. • Understand the accretion on to a super massive B.H. and Active Galactic Nuclei. • Understand failure of Newtonian Gravity and need of General Relativity. • Construct Cosmological Models of the Universe and their verification through observational techniques.
18.	PHY 404 (C)	Physics of Nano-material-II	• Understand the basic knowledge of electrical transport properties in Nano structure. • Different application of CNT and Polymeric nanofibers. • Get knowledge of sustainable nano technology and human health.

			• Understand principle of nano lithography and their applications.

Detailed Course Content

Semester - I

PAPER-I: MATHEMATICAL PHYSICS

Unit-I
Vector space and Matrices, Linear independence, Bases, dimensionality, Inner product, Linear transformation, matrices, Inverse, Orthogonal and Unitary matrices, Independent element of a matrix, Eigen values and eigen Vectors, Diagonalization, Complete orthonormal sets of functions.

Unit-II
Complex Variables: Analytic functions, Condition for f(z) to be analytic, C-R Equations in Polar form, Harmonic function, Method to find the conjugate function, Cauchy's integral theorem, Cauchy integral formula, Taylor's series, Laurent's series, Singular point, Residue and their evaluation, Cauchy's Residue theorem, Contour integration, evaluation of definite integrals, Problem's.

Unit-III
Differential equations, first order differential equation, second order differential equation with constant coefficients, second order linear ODEs with variable coefficients, Solution by series expansion, nonhomogenous differential equations and solution by the method of Green's functions.

Unit-IV
Special functions, Legendre, Bessel, Hermite and Laguerre functions with their physical applications, generating functions, orthogonality conditions, recursion relations,

Unit-V
Integral transforms, Fourier integral and transforms, inversion theorem, Fourier series; properties and applications, discrete Fourier transform, Fourier transform of derivatives, convolution theorem, Laplace Transform(LT), LT of Derivatives, Inverse LT.

TEXT AND REFERENCE BOOKS

1. Mathematical Methods for Physics, by G. Arfken.
2. Matrices and Tensors for Physicist, by A. W. Joshi.
3. Advanced Engineering Mathematics, by E. Kroyazig.
4. Special Functions, by E. B. Rainville.
5. Special Functions, by W.W. Bell.
6. Mathematical Method for Physicist and Engineers, by K. F. Relly, M. P. Hobson and S. J. Bence

7. Mathematics for Physicists, By Marry L. Boas.

Paper - II: CLASSICAL MECHANICS

Unit-I

Preliminaries, Newtonian mechanics of one and many particle systems, Conservation laws, Constraints & their classification, Principle of virtual work, Generalized coordinates, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and dissipation function, Simple applications of the Lagrangian formulation, Hamilton's principle, Lagrange's equations from Hamilton's principle, Conservation theorems and Symmetry properties, Energy function and the conservation of energy.

Unit-II

The Hamiltonian formulation of mechanics, Legendre transformations and the Hamilton's equations of motion, Cyclic coordinates and Conservation Theorems, Hamilton's equations from Hamilton's principle, The principle of least action, Simple applications of the Hamiltonian formulation.

Unit-III

Canonical transformations with examples, the harmonic oscillator, Poisson's brackets, Equations of motion and conservation theorems in the Poisson Bracket formulation. Hamilton-Jacobi (HJ) theory: The HJ equation for Hamilton's principal function, Harmonic oscillator as an example of the HJ method, The HJ equation for Hamilton's characteristic function, the action-angle variables

Unit –IV

The Central force: Two-body central force problem and its reduction to the equivalent one-body problem, The equations of motion and first integrals, The equivalent one-dimensional problem and classification of orbits, The differential equation of the orbit, Closure and stability of orbits, The Kepler problem, Scattering in a central force field: Rutherford scattering.

Unit – V

Rigid body dynamics, The Euler angles, Euler's theorem on the motion of a rigid body, Rate of change of a vector, The Coriolis force, Angular momentum and Kinetic energy of motion about a point, The Euler equations of motion of rigid bodies. Formulation of the problem of small oscillations, the eigen-value equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, free vibration of linear triatomic molecule.

TEXT AND REFERENCE BOOKS

1. Classical Mechanics, By N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)
2. Classical Mechanics, by H.Goldstein (Addison Wesley, 1980)
3. Classical Mechanics, by H.Goldstein, C Poole & J Fafko (Pearson Education, Inc, 2002)
4. Mechanics, by A.Sommerfeld, (Academic press, 1952)

5. Introduction to Dynamics by Perceival and D.Richaeds(Cambridge University, press, 1982).

Paper-III: ELECTRODYNAMICS & PLASMA PHYSICS

Unit-I

Maxwell's equations, E-M wave equation in free space/vacuum, vector and scalar potentials, Gauge transformations: Coulomb gauge, Lorentz gauge, Minkowski,s space, Four-vectors, Mathematical properties of the space-time in special relativity, Lorentz transformation of space and time in four vector form, Covariance of electrodynamics: Transformation equation's for the E-M potential, Covariant form of electric and magnetic field equation.

Unit-II

Radiation by moving charges: Retarded potential, Lienard-Wiechert potentials and E-M fields equation for a moving point charge, Poynting vector, total power radiated by an accelerated charge- Larmor's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge.

Unit -III

Bremsstrahlung emission: emission from single-speed electrons, thermal Bremsstrahlung emission and absorption, Synchrotron radiation: Total emitted power, spectrum of synchrotron radiation, spectral index for power law electron distribution, transition from Cyclotron to Synchrotron emission, Cherenkov radiation.

Unit-IV

Plasma: definition, Debye shielding phenomenon and criteria for plasma, motion of charged particles in electromagnetic field; Uniform E & B fields, Electric field drift, Non-uniform magnetostatic field, Gradient B drift, Parallel acceleration and magnetic mirror effect, Curvature drift, adiabatic invariants.

Unit-V

Elementary concepts of plasma kinetic theory, the Boltzmann equation, the basic plasma phenomena, plasma oscillations. Fundamental equations of magneto-hydrodynamics (MHD), Hydrodynamics Waves; Magneto sonic and Alfven waves, Magnetic viscosity and magnetic pressure, plasma confinement schemes.

REFERENCE BOOK:

1. Jackson, classical electrodynamics.
2. Rybicki & Lightman: Radiative Processess in Astrophysics
3. Panofsky and Phillips: Classical electricity and magnetism.
4. Bittencourt, Plasma physics.
5. Chen: Plasma physics.

Paper - IV: ELECTRONICS

Unit-I

Operational Amplifier- Basic Op. Amp. Differential amplifier, the emitter coupled Difference Ampl, Transfer characteristics of a Diff. Ampl., an example of an IC Op.-Amp., offset error voltage and currents, measurement of Op.-Amp. Parameters, frequency response of Op-amp. Linear analog systems: Basic Op.-Amp. Applications, Analog integration and differentiation, Electronic analog computation, Non-linear analog systems: Comparators, Waveform generators.

Unit-II

Combinational Logic –Basic logic gates: OR, AND and NOT gates, NOR and NAND gates, Boolean algebra, De Morgan's theorems, exclusive OR gate, Latch, multiplexer, Demultiplexer, decoder, characteristics of logic families, saturated logic families: RTL, DCTL, non-saturated logic families: TTL and ECL, Unipolar logic families.

Unit -III

Sequential Logic, Flip-flops: RS Flip-flop, level clocking, Edge triggered Flip Flops, D Flip flops. JK Flip-flops, J.K.master slave Flip-flops, Registers: buffer, shift and control shift registers, counters: ripple synchronous & ring counters, tri-state registers, Buffer: controlled buffer Register, Bus organized structure, ALU Memories: RAM, ROM, PROM, EPROM, A/D and D/A converters.

Unit-IV

Microprocessors – Building concept of microprocessors, developing inside of microprocessor, Instruction codes, Instruction Register, Introducing RESET Pin, Introducing on chip oscillator, Interfacing I/O devices, Introducing Interrupt lines: Stack, Push, Pop operation, delay in servicing interrupts, multiply interrupts, location for interrupts. Introducing slow and fast data transfer, Status of microprocessor, interrupt pins, General purpose Register, flag Register, Increment/decrement register. Features of 8085 microprossor. Pin diagram of 8085, block diagram of 8085. CPU of a microprocessor, timing and control, system timings and interrupt timings of 8085, registers in 8085, interfacing memory and I/O devices- a preliminary idea. Number system, Floating Point notation.

Unit – V

Instructions set of 8085, types of instructions- Data transfer group, Arithmetic logic, branch group, stack I/O machine control group, addressing mode of Intel 8085, examples of Assembly language programs of 8085, summing of two 8-bit numbers to result a 16-bit number, summing two 16-bit number, multiplying two 8-bit number to result a 16-bit product, block transfer of data from one memory block to other, BCD to hexadecimal data, finding the largest number in a series.

