M. Sc. PHYSICS

SEMESTER WISE DISTRIBUTION OF COURCES

SEMESTER – I

	Course	
1.	Mathematical Physics	101
2.	Atomic, Molecular and Laser Physics	102
3.	Analog and Digital Electronics	103
	Practical – Optics and Allied Exp.	104

SEMESTER – II

1.	Quantum Mechanics	201
2.	Condensed Matter Physics	202
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SEMESTER – III

	Course	
1.	Nuclear Physics	301
2.	(a) Statistical Mechanics	302
	(b) Astrophysics	
3.	(a) Computational Physics	303
	(b) Microprocessor	
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SEMESTER – IV (ELECTIVE)

1.	(a) Communication Electronics – I	401 (E)
	(b) Communication Electronics – II	402 (E)
2.	(a) Solid State Physics	401 (S)
	(b) Advanced Solid State Physics	402 (S)
3.	(a) Nuclear and Particle Physics	401 (N)
	(b) Field Theory and Quantum Electrodynamics	402 (N)
	Practical (Elective Paper) –	
1.	Communication Electronics	403 (E)
2.	Solid State Physics	403 (S)
3.	Nuclear and Particle Physics	403 (N)
	Project and Dissertation –	404
	Based on elective paper and topics are of current interest	

101 – MATHEMATICAL PHYSICS

Complex Variable Theory

Function of complex variable, Cauchy Riemann Equation, Cauchy's Integral, Differentiation Series expansion, Zeroes and singularity, Residue theorem, Integration of complex functions, Representation of function by counter integrals, Analytical continuation.

Transform Theory

Fourier series, Periodic functions, Fourier transformations, Complex Fourier transform, Laplace transform, Inverse Laplace transform, convolution theorem, Application to solution of differential and integral equations.

Tensor Analysis

Curvilinear coordinate, Definition of tensor, Algebraic operations on tensor, Differentiation, Metric tensor, Concept of parallelism, Covariant differentiation, Christoffel symbol, Curvature tensor and its properties, Equation of geodesic.

Differential Equation and Functions

Series solution of differential equations, Hermit polynomial, Bessel functions, Legender function and hypergeometric function, Green's function-method in the solution of boundary value problems, Step function, Gamma and Beta function.

Group Theory

Group, sub-group, classes, co-sets factor point symmetric groups, Direct product of groups, Reducible and Irreducible representation, unitary representation, Schur's Lemma, introduction to continuous groups, rotational and unitary group.

Books Recommended:

1. Mathematics for Physicist and Engineers – Pipes
2. Mathematical methods for physics – Ghatak
3. Mathematical Method for Physics – Arfken & Weber
4. Group Theory – Winger
5. Mathematical Physics – B. S. Rajpur
6. Mathematical Physics – B. D. Gupta
7. Group Theory – A. W. Joshi

102 –ATOMIC, MOLECULEAR & LASER PHYSICS

Atomic Spectroscopy

Spectra of two electron atoms, L-S & J-J coupling schemes, Singlet and triplet atomic states, Line shapes and widths, Natural width, Doppler width, Collision and pressure induced width, Zeemen effect, Paschen Back effect, Hyperfine structure, Isotopic shift (mass effect and volume effect), Astrophysical application of atomic spectra.

Molecular Spectroscopy

LCAO, MO theory of H2, Molecular orbits for homonuclear and hetronuclears molecules (H2, N2 and CO2), Valence bond theory for H2. Bonding in molecular system, Angular momentum of diatomic molecules, Vibrational spectra of diatomic molecules: Harmonic and Anharmonic oscillator, selection rules. Rotational spectra of diatomic molecules: Rigid rotator and non-rigid rotator, Selection rules.

Infrared spectra of linear molecules – Characteristic, Raman Shift, Experimental setup and its theoretical explanation.

LCAO – Linear Combination of Atomic Orbitals.

MO – Molecular Orbitals.

Electron-Atom Collisions

Theory of Electron scattering (general principles), Cross section for elastic scattering and excitation of atoms to discrete levels.

Lasers and their applications

General Principles: Einstein coefficients, Population inversion, Line broadening mechanism, Saturation behavior of homogeneously and in-homogeneously broadening transitions, Optical resonators, Quality factor, ultimate line width of the laser.

Properties of laser light, Temporal and Spatial coherence, Ruby laser Helium-Neon Laser, Semiconductor laser.

Books Recommended:

1. Introduction to Atomic Spectra – H. E. White
2. Introduction to Atomic Spectra – H. G. Kuhn
3. Physics of Atoms and Molecules – Brandsen and Joachain
4. 4. Molecular Spectra – Banewel
5. Molecular Spectra – Hezberg
6. Lasers – Theory and Applications – Thyagrajan & Ghatak
7. Lasers (theory & Applications) – D. K. Barauh
8. Principle of Laser – O. Svello

103 –ANALOG AND DIGITAL ELECTRONICS

Analog Electronics

OP-AMP: Functional block diagram, DC and AC analysis of differential amplifier. CMRR, current mirror circuit, level translator, emitter follower, output stage, offset current and voltage, slew-rate, inverting and non-inverting configuration for op-amp and their characterization.

