HEMCHANDYADAV VISHWAVIDYALAYA, DURG (C.G.)

Website -www.durguniversity.ac.in, Email - durguniversity@gmail.com

SCHEME OF EXAMINATION
&
SYLLABUS
of
M.Sc. (Physics) Semester Exam

UNDER

FACULTY OF SCIENCE

Session 2025-26

(Approved by Board of Studies)
Effective from June 2025

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Syllabus for M.Sc. Physics (Semester System)

Semester – I (2025-2026)

Paper – I	:	Mathematical Physics
Paper – II	:	Classical Mechanics
Paper – III	:	Electrodynamics & Plasma Physics
Paper – IV	:	Electronics
Laboratory Course I-A	:	General & Optics
Laboratory Course I-B	:	Electronics

Semester – II (2025-2026)

Paper – I	:	Quantum Mechanics - I
Paper – II	:	Statistical Mechanics
Paper – III	:	Electronic & Photonic Devices and Optical Modulators
Paper – IV	:	Computational Methods & Programming
Laboratory Course I-A	:	Numerical Analysis & Computer Programming
Laboratory Course I-B	:	Digital Electronics & Microprocessor

Semester – III (2026-2027)

Paper – I	:	Quantum Mechanics - II
Paper – II	:	Atomic & Molecular Physics
Paper – III	:	Solid State Physics - I
Paper – IV	:	(A) Astronomy & Astrophysics - I (B) Electronics (Communication) - I (C) Physics of Nano-material - I (D) Space Physics - I
Laboratory Course III-A	:	Material Science & General
Laboratory Course III-B	:	Astronomy & Astrophysics **OR** Electronics (Communication **OR** Physics of Nano-material **OR** Space Physics

Semester – IV (2026-2027)

Paper – I	:	Nuclear & Particle Physics
Paper – II	:	Laser Physics and Applications
Paper – III	:	Solid State Physics - II
Paper – IV	:	(A) Astronomy & Astrophysics - II (B) Electronics (Communication) - II (C) Physics of Nano-material - II (D) Space Physics - II

Project Work

The Syllabus for M.Sc. Physics (Semester System) is hereby approved by the members of the Board of Studies.

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M. Sc. - PHYSICS

M.Sc. in Physics is a full time 2-year (4-semesters course). There will be four theory papers, and two laboratory courses/project in each semester. In each semester, there will be two internal examinations/assessments. 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
A : General & Optics	-		-		100	2
Laboratory Course I-B : Electronics	-		-		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 Methods & Programming	80	16	20	04	100	4
Laboratory Course II-A : Numerical Analysis & Computer Programming	-		-		100	2
Laboratory Course II-B : Digital Electronics & Microprocessor	-		-		100	2
Total Marks					**600**	**20**

Total Marks for Semester II = 600 & Credit = 20

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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-material-I (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-material **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-material-II (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

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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	: 20Marks
Viva	: 20Marks
Experiment	: 60Marks

(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.

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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: Cauchy- Riemann condition, analytic functions, Cauchy's theorem, Cauchy integral formula, Laurent series, singularities, residue theorem, contour integration, evaluation of definite integrals, problems.

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, nonhomogeneous 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 transform of derivatives, convolution theorem, Laplace Transform(LT), LT of Derivatives, Inverse LT, Fourier series; properties and applications, discrete Fourier transform.

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.

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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, Simple applications of the Lagrangian formulation, 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 Principle, 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, The HJ equation for Hamilton's characteristic function.

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, 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.

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 (PearsonEducation, Inc,2002)
4. Mechanics, by A.Sommerfeld, (Academic press,1952)
5. Introduction to Dynamics by Perceival and D.Richaeds(Cambridgeniversity, press ,1982).

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Paper-III: ELECTRODYNAMICS & PLASMA PHYSICS

Unit-I Maxwell's equations, vector and scalar potentials and the wave equation, Gauge transformations, Lorentz gauge, Coulomb gauge, Green function for the wave equation, four-vectors, mathematical properties of the space-time in special relativity, matrix representation of Lorentz transformation, covariance of electrodynamics, transformation of electromagnetic fields.