Text and reference books

1. Integrated Electronics: J.Millman R.C.C.Halkias.
2. Electronics devices and circuit theory, by Robert Boylested and Louis Nashdaky

PHI, New Delhi-110001, 1991.
3. Operational amplifier linear integrated circuits, by Romakanth A. Gayakwad PHI, second edition 1991.
4. Digital computer electronics- An introduction to microcomputers-A.P.Malvino.
5. Digital finances and applications, by A.P. Malvino and Donald P.Leach, Tata McGraw Hill company, New Delhi 1993.
6. Microprocessor architecture, programming applications with 8085/8086 by Ramesh S.Gaonkar, Willey-Eastern limited 1987.
7. Introduction to microprocessors – A.P.Mathur (Tata McGraw).
8. Microprocessors-Theory and applications- M.Hafiquizzaman (Prentice hall).
9. Microprocessors fundamentals- Schanmi Outling Service Author Pocer L.Tokheim.
10. Integrated circuits : K KBotkar(Khanna publications)
11. Digital Electronics : R P Jain (Tata McGraw Hill)
12. Microprocesss : B Ram
13. 8-bit microprocessor : V.J.Vibhute & P.B. Borole(Tecn-Max Publication, Pune)

Laboratory Course I-A: General & Optics (Any ten)

1. Determination of band gap of semiconductor by four probe method.
2. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration.
3. Determination of wavelength of mercury light by constant deviation spectrometer using Hartmann formula.
4. Ultrasonic velocity in a liquid as a function of temperature using ultrasonic interferometer.
5. Experiment on transmission line (A) Determination of characteristics impedance, (B) Study of voltage distribution.
6. Determination of the Curie temperature of ferromagnetic material.
7. Determination of forbidden gap of a diode by plotting reverse saturation current as a function of temperature.
8. Determination of operating voltage and study the characteristics of a GM tube.
9. Determination of operating voltage of a GM tube and determine the linear absorption coefficient.
10. Determination of operating voltage of a GM tube and verify inverse-square law.
11. Determination of short half life of a given source which can be obtained from a mini generator or produced with a neutron source by activation.
12. X-ray diffraction by Telexometer.
13. Determination of ionization potential of Lithium/Mercury.
14. Determination of e/m of electron by Normal Zeeman Effect using Febry -Perot Etalon.
15. Determination of Dissociation energy of iodine (I_2) Molecule by photography, the absorption bands of I_2 in the visible region.
16. Measurement of wavelength of He-Ne Laser light using a ruler and thickness of thin wire by the laser.
17. To study Faraday Effect using He-Ne Laser.

Laboratory Course I-B: Electronics-I (Any ten)

1. Study of Differential Amplifier.
2. Basic Logic gates and verification of their Truth- Tables.
3. Combinational logic gates and verification of De-Morgan's Theorem.
4. Study of Op-Amp.-IC-741 is inverting/ Non inverting amplifier and draw frequency response curve.
5. Construction of Schmitt triggers using IC-741 and study of its characteristics.
6. Study of Astable and monostable Multi Vibrator using IC 555.
7. Digital electronics experiments on bread board using IC-7400.
8. Study of R-S, D/T, J-K Flip-Flops.
9. Study of counters: Ripple, Mode 3, Mode 5 counters.
10. Study of Shift Register.
11. Study of R-2R D/A Converter.
12. Study of Random Access Memory (RAM) Read Only Memory. (ROM)
13. Study of A/D Converter.

14. Study of adder/Subractor.

Semester – II

PAPER - I : QUANTUM MECHANICS-I

Unit - I

Inadequacy of classical mechanics, Plank quantum hypothesis and radiation law, Photoelectric effect, de-broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, general formalism of wave mechanics, representation of states and dynamical variables, stationary states, one-dimensional problems; walls and barriers, Schrödinger equation for harmonic oscillator and its solution.

Unit –II

Superposition principle, uncertainty relations, states with minimum uncertainty product, commutation relationship, completeness and normalization of eigen functions, Dirac-delta function, Bra & Ket notation, matrix representation of an operator, harmonic oscillator and its solution by matrix method, Heisenberg equation of motion.

Unit -III

Angular momentum in quantum mechanics, commutation relationships, eigen values, Spin angular momentum, Pauli`s matrices, addition of angular momentum, Clebsch-Gordon coefficients.

Unit – IV

Central force problem, spherically symmetric potentials in three dimensions, separation of wave equation, parity, three-dimensional square-well potential and energy levels, the hydrogen atom; solution of the radial equation, energy levels and stationery state wave functions, discussion of bound states, degeneracy.

Unit –V

Time- independent perturbation theory, non-degenerate case, first order and second perturbations with the example of an oscillator, degenerate cases, removal of degeneracy in second order, Zeeman effect without electron spin, first-order Stark effect in hydrogen, perturbed energy levels, correct eigen function, occurrence of permanent electric dipole moments.

TEXT AND REFERENCE BOOKS:

1. L.I. Schiff: quantum mechanics (McGraw-Hill).
2. S.Gasiorowicz, Quantum Physics (Wiley).
3. Landau and Lifshitz : Non-relativistic quantum mechanics.
4. B.Craseman and Z.D.Powell: quantum mechanics (Addison Wesley)
5. A.P. Messiah: Quantum Mechanics.
6. J.J. Sakurai : Modern Quantum Mechanics.
7. Mathews and Venkatesan : Quantum Mechanics.

PAPER – II: STATISTICAL MECHANICS

Unit-I

Foundation of statistical mechanics : macroscopic and microscopic states, contact between statistics and thermodynamics, physical significance of Ω(N, V, E), the classical gas, entropy of mixing and Gibb's paradox, phase space of classical system, Liouville`s theorem and its consequences, quantum states and phase space.

Unit- II

Elements of ensemble theory – A system in microcanonical, canonical, and grand canonical ensembles, partition functions, physical significance of statistical quantities, example of classical system, energy and energy-density fluctuations and mutual correspondence of various ensembles.

Unit -III

Formulation of quantum statistics – Quantum mechanical ensemble theory, density matrix, statistics of various quantum mechanical ensembles, system composed of indistinguishable particles.

Theory of simple gases –Ideal gas in various quantum mechanical ensemble, Maxwell-Boltzmann, Bose-Einstein, Fermi-Dirac distributions, statistics of occupation number.

Unit - IV

Ideal Bose and Fermi gases -Thermodynamic behavior of an ideal Bose gas, Bose-Einstein condensation and, elementary excitations in liquid helium II, Thermodynamic behavior of an ideal Fermi gas, the electron gas, nonrelativistic and relativistic degenerate electron gas, theory of white dwarf stars.

Unit -V

Statistical Mechanics of interacting systems – the method of cluster expansion for a classical gas, Virial expansion of the equation of state. Theory of phase transition – general remark on the problem of condensation, Fluctuations: thermodynamic fluctuations, Spatial correlation in a fluid Brownian motion: Einstein Smoluchowski theory of Brownian motion.

TEXT & REFERENCE BOOKS –

1. R. K. Pathria, Statistical Mechanics (Pergamon Press).
2. L. D. Landau & E. M. Lifshitz (Butter worth and Heinemann Press).
3. Federick Reif, Fundamental of statistical and thermal physics (McGraw-Hill publishers).
4. Kerson Huang, Statistical Mechanics (Wiley Eastern).

PAPER –III: ELECTRONIC & PHOTONIC DEVICES AND OPTICAL MODULATORS

Unit – I

Special Bipolar devices: Thyristors- the four-layer diodes and their basic characteristics, Shockley diode, three terminal Thyristor, Diac & Triac, SCR, UJT, Field controlled Thyristors.

Unit- II

Unipolar Devices : JFET, MESFET and MOSFET, basic structure, working and device I-V characteristics, small signal equivalent circuit for Microwave performance Introduction to MIS and MOS diodes, charge coupled devices (CCDs), basic structure and working principle , MOSFET-basic device characteristics, types of MOSFET.

Unit-III

Special Microwave Devices: Tunnel diode and backward diode- basic device characteristics, IMPATT diodes and their static and dynamic characteristics, Transfer electron devices- transferred electron effect, Gunn diodes.

Unit-IV*

Photonic Devices : Radiative transitions, LEDs, Visible and infrared SC lasers; Photo detectors; Photo conductor, & Photodiode, Solar cells, Solar radiation and ideal conversion efficiency, p-n junction solar cells, Hetero junction. Interface thin film solar cells.

Unit –V*

Optical Modulators and Liquid Crystal Displays: Modulation of light- Birefringence, Optical activity, Electro-optic, Magneto-optic and Acoustic- optic effects, Materials exhibiting these properties, Non-linear optics. Liquid crystal displays: The Liquid crystal, Various LCD modes of operation, Principle of operation of Twisted Nematic LCD, Operating Characteristics of LCD, Liquid Crystal Materials, and Construction of LCD.

Cross cutting issues- ***Professional Ethics**

TEXT & REFERENCE BOOKS-

1. Semiconductor Devices – Physics and Technology, by S M Sze ,Wiley (1985)
2. Introduction to semiconductor device, M.S. Tyasi, John Wiley and sons
3. Measurement, Instrumentation and experimental design in physics and engineering by M.Sayer and A.Mansingh, Prentice Hall India 2000
4. Optical electronics by Ajay Ghatak and K.Thyagarajah, Cam.Univ. Press.
5. Opto electronics – An introduction: J.Wilson and JFB Hawkes (Eastern Economy Edition).
6. Optical Communications: J.H. Franz and V.K. Jain (Narosa).

7. Integrated Circuits : K. R. Botkar, Khanna Publishers.

PAPER – IV: Computational Physics & Computer Programming

Unit –I

Methods for determination of zeroes of linear and nonlinear algebraic equations and transcendental equations, convergence of solutions. Solution of simultaneous linear equations, Gaussian elimination, pivoting, iterative method, matrix inversion.

Unit –II

Finite differences, interpolation with equally spaced and unevenly spaced points, curve fitting, polynomial least squares and cubic spline fitting. Numerical differentiation and integration, Newton-Cotes formulae, error estimates, Gauss method.

Unit –III

Numerical solution of ordinary differential equations, Euler and Runga-Kutta methods, predictor-corrector method, elementary ideas of solutions of partial differential equations.

Unit- IV

Elementary information about digital computer principles, compilers, interpreters and operating systems(Windows/Linux) Fortran programming, flow charts, integers and floating point arithmetic, expressions, built in functions.