Application of OP-AMP

Summimg and difference amplifier, differentiator, integratorm, multiplication and, Log and Antilog amplifier, Active filters and voltage regulator.

Comparator, Schmitt trigger, Astable and monostable multivibrators using op op-amp.

555 Timer: Functional block diagram, monostable and astable multivibrators.

Digital Electronics

Number systems (binary, octal and hexadecimal) and their arithmetic, BCD, ASCII, and gray codes.

Review of basic logic gates, laws and theorems of Boolean algebra, 4-variable K-map, Algebric and K-map simplifications, Code Conversions.

Implementation of DTL, TTL & ECL, logic family, decoder, encoder, multiplexer, de-multiplexer, BCD to seven segment decoder, parity generatoe/checker, magnitude comparator, serial and parallel adder, implementation of binary addition, subtraction, multipilation and division, ALU.

1-bit Memory circuit, Flip-Flops: clocked S. R., J-K, race-around problem, Master-slave, D- and T-type, Shift-registers, Ripple counter, Decade Counter, synchronous binary counter, up/down counter, D/S-converter, Weighted Register Type and ladder ype, A/D-converter: successive approximation type.

Books Recommended:

1. Integrated circuit – Milliman and Halkias
2. Physics of semiconductor Device – S. M. Sze
3. Op-amp and linear Integrated circuit – Gayakwad
4. Digital Fundamental – Floyed
5. Digital Electronics – R. P. Jain
6. Linear Integrated Circuit – Choudhary & Jain
7. Functional Electronics – K. V. Ramanam

104 –Optics and Allied Experiments

1. To determine the wave length of monochromatic radiation by using Bi-prism on optical bench.
2. To determine the wave length of monochromatic radiation by using a Bi-mirror on optical branch.
3. To determine the wave length of monochromatic radiation by using a Bi-prism on spectrometer.
4. To determine the wave length of monochromatic radiation by using a single slit on spectrometer.
5. To determine the wave length of monochromatic radiation by using single slit, narrow wire straight edge on optical bench.
6. To determine (i) the wave length of D-lines, (ii) thickness of mica sheet, using Michelson's interferometers.
7. Measurement of wave length by Fabry-Perot Etalon.
8. Resolving power of (a) grating (b) prism.
9. Verification of Frensel's laws for polarized light.
10. To analyse elliptically polarized light using Babinefs compensator.
11. Zeeman-effect.
12. Verification of Einstein's Photoelectric equation and determination of Plank's constant.

201 –QUANTUM MECHANICS

General Principle

Linear vector space, Hibert space, Bra and Ket vectors, Linear operators, Hermitian and unitary operators Dirac delta function.

Representation

General principle of representation Coordinate, momentum nd energy representations, Momentum and position operators in momentum representation, Schrodinger and Heigenberg interactions pictures, Matrix representation of state vector and dynamical variable, One dimensional Harmonic oscillator by matrix mechanics.

Angular Momentum

General treatment, Eigen value and Eigen Ket of Angular momentum, Matrices of angular momentum, Spin angular momentum, Pauli spinorts, Addition of spin and orbital angular momentum, Clebsch Gordon Coefficient.

Theory of Potential Scattering (Non-Coulomb potential)

Kinematics of quantum scattering process, Centre of mass frame and laboratory frame, Scattering amplitude by the methods of Green's function, Born's approximation, Partial wave analysis, Optical theorem and expression for phase shift.

Approximation Methods

Time independent perturbation theory (degenerate and non-degenerate) cases, Simple application, First order stark effect, Zeemam levels of alkali metals, L-S coupling, Variational methods and its application to ground states of Hydrogen and Helium atoms. W. K. B. Approximation and its applications.

Symmetry and Conservation Laws

Transitional symmetry and conservation of linear angular momentum, Rotational symmetry and conservation of angular momentum, Time Translation and energy conservation, Ground state problem, Time dependent perturbation theory, Transition probability for constant and harmonic perturbation.

Relativistic Wave-Mechanics

K. G. equation for free particle, K. G. equation solution for coulomb field, Dirac-equation, Dirac matric, Free particle solution and negative energy states (anti-particles), Spin and magnetic moment of Dirac particle, Dirac Covariance, gamma matrices, projection operators, bilinear covariant, two-component theory of neutrino.