Unit-II Radiation by moving charges, Lienard-Wiechert potential and fields for a point charge, total power radiated by an accelerated charge- Larmor's formula and its relativistic generalization, angular distribution of radiation emitted by an accelerated charge, radiation emitted by a charge in arbitrary extremely relativistic motion.

Unit -III Bremsstralung: emission from single-speed electrons, thermal Bremsstralung emission and absorption, Synchrotron radiation: 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 magneto static field, Gradient B drift, Curvature drift, adiabatic in variants.

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, Magnetic viscosity and magnetic pressure, plasma confinement schemes.

REFERENCE BOOK:

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

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Paper - IV: ELECTRONICS

Unit-I Operational Amplifier- Basic Op.Amp. Differential amplifier, the emitter coupled Difference Amp, Transfer characteristics of a Differential Amp, an example of an IC Op.-Amp., off set 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, Non-linear analog systems: Comparators, Wave form generators.

Unit-II Combinational Logic Gate – Basic logic gates: OR, AND and NOT gates, NOR and NAND gates, Boolean algebra, K-Map, De Morgan's theorem, Exclusive OR gate, characteristics of logic families.
Number System: Binary numbers, Binary to decimal conversion, Decimal to Binary conversion, Binary Addition, Binary Substration, 1's compliment, 2's Compliment, Binary Multiplication and division, Octal and Hexadecimal Numbers.

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, multiplexer, De multiplexer, decoder.

Unit-IV ALU Memories: RAM, ROM, PROM, EPROM, A/D and D/A converters.
Microprocessors – Building concept of microprocessors, Instruction codes ,Instruction Register ,Introducing RESET Pin, Introducing on chip oscillator, Interfacing I/O devices, 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 ideas. 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, summing of two 8-bit numbers, summing of two 16-bit number, multiplying two 8-bit number, finding the largest number in a series.

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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. GayakwadPHI, second edition1991.
4. Digital computer electronics- An introduction tomicrocomputers-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 limited1987.
7. Introduction to microprocessors – A.P.Mathur (TataMcGraw).
8. Microprocessors-Theory and applications- M.Hafiquizzaman (Prenticehall).
9. Microprocessors fundamentals- SchanmiOutling Service AuthorPocerL.Tokheim.
10. Integrated circuits : K KBotkar(Khannapublications)
11. Digital Electronics : R P Jain (Tata McGrawHill)
12. Microprocesss : BRam
13. 8-bit microprocessor : V.J.Vibhute& P.B. Borole(Tecn-Max Publication,Pune)

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Laboratory Course

Lab I-A: General & Optics (Any ten)

1. Determination of band gap of semiconductor by four probmethod.
2. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrierc on centration.
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 G Mtube.
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.

Lab I-B: Electronics (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. Study of Silicon Controlled Rectifier.
6. Experiment of Uni – Junction Transistor and its application.
7. Experiment of FET and MOSFET characterization and application as an amplifier.
8. Study of Differential. Amplifier.
9. Basic Logic gates and verification of their Truth-Tables.
10. Combinational logic gates and verification of De-Morgan's Theorem.
11. Study of Basic Operational Amplifier(741).
12. Study of Opto- Electronics Devices.

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Semester – II

PAPER - I: QUANTUM MECHANICS-I

Unit - I Inadequacy of classical mechanics, Planck's quantum hypothesis and radiation law, Photoelectric effect, De-Broglie's theory. Schrödinger equation, continuity equation, Ehrenfest theorem, admissible wave functions, stationary states, one-dimensional problems; potential well and barriers, Schrödinger equation for harmonic oscillator and its solution, uncertainty relations, states with minimum uncertainty product.

Unit –II Superposition principle, general formalism of wave mechanics, representation of states and dynamical variables, commutation relationship, completeness and normalization of Eigen functions, Dirac-delta function, Bra & Ket notation, matrix representation of an operator, 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 order 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.

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.

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PAPER – II: STATISTICAL MECHANICS

Unit-I Foundation of statistical mechanics: macroscopic and microscopic states, contact between statistical and thermo dynamical quantities, 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.

Unit- II Elements of ensemble theory – A system in micro canonical, 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 -Thermodynamical 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, Fluctuations: thermodynamic fluctuations, Brownian motion: Einstein theory of Brownian motion.