Unit-V

Executable and non-executable statements, assignments, control and input-output statements, subroutines and functions; The statement functions, main features of functions and subroutines ,subprogram, function subprogram, overall structure of FORTRAN programe, external statement, subroutine subprogram ,common statement, equivalence statement, operations with files-open and close statement, Format statements, field specifications.

TEXT AND REFERENCE BOOKS

1. Sastry: Introductory Methods of Numerical Analysis.
2. Rajaraman: Numerical Analysis.
3. Antia: Numerical methods.
4. Raja Raman: FORTRAN programming.

Laboratory Course II-A: Numerical Analysis & Computer Programming (Any ten)

1. To solve simultaneous Linear equation by Gauss Elimination method.
2. To calculate the root of a transcendental equation by Newton – Raphsons method.
3. Solving the system of linear simultaneous equation by Gauss Serdel method.
4. Numerical Integration by Simpson's 1/3 Rule.
5. Solving simultaneous Linear equation by Gauss-Jordon method.
6. Solution of Differential equation by Euler's Method.
7. To invert a given matrix by Gauss-Jordon Method.
8. Solution of Differential equation by Runga Kutte Method.
9. To fit the given data in a straight line by linear regression Method.
   a) WAP to find the Largest of n number of series.
   b) To calculate the standard deviation of a given set of data.
10. To write a program to compute the complex roots of a given polynomial of N^{th} degree by Grafffe's Method.
11. To write a program to compute the Eigen values of a given matrix.
12. To integrate a given function by: (a) Trapezoidal method or by (b) Gauss Quadrature.
13. To find solutions of Ist order, ordinary differential equation by Taylor method

Laboratory Course II-B: Electronics-II (Any ten)

1. Design & Study of Regulated Power supply.
2. Study of Transistor Amplifiers in CE, CB, and CC modes.
3. Study of Transistor Bias Stability.
4. Study of Astable, Monostable and Bistable Multivibrator.
5. Experiment of Uni – Junction Transistor and its application.
6. Experiment of FET and MOSFET characterization and application as an amplifier.
7. Experiment with Microprocessor:- I
   (a) Convert BCD in to HEXADECIMPL
   (b) To transfer group of date blocks from one location to another location.
8. Experiment with microprocessor: - II
   (a) To write programs for addition of two 1 byte data giving results of 2 bytes.
   (b) To write programs for multiplication of two 1 byte data giving results of 2 bytes.
9. (a) To add 2 16-BIT numbers stored in locations from x x x x to x x x x + 3 and add them store the results from x x x x + 4 to x x x x+6 memory location
   (b) To find the largest of n numbers of a series.
10. To arrange N numbers in an ascending orders.
11. Experiments with Microprocessor.
    (a) Convert BCD in to binary and vice-versa.
    (b) To transfer group of data blocks from one location to another location.
    (c) To write programs for addition of two 1byte data giving result of 2byte data

(d) To write programs for multiplication of two 1 byte data giving result of 2byte data.

12. Logic gate study DTL and RTL.
13. Study of Silicon Controlled Rectifier.

SCHEME OF EXAMINATION
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SYLLABUS
of
M.Sc. (PHYSICS)
UNDER

FACULTY OF SCIENCE

Approved by Board of Studies in Physics

EFFECTIVE FROM JULY 2022

School of Studies in Physics & Astrophysics
Pt. Ravishankar Shukla University
Raipur (C.G.) 492010
PH: - 0771-2262864
WEBSITE: -www.prsu.ac.in

Approved by Board of Studies in Physics on 27, April 2022
PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR

M. Sc. - PHYSICS

M.Sc. in Physics is a full time 2-year (4-semesters course). There will be four theory papers in each semester, two laboratory courses in semester I, II, III and one project in semester IV. In each semester, there will be two internal examinations/assessments. Semester-wise course structure along with distribution of marks is given below:

Semester III

Name of the Paper	Marks					Credits
	Theory		Internal		Total	
	Max	Min	Max	Min		
1. Quantum Mechanics-II	80	16	20	04	100	4
2. Atomic & Molecular Physics	80	16	20	04	100	4
3. Solid State Physics-I	80	16	20	04	100	4
4. (A) Astronomy & Astrophysics-I (B) Electronics (Communication)-I (C) ***Physics of Nano-materials-I** (only for UTD) (D) Space Physics-I	80	16	20	04	100	4
Laboratory Course III-A Materials Science & General	-		-		100	2
Laboratory Course III-B : Astronomy & Astrophysics **OR** : Electronics (Communication) **OR** : ***Physics of Nano-materials OR** : Space Physics	-		-		100	2
Total Marks					600	20

Total Marks for Semester III = 600 & Credit = 20

Semester IV

Name of the Paper	Marks					Credits
	Theory		Internal		Total	
	Max	Min	Max	Min		
1. Nuclear & Particle Physics	80	16	20	04	100	4
2. Laser Physics and Applications	80	16	20	04	100	4
3. Solid State Physics -II	80	16	20	04	100	4
4. (A) Astronomy & Astrophysics-II (B) Electronics (Communication)-II (C) Physics of Nano-materials-II (only for UTD) (D) Space Physics-II	80	16	20	04	100	4
Project Work	-		-		200	4
Total Marks					600	20

Total Marks for Semester IV = 600 & Credit = 20

***Physics of Nano Materials: This paper is run under the DST FIST program awarded to the SoS in Physics and Astrophysics, hence only students of University Teaching Department can opt the special paper. College students are not allowed to opt this special paper because of lack of advance instrumentation facilities.**

In Each Semester

MAXIMUM MARKS TOTAL	PASS PER TH.	PR.
600	**36**	**36**

In semester IV, Project work in Solid State Physics/ Astronomy & Astrophysics/ Electronics/ Physics of Nano-materials/ Space Physics will lead to specialization in the respective area. It will be primarily based on research oriented topics. On completion of the project, student will submit project report in the form of dissertation which will be examined by an external examiner. The examination of project work shall consist of (a) Presentation and (b) comprehensive viva-voce.

Marks-distribution for Laboratory Courses and Project Work:

(a) Laboratory courses (Semesters I-III):

Sessional : 20 Marks
Viva : 20 Marks
Experiment : 60 Marks

(b) Project Work (Semester IV) :

Report – Dissertation : 60 Marks
Presentation : 100 Marks
Comprehensive viva-voce : 20 Marks
Internal assessment : 20 Marks

Note: Paper IV of both Semesters III and IV is a major elective course. Student has to opt for any one of the courses: (A) or (B) or (C) or (D). The commencement of any one of the major elective paper is subjected to the availability of basic infrastructural facilities viz. expert faculty, laboratory etc.

Detailed Course Content

Semester – III

PAPER –I: QUANTUM MECHANICS -II

Unit-I

Variation method, expectation value of energy, application to excited states, ground state of He-atom, Zero point energy of one dimensional harmonic oscillator, Vander-waals interaction, the W.K.B. approximation, approximate solutions, asymptotic nature of the solution, solution near turning point, connection formulae, energy levels of a potential well and quantization rule.

Unit -II

Theory of scattering: differential and total scattering cross section, wave mechanical picture of scattering & the scattering amplitude, Green's functions and formal expression for scattering amplitude, The Born approximation and its validity, Partial wave analysis, asymptomatic behavior of partial waves and phase shifts, optical theorem, scattering by a square well potential, scattering by a hard sphere, scattering by a Coulomb potential..

Unit – III

Time-dependent perturbation theory, first order perturbation, Harmonic perturbation, Fermi`s Golden rule, Ionization of a H-atom, absorption and induced emission, Selection rules. Identical particles, symmetric and anti symmetric wave functions

Unit –IV

Relativistic quantum mechanics, formulation of relativistic quantum theory, the Klein-Gordon equation; plane wave solutions, charge and current densities, The Dirac equation for a free particle, matrices alpha and beta, Lorentz covariance of the Dirac equation, free particle solutions and the energy spectrum, charge and current densities.

Unit-V

The spin of the Dirac particle, Dirac particle in electromagnetic fields and the significance of the negative energy state, Dirac equation for a central field : Spin angular momentum, approximate reduction, spin –orbit energy, separation of equation, the hydrogen atom, classification of energy levels and negative energy states.

TEXT AND REFERENCE BOOKS –

1. L.I. Schiff: Quantum Mechanics (McGraw-Hill).
2. S.Gasiorowicz: Quantum Physics (Wiley).
3. Landau and Lifshitz : Quantum Mechanics.
4. B.Craseman and Z.D.Powell : Quantum Mechanics (Addison Wesley)
5. A.P. Messiah: Quantum Mechanics.
6. J.J. Sakurai: Modern Quantum Mechanics.
7. Mathews and Venkatesan: Quantum Mechanics.
8. Bjorken and Drell : Relativstic Quantum Mechanics.

PAPER –II: ATOMIC AND MOLECULAR PHYSICS

Unit-I

Quantum states of one electron atoms-atomic orbitals, Hydrogen spectrum, spin- orbit(l-s) interaction energy, fine structure of hydrogen spectrum including l-s interaction and relativistic correction, spectra of alkali elements, fine structure in alkali spectra, penetrating and non-penetrating orbits, Selection rules, intensity rules.

Unit-II

Pauli's principle, equivalent and non-equivalent electrons, ground state (basic level of different elements), two electron systems, interaction energy in L-S and J-J. Coupling, Hyperfine structure, line broadening mechanisms (general ideas).

Unit–III

Normal and anomalous Zeeman effect, early discoveries and developments, vector models of one electron system in a weak magnetic field, magnetic moment of a bound electron, magnetic interaction energy, selection rules, intensity rules, Paschen-Back (PB) effect – principal series effect, Zeeman and PB effects in hydrogen, Stark effect-discovery, Stark effect in Hydrogen, orbital model, weak and strong effect in Hydrogen.