Books Recommended:

1. Quantum Mechanics - L. I. Schift
2. Modern Quantum Mechanics - J. J. Sakurai
3. Introduced to Quantum Mechanics - D. J. Griffiths
4. Principles of Quantum Mechanics - P. A. M. Dirac
5. Quantum Mechanics - G. P. Singh
6. Quantum Mechanics I – Grainer, Springer – Verlog (Berlin)
7. Quantum Mechanics - G. Aruldas
8. Quantum Mechanics - Shanker
9. Quantum Mechanics - Satya Prakash
10. Quantum Mechanics - Ashok Das
11. Quantum Mechanics - S. N. Biswas
12. Relativistic Quantum Mechanics - J. D. Bjoken and S. D. Drell
13. Relativistic Quantum Field - J. D. Bjoken and S. D. Drell
14. A first book on Quantum Field Theory – Amitabh Lahari and P. B. Pal
15. Modern Quantum Mechanics - J. J. Shankar
16. Principles of Quantum Mechanics - R. Shankar
17. Quantum Mechanics - S. N. Biswas
18. Quantum Mechanics – II – Grainer Springer – Verlog (Berlin)

202 –ONDENSED MATTER PHYSICS

Free electron theory of metals

Free election model, density of available electron states D (E), effect of temperature on the parameters of free electron gas, thermal capacity of fee electron systems, Hall effect, Magneto-resistance effects, Failure of free electron theory.

Band Theory of Metals

Bloch theory, Kroning-Penny model, Effective mass, Nearly free electron approximation, the tight-binding approximation, calculation of energy bands, Brillouin Zones, Fermi Surfaces, Density of states, limit of band theory: metal-insulator transition.

Magnetism

Quantum theory of diamagnetism, paramagnetism and ferromagnetism, natiferromagnetism, ferrimagnetism, ferrites, exchange interaction, spin waves and its quantization, thermal excitation of magnons and $T^{3/2}$ law, charge density waves, spin glasses, Kondo effect (elementary treatment).

Superconductivity

Phenomenon of superconductivity, effects that destroy superconductivity, magnetic properties and Meissner effect, phenomenological theory, London's equations, the BCS theory and Cooper pairs.

Super fluidity

Super fluidity and two fluidy theory, the theory of Bose-Einstein condensation, Landau's theory, First, Second, Third and Fourth sound, Ground state properties of liquid ^{4}He, Pairing theory of liquid ^{4}He, Liquid ^{4}He, normal and super fluid phase of Liquid ^{4}He, Landau theory of Fermi liquid, Zero-Sound.

Books Recommended:

1. Solid state Physics - A. J. Deeker
2. Introduction to Solid state Physics- C. Kittel
3. Elementary Solid State Physics- J. P. Srivastava
4. Elementary Solid State Physics - M. Ali Omar
5. Solid State Physics - S. O. Pillai
6. Solid State Physics - S. L. Kakani & C. Hemrajan (S. Chand & Sons, New Delhi)
7. Intermediate Quantum Theory of crystalline Solids – A. O. E. Animation (Prentice Hall India Pvt. Ltd.), New Delhi
8. Superconductivity and Superliquidity – John Telliy & Telliy
9. An Introduction to Liquid Helium- J. Wilks (Clarendon Presss Oxford)
10. Theory of Soild - A. H. Wilson
11. Solid State Physics - M. A. Waheb

203 (a) –RELATIVITY

Special Theory

Lorentz transformation as orthogonal transformation, Infinitesimal, Lorentz transformation, invariance of Maxwel equation under Lorentz transformation, Transformation properties of field quantities, Covariant equation of motion of particle in electromagnetic field, energy momentum tensor, Lineard-Wichardt Potential, Radiation from a moving charged particle (uniform and accelerated).

General Theory

The equivalence principle, Accelerated observer, Conservation Laws, Derivation of Einstein equation, Newtonian Limit, Schwar-child solution, Precession of perihelion of Mercury, Deflection of light, Gravitational red-shift, Use of Mossabuer reffect, Gravitational collapse, Black hole, Model of Universe, Einstein static model, de-sitter model, Hubble constant.

203 (B) Plasma Physics Introduction

Review of plasma properties,Plasma oscillation, Debye shielding, Debye Lengthh, Plasma conditions.

Kinetic and Fluid Models Plasma

Phase space, distribution function, Number density and average velocity, Boltzman equation, Effect of collisions, Derivation of transport equations: Continuity and momentum equations (Closure scheme).

Boltzman-Vlasov equation, Development of dispersion relation for longitudinal electron waves, Landau damping, Basic equations of MHD plasma, Magnetic diffusion, Magnetic pressure, Magnetic viscosity, Reynolds number, Development of dispersion relation for MHD waves and Alfven velocity.

Plasma waves

Development of dispersion relation in warm collisional magneto-plasma, Cut-off and resonance for the electromagnetic wave propagation parallel and perpendicular to magnetic field (Appleton-Hartree formula) in the ionosphere, Deduction of Whistler mode of wave propagation, Determination of plasma parameters in the ionosphere.