TEXT & REFERENCE BOOKS –

1. R. K. Pathria, Statistical Mechanics (PergamonPress).
2. L. D. Landau & E. M. Lifshitz (Butter worth and HeinemannPress).
3. FederickReif, Fundamental of statistical and thermal physics (McGraw-Hill publishers).
4. Kerson Huang, Statistical Mechanics (WileyEastern).

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PAPER –III: ELECTRONIC & PHOTONIC DEVICES AND OPTICAL MODULATORS

Unit– I Special Bipolar devices: Thyristors- the four-layer diodes and their basic characteristics, Schottky diode, three terminal thyristor, Diac &Triac, SCR, UJT, Field controlled Thyristors.

Unit- II Unipotar 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 Display Devices: Modulation of light- Birefringence, Optical activity, Electro-optic, Magneto-optic and Acoustic- optic effects, Materials exhibiting these properties, Non-linear optics. Display devices: Luminescence, Photo-luminescence, Electro-luminescence, Liquid crystal displays, Numeric displays.

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 andsons
3. Measurement, Instrumentation and experimental design in physics and engineering by M.Sayer and A.Mansingh, Prentice Hall India2000
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).

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PAPER – IV: COMPUTATIONAL METHODS AND 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 Runge-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 program, external statement, common statement, equivalence statement, Format statements.

NOTE :-

Paper Setter should clearly mention in the question paper that **scientific calculator** is allowed in this paper.

TEXT AND REFERENCE BOOKS

1. Sastr: Introductory Methods of NumericalAnalysis.
2. Rajaraman: NumericalAnalysis.
3. Antia: Numericalmethods.
4. Raja Raman: FORTRANprogramming.

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Laboratory Course

Lab 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 1/3Rule.
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

Lab II-B: Digital Electronics & Microprocessor (Any ten)

1. Study of R-S, D/T, J-KFlip-Flops.
2. Study of counters: Ripple, Mode 3, Mode 5counters.
3. Study of ShiftRegister.
4. Study of R-2R D/AConverter.
5. Study of Random Access Memory (RAM) Read Only Memory.(ROM)
6. Study of A/DConverter.
7. Experiment with Microprocessor:-I
   (a) Convert BCD in toHEXADECIMPL
   (b) To transfer group of date blocks from one location to anotherlocation.
8. Experiment with microprocessor: -II
   (a) To write programs for addition of two 1 byte data giving results of 2bytes.
   (b) To write programs for multiplication of two 1 byte data giving results of 2bytes.
9. (a) To add 2 16-BIT numbers stored in locations from x xxx to x xxx + 3 andadd them store the results from x xxx + 4 to x xx x+6 memorylocation
   (b) To find the largest of n numbers of aseries.
10. To arrange N numbers in an ascendingorders.
11. Experiments withMicroprocessor.
    (a) Convert BCD in to binary andvice-versa.
    (b) To transfer group of data blocks from one location to anotherlocation.
    (c) To write programs for addition of two 1byte data giving result of 2bytedata
    (d) To write programs for multiplication of two 1 byte data giving result of 2bytedata.
12. Logic gate study DTL andRTL.
13. Study ofadder/Subractor.

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Semester – III

PAPER –I: QUANTUM MECHANICS -II

Unit-I Variational 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, 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, 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 : QuantumMechanics.
4. B.Craseman and Z.D.Powell : Quantum Mechanics (AddisonWesley)
5. A.P. Messiah: QuantumMechanics.
6. J.J. Sakurai: Modern QuantumMechanics.
7. Mathews and Venkatesan: QuantumMechanics.
8. Bjorken and Drell :Relativstic QuantumMechanics.

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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, 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.

Unit – III Normal and anomalous Zeeman effect, 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 and diatomic molecules, symmetric top, asymmetric top and spherical top molecules. Rotational spectra of diatomic molecules: rigid rotator model, energy levels, Eigen functions, 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 andstraughner.
4. Introduction to Molecular spectroscopy – G.M.Barrow.
5. Spectra of diatomic molecules –Herzberg.
6. Molecular spectroscopy – JeanneL.Mc-Hale.
7. Molecular spectroscopy – J.M.Brown.
8. Spectra of atoms and molecules–P.F.Bemath.
9. Modern section copy, J.M.Holias.

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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 dimensions. 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.

