KHALLIKOTE AUTONOMOUS COLLEGE, BRAHMAPUR

Post Graduate Department of PHYSICS

M. Sc. First Semester Exam. – 2020-21 onwards
M. Sc. Second Semester Exam. – 2020-21 onwards
M. Sc. Third Semester Exam. – 2021-22 onwards
M. Sc. Fourth Semester Exam. – 2021-22 onwards

Introduction:

The P.G. Physics course shall comprise of four semesters, each consisting of five papers. Each paper carries 100 (hundred) marks out of which 80 (eighty) marks are earmarked for Term End Examination and 20 (twenty) marks are earmarked for internal assessment. Alternative questions shall be set from each unit. The candidates shall have to answer questions from all the units. The duration of the examination of each theory paper shall be three hours and practical papers shall be six hours.

COURSE STRUCTURE

First Semester

Paper	Topic	Full Marks
101	Classical Mechanics	80
102	Electrodynamics-I	80
103	Quantum Mechanics-I	80
104	Solid State Physics-I	80
105	Practical (Computational Physics)	100

Internal Assessment+ Home Assignment	80(40+40)

Second Semester

Paper	Topic	Full Marks
201	Mathematical Methods in Physics.	80
202	Electrodynamics-II & Plasma Physics	80
203	Quantum Mechanics-II	80
204	Solid State Physics-II	80
205	Practical (Optics, Electricity & Magnetism & Electronics)	100
Seminar +Viva		80(40+40)

Third Semester

Paper	Topic	Full Marks
301	Statistical Mechanics-I	80
302	Nuclear Physics-I	80
303	Relativistic Quantum Mechanics	80
304	Special Paper (Electronics)-I	80
305	Practical (Modern Physics)	100
Internal Assessment+ Home Assignment		80(40+40)

Fourth Semester

Paper	Topic	Full Marks
401	Statistical Mechanics-II	80
402	Nuclear Physics-II & Particle Physics	80
403	Quantum field Theory	80
404	Special Paper (Electronics)-II	80
405	Practical (Special Paper) Electronics	100
Seminar +Viva		80(40+40)

FIRST SEMESTER

P – 101
Classical Mechanics

Marks: 100
Duration: 3 hrs.

Unit - I 20 Marks

Rigid body motion, The independent coordinates of a rigid body, orthogonal transformation. Eulerian angles. Infinitesimal rotation, Rate of change of vector, the Coriolis force. Angular momentum and kinetic energy of motion about a point. The inertia tensor and the angular momentum of a rigid body. The heavy symmetrical top with one point fixed.

Unit - II 20 Marks

Legender transformation and the Hamilton's equation of motion from a variational principle, conservation theorem and the physical significance of Hamiltonian. The principle of least action.

Unit - III 20 Marks

The equation of canonical transformation. Example of canonical transformation. The integral invariant of Poincare. Lagrange and Poission Bracket as canonical invariant, the equation of motion in Poission Bracket's notation, the infinitesimal contact transformations.

Unit - IV 20 Marks

The Hamilton Jacobi equation for Hamilton's principal function. The harmonic oscillator problem as an example of H.J. Method, Kepler problem.

Small oscillations, formulations of the problem, the eigenvalue equation and the principal axis transformations, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Classical Mechanics - Goldstein
2. Mathematical Physics - Satya Prakash

P – 102
Electrodynamics - I

Marks: 100
Duration: 3 hrs.

Unit - I 20 Marks

Inhomogeneous wave equation : The wave equations for the potentials, solution by Fourier analysis, the radiation fields, radiation energy, radiation from monochromatic source - centerfed linear antenna

Unit - II 20 Marks

Electric and magnetic field due to an oscillating dipole, power radiated by a dipole. Wave guides and resonant cavities: Cylindrical cavities and wave guides, mode in a rectangular wave guide, resonant cavities.

Unit - III 20 Marks

Radiation by a moving charge: The L.W. potentials, the fields due to a charge in uniform motion, Direct solution of the wave equation.
Radiation from an accelerated charge: Fields of an accelerated charge, Radiation at low velocity

Unit - IV 20 Marks

Total power radiated by an accelerated charge, Larmor's formula, Angular distribution of radiation power from an accelerated charge. The cases of acceleration parallel to velocity and perpendicular to velocity.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Classical Electro dynamics - J.D. Jackson.
2. Classical Electricity and Magnetism - Panofsky & Phillips
3. Electrodynamics - Gupta, Kumar and Singh
4. Electromagnetic theory & Electro dynamics - Chopra & Agrawal
5. Classical Electro dynamics - S.P. Puri

P – 103
QUANTUM MECHANICS - I

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I General Principles of Quantum Mechanics 20 Marks

Linear vector space, ket and Bra vectors, scalar product of vectors. The Kronecker and Dirac delta function. Linear Operators, Adjoint, Unitary Operators, Expectation values of dynamical variables and physical interpretation, Hermitian Operators. Eigen Values and eigen vector, Orthonormality of eigen vectors, Probability interpretation, Degeneracy, Schmidt method of orthogonalisation. Representation of Ket and bra vectors and operators in matrix form, Unitary transformations of basis vector and operators.