Plasma Production

Production of low temperature plasma in laboratory, Theory of Longmuir probe, Measurement of plasma number density and temperature.

Fusion reaction and high temperature plasma, Lawson’s criterion, Elementary ideas of plasma confinement scheme at high temperature (Tokomak machine).

Books Recommended:

1. Special theory of relativity - Patheria
2. Relativity and Cosmology - Weinberg
3. Space Plasma Physics - A. C. Das
4. Basic Space Plasma Physics - W. Maumjohau and R. A. Treumann
5. Introduction to Plasma Physics- R. j. Goldstein and P. H. Rutherford
6. Plasma Physics - F. Chen

204 –Electronics and Allied Experiments

1. Design and study of op-amp characteristics in operational modes and determination of work function.
2. Design and study of op-amp as integrator, differentiator, adder and substractor.
3. Design and study of multi vibrator using transistors.
4. Study the truth-table verification of various logic gates.
5. Design and study address (half and full) using logic gates.
6. Design and amplitude modulation process.
7. Design and study amplitude demodulation process.
8. Design and study R-C coupled amplifier using B. J. T.
9. Design and study of simple R. F. oscillator, (Hartley oscillator).
10. Study the characteristics of Bipolar Junction Transistor.
11. Study the characteristics of Junction Field Effect Transistor.
12. Design and study of a regulated power Supply.
13. Study of series and parallel resonant circuits, Dependence of Q or R and L C.
14. Study of constant K type low and high pass filters (T and Pi sections)
15. Use of oscilloscope to determine frequency and phase.
16. E.S.R. Spectrometer for Determination of Lande's factor.
17. Study of op-amp characteristics in Inverting and non-Inverting mode.

301 –NUCLEAR PHYSICS

Nuclear Radiation

Alpha Decay-alpha ray spectra, Gamow's theory of alpha decay, Geiger Nuttal law.

Beta Decay

Fermi theory of beta decay, selection rules, neutrino production and detection, non-conservation of parity.

Gamma Rays

Multiple gamma transition, selection rules, theory of internal conversion, interaction of gamma rays with matter, Mossbauer-effect.

Accelator Physics

Betatron, synchrocyclotron, proton synchrotron.

Theory of Nuclear Force and Nucleon-Nucleon Interactions

Theory of ground state of deuteron, Meson theory of nuclear forces, exchange forces, theory of low energy n-p and p-p scattering, effective range theory.

Nuclear Reaction

Kinematics of nuclear reaction, Reaction cross-section, compound nucleus hypotheisi, resonance, Berit-Wigner one level formula.

Nuclear Models

Liquid drop model, Semi-empirical mass formula, Bohr-wheeler theory of nuclear fission, Shell model, magic numbers, Schmidt lines, collective model and optical model.

Reactor Physics

Interaction of neutrons with matter Slowing down of fast neutrons, The fFermi Age equation, critically of reactors.

Fundamental Particles

Fundamental particles and classification schemes of particle. Charge Conjugation, Time reversal, Iso Spin and G parity operation and anociated conservation law, Quarks and Gluon's, Magnetic moments of nucleons and their measurements.

Books Recommended:

1. Atomic and Nuclear Physics – Ghosal
2. Nuclear Structure – Pal, M. K.
3. Introductory Nuclear Physics – Wong
4. Nuclear Structure – Preston and Bhaduri
5. Nuclear Physics – D. Tayal
6. Nuclear Physics – Roy and Nigam

302 (a) –STATISTICAL MECHANICS

Formulation of quantum statistics

Ensembles in quantum statistical mechanics, density matrix, quantum, Liouvile theorem.

Ideal Gas

Statistical thermodynamics of gas in various quantum mechanical ensembles.

Liquid Helium

The field of sound waves, Elementary excitation in liquid helium, Super fluidity in Liquid He II.

Interaction Sytem

Cluster expansion method for a quantum mechanical system. The binary collision method of Lee and Yang and its application to gases of interacting particles. Two body and N-body and pseudo potential methods. Low temperature behavior of an imperfect Fermi and Bose gases.

Phase Transition

Ising model, mean-field theory in zeroth and first approximation, exact solution in one dimension.

Fluctuation

Thermodynamics fluctuations, Langevin theory of Brownian motion, The Fokker-Planck equation.

Books Recommended:

1. Statistical Mechanics – Patheria
2. Statistical Mechanics – Haung
3. Statistical Mechanics – Landau & Lifshitz
4. Statistical Mechanics – M. C. Qurien
5. Statistical Mechanics – S. K. Sinha (TMH)
6. Statistical Mechanics – R. K. Srivastava & J. Ashok (PHI)

302 (b) –ASTROPHYSICS

Stars and their structure

Basic equation of equilibria, coordinates, mass distribution and gravitational field in spherical stars, conservation of momentum, stars in hydrostatic equilibrium, conservation of energy, transport of energy by radiation, conduction and convection, the chemical composition. The system of differential equations and boundary conditions for internal structure of normal stars, Jean's criteria, Stellar evolution and different stages of a star, Formation of prostostars and premainsequence contraction.