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 by magnetic field, Meissner effect, heat capacity, energy gap, MW, and IR properties, isotope effect. Theoretical survey : thermodynamics of superconducting transition, London equation, Coherence length, Cooper pairing due to phonons, BCS theory of superconductivity, BCS ground state, flux quantization of superconducting ring, duration of persistent currents, Type II superconductors, Vortex states, estimation of H_{C1} and H_{C2}, single particle and Josephson superconductor tunneling, DC/AC Josephson effect, Macroscopic quantum interference. High temperature superconductors, critical fields and currents, Hall number, fullerenes ring.

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.

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TEXT AND REFERENCE BOOKS:-

1. C. Kittel: Introduction to Solid State Physics (Wiley andSons).
2. J.M.Ziman: Principles of theory of solids (CambridgeUniv.Press).
3. Azaroff: X-raycrystallography.
4. Weertman and weertman : Elementary DislocationTheory.
5. Verma and Srivastava: Crystallography for Solid StatePhysics.
6. Azeroff and Buerger: The PowerMethod.
7. Buerger: Crystal StructureAnalysis.
8. Thomas: Transmission ElectronMicroscopy.
9. Omar: Elementary solid statephysics.
10. Ashcroft and Mermin: Solid StatePhysics.
11. Chalking and Lubensky: Principles of Condensed MatterPhysics.
12. Madelung: Introduction to solid statetheory.
13. Callaway: Quantum theory of solid statephysics.
14. Huang: Theoretical Solid StatePhysics.
15. Kittel: Quantum theory ofsolids.

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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, degenerate states, 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 Observational and Conceptual foundations of Newtonian gravity and General Theory of Relativity(GR), Principle of Equivalence, Metric tensor, Covariant differentiation, Riemann curvature tensor, Geodesics.
Stress- Energy tensor, Einstein's field equations, Schwarzschild metric, Particle trajectories in Schwarzschild space- time, Precession of Perihelion, Gravitational red-shift and bending of light.

TEXT AND REFERENCE BOOKS:

1. Astrophysics for Physicists, Arnab Rai Choudhuri, Camb. University Press,2010.
2. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey Pub.Co.
3. Introductory Astronomy and Astrophysics, M.Zeilik and S.A. Gregory, 4th edition, Saunders collegepublishing.
4. Theoretical Astrophysics, vol. – II: Stars and stellar systems, T. Padmanabhan, Cambridge universitypress.
5. The Physical Universe: An introduction to astronomy, F.Shu, Mill valley : University science books.

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

Unit - I **Microwave devices**
Klystron, magnetron & traveling wave tubes ,velocity modulation ,basic principle of two cavity klystrons & relex klystrons ,principle of operation of magnetrons ,helix traveling wave tubes.

Unit - II **Microwave wave guides &components**
(Wave modes) rectangular wave guides: solution of wave equation in rectangular coordinates, TE modes in rectangular wave guides, TM modes in rectangular wave guides.
Circular wave guides: solutions of wave equation in Cylindrical coordinates, TE modes in Circular wave guides, TM modes in Circular wave guides, TEM modes in Circular wave guides.

Unit - III **Microwave cavities**: rectangular cavity resonator, circular –cavity resonator & semicircular cavity resonators Q- factor of a cavity resonator.
Transferred Electrons devices (TEDs)
Gunn effect diodes, principle of operation, modes of operations, read diodes, IMPATT diodes, TRAPATT diodes.
Microwave communications: advantages of microwave transmission, loss in free space, propagation of microwave.

Unit - IV **Radar system**:
Radar-Block diagram & operation, radar frequencies ,pulse consideration, radar range equation, derivation of radar range equation, minimum detectable single receiver noise, signal to noise ratio, radar cross sections, pulse reflections frequency, antenna, parameters, systems losses & propagation losses, radars transmitters receivers, antennas displays

Unit - V **Satellite communication**
Orbital Satellite, geostationary satellite, orbital patterns, look angles, orbital spacing , satellite system ,link modules.

REFERENCEBOOKS

1) "Microwaves" by K.L. Gupta Wiley Estern Ltd.Delhi.
2) Advanced Electronic communication system by Wayne Tomsi Physicseducation.
3) Principle of communication of system-by Toub& Schilling: 2nd ed. TMH1994
4) Communication system: by SimanHaykin, 3rd ed. John wiley&sonsinc.1994.
5) Microwave devices & circuits by : Samuel, Y.Liau.
6) Electronic communication: Georgekennedy.