Unit – II Quantum dynamics 20 Marks

Schrödinger's Equation of time, evolution of quantum states, Schrödinger picture, Heisenberg picture, Interaction picture, Equation of motion.

Operator formalism

Postulates of quantum mechanics, operator method solution of Harmonic oscillator, Matrix representation and time evolution of creation. annihilation operators.

Unit – III Orbital Angular Momentum: 20 Marks

Orbital angular momentum operators L_x,L_y,L_z and L^2 and their commutation relations, L_x,L_y,L_z and L^2 in Spherical Polar Coordinate. Eigen value of L^2 and L_z with respect to Spherical harmonics, Raising and Lowering operators, Orbital angular momentum wave function, Matrix representation of L^2, L_x,L_y,L_z, L_+ and L_-, Angular momentum on generators of rotation.

Unit – IV Spin - angular momentum: 20 Marks

Spin 1/2 Particles, Pauli-spin matrices and their properties, eigen values and eigen functions, Spinor transformations under rotation.

Addition of angular momenta

Total angular momentum $\vec{J}$. Eigen value problem of J_Z & J^2, Angular momentum matrices, Addition of angular momenta, Clebsch Gordon Coefficients and their values for $J_1 = 1/2$, $J_2 = ½$ and $J_1=1$ and $J_2= 1/2$.

Home Assignment 20 Marks

BOOKS RECOMMENDED

1. Quantum Physics - S. Gasiorowicz
2. Quantum Mechanics - L. I. Schiff
3. Introduction to Q M. - R. H. Dicke & J.P. Wittke
4. Advanced Q.M. - P. Roman

P – 104
SOLID STATE PHYSICS - I

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I Band Theory 20 Marks

Bloch's theorem, wave equation of an electron in a periodic potential, Kronig-penney model, Origin of band gap, Nearly free electron model, Brillouin zones for square and cubic lattices, zone schemes, Classification of solids (Conductors, Semiconductors and Insulators).

Unit - II 20 Marks

Energy Bands: General properties of Energy bands, Properties of Bloch functions, Tight Binding methods, Oorthogonalised plane waves, Pseudopotential methods of energy band calculations, de-Haas-van Alphen effect.

Unit – III 20 Marks

Representation Theory and Semiconductor: Wannier functions, equation of motion in Wannier representation, Equivalent Hamiltonian and impurity levels, Intrinsic and extrinsic semiconductor, Laws of mass action and Hall effect, Intrinsic carrier concentration, Mobility in the intrinsic region.

Unit – IV Magnetism 20 Marks

Diamagnetism: Langevins theory of diamagnetism, Quantum theory of diamagnetism of core electrons, Landau diamagnetism of conduction electrons, Paramagnetism: Quantum theory of Paramagnetism and Langevin's theory.

Home Assignment 20 Marks

BOOKS RECOMMENDED

1. Solid State Physics - Aschroft and Mermin
2. Solid State Physics - A. Omar
3. Solid State Physics - A.J. Dekker
4. Introduction to Solid State Physics - C. Kittel

5. Solid State Physics - A.O.E.Animalu
6. Physics of Semiconductor Devices - Michael Shur (PHI).
7. Quantum theory of Solids - C. Kittel.

P – 105
PRACTICAL

Marks: 100
Duration: 3 hrs.

Computational Physics:

a) Preliminaries of running computers taking out print out etc.
b) Exercises to study various features of C-Language.

SECOND SEMESTER

P – 201
Mathematical Methods of Physics

Marks: 100
Duration: 3 hrs.

Unit - I Complex variables and Delta function 20 Marks

Multivalued function. Branch point & branch cut, simple conformal mapping and applications, Schwartz-Christoffel transformation, Dirac delta function and its properties.

Unit - II Special Functions 20 Marks

Hypergeometric and confluent Hypergeometric equation by generating function method and their properties. Solutions of inhomogeneous partial differential equations by Green's function method.