White Dwarf and Neutron

Degenerate Fermi gas, The degeneracy parameters, The number density as a function of Fermi momentum and energy, Critical number density, the non-relativistic (NR) and Ultrarelativistic (UR) approximation, Fundamental general relations, The pressure as a function of energy density and number density, Polytropic white dwarfs studied by means of Emden-Lane equation, Chandrashekhar's theory of white dwarfs, The neutron stars and their radius as a function of mass. Pulsars Black Holes – concept and theories.

Books Recommended:

1. Steller Structure and Evolution – R. Kippenhahn and A weigest (Spinner, 1996)
2. Modern Astrophysics – Canol and Ostlie (Addisou Klesley – 1996)
3. Principles of Steller Structure Vol I & II – J. P. cox and R.T. Giusli (Gordon and Breach 1996)
4. An Introduction to study of steller structure – S. Chandrashekhar (Dover 1968)
5. A Textbook of Astronomy and Astrophysics – U. B. Bhatia (Narosa, 2001)
6. Cosmology – Steven Weinberg (Oxford University, 2008)
7. Physical Universe – F. Shu (University Science Books, 1982)
8. Steller Interiors – D. Menzol, P.L. Bhatanagar & H. K. Sen (Chapman and Hall 1963)

303 (a) – COMPUTATIONAL PHYSICS

Computer Programming

Overview of Computer organization, Hardware, Software, Scientific Programming, FORTRAN, and Basic, Flow chart, integer and floating point, arithmetic expression, built in function, executable and non-executable statements, assignment, control and input/output statements, subroutines and functions.

Numerical Techniques

Roots of functions, bisection method, False position method, Newton-Raphson method (One variable) using derivative, Sorting.

Interpolation with evenly spaced and unevenly spaced points, curve fitting, polynomial least squares and cubic spline fitting, extrapolation, regression (Linear and quadratic).

Newton-Cotes formula, integration by trapezoid and Simpson's rule (1/3 and 3/8), Monte Carlo evaluation of integrals, Integration of initial value problems, Euler, Runge-Kutta and Varlet schemes, Finite difference method, Adam's method.

Random number generation, linear algebra and matrix manipulations, inversion, diagonalization, eigenvectors and eigenvalues, optimization.

Simulation Techniques

Monte Carlo methods, molecular dynamics, simulation of Ising model, simulation of time-dependent Schrodinger's equation.

Books Recommended:

1. V Rajaraman, Computer programming in Fortran 77 and Fortran 90.
2. D. W. Hermann, Computer simulation methods in Theoretical Physics.
3. H. Gould and J. Tobochnik, An introduction to computer simulation methods.
4. J. M. Jhissen, Computational Physics.
5. J. M. Carrol, Simulation using personal computers (PHI).
6. E. Balaguruswamy, Programming in Basic (TMH).
7. V. Rajaraman, Computer Oriented Numerical Methods (PHI, 1994)
8. Brian, W. Kenighan and Dennis M. Ritchie, C-Programming Language.
9. Balaguruswamy Programming in C.
10. S. Balachandra Rao and C. K. Shantha – Numerical Methods
11. E. Balaguruswamy, Numerical Methods.

303 (b) –MICROPROCESSORS

Architecture

Basic microcomputer architecture-System bus, memory and I/O devices, Architecture of 8085 and pin description, Machine cycles and their timing diagrams.

Programming of 8085

Instruction format, Instruction set classification – Data transfer instructions, Arithmetic and logical instructions, Program control instructions, machine control instructions, Addressing modes of 8085.

Interfacing

Memory interfacing, I/O interfacing, Special purpose programmable interfacing ICs 8253 (Programmable interval timer), 8255 (Programmable peripheral interface), 8259 (Programmable interrupt controller).

Other Microprocessors

8086 & 8088 architecture & pin description, real mode memory addressing, addressing modes and instruction set. Programming of 8086 & 8088

Books Recommended:

1. Microprocessor 8085 – R S Gaonkar
2. Microprocessor 8085 – B. Ram
3. Microprocessor 8086 – 80486 – Barry B Brey, PHI

304 –Microprocessor and Digital Electronics

1. Design and study of op-amp characteristics in operational modes.
2. Design nd study of Flip-Flops as a logic trainer.
3. Design and study of Adders (Half and Full) using logic gates.
4. Study of A/D and D/A converters.
5. Study the performance of characteristics of shift Register.
6. Write and test a program in assembly language to add 3 decimal numbersusing 8086 microprocessor.
7. Write and test a program in assembly language to add 16-bit numbers using 8086 microprocessor.
8. Measurement of frequency, phase, power factor, resistance and temperature using 8085 microprocessor.
9. Study of Phase-shift using cathode rayoscilloscope.
10. Study of Amplitude modulation and demodulation processes.
11. Study of different counting mode using counters.