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Paper IV (C) PHYSICS OF NANO MATERIALS - I

Unit-I: **Nano Materials**

Properties of Nano-Particles: Metal Nano-clusters: Magic Numbers, theoretical modeling of nanoparticles, geometric and electronic structure, Reactivity, Fluctuations, magnetic clusters, Bulk to Nano transition. Semiconducting nanoparticles: optical properties, Photo fragmentation, Columbic Explosion. Rare gas and molecular clusters: Inert-Gas Clusters, Superfluid Clusters, Molecular Clusters. Methods of Synthesis: RF Plasma, Chemical Methods, Thermolysis, Pulsed Laser Methods.

UNIT II: **Carbon Nanostructures**

Carbon Molecules: Nature of Carbon Bonds, New Carbon Structures. Carbon Clusters: Small Carbon Clusters, Discovery of C_{60}, Structure of C_{60} and its Crystal, Alkali-Doped C_{60}, Superconductivity in C_{60}, Larger and Smaller Fullerenes, Other Bucky balls. Carbon Nanotubes: Fabrication, structure, Electrical Properties, Vibrational Properties, Mechanical Properties. Applications of Carbon Nanotubes: Field Emission and Shielding, Computers, Fuel Cells, Chemical Sensors, Catalysis, Mechanical Reinforcement.

UNIT III: **Bulk Nanostructured Materials**

Solid Disordered Nanostructures: Methods of Synthesis, Failure Mechanisms of Conventional Grain-Sized Materials, Mechanical Properties, Nanostructured Multilayers, Electrical Properties, Other Properties, Metal Nano cluster Composite Glasses, Porous Silicon. Nanostructured Crystals: Natural Nano crystals, Computational Prediction of Cluster Lattices, Arrays of Nanoparticles in Zeolites, Crystals of Metal Nanoparticles, Nanoparticle Lattices in Colloidal Suspensions, Photonic Crystals. Nanostructured Ferromagnetism: Basics of Ferromagnetism, Effect of Bulk Nano structuring of Magnetic Properties, Dynamics of Nano magnets, Nano pore Containment of Magnetic Particles, Nano carbon Ferro magnets, Giant and Colossal Magneto resistance, Ferro fluids.

UNIT IV: **Quantum Wells, Wires, and Dots**

Preparation of Quantum Nanostructures, Size and Dimensionality Effects: Size Effects, Conduction Electrons and Dimensionality, Fermi Gas and Density of States, Potential Wells, Partial Confinement, Properties Dependent on Density of States. Excitons, Single- Electron Tunneling, Applications: Infrared Detectors, Quantum Dot Lasers. Superconductivity.

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UNIT V: Self-Assembly and Catalysis

Self-Assembly: Process of Self-Assembly, Semiconductor Islands, Monolayers. Catalysis: Nature of Catalysis, Surface Area of Nanoparticles, Porous Materials, Pillared Clays, Colloids.

Nanomachines and Nanodevices: Microelectromechanical Systems (MEMSs), Nanoelectromechanical Systems (NEMSs): Fabrication, Nanodevices and Nanomachines. Molecular and Superamolecular Switches.

TEXT AND REFERENCE BOOKS

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.CCammaratra
5. Nanotechnology, Kohlr,Michael.
6. X-ray diffraction procedures, H. P. Klung andL.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 :MaricIsbella andBuraton
12. Encyclopedia of Nanotechnology, H.S.Nalwa
13. Handbook of Nanotechnology: Bhushan(Ed), Springer Verlag, New York(2004).
14. Nanostructures and Nanomaterials- Synthesis properties and Applications by Guozhong Cao (Empirical College Press World Scientific Pub.,2004).
15. Nanocomposite Science and Technology, Ajayan, Schadler andBraun
16. Fullerene & Carbon nanotubes, DresselShaus
17. Carbon Nanotubes,Elizer
18. Physical properties of CNT,Saito
19. Carbon nanotechnology, LimingDai
20. Nanotubes and nanowires, CNR Rao and Govindaraj RCSPublishing.
21. Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh, CRC press,2007.
22. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele Mosca
23. The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation by Dirk Bouwmeester, Artur K. Ekert, Anton Zeilinger
24. Problems And Solutions in Quantum Computing And Quantum Information Yorick Hardy Willi-HansSteeb

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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.