Unit-IV

Types of molecules: linear diatomic molecules, symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules: rigid rotator model, energy levels, selection rule, spectrum, comparison with observed spectrum and non-rigid rotator model, Intensities of spectral lines, microwave spectrometer, Raman spectrum; classical and quantum theory of Raman Effect, pure rotational Raman spectrum.

Unit-V

Vibrational spectra of diatomic molecules: simple harmonic model, energy levels and spectrum, comparison with observed spectrum and anhormonic model, Vibrating rotators, Interaction of rotations and vibrations, fine structures and P-Q-R branches, IR spectrometer, Vibrational Raman spectrum, Vibrational rotational Raman spectrum.

TEXT AND REFERENCE BOOKS:

1. Introduction to atomic spectra - H.E. White (T).
2. Fundamentals of molecular spectroscopy – C.N. Banwell and E.M McCash (T).
3. Spectroscopy vol. I, II and III – Walker and straughner.
4. Introduction to Molecular spectroscopy – G.M. Barrow.
5. Spectra of diatomic molecules – Herzberg.
6. Molecular spectroscopy – Jeanne L.Mc-Hale.
7. Molecular spectroscopy – J.M. Brown.
8. Spectra of atoms and molecules –P.F.Bemath.
9. Modern spectroscopy, J.M. Hollas.

PAPER – III: SOLID STATE PHYSICS-I

Unit- I: Electrons in Solids and Electronic Properties

Energy bands: nearly free electron model, origin of energy gap and its magnitude, Bloch function, Kronig-Penny model, Wave equation of electron in periodic potential, restatement of Bloch theorem, crystal moment of an electron, solution of Central equation, Kronig-Penny model in reciprocal space, empty lattice Approximation, approximate solution near zone boundary, Number of orbitals in a band, metals and insulators.

Unit -II: Fermi surfaces and metals

Effect of temperature on F-D distribution, free electron gas in three dimension. Different zone schemes, reduced and periodic zones, construction of Fermi surfaces, nearly free electrons, electron, hole, open orbits, Calculation of energy bands, Tight binding, Wigner-Seitz, cohesive energy, pseudo potential methods. Experimental methods in Fermi surface studies, quantization of orbits in a magnetic field, de Haas van Alphen Effect, External orbits, Fermi surface of copper.

Unit- III: Crystal vibration and thermal properties

Lattice dynamics in monoatomic and diatomic lattice: two atoms per primitive basis, optical and acoustic modes, quantization of elastic waves, phonon momentum, inelastic neutron scattering by phonons, Anharmonic crystal interactions-thermal expansion, thermal conductivity, thermal resistivity of phonon gas, umklapp processes, imperfections.

Unit –IV: Electron-Phonon interaction- superconductivity

Experimental survey: occurrence of superconductivity, Destruction of superconductivity, Meissner effect, heat capacity, energy gap, MW, and IR properties, isotope effect. Theoretical survey : thermodynamics of superconducting transition, London equation, Coherence length, BCS theory of superconductivity, BCS ground state, flux quantization of superconducting ring, duration of persistent currents, Types of superconductors, Vortex states, Josephson in tunneling superconductor, DC/AC Josephson effect, Macroscopic quantum interference. High temperature superconductors, Hall number, fullerenes ring, applications of superconductors.

Unit – V: Semiconductor crystals

Band gap, equation of motion, physical derivation of equation of motion, holes, effective mass, physical interpretation of effective mass, effective masses of semiconductors Si and Ge, intrinsic carrier concentration, intrinsic mobility, impurity conductivity, donor and acceptor states, thermal ionization of donors and acceptors, thermo-electric effects.

TEXT AND REFERENCE BOOKS

1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons).
2. J.M.Ziman: Principles of theory of solids (Cambridge Univ.Press).
3. Azaroff: X-ray crystallography.
4. Weertman and weertman : Elementary Dislocation Theory.
5. Verma and Srivastava: Crystallography for Solid State Physics.
6. Azeroff and Buerger: The Power Method.

7. Buerger: Crystal Structure Analysis.
8. Thomas: Transmission Electron Microscopy.
9. Omar: Elementary solid state physics.
10. Ashcroft and Mermin: Solid State Physics.
11. Chalking and Lubensky: Principles of Condensed Matter Physics.
12. Madelung: Introduction to solid state theory.
13. Callaway: Quantum theory of solid state physics.
14. Huang: Theoretical Solid State Physics.
15. Kittel: Quantum theory of solids.

PAPER –IV (A): ASTRONOMY AND ASTROPHYSICS-I

Unit – I

Stars-apparent magnitudes, Colour index, Spectral classification, Stellar distances, Absolute magnitude, The H-R diagram of stars.

Stellar interiors: The basic equations of stellar structure, Hydrostatic equilibrium, Thermal equilibrium, Virial Theorem, Energy sources, Energy transport by radiation and convection, Equation of state

Unit – II

Formation and evolution of stars: Inter stellar dust and gas, Formation of protostars, Pre-main sequence evolution, Post main sequence evolution and Evolution on the main sequence for low and high mass stars, Late stages of evolution, Fate of massive stars, Supernovae and its characteristics.

Unit – III

End states of stars, Electron degeneracy pressure, White dwarfs, and Chandrasekhar limit, Neutron stars and Pulsars, Black holes.

Binary stars and their classification, close binaries, Roche Lobes, Evolution of semidetached systems: Algols, Cataclysmic variables and X-ray binaries.

Unit– IV

Solar Physics: Physical Characteristics of sun, Photosphere: Limb darkening, Granulation, Faculae, Solar Chromosphere and Corona, Prominences, Solar Cycle and Sunspots, Solar Magnetic Fields, Theory of Sunspots, Solar flares, solar wind, Helioseismology.

Unit – V

Kepler's law and its implication to Binary Stars, Doppler Effect and its use in velocity measurement e.g. rotation of Saturn and its Ring, determination of velocity of galaxies, Hubble's law and Age of the Universe, Star clusters, HR diagram of star clusters, distance and age determination through HR diagram. Variable stars, Cepheid Variables, Period Luminosity relation and Distance measurement. Period, dispersion and distance of the Pulsars. Photometer and photoelectric photometry.

TEXT AND REFERENCE BOOKS:

1. Astrophysics for Physicists, Arnab Rai Choudhuri, Camb. University Press, 2010.
2. Astrophysics : Stars and Galaxies, K.D. Abhayankar, Universities Press (India) Ltd, 2001.

3. An Introduction to Astrophysics, Baidyanath Basu, PHI, 2010.
4. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey, 2007.
5. Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th ed., Saunders College Publishing, 1998.
6. The Physical Universe: An introduction to astronomy, F.Shu, University Science Books 1982.
7. Textbook of astronomy and astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publishing House, 2000.
8. The new cosmos, A.Unsold and B. Baschek, Newyork, Springer 2002.
9. Theoretical Astrophysics, vol. I: Astrophysical Processes T. Padmanabhan, Cambridge University Press, 2000.
10. Theoretical Astrophysics, vol. – II: Stars and stellar systems, T. Padmanabhan, Cambridge University Press 2001.
11. A Workbook for Astronomy, Jerry Waxman, Cambridge University Press, 1984.

Paper – IV (B) ELECTRONICS (Communication)-I

Unit I Microwave devices

Klystron, magnetron & traveling wave tubes, velocity modulation, basic principal of two cavity klystrons & relex klystrons, principle of operation of magnetrons, helix traveling wave tubes.

Unit II Waveguides

Rectangular waveguide, circular waveguide, dielectric slab waveguide surface guided waves, TE and TM modes, waveguide components. solution of wave equation in cylindrical, rectangular coordinates.

Unit-III Wireless Communication

Fundamental concepts in wireless, Basic Terminologies, cellular technology, Standards evolved, Mobile Radio Propagation, Mobile System and Network Architectures, Advanced Wireless IP network Architectures, Wireless Standards.

Antennas: Antenna parameters, radiation from simple dipole and aperture, concept of antenna arrays, end fire and broadside arrays, horn antenna, microstrip antenna, parabolic disc antenna. Ground wave, space wave and ionospheric propagation.

Unit-IV Radar system and Radar Communication

Radar block diagram & operation, radar frequencies, pulse consideration, Continuous and pulse Radar system, Radar performance factors, Radar Transmitting systems, Radar waveform range determination, Radar Antenna Duplexer, Radar receiver, Automatic tracking Radar, Doopler effect in Radar. Radar cross sections, pulse reflections frequency, antenna, parameters, systems losses & propagation losses, radars transmitters receivers.

Unit V Satellite Communication:

Radiation and propagation of waves: fundamental of EM waves and their effects ground, sky and space waves propagation, Orbital Satellite, geostationary satellite, orbital patterns, look angles, orbital spacing, satellite system, link modules Orbits and Launching Methods, Satellite Services.