401 (E) –COMMUNICATION ELECTRONICS-I

Signal, System and Noise:

Classification of Signal and its characterization, Energy and power spectral density, Impulse and step response functions, Time and frequency domain analysis of system, Ideal and Real filter and its responses. .

Noise in communication system, Representation of narrow band Noise, Noise equivalent bandwidth, Signal to noise ratio (SNR) and Noise figure.

Digital Signal Transmission

Analog to digital signal conversion, sampling theorem and pulse code modulation, Analog signal reconstruction, transmission bandwidth and output SNR, Generation and detection of differential puse code modulation (DPCM) and delta modulation.

Principle of Digital Data Transmission

Elements of digital communication system: multiplexer, line coder, regenerative repeater, power spectral density for line coding.

Digital Carrier System

Concept of base band and carrier system, Generation and detection of ASK, FSK and PSK Scheme. Brief idea about M-ray signaling scheme.

Digital Switching Technology

Concept of Asynchronous transfer mode (ATM), Brief idea about TDM, STATDM.

Books Recommended:

1. Electronics Communication – Roddy and Coolen
2. Microwave and Radar Engineering – M. Kulkarni
3. Communication Systems – Symon Haykin
4. Digital and Analog Communication – K. Son Shanmugam
5. Satellite Communication – Prattant Bostien
6. Electronic Communication – Prattanl Bosien
7. Modern Analog & Digital Communication System – B. P. Lathi
8. Introduction to Pulse & Digital Communication – Taub & Schilling
9. Advance Electronics Communication Systems – Wayne Tomasi (Printics Hall of India)

402 (E) –COMMUNICATION ELECTRONICS-II

Information Theory and Coding

Introduction, amount of information, average information, Shanon's encoding algorithm, communication channel, rate of information and capacity of discrete memoryless channel, Shanon Hartley theorem, Linear block codes, Binary Cyclic code and convolution codes.

Spread-Spectrum Modulation:

Pseudo noise (PN), sequences and its properties, model for base band carrier, transmission of PN signal.

Satellite Communication

Kepler Law, types of orbits and satellite, geosynchronous satellite, Attitude control, station keeping antenna, look angle, limit of visibility, frequency band and polarization, transponer satellite link modem, satellite link budget, digital carrier transmission multiple access method (TDM and TDMA).

Radar Communication:

BasicRadar System, Radar range equation, Radar performance factor, Radar Display, Moving target indication radar, CW radar.

Fiber Optics Communication:

Basic optical communication system, wave propagation in optical fiber media, step and graded index fiber, material deispersion and mode propagation losses in fiber, optical fiber source and detector, optical joints and coupler, digital optical fiber communication system, data communication networks.

Books Recommended:

1. Modern Analog & Digital Communication System – B. P. Lathi
2. Principles of Communication systems – Taub & Schiling
3. Communication System – Symon Haykin
4. Advance Electronics Communication System (Printies Hall of India) – Wayne Tomasi
5. Electronics Communication – Roddy and Coolen
6. Laser Theory and Application – Thyagrajan and Ghatak
7. Optical Fiber Communication – Kerinev
8. Communication Sytem – Symon Haykin
9. Electronic Communication Systems – G. Kennedy & B. Davis
10. Digital Communication – Tomasi

401 (S) – SOLID STATE PHYSICS-I

Lattice Waves and Electron States

Diffraction from crystal with lattice vibration, normal and Umklapp processes. The Debye-Waller factor, Anharmonicity and thermal expansion, Photon-photon interaction, One electron approximation. Hartee-Fock equation , Calculation of band structure by O.P.W. and A.P.W. methods.

Dynamic of Electron

Perturbation formalim Quantum theory of screening Lindhard's expression for wavelength and frequency dependent dielectric constant, Singularities in screening, Kohn effect, The Friedel sum rule.

Energy Band in Semiconductors

Transport behavior of excess carries The continuity equation, Drift mobility and Hayness Shockley experiment, Surface recombination and surface boundary conditions, Shockley-Read theory of recombination.

Optical properties of Solids

Complex refractive index, Kramers Kroning relations, Interaction with conduction electrons, Drude theory, The amomalus skin effect.

Integral Quantum Hall Effect

Quantization of Hall conductivity in 2D electron, localization and scaling, theoretical interpretation.

Fractional Quantum Hall Effect

Experimental results, Ground state of FQHE, Elementary excitation and off diagonal long-range order.