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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. Mc Elhinny, 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. Mc Cormac, 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, WileyInter science, 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 GeorgeJoseph
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. ReidelPublish.

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34. Physics of Geomagnetic Phenomena, Vol. I and II, S. Matsushita and W. H. Campbell, AcademicPress
35. Introduction to Ionospheric Physics, H. Risbeth and H. Garriot, AcademicPress
36. Space Weather, Physics and Effects by Volker Bothmer and Loannis.A.Depli Springer
37. Aerospace Environment by TBeer
38. Free flight of a rocket ByGantmaker
39. Orbital Mechanics, Ed. Vladimir A, Chobotov, AIAA EdnSeries
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 HinglarLtd
42. Orbital Methods in Astrodynamics, P. R. Escobal, JohnWiley
43. Fundmentals of Astrodynamics, R. R. Bates et al,Dover
44. Orbital Motion, A. E. Roy, Adam HinglarLtd
45. Design of Orbital Flights, J. Johnson et al., McGrawHill
46. Modern Astrophyiscs, B. W. Carroll and D. A. Ostlie, Addison-Wesley
47. The Physical Universe, F. Shu, University ScienceBooks
48. The Physics of Astrophysics, Vol. I and II, F. Shu, University ScienceBooks
49. Theoretical Astrophysics, Vol. I, II and III, T. Padmanabhan, CambridgeUni.Press
50. The Physics of Fluids and Plasmas, Arnab Rai Choudhuri, CambridgeUni.Press
51. Astrophysical Concepts, M. Harwitt,Springer-Verlag
52. Galactic Astronomy, J. Binney and M. Merrifeld, Princeton UniversityPress
53. Galactic Dynamics, J. Binney and S. Tremaine, Princeton UniversityPress
54. Quasars and Active Galactic Nuclei, A. K. Kembhavi and J. V. Narlikar,Cambridge UniversityPress
55. An Introduction to Active Galactic Nucleii, B. M.Peterson

Lab 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.

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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 IC555.
18. Digital electronics experiments on bread board usingIC-7400.

Lab III-B: Astronomy & Astrophysics

1. Study of Quasar.
2. Study of the orbit of a visual binary Star.
3. Determine the mass of Saturn &its rotational velocity.
4. Verification of Hubble's law and determination of Hubble'sconstant.
5. Identification of element from Fraunhoffer spectrum of the sun.
6. Study of sunspots.
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 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 Demerging's Theorem.
(4) Study of Adder/Subtract or.
(5) Study of Encoder &Decoder.
(6) Study of Multiplexer &DE multiplexer
(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 segments Decoder.
(15) Study of modulation & demodulation.
(16) Optical fiber based experiment.
(17) Microwave characterization and measurements.

OR 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

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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 nanoparticles 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 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 Fraunh offer spectrum of the sun.
7. The transit of Venus and Mercury.
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.

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Semester – IV
PAPER – I: NUCLEAR AND PARTICLE PHYSICS

Unit-I **Nuclear Interactions:** Nucleon-nucleon interaction, 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, Femi's theory of beta decay, Shape of the beta spectrum, Total decay rate, Angular momentum and parity selection rules, Allowed and forbidden transitions, Selection rules, Parity violation, Detection and properties of neutrino, Gamma decay, Angular momentum and Parity selection rules.

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, 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. Kiane, Introductory Nuclear Physics, Wiley, New York,1988.
3. Ghoshal, Atomic and Nuclear Physicsvol.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-hall and Amsterdam, 1976.
9. S.D. Benedetti, Nuclear interaction, John Willey and sons, New York, 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.

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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.

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, mode locking, 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, 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 AgeInt.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. Press1986)
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, Springeverlag, Berlin,1981).
8. Harper, P.G. and Wherrett B.S. (Ed.): Non-linear-optics (Acad.press,1977).

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PAPER – III: SOLID STATE PHYSICS- II

Unit- I: **Plasmon's, Polaritons**

Dielectric function of the electron gas, Plasma optics, Dispersion relation for EM wave, Transverse optical modes in Plasma, 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.