REFERENCE BOOKS

1) "Microwaves" by K.L. Gupta Wiley Estern Ltd. Delhi.
2) Advanced Electronic communication system by Wayne Tomsi Physics education.
3) Principle of communication of system-by Toub & Schilling: 2nd ed. TMH 1994
4) Communication system: by Siman Haykin, 3rd ed. John wiley & sons inc.1994.
5) Microwave devices & circuits by: Samuel, Y. Liau.
6) Electronic communication: George kennedy.
7) Digital and Analog Communication Systems, by Sanjay sharma 8ed, 2013
8) N. Narayan Rao, Elements of Engineering Electromagnetics, Pearson Education (2006)
9) Electromagnetic Wave and Radiating System, Jordan and Balmain, Prentice Hall (1979)
10) Rappaport, T.S., "Wireless Communications", Principles and Practice, Prentice Hall, NJ, 1996.
11) William Stallings, "Wireless Communication and Networking", Pearson Education, 2002.
12) Siegmund M. Redl, Mathias K. Weber, Malcolm W. Oliphant, "An Introduction to GSM", Artech House Publishers, 1995.
13) Kraus, J.D., "Antennas", II Edition, John Wiley and Sons, NY, 1977.
14) Collin, R.E. and Zucker, F., - "Antenna theory: Part I", Tata McGraw Hill, NY, 1969
15) Modern Electric Communication: Miller.
16) Electronics Communication: Raddv . G. and Collen .J.
17) Electronic Fundamental & Application: Kennedy
18) Electronics communication: Sanjeeva Gupta
19) Dennis Roddy, "Satellite Communications", McGraw Hill, 1996.
20) Tri.T.Ha, "Digital Satellite Communications", Mcmillan Publishing Company, 1986.
21) Dr.D.C. Agarwal, "Satellite Communications", Khanna Publishers, 2001.
22) Trimothy Pratt, Charles W. Bostian, "Satellite Communications", John Wiley & Sons, 198

Paper IV (C) PHYSICS OF NANO MATERIALS - I

Unit I: Nano Materials

Properties of Nano-Particles: Metal nano-clusters, theoretical modeling of nanoparticles, geometric and electronic structure, magnetic clusters, Semiconductor nanoparticles, optical properties, rare gas and molecular clusters, Bulk nano-structured materials: Solid disordered nanostructures, methods of synthesis, properties,nano-cluster composite glasses, porous silicon, nano structured crystals.

UNIT II: Carbon Nano Tubes (CNTs)

Nature of carbon bonds, different allotropies of carbon, structure and properties of C_{60}, graphene, carbon nanotubes and its types, laser vaporization techniques, arc discharge method and chemical deposition technique, purification techniques, Properties of Carbon Nanotubes and Graphene: Optical, electrical, electronic, mechanical, thermal, optical, and

vibrational properties.

UNIT III: Synthesis of Nano- Materials

Top-down & Bottom-up approaches: Formation of nanostructures by mechanical milling (ball milling) and mechanical attrition, Chemical Vapor Deposition (CVD), Physical Vapour Deposition (PVD), thermal and e beam evaporation, Pulsed Laser Ablation (PLD).

Chemical Routes for synthesis of Nanomaterials:Chemical precipitation and co-precipitation, chemical bath deposition (CBD), Sol-gel synthesis, Microemulsions or reverse micelles, Solvothermal synthesis, Thermolysis routes and spray pyrolysis.

UNIT IV: Characterization of Nano-materials (a)

X-ray Diffraction (XRD), powder and single crystal Diffraction, X-ray fluorescence (XRF), X ray photoelectron spectroscopy (XPS), Energy Dispersive X-ray analysis (EDAX), Extended X ray absorption and fluorescence spectroscopy (EXAFS), Dispersive high pressure XRD and Diamond anvil cells (DAC).

Nuclear Magnetic Resonance (NMR) and Raman spectroscopy: description and analysis. Surface analysis methods: Secondary ion mass spectroscopy (SIMS), Auger Electron Spectroscopy, ESCA, Deep Level Transient Spectroscopy (DL TS), Thermo Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis.

UNIT V: Characterization of Nano-materials (b)

Scanning Tunneling Microscopy (STM), Contact and non contact Atomic Force Microscopy (AFM), Magnetic Force Microscopy (MFM), Nano indentation. Scanning Electron Microscopy (SEM), Transmission electron microscopy (TEM), High resolution TEM Field emission SEM, Electron Energy Loss Spectroscopy (EELS).

Spectrophotometry: UV-Vis spectrophotometers, IR spectrophotometers, Fourier Transform Infrared Radiation (FTIR), Photoluminescence (PL), electroluminesce and thermoluminescence spectroscopy, Near-field Scanning Optical Microscopy (NSOM).

References

1. Nano materials: Synthesis properties ,characterization and application: A.S Edelstein and R.C Cammaratra
2. Introduction to Nanotechnology: Charles P. Poole Jr and Franks J. Qwens
3. Nanotechnology, Kohlr, Michael.
4. Nanoelectronics and Nanosystems , Karl Goser, Peter Glosekotter, Jan Dienstuhl., Springer, 2004
5. Handbook of Analytical instruments, R.S. Khandpur
6. X-ray diffraction procedures, H. P. Klung and L.E.Alexander
7. The Powder Method IV. Azaroff and M. J. Buerger
8. Elements of X-ray diffraction, B. D.Cullity
9. Differential Thermal Analysis, R.C.Mackenzie
10. Thermal Methods of Analysis, W.W.Wendlandt
11. Synthesis, Functionalization and Surface treatment of Nanoparticles :Maric Isbella and Buraton
12. Encyclopedia of Nanotechnology, H.S. Nalwa
13. Nanomaterial Systems Properties and Application, A.S.Eldestein and R.C.Cammarata.
14. Handbook of Nanotechnology: Bhushan (Ed), Springer Verlag, New York (2004).
15. Nanostructures and Nanomaterials- Synthesis properties and Applications by Guozhong Cao (Empirical College Press World Scientific Pub., 2004).
16. Nanocomposite Science and Technology, Ajayan, Schadler and Braun

17. Fullerene & Carbon nanotubes, Dressel Shaus
18. Carbon Nanotubes, Elizer
19. Physical properties of CNT, Saito
20. Carbon nanotechnology, Liming Dai
21. Nanotubes and nanowires, CNR Rao and Govindaraj RCS Publishing.
22. Piezoelectric Sensors: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi.
23. Block Copolymers in Nanoscience Massimo Lazzari
24. Supramolecular Chemistry, Jonathan W. Steed, Jerry L. Atwood
25. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
26. Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh, CRC press, 2007.
27. Nanosystem characterization tools in the life sciences by Challa Kumar. Wiley-VCH, 2006.
28. Nanolithography M.Gentili et al.(edits),Springer.
29. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
30. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
31. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
32. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca
33. The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation by Dirk Bouwmeester, Artur K. Ekert, Anton Zeilinger
34. Problems And Solutions in Quantum Computing And Quantum Information Yorick Hardy Willi-Hans Steeb

PAPER –IV (D): SPACE PHYSICS - I

Unit I: Solar Physics

Physical Characteristics of sun, Source of solar energy, thermonuclear reaction and building up of higher elements, Description of solar internal and external layers, Photosphere: Limb darkening, Granulation, Faculae, Solar Chromosphere and Corona, Heating of the solar chromosphere and corona, Prominences, Solar Cycle and Sunspots, Solar Magnetic Fields, Theory of Sunspots, Solar flares, Solar wind, Coronal mass ejections, Helioseismology.

Unit II: Planetary System

Solar planetary system, Major characteristics of the Planets, Atmospheric Composition, Planetary magnetism, Magnetic fields, Magnetic dipole, Asteroids, Comets, Extra Solar Planets, Magnetic fields of Extra Solar Planets

Unit III: Celestial Mechanics

Time and Coordinate system: Celestial Sphere, Solar Time, Sidereal Time, Julian Date, Right Ascension and Declination, Azimuth and Elevation, galactic coordinates, WGS 84 coordinate system. GPS – operation, accuracy, time and position information.

Unit IV: Space and Observational tools

Electromagnetic bands of observation: radio, infrared, optical, UV, X-ray and Gamma-ray windows. Ground-based, balloon-borne and satellite-borne telescopes, Resolution of Instruments and Limitations, Optical telescopes, Photometers,

Spectrographs, CCDs, Polarimeters. Radio telescopes - interferometry, X-ray and Gamma-ray detectors, Neutrino and Cosmic Ray astronomy, Radar.

Unit V: Space Missions

Planetary Exploration, Early spacecraft visits to the moon, Unmanned Lunar landers; The Apollo program - man on the moon – instruments and experiments, Lunar structures; Exploration of Mercury, Venus, Mars - the Red Planet – Structure of Mars, Martian atmosphere; ice at the poles, Martian landscapes: linear features, volcanoes, and impact craters; exotic terrains; Study of Planetary moons with space missions, The Cassini-Huygens Mission, The Deep Impact Mission. Search for extra terrestrial life – SETI experiments.

Text and Reference Books

1. Solar System Astrophysics, J. C. Brandt and P. W. Hodge
2. Introduction to Experimental Physics, W. B. Fretter.
3. The Magnetic Field of the Earth, Roland T. Merrill, Michael W. McElhinny, Phillip L. Mcfadden,Academic Press
4. Physics of Geomagnetic Phenomena, Vol. I and II, S. Matsushita. and W. H. Campbell, Academic Press
5. Earth's Magnetospheric Process, Ed. B. M. McCormac, D. Reidel Publishers
6. Physics of the Magnetosphere, Eds. R. L. Corovillano, J. T. McCaulley and H. Radosky, D. Reidel Publishers
7. Solar System Plasma Physics, Vol. I, II and III, Eds. C. F. Kennel, L. J. Lanzenrutti and E. N. Parker
8. Dynamics of the Geomagnetically Trapped Radiation (Physics and Chemistry in Space, Vol II)
9. Solar Terrestrial Physics, Ed. E. R. Dyer, D. Reidel Publishers
10. Solar Magneto–Hydrodynamics, E.R. Priest; D Reidel, 1982
11. R.C. Smith, Observational Astrophysics; CUP, 1995.
12. C.R. Kitchin, Astrophysical Techniques; Adam Hilger, 1984.
13. Digital Image Processing, R. C. Gonzales and R. E. Woods, 2nd Ed, Pearson India, 2002
14. Satellite Meteorology, S. Q. Kidder and T. H. Von der Haar, Academic Press, 1995
15. Lecture Notes on Satellite Meteorology, Vol 1 and 2, SAC, Ahmedabad
16. Remote Sensing and Image Interpretation, T. M. Lillesand and R. W. Kieffer, John Wiley, 2002
17. Fundamentals of Space Systems, V. L. Pisacane and R. C. Moore, Oxford University Press, 1994
18. Fundamentals of Remote Sensing, George Joseph, 2003
19. Processing Remote Sensing Data, M. C. Girgard and C. Girgard, Oxford-IBH, 1999
20. Quantitative Remote Sensing of Land Surfaces, Shunlin Liang, Wiley Interscience, 2004
21. Scale in Remote Sensing and GIS, D. A. Quattrachi and M. F. Goodchild
22. Theory of Satellite Orbits in an Atmosphere, King-Hele Desmond, Butterworths, 1964
23. Uncertainty in Remote Sensing and GIS, Ed: G. M. Foddy and P. M. Atkinson
24. Remote Sensing by George Joseph
25. Concepts in Space Sciences Edited by R.R. Daniel
26. Mathematical Principles of Remote Sensing by A.. Milman
27. An Introduction to Ionosphere and Magnetosphere, J. A. Raticliffe