Superconductivity

B. C. S. theory of superconductivity, coper pairs Superconductivity ground state, energy gap and its determination, Josephson effect, theory of type-II superconductivity Ginzberg-Landau theory.

Books Recommended:

1. Principle of the theory of solids by – J. M. Ziman
2. Quantum Theory of Solids – C. Kittle
3. Intermediate Quantum theory of Crystalline Solids – A. O. W. Animative
4. Concepts of Solids (Lectures on the theory of Solids) – P. W. Anderson
5. Introduction to solid state theory – O. Madelung
6. The Quantum Hall effects R. E> Prange and S.M. Girvin (eds)

402 (S) – SOLID STATE PHYSICS-II

New Superconductors

Magnetic superconductors, Heavy-Fermion superconductor, Rare-earth transition metal Borocarbides, Sr_2RuO_4, MgB_2 (magnetism- de Boride), Quantum Spin ladder materials, Organic superconductors, Fullerene superconductor.

High Temperature Superconductivity

High temperature cuprate crystallographic structures, thermodynamic properties, magnetic properties, Hubbard models and Band structures, critical states, transport properties, Some application of high-temperature superconductor.

Nano Physics

Properties of individual nano clusters, magic numbers ,modeling of nano paticles, bulk to nano Transition, methods of synthesis: R.F. Plasma, chemical methods, thermolysis, puse laser method.

Carbon nanostructure, nature of carbon clusters, discovery of C^{60}, Structure of C^{60} Carbon Nanotubes: synthesis, electrical and mechanical properties.

Quantum wells, wires and dots, preparation of quantum nanostructure, size effects, conduction electrons and dimensionality, properties dependent on density of states

Books Recommended:

High-temperature superconductivity

1. High-temperature superconductivity – J. W. Lynn (Springer-Verlag Berlin)
2. Superconductivity – Charles P. Poole Jr. H. I. Farach and Richard J. Creswick (Academic Press-Londan 1995)
3. Advances in superconductivity – R. Pinto, S. K. Malik, A. K. Grover and P. Ayub (New Age International publication)
4. Solid State Physics – S. L. Kakani & C. Hemerajani (S. Chand Sons Pvt Ltd.)
5. Superconductivity Vol-I & Vol-II – R. D. Parkes (Marcel Dekker Int. New York 1969).

Nano-Physics

1. Introduction to Nanotechnology – Pool and Owgers
2. Quantum dots – Jack Hawrylak and Wojs
3. Introduction to Nanotechnology – Charles P. Pools, Frank J. Owens Wiley-inetrscience (2003)
4. Nanotechnology : Basic science and emerging technologies – Mick Wilson, Kamli Kannangava, Geoff Smith, Michelle Simmon, Burkhard Ragues (Overseas Press 2005)
5. Nano Materials – A. K. Banopadhyay (New Age International 2010)
6. Carbon Nanotubes, Synthesis, Structure, Properties and application M. S. Dresselhauss, G. Dresselhauss, Ph. Avouris (Eds.) (Springer – Verlag Berlin 2000)
7. The Hand Book of Nanotechnoogy Nanometer structure Theory, Modeling aand Simulations – Akhilesh Lakhtaka, (Edition SPIE – Press New York 2004)
8. NAno Technology (Principle and practical) – S. K. Kulkarni
9. Carbon Nanotubes – Silvana Fiovito
10. Nanotechnology – Richard Boooker and Earl Boysen

401 (N) – NUCLEAR AND PARTICLE PHYSICS

General Theory of Collision

S-matrix and T-matrix Lippmann Schwinger equation, Born series for S-matrix and T-matrix, Application to potential scattering of scalar particles. Born's and Eikonal approximations, Scattering cross section and decay constant in terms of T-matrix element, Analyticity of S-matrix, Reciprocity relation for S-matrix element and principle of detailed balance, Jost function, S-matrix in bounded states.

Dispersion relation, Relation to casuality Kramers-Kronin-relation, Dispersion relation for forward potential scattering amplitude. Mandelstaum representation, Mandelstaum variable and their application, Interaction picture and Dyson's covariant perturbation theory of S-matrix, Feynman graph and its simple applications (Mott scattering and Compton scattering).

QCD

Feynman rules for QCD, Quark-Quark Interaction, Charged weak interactions, Natural weak interactions, Electro-weak mixing (Glashow-Wienberg-Salaam model) standard model, MIT bag model.

Symmetry and Conservation Laws

General structure of Lie group, lie Algebra of SO (3) SU (2), Charge independence of nuclear forces, Lie Algebra of SU (3) and shift operators, Quark and SU (3), Smallest Su (3) representation SU (4), smallest SU (4) representation. Direct product of SU (3) multiplets, Abelian and Non-Abelian guage theory with example.