Unit –III: **Magnetism**

General ideas of dia - and para - magnetisms, quantum theory of paramagnetism, rare earth ions, iron group ions, crystal field splitting, quenching of orbital angular momentum, spectroscopic splitting factor, van vleck temperature dependent paramagnetism, Cooling by isentropic demagnetization, nuclear demagnetization, paramagnetic Susceptibility of conduction electrons.

Unit –IV: **Ferromagnetism and anti-ferromagnetism**

Ferromagnetic order, Curie point and exchange integral, temp dependence of saturation magnetization, saturation magnetization at absolute zero; magnons, quantization of spin waves, thermal excitation of magnons; neutron magnetic scattering, Ferrimagnetic order, Curie temp and susceptibility of ferrimagnets, iron garnets. Antiferromagnetic order, antiferromagnetic magnons, ferromagnetic domains.

Unit – V: **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 centers, Line defect. Shear strength of single crystals, dislocations- edge and screw dislocations, Burger vectors, Stress fields of dislocations, dislocation densities, dislocation multiplication and slip, strength of alloys, dislocations and crystal growth.

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TEXT AND REFERENCE BOOKS

1. C. Kittel: Introduction to Solid State Physics (Wiley and Sons).
2. J.M. Ziman: Principles of theory of solids (Cambridgeuniv. 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. Aschroft 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.

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

Unit– I The Milky Way Galaxy: Structure of the Milky way, Oort's theory of galactic rotation, Dynamics of the spiral arms, Distribution of Interstellar matter, Central regions of the Milky way. Normal Galaxies: Classification of galaxies, Hubble sequence: Elliptical, Lenticulars and Spiral galaxies, and their properties, Distribution of light and mass in galaxies, Brightness profiles, Distribution of gas and dust in galaxies.

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 Cosmology: Cosmological principle, Observational support and other arguments to support cosmological principle, Fundamental observers and co-moving frame, Robertson-Walker line element (without derivation), Observational features of Robertson-Walker space time e.g. Red shift etc, Models of the universe, Friedmann models, Quantitative predictions of FRW model, Quantitative solutions, Open and closed universes, Hubble's law, Angular size, Source counts, Models with the cosmological constant, Steady state cosmology.

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.

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TEXT AND REFERENCE BOOKS:

1. Astrophysics for Physicists, Arnab Rai Choudhuri, Cambridge Uni.ty Press,2010.
2. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison-Wealey Pub.Co.
3. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th edition, Saunders college publishing.
4. Theoretical Astrophysics, vol. – II: Stars and stellar systems, T. Padmanabhan, Cambridge university press.
5. The Physical universe: An introduction to astronomy, F. Shu, Millvalley: University science books.
6. Textbook of astronomy and astrophysics with elements of cosmology, V.B. Bhatia, Pb -New Delhi, Narosa publishing house.
7. The new cosmos, A. Unsold and B. Baschek, Newyork, Springer Velas.
8. Quasars and active galactic neuclei, A.K. Kembhavi and J.V. Narlikar, Cambridge university press.
9. Modern Astrophysics, B.W. Carroll and D.A. Ostlie, Addison Wesley publish.co.
10. Introductory astronomy and astrophysics, M.Zeilik and S.A.Greogry, 4 th edition, Saunders college publishing.
11. Theoretical Astrophysics, vol. I: Astrophysical processes T. Padmanabhan, Cambridge university press.
12. Introduction to cosmology, J.V. Narlikar, 3 rd edition, Cambridge uni. press.
13. Structure formation in the universe, T. Padmanbhan, Cambridge University, press.
14. General relativity and cosmology, J.V. Narlikar-Delhi: Macmil. Comp.of Indialtd.
15. Galactic Astronomy: Binney and Merrifield.

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Paper – IV (B) Electronics II (Communication)

Unit-I **Digital communications**

Pulse modulation systems, Sampling Theorem, Low pass &Band pass signal, PAM- Channel BE for PAM signal, Natural Sampling, Flattop sampling, Signal through holding, Quantization of signals, quantization error.

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.

Unit-IV **Data Transmission I**

Base band signal receiver, Probability of error optimum filter, White noise: Matched filter & probability of error, Coherent reception correlation, PSK, FSK, Non-Coherence detection on FSK, Differential PSK, QASK.