28. Solar System Astrophysics, J. C. Brandft and P. W. Hodge
29. Plasma Diagnostic Techniques, R. H. Huddlestone and S. L. Leonard
30. Introduction to Experimental Physics, W. B. Fretter
30. High Vacuum Techniques, J. Yarwood
31. Plasma Diagnostics, Vol. I, O. Anciello and D. L. Flamn
32. The Earth's Ionosphere: Plasma Physics and Electrodynamics, Michael C. Kelley, AcademicPress
33. Ionospheric Techniques and Phenomena, A. Giraud and M. Petit, D. Reidel Publish.
34. Physics of Geomagnetic Phenomena, Vol. I and II, S. Matsushita and W. H. Campbell, Academic Press
35. Introduction to Ionospheric Physics, H. Risbeth and H. Garriot, Academic Press
36. Space Weather, Physics and Effects by Volker Bothmer and Loannis.A.Depli Springer
37. Aerospace Environment by T Beer
38. Free flight of a rocket By Gantmaker
39. Orbital Mechanics, Ed. Vladimir A, Chobotov, AIAA Edn Series
39. Introduction to Celestial Mechanics, S. W. McCusky, Addison-Wesley
40. Fundamentals of Astrodynamics, R. R. Bates et al, Dover
41. Orbital Motion, A. E. Roy, Adam Hinglar Ltd
42. Orbital Methods in Astrodynamics, P. R. Escobal, John Wiley
43. Fundmentals of Astrodynamics, R. R. Bates et al, Dover
44. Orbital Motion, A. E. Roy, Adam Hinglar Ltd
45. Design of Orbital Flights, J. Johnson et al., McGraw Hill
46. Modern Astrophyiscs, B. W. Carroll and D. A. Ostlie, Addison -Wesley
47. The Physical Universe, F. Shu, University Science Books
48. The Physics of Astrophysics, Vol. I and II, F. Shu, University Science Books
49. Theoretical Astrophysics, Vol. I, II and III, T. Padmanabhan, Cambridge Uni.Press
50. The Physics of Fluids and Plasmas, Arnab Rai Choudhuri, Cambridge Uni.Press
51. Astrophysical Concepts, M. Harwitt, Springer-Verlag
52. Galactic Astronomy, J. Binney and M. Merrifeld, Princeton University Press
53. Galactic Dynamics, J. Binney and S. Tremaine, Princeton University Press
54. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar, Cambridge University Press
55. An Introduction to Active Galactic Nucleii, B. M. Peterson

Laboratory Course III-A: Materials Science & General

At least ten experiments should be performed from the following list of experiments or parallel level experiment depending upon the facilities available.

1. To determine activation energy of ionic/superionic solid by Temperature depended conductivity measurement.
2. To study Electron Spin(ESR) Resonance in DPPH (Diphenyl Pricyl Hydrazy) sample.
3. To study I-V characteristics of photovoltaic solar cell and find the efficiency.
4. To study the decay of photoconductivity of given sample and find out trap depth.
5. Study of decay of photoluminescence of a given sample.
6. Measurement of electrical conductivity using Impedance Spectroscopy technique.
7. To determine drift velocities of Ag+ ion in AgI from temperature dependence of ionic transference number study.

8. Electrical conductivity of Ball milled/Mechano-chemical synthesized materials.
9. Determination of strength of a given radioactive source.
10. Study of complete spectra of radioactive sources, and study of photo peak efficiency of NaI(Tl) crystal for different energy gamma rays.
11. Structural analysis of powder sample by XRD and particle size determination using Scherrer's formula.
12. FTIR studies of solid samples.
13. Mechanoluminescence of sucrose crystals.
14. Thermoluminescence of irradiated samples.
15. Study of Op-Amp.-IC-741 is inverting/ Non inverting amplifier and draw frequency response curve.
16. Construction of Schmitt triggers using IC-741 and study of its characteristics.
17. Study of Astable and monostable Multi Vibrator using IC 555.
18. Digital electronics experiments on bread board using IC-7400.

Laboratory Course III-B: Astronomy & Astrophysics

1. Study of Quasar.
2. Study of the orbit of a visual binary Star.
3. Determine the mass of Saturn & it's rotational velocity.
4. Verification of Hubble's law and determination of Hubble's constant.
5. Identification of element from Fraunhoffer spectrum of the sun.
6. Study of sun spots.
7. Study of light curves of Cepheid variable stars.
8. Study of Proper motion of stars.
9. Determination of Pulsar period and distance.
10. Photo-electric photometry of Pleiades star cluster.
11. Study of expansion of the universe and calculate the age of the Universe.

OR Laboratory Course III -B: Electronics

(1) Experiments with microprocessor.
   (a)Convert BCD in to binary & vice versa.
   (b) To transfer group of data blocks from one location to another location.
   (c) To write programme for addition & subtraction.
   (d) To write programme for multiplication & division.
(2) Logic gate study DTL & RTL.
(3) To study& verify the Demorgon's Theorem.
(4) Study of Adder/ Subtractor.
(5) Study of Encoder & Decoder.
(6) Study of Multiplexer & Demultiplexer
(7) Study of digital to analog converter.
(8) Study of analog to digital converter.
(9) Study of 4-bit Counter/ ripple Counter.
(10) Study of left/right shift register.
(11) Study of read only memory.
(12) Study of Random Access Memory.
(13) Study of Phase locked loop.

(14) Study of BCD to seven segment Decoder.
(15) Study of modulation & demodulation.
(16) Optical fiber based experiment.
(17) Microwave characterization and measurements.

OR Laboratory Course III -B: Physics of Nano-material

1. Synthesis of II-IV semiconductor nanoparticles by wet chemical method.
2. Synthesis of nanoparticles (ZrO_2) by Combustion method.
3. Synthesis of nanoparticles by Sol-gel method.
4. Synthesis of nanoparticles by Ball milling method.
5. Synthesis of Quantum cells structures using vacuum coating unit.
6. Synthesis of nanoparticles using Solid state reaction method.
7. Measurement of band gap energy and size of the nano particle of II-IV semiconductor using absorption spectrophotometer.
8. To make the peak analysis of IR transmission spectra of nanoparticle using FTIR spectrometer.
9. Study of effect of capping agent on the size of the nanoparticle during synthesis.
10. To determine the average particle size of nano materials by XRD using Sherer's formula.
11. To determine the Hall coefficient and carrier type for a semiconducting nanoparticles.
12. To determine the Band gap of a given semiconductor using Four probe method from room temperature to 100°C.
13. To determine the average size of naonparticles using Zetasizer.
14. To measure the change of dielectric constant and dielectric loss of nanoparticle with the change of signal frequency by impedance analyzer.
15. To characterize the mechanical properties by tensile testing.
16. To estimate the particle size by SEM.
17. To perform electron diffraction analysis from TEM image.
18. To do roughness analysis of nanostructured sample using AFM.

OR Laboratory Course III -B: Space Physics

1. The flow of energy out of the Sun.
2. Study of Sun-spot.
3. Astrometry of asteroids.
4. Study of expansion of the universe and calculate the age of the Universe.
5. Identification of element from Fraunhoffer spectrum of the sun.
7. The transit of Venus and Murcury.
8. Jupiter's Moon and speed of light.
9. Determination of Pulsar period and distance.
10. Photo-electric photometry of Pleiades star cluster.
11. The large scale structure of the Universe.

Semester – IV

PAPER – I: NUCLEAR AND PARTICLE PHYSICS

Unit-I Nuclear Interactions

Nucleon-nucleon interaction, Two-nucleon system, The ground state of the deuteron, Tensor forces, Nucleon-nucleon scattering at low energy, Scattering length, Effective range theory, Spin dependence of nuclear forces, Charge independence and charge symmetry of nuclear forces, Iso-spin formalism, Exchange forces, Meson theory of nuclear forces and the Yukawa interaction.

Unit-II Nuclear Reactions

Reaction energetics: Q-equation and threshold energies, Reactions cross sections, Resonance: Breit-Wigner single-level formula, Direct and compound nuclear reactions, Formal reaction theory: Partial wave approach and phase shifts, Scattering matrix, Reciprocity theorem,

Unit-III Nuclear Decay

Beta decay, Shape of the beta spectrum and problems in conservation laws, Pauli's neutrino hypothesis, Femi's theory of beta decay, Total decay rate, Angular momentum and parity selection rules, Comparative half-lives, Allowed and forbidden transitions, Parity violation, Detection and properties of neutrino.

Gamma decay, Multiple transitions in nuclei, Angular momentum and Parity selection rules, Internal conversion.