Books Recommended:

1. Relativistic Quantum Mechanics – Bjorken and Drell
2. Relativistic Quantum Mechanics – W. Greiner
3. Field Quantization – Griener and Reinhardt
4. Introduction to Elementary Particles – David Griffiths
5. Quarks and Leptons (An introductory course in Modern Particle Physics) – Francis Halzen & Alan D. Martin
6. Unitary symmetry and elementary particles – D. B. Lichtenberg
7. Quantum Mechanics Symmetries – W. Greiner and Berndt Muller.
8. Quantum field Theory – Ryder
9. Advanced Quantum Mechanics – P. Roman

402 (N) –FIELD THEORY AND QUANTUM ELECTRODYNAMICS

Classical field theory

Concept of system with infinite degrees of freedom. Classical fields, Langragian equation of motion, Hamiltonian Symmetries and invariance Principles, Noether's Theorem, (Statement and short derivation, applications stress tensor)

Field Quantization

Canonical quantization of scalar field, creation and annihilation operators and their communication reactions, Hamiltonian interpretation of the quantized field, Number operator, connection with harmonic oscillators.

Radiation Field

Classical Maxwell field, Gauge invariance, quantization of scalar field, Canonical quantization of vector fields.

Applications

Interaction of radiation with matter, (spontaneous & stimulated emission, absorption) Planck's Law, Thomson Scattering, Kramer-Heisenberg formula, and Rayleigh scattering from this formula, Coherent and Raman scattering, Theory of line width, Elementary Theory of photoelectric effect, Non-relativistic theory of Lamb shift, Elementary idea of mass renormalization.

Books Recommended:

1. Quantum Field Theory – L. H. Ryder
2. Relativistic Quantum Field – J. D. Brojken and S. D. Drel
3. An Introduction to Quantum Field Theory – F. Mandl and G. Shaw
4. An Introduction to Quantum Field Theory – M. Perkin and D. Schroader
5. Quantum Mechanics – S. N. Biswas

403 (E) –Communication electronics

1. Non linear application of OP amplifier.
2. Pam, PWM, and PPM Modulation and Demodulation .
3. PCM/delta modulation and demodulation
4. Experiments of MUX, DEMUX and decoder.
5. Study the performance characteristic, characteristic of shift register.
6. D/A Converter and temperature measurement with microprocessor8085/8086
7. A/D converter and AD/DC voltage/current measurement using microprocessor 8085/8086
8. Arithmetical operation using microprocessor 8085/8086.
9. To measure the numerical aperture of an optical fiber.
10. To set up an experiment for the transmission of analog and digital data.
11. Design and study of a experiment for operation of optical repeater.

404 (E)

Project and Dissertation

Based on topic of current interest

403 (S) –Solid State Physics

1. To measure resistivity of semiconductor sample by Four Probe method.
2. To calibrate the magnetic field of an electromagnet and to measure Hall-coefficient od a semiconducting material.
3. To determine the value of Lande'g Factor by ESR spectrometer.
4. To determine velocity of ultrasonic waves through different liquids by ultrasonic interferometer.
5. To study the effect of temeperature on the characteristics of transistor.
6. To study the characteristics of wave propagation in a wave guide by microwave bench.
7. To study the fully wave and half wave rectifier with different filters using crystal diode and to determine the ripple-factor.
8. Determination of magnetic parameters of ferromagnetic metarials by magnetic hysteresis loop tracer.
9. Measurement of magneto resistance of Bismuth.
10. To study the dielectric constant of a liquid by transistorized R. F. oscillators.
11. To study the colour centers obtained in alkali-halides.
12. To study lattice structure by lattice dynamics kit.

404 (S) Project + Dissertation in elective paper of 100 Marks

403 (N) –Nuclear and Particle Physics

1. To study the characteristics of G. M. Tube.
2. To determine the dead time G. M. Counter.
3. To measure the linear absorption co-efficient of Beta-particle in the given substance using G. M. Counter.
4. Experiments with magnetic field Beta-Spectrometer
    a. To plot the Beta-spectrum of C_2^{187} source.
    b. To determine the beta and point energy by Curie plot.
    c. To determine the binding energies in the K + L atomic Shell of B^{182}
5. To study the (emitter) follower amplifier.
6. To study the R. C. Coupled amplifier (transistorized)
7. Design and study of :
    a. Mono-stable multivibrator (integrating and differentiating circuits).
    b. A stable-multivibrator (integrating and differentiating circuits).
8. To calibrate the gamma ray spectrometer with Na detector using single channel analyzer.
9. To calculate the Gamma-ray spectrometer with Na detector using single channel analyzer and Using the above calibration curve –
    i. Plot the percentage resolution against energy.
    ii. Measure the Gamma energies of an unknown source
    iii. Determine energies of the Compton edge and back scattered peak in the gamma spectra. Compare the result with theoretical values.
    iv. Measure the intensities of gamma ray photo prok

403 (N)

Dissertation in Elective Paper and Topics of Current Interest