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 & cktsby: Samuel, Y. Liau.
6) Electronic communication: George kennedy.

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

UNIT I: **Synthesis of Nano-materials**

Top-down & Bottom-up approaches: Kinetically confined synthesis of nanoparticles: micro emulsion and spray pyrolysis. Template based synthesis: Electrochemical deposition, Physical Vapour deposition, Chemical Vapour deposition, Electron Beam Lithography (EBL), X-ray Lithography (XRL).

Chemical Route synthesis of Nanomaterials: Chemical precipitation and co- precipitation, Chemical Bath Deposition (CBD), Sol-gel, Combustion technique.

UNIT II: **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), Thermo analytic Methods: Thermo Gravimetric Analysis (TGA), Differential Scanning Calorimetry (DSC), Differential Thermal Analysis(DTA).

UNIT III: **Characterization of Nano-materials (b)**

Scanning Tunneling Microscopy (STM), Contact and non-contact Atomic Force Microscopy (AFM), Conductive AFM. Scanning Electron Microscopy (SEM), Transmission electron microscopy (TEM), High resolution TEM Field emission SEM. Spectrophotometer: UV-Vis spectrophotometers, IR spectrophotometers, Fourier Transform Infrared Radiation (FTIR), Photoluminescence (PL), electroluminescence and thermo luminescence spectroscopy.

UNIT IV: **Applications of Nano-materials**

Quantum wells, wires and dots. Organic Semiconductors, Organic Light Emitting Diodes (OLEDs), self-assembly of complex organic molecules, molecular switches, thermochromic switches, Motor molecules and bio-mimetic components, charge transfer complexes, molecular connections, contact issues, conducting polymers, light emitting polymers, polymer-polymer heterostructures, plastic FETs, photodiodes &solar cells, Nano Robotics: Nano robots and NEMS, Sensors and actuators, Artificial molecular machines, Biomotors, Other Nano machines, Propulsion, Control, Communication, Programming and coordination.

UNIT V: **Nano Sensors and Biomedical applications**

Nanosensors: Gas sensors, Pollution sensor, Photo sensor, Temperature sensor, IR detector, Biosensor, nanomaterial gas discharge devices, CNT based fluid velocity sensor. Nanoparticle in Drug delivery, Targeting Legends, Cancer Treatment, Mediated Delivery of Sirna, Nanonephrology, Nanosystems in Inflammation, Targeting Macrophages to Control Inflammation, Tissue Regeneration, Growth And Repair, Tissue Bioengineering, Future Understanding for Treatment, nanosurgery, Drug Delivery Technology Significance, Impact and Development.

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References: Books/ Research Monographs

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.CCammaratra
5. Nano electronicsand 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
11. Sensors, Materials and Amplifiers, G. Gautschi.
12. Block Copolymers in Nanoscience Massimo Lazzari
13. Supramolecular Chemistry, Jonathan W. Steed, Jerry L. Atwood
14. Nanotechnology: Importance and Application by M.H. Fulekar, IK International, 2010.
15. Nanotechnology in Biology and Medicine: Methods, Devices and Application by Tuan Vo-Dinh, CRC press,2007.
16. Nano system characterization tools in the life sciences by Challa Kumar. Wiley- VCH,
17. 2006.
18. Nanolithography M.Gentili etal.(edits),Springer.
19. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin
20. Wang, RachidSliman, Ian Wright. Elsevier,2010.
21. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.
22. Nanotechnlogy: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2008.
23. An Introduction to Quantum Computing Phillip Kaye, Raymond Laflamme, Michele
24. Mosca
25. The Physics of Quantum Information: Quantum Cryptography, Quantum
26. Teleportation, Quantum Computation by Dirk Bouwmeester, Artur K. Ekert,Anton
27. Zeilinger
28. Problems and Solutions in Quantum Computing And Quantum Information Yorick Hardy Willi-HansSteeb

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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: **Spacecraft& 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 Sun-synchronous, orbit optimization, viewing geometry, launch vehicles and spacecraft, 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 Interactions**

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, micro pulsation indices, variations of geomagnetic field, quiet and disturbed variations and 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 Spacecraft's hardware and Operations, Effects on Satellite Navigation, Forecast of Space Weather.

Text and Reference Books

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

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