Unit –IV Nuclear models

Liquid drop model, Bohr-Wheeler theory of fission, Shell Model, Experimental evidence for shell effects, Single particle shell model, Spin-orbit interaction and magic numbers, Analysis of shell model predictions, Magnetic moments and Schmidt lines, Collective model of Bohr and Mottelson.

Unit –V Elementary particle Physics

The fundamental interactions, Classification of elementary particles, Leptons and Hadrons, Symmetries, groups and conservation laws, SU(2) and SU(3) multiplets and their properties, Quark model, Properties of Quarks, the standard model.

TEXT AND REFERENCE BOOKS:

1. A. Bohr and B.R.Mottelson, Nuclear structure, vol. 1 (1969) and vol.2, Benjamin, Reading, A, 1975.
2. Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988.
3. Ghoshal, Atomic and Nuclear Physics vol.2.
4. P.H.Perking, Introduction to high energy physics, Addison-Wesley, London, 1982.
5. Shriokov Yudin, Nuclear Physics vol.1 & 2, Mir Publishers, Moscow, 1982.
6. D.Griffiths, introduction to elementary particles, harper and row, New York, 1987.
7. H.A.Enov, introduction to Nuclear Physics, Addison-Wesley, 1973.
8. G,E.Brown and A.D.Jackson, Nucleon-Nucleon interaction North-halland Amsterdam, 1976.
9. S.D.Benedetti, Nuclear interaction, John Willey and sons, NewYork, 1964.

10. M.K.Pal, theory of Nuclear structure, affiliated East West, Madras, 1982.
11. Y.R.Waghmare,introductory nuclear physics, Oxford, IBH, Bombay, 1981.
12. J.M.Longo, elementary particles, McGraw Hill, New York, 1971.
13. R.R.Roy and B.P.Nigam, Nuclear Physics, Wiley-Easterm Ltd. 1983.

PAPER – II LASER PHYSICS AND APPLICATIONS

Unit- I Laser Characteristics

Spontaneous and stimulated emission, Einstein's quantum theory of radiation, theory of some optical processes, coherence and monochromacity, kinetics of optical absorption, line broadening mechanism, Basic principle of lasers, population inversion, laser pumping, two & three level laser systems, resonator, Q-factor, losses in cavity, threshold condition, quantum yield.

Unit – II Laser Systems

Solid state lasers- the ruby laser, Nd: YAG laser, ND: Glass laser, semiconductor lasers – features of semiconductor lasers, intrinsic semiconductor lasers, Gas laser -neutral atom gas laser, He-Ne laser, molecular gas lasers, CO2 laser, Liquid lasers, dye lasers and chemical laser.

Unit-III Advances in laser Physics

Production of giant pulse -Q-switching, giant pulse dynamics, laser amplifiers, mode locking and pulling, Non-linear optics, Harmonic generation, second harmonic generation, Phase matching, third harmonic generation, optical mixing, parametric generation and self-focusing of light.

Unit – IV

Multi-photon processes; multi-quantum photoelectric effect, Theory of two-photon process, three- photon process, second harmonic generation, parametric generation of light, Laser spectroscopy : Rayleigh and Raman scattering, Stimulated Raman effect, Hyper-Raman effect, Coherent anti-stokes Raman Scattering, Photo-acoustic Raman spectroscopy.

Unit – V

Laser Applications – ether drift and absolute rotation of the Earth**,** isotope separation, plasma, thermonuclear fusion, laser applications in chemistry, biology, astronomy, engineering and medicine.

Communication by lasers: ranging, fiber Optics Communication**,** Optical fiber, numerical aperture, propagation of light in a medium with variable index, pulse dispersion.

TEXT AND REFERENCE BOOKS:

1. Laud, B.B.: Lasers and nonlinear optics, (New Age Int.Pub.1996).
2. Thyagarajan, K and Ghatak, A.K.: Lasers theory and applications (Plenum press, 1981).
3. Ghatak, A.K.and Thyagarajan, K : Optical electronics (Cambridge Univ. Press 1999).
4. Seigman, A.E.: Lasers (Oxford Univ. Press 1986)
5. Maitland, A. and Dunn, M.H. : Laser Physics (N.H.Amsterdam, 1969).
6. Hecht, J.The laser Guide book (McGraw Hill, NY, 1986).

7. Demtroder, W. : Laser Spectroscopy (Springe series in chemical physics vol.5,Springe verlag, Berlin, 1981).
8. Harper, P.G.and Wherrett B.S. (Ed.): Non-linear-optics (Acad.press, 1977).

PAPER – III: SOLID STATE PHYSICS- II

Unit- I Plasmons, Polaritons

Dielectric function of the electron gas, Plasma optics, Dispersion relation for EM wave, Transverse optical modes in Plasma, Transparency of Alkali metals in the ultraviolet, Longitudinal Plasma oscillations, Plasmon, electrostatic screening and screened Coulomb potential, Mott metal-insulator transition, screening and phonons in metals, Polaritons, LST relation .

Unit –II Dielectric and ferroelectrics

Maxwell's equations, polarization, macroscopic electric field, depolarization filed, E1;local electric field at an atom, Lorentz filed E2, fields of dipoles inside cavity E3; dielectric constant and polarizability, electronic polarizability; structural phase transition; ferro-electric crystals, classification; displacive transition, soft optical phonons, Landau theory of phase transitions, first and second order transition, antiferro-electricity, ferro-electric domain, piezoelectricity, ferro-elasticity, optical ceramics.

Unit –III Magnetism

Diamagnetism: Classical and Quantum theory of diamagnetism, **Paramagnetism**: Origin of permanent magnetic moment, quantum theory of paramagnetism, rare earth ions, Hund rule, iron group ions, crystal field splitting, quenching of orbital angular momentum, spectroscopic splitting factor, cooling by adiabatic demagnetization, determination of susceptibility of dia and para magnetic materials, **Ferromagnetism**: Weiss theory of spontaneous magnetization, Weiss molecular field, Curie-Weiss law, Ferromagnetic domain, antiferromagnetism, spin wave , quantization of spin waves.

Unit –IV Optical Processes & Excitons and defects

Optical reflectance, excitons, Frenkel and Mott-Wannier excitons, Alkali Halides and Molecular crystals Defects: lattice vacancies, Schottkey and Frenkel point effects, colour centers, F and other centres, Line defect. Shear strength of single crystals, dislocations-edge and screw dislocations, Burger vectors, Stress fields of dislocations, low angle grain boundaries, dislocation densities, dislocation multiplication and slip, strength of alloys, dislocations and crystal growth, hardness of materials.

Unit – V Luminescence of Solid

Fundamental of luminescence, fluorescence and phosphorescence, **Luminescence model**: jablonski model, configuration–coordinate model, energy band model, **Photoluminescence**: Introduction, classification of photoluminescence in solid, Intrinsic and Extrinsic luminescence, Band to Band luminescence, Direct and indirect transitions, Luminescence transition rates and spectra. Recombination cross section and Impurities.

TEXT AND REFERENCE BOOKS

1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons).
2. J.M.Ziman: Principles of theory of solids (Cambridge univ.press).
3. Azaroff : X-ray crystallography.
4. Weertman and weertman : Elementary Dislocation Theory.

5. Verma and Srivastava: Crystallography for Solid State Physics.
6. D. R. Vij: Luminescence of Solid.
7. Azeroff and Buerger: The Power Method.
8. Buerger: Crystal Structure Analysis.
9. Thomas: Transmission Electron Microscopy.
10. Omar: Elementary solid state physics.
11. Aschroft and Mermin : Solid State Physics.
12. Chalking and Lubensky: Principles of Condensed Matter Physics.
13. Madelung : Introduction to solid state theory.
14. Callaway: Quantum theory of solid state physics.
15. Huang: Theoretical Solid State Physics.
16. Kittel: Quantum theory of solids.

PAPER –IV (A): ASTRONOMY AND ASTROPHYSICS - II

Unit– I

The Milkyway Galaxy: Structure of the Milkyway, Oort's theory of galactic rotation, Dynamics of the spiral arms, Distribution of Interstellar matter. Normal Galaxies: Classification of galaxies, Hubble sequence: Elliptical, Lenticulars and Spiral galaxies, and their properties, Brightness profiles, Distribution of gas and dust in galaxies, Rotation curve and dark matter.

Unit- II

Active galaxies: Active Galactic Nuclei (AGNs), Seyfert galaxies, BL Lac Objects, Radio galaxies: General properties, Superluminal motion, Quasars: Properties and Energy requirements, Nature of quasar redshifts, Supermassive black hole model and Unified model of AGNs.

Unit-III

Problem in Newtonian gravity and need of General Relativity. Principle of Equivalence. Concept of curved space, Predictions of General Relativity: precession of perihelion of Mercury, bending of light, gravitational lensing, Gravitational wave and its detection through Laser interferometer. Weyl's Postulate, Cosmological Principle, Friedmann Model, Einstein's model with cosmological constant, Steady State Model.

Unit- IV

Relics of the big bang, The early universe, Thermodynamics of the early universe, Thermal History, Primordial neutrinos, Helium synthesis and other nuclei, Microwave background, The very early universe, The formation of structures in the Universe, Jeans Mass, Growth Rate, Recombination era, Onset of matter dominated era.

Unit- V

Observations of the cosmological significance, Measurement of Hubble`s constant, Anisotropy of local large - scale velocity fields, Age of the universe, Abundance of light nuclei, Dark matter, The redshift-magnitude relation, Number counts of extragalactic objects, The variation of angular sizes with distance.

TEXT AND REFERENCE BOOKS:

1. Astrophysics for Physicists, Arnab Rai Choudhuri, Camb. University Press, 2010.

2. Astrophysics : Stars and Galaxies, K.D. Abhayankar, Universities Press (India) Ltd, 2001.
3. An Introduction to Astrophysics, Baidyanath Basu, PHI, 2010.
4. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey, 2007.
5. Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th ed., Saunders College Publishing, 1998.
6. Quasars and active galactic neuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge University Press, 1999.
7. Elements of Cosmology, J.V. Narlikar, Universities Press, 1996.
8. Introduction to cosmology, J.V. Narlikar, 3rd edition, Cambridge Uni. Press, 2002.
9. The Physical Universe: An introduction to astronomy, F.Shu, University Science Books 1982.
10. Textbook of astronomy and astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publishing House, 2000.
11. The new cosmos, A.Unsold and B. Baschek, Newyork, Springer 2002.
12. Theoretical Astrophysics, vol. I, II, III, T. Padmanabhan, Cambridge University Press.
13. A Workbook for Astronomy, Jerry Waxman, Cambridge University Press, 1984.
14. Structure formation in the universe, T.Padmanbhan, Cambridge University, press 1993.
15. Galactic Astronomy: Binney and Merrifield, Princeton University Press,1981.
16. General relativity and Cosmology, J.V. Narlikar, Macmillan Company of India Ltd, New Delhi 1978.
17. General relativity, I.R. Kenyon, Oxford University Press 1990.
18. Classical theory of fields, vol. 2, L.D. Landau and E.M. Lifshitz, Oxford: Pergamon press 1971.
19. First course general relativity, B.P. Schutz – Cambridge Univ. Press 2009.

Paper – IV (B) Electronics II (Communication)

Unit-I Sampling

Digital communications Pulse modulation systems, Sampling Theorem for Low pass &Band pass signal, sampling techniques, Impulse sampling, Natural Sampling, Plat-top sampling, Signal through holding, Quantization of signals, quantization error, Aperture effect.

Unit-II Digital modulation techniques

PCM, Differential PCM, Delta modulation, Adaptive, delta modulation (CVSD).
BPSK, DPSK, QPSK, PSK, QASK, BFSK, FSK,MSK

Unit-III Mathematical representation of noise

Sources of noise, Frequency domain representation of noise , Effect of filtering on the probability density of Gaussian noise, Spectral component of noise, Effect of a filter on the power spectral density of noise, Superposition of noise, Mixing involving noise, binear filtering, Noise bandwidth, Quadrature component of noise, Power spectral density of $n_c(t)$ $n_s(t)$ & their time derivatives.

Unit-IV Introduction to Embedded Systems

Sensors and Actuators, Examples and Real-world applications of Embedded Systems, Recent trends in Embedded Systems, Requirements of Embedded Systems.

Unit-V Data Transmission II

Noise in pulse code & delta modulation system, PCM transmission, Calculation of quantization noise output signal power, Effect of thermal noise, output signal to noise ratio in PCM, DM, Quantization noise in DM, output signal power, DM output signal to quantization noise ratio, effect of thermal noise in delta modulation, output signal to niose ratio in DM

Text and Reference Books:

1) "Microwaves" by K.L. Gupta Wiley Estern Ltd. Delhi.
2) Advanced Electronic communication system by Wayne Tomsi Physics education.
3) Principle of communication of system-by Toub & Schilling: second edition TMH 1994
4) Communication system: by siman Haykin, third edition John wiley & sons inc.1994.
5) Microwave devices & ckts by: Samuel, Y. Liau.
6) Electronic communication: George kennedy.
7) S. Haykin, B. V.Veen "Signals & Systems", Wiley Publication
8) Digital and Analog Communication Systems, by Sanjay sharma 8ed, 2013
9) P.H. Dave, H.B. Dave,"Embedded Systems- Concepts Design and Programming", Pearson Publication.
10) Shibu KV,"Introduction to Embedded Systems", Tata McGraw Hill Publication.

Paper – IV (C) PHYSICS OF NANO MATERIALS- II

UNIT I Electrical transport in nano-stucture

Crystal bonding, structure, growth and symmetries; Band structure and density of states at nano-sclale; Electrical transport in nano-structure- Electical conduction in metals, classical and quantum theory, Conduction in Insulator and Ionic crystal, electron transport in semiconductors, various conduction mechanism in 3D (bulk) and 2D (thin film) and low dimensional systems, thermoionic emission , Field –enhanced thermoionic emission, Arrhenius type thermally activated conduction, variable range hopping and Polaron conduction.

UNIT II Application of CNT

Applications of Carbon NanoTubes (CNTs) in field emission, fuel cells, CNT FETs, Light Emitting Displays (LEDs) and Flat Panel Displays (FPD), hydrogen storage, solar panels. Application of functional nanomaterials: clean energy (Hydrogen Production from Biomass, Catalytic coal hydrogasification), environmental technologies (clean water and air), health care (tissue and bone repairs, bio medical sensors)

Unit III Next Generation Applications for Polymeric Nanofibres

Background, Biomedical Applications, Medical Prostheses, Tissue Engineering Scaffolds, Drug Delivery, Wound Dressing, Cosmetics. Filtration applications, Filter media, Protective Clothing, Material Reinforcement, Electrical Conductors, Optical applications, Sensor devices, Conclusion.
Reference: Nanotechnology: Global Strategies, Industry Trends and Applications (Editor: Jurgen Schulte)

UNIT IV Nano-Lithography

Photolithography Principles; Phase Shifting Optical Lithography; Electron Beam Lithography (EBL); Neutral Atomic Beam Lithography; Ion-Beam Lithography (IBL);

X-ray Lithography (XRL); Proximal Probe Lithography, Proximal Probes, STM based Electron-Beam Lithography, Soft Lithography. Nano lithographic applications and current research.

UNIT V Self assembly and Catalysis

Process of self assembly, semiconductor islands, Monolayers, Nature of catalysis, Surface area of nano particles, porous materials, pillared clays, colloids.

References

1. Nanostructures & Nanomaterials: Synthesis, Properties & Applications: Guozhang Cao.
2. Introduction to Nanotechnology: Charles P. Poole Jr and Franks J. Qwens.
3. Handbook of Analytical instruments, R.S. Khandpur
4. Nano materials: Synthesis properties ,characterization and application: A.S Edelstein and R.C Cammaratra
5. Nanoelectronics and Nanosystems , Karl Goser, Peter Glosekotter, Jan Dienstuhl.,
6. Springer, 2004
7. Nanomaterial Systems Properties and Application, A.S.Eldestein and R.C.Cammarata.
8. Handbook of Nanotechnology: Bhushan (Ed), Springer Verlag, New York (2004).
9. Nanocomposite Science and Technology, Ajayan, Schadler and Braun
10. Piezoelectric Sensors: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi.
11. Block Copolymers in Nanoscience Massimo Lazzari Supramolecular Chemistry, Jonathan W. Steed, Jerry L. Atwood
12. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
13. Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh, CRC press, 2007.
14. Nanosystem characterization tools in the life sciences by Challa Kumar. Wiley-VCH, 2006.
15. Nanolithography M.Gentili et al.(edits),Springer. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin
16. Wang, Rachid Sliman, Ian Wright. Elsevier, 2010.
17. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
18. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
19. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca
20. The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation by Dirk Bouwmeester, Artur K. Ekert, Anton Zeilinger
21. Problems And Solutions in Quantum Computing And Quantum Information Yorick Hardy Willi-Hans Steeb
22. Introduction to Nano Science and Nano Technology- K.K. Chatopadhyay and A. N. Banerjee

PAPER –IV (D): SPACE PHYSICS - II

Unit I Glimpse of Universe

Universe - description, origin, its evolution, age and size; Stars–birth, life, death, spectral analysis, stellar composition - element synthesis in stars, Exotic stars- novae, supernovae, pulsars, black holes and gamma ray bursts; Galaxies; Starbursts and Active Galactic Nucleus; Evidence for the Big Bang; Cosmic Background Radiation; Expansion Models; Dark Matter and Energy Recent innovations about the concept of Universe: Dark Energy and an accelerating universe

Unit II Spacecrafts & Satellites

Satellite orbits and attitude: principles of satellite motion, Kepler's laws, orbital elements, satellite attitude and its control, types of orbits, polar and geostationary, earth and sunsynchronous, orbit optimization, viewing geometry, launch vehicles and spacecrafts, rocket propulsion concepts such as solid, hybrid, liquid, nuclear and antimatter. Rocket motors and their design, flight stability and recovery systems, stability and control system.

Unit III Remote Sensing

Sensors and systems: visible, infrared, water vapour and microwave sensors, sensor characteristics, sensor materials, passive and active sensors, scanning radiometers, spectral signatures.

Satellite data processing: satellite data acquisition, satellite communications, data collection platforms, earth station, image processing, geometric and radiometric corrections, image navigation, registration, image enhancement techniques, noise removal methods, histogram methods, density slicing, image classification.

Applications of remote sensing in earth resources management, agriculture, forestry, water resources and disaster mitigation

Unit IV Solar Wind and Interuactions

The ionospheric layers D, E, F and their formation, effect of radiation on earth's atmosphere, photochemical processes,

Geomagnetic and magnetic coordinates, poles, measurement of geomagnetic field components, micropulsation indices, variations of geomagnetic field, quiet and disturbed variations, geomagnetic storms, equatorial and auroral phenomena.

Solar wind, model of solar winds, interaction in the interplanetary medium and with the planets. Magnetosphere: interaction of solar wind with the geomagnetic field and formation of the magnetospheric tail, storm and sub-storm phenomena, Van Allen radiation belts

Unit V Space Weather

Space Weather Effects on Communication, Space Weather Effects on Power Grids, Space Radiation Protection, Effects on Spacecrafts hardware and Operations, Effects on Satellite Navigation, Forecast of Space Weather.

Text and Reference Books

Same as mentioned in Semester III, Paper IV (D)