Unit - III Tensors 20 Marks

Covariant, contravariant and mixed tensors, rank of a tensor, symmetric and antisymmetric tensors, invariant tensor, epsilon tensor, pseudo tensors, properties of tensor, metric tensor, raising and lowering of tensors, covariant derivative, christoffel symbols.

Unit - IV Group Theory 20 Marks

Definition, subgroups and classes, Cayley's theorem, group representation characters. Reducible and irreducible representation of SU (2) and O (3) group.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Mathematical Methods for Physicists - Arfken
2. Mathematical Methods of Physics - Mathews and Walker
3. Mathematical Physics - Satya Prakash
4. Mathematical Physics - P.K. Chattopadhyay

P – 202
Electrodynamics & Plasma Physics - II

Marks: 100
Duration: 3 hrs.

Unit - I 20 Marks

Radiation, scattering dispersion and diffraction: Radiative damping of a charged harmonic oscillator, forced vibrations, scattering by an individual free electron (Thomson scattering) and by a bound electron (Rayleigh scattering) Dispersion in gases (Lorentz-theory) Normal and Anomalous dispersion, causality and dispersion relation.

Unit - II 20 Marks

Kramer - Kronig relation, Kirchoff's formulation of diffraction, diffraction by a circular aperture. Covariant Formulation: Four vector notation, Relativistic particle kinematics and dynamics.

Unit - III 20 Marks

Covariant form of Maxwell's equation(four vector and tensor form), Maxwell field tensor, covariant definition of electromagnetic energy and momentum, transformation of electromagnetic field components, Lagrangian of a charged particle in an external electromagnetic field.

Unit - IV 20 Marks

Plasma: An Introduction, Conditions for plasma existence. Occurrence of plasma. Charged particle in electric & magnetic fields: (1) Charged particle in uniform constant electric field, (2)Charged particle in homogeneous magnetic field, (3) Charged particle in simultaneous magnetic field and electric field, (4) Charged particle in non-homogeneous magnetic field. Magneto hydrodynamics.Magnetic confinement - Pinch effect. Instabilities in pinched plasma column. Plasma waves.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Electrodynamics - Gupta, Kumar and Singh
2. Electromagnetic theory & Electro dynamics - Chopra & Agrawal
3. Classical Electro dynamics - S.P. Puri
4. Electromagnetic Theory & Electrodynamics - Satya Prakash

5. Plasma Physics by - Chen.
6. Foundations of Electromagnetic theory - Reitz, Milford & Christry.

P – 203
QUANTUM MECHANICS-II

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I Central Forces 20 Marks

Hydrogen atom, Parity, Reduction to equivalent one body problem, Radial equation, Energy eigen values and eigen functions. Degeneracy, Radial probability distribution, The free particle problem, Expression of plane waves interims of spherical waves, Bound states of 3D square well, Particle in a sphere.

Unit – II Approximation methods 20 Marks

Time independent perturbation theory (Non degenrate and degenrate), Removal of degenracy, Linear and quadratic Stark effect. Normal and anomalous Zeeman effect, Fine structure of spectral lines of H-Like atoms.

Unit - III 20 Marks

Variational method: Ground state of the He-atom WKB method, Connection formulae, Bohr-Sommerfeld quantization rule, Time dependent perturbation theory, Fermi golden rule, Harmonic perturbation and constant perturbation, Einstein Aand B coefficients.

Unit – IV Scattering 20 Marks

Scattering amplitude and cross section, Born approximation, Application to coulomb and Screened coulomb potentials.

Partial wave analysis for elastic and inelastic scattering, optical theorem, Scattering from a hard sphere.

Home Assignment 20 Marks

BOOKS RECOMMENDED

1. Quantum Physics - S. Gasiorowicz
2. Quantum Mechanics - L. I. Schiff
3. Introduction to Q M. - R. H. Dicke & J.P. Wittke
4. Advanced Q.M. - P. Roman

P – 204
SOLID STATE PHYSICS - II

Marks: 100 (80+20)
Duration: 3 hrs.

Unit - I 20 Marks

Ferromagnetism: Exchange integral and origin of ferromagnetism, Ferromagnetic order, Mean field approximation, Curie-Weiss law, spin waves and magnons, Block $T^{3/2}$ Law, Antiferromagnetic orders, Neel temperature.

Unit - II 20 Marks

Imperfections in crystals- Classification, Schottky defects, Frenkel defects, Extrinsic vacancies, diffusion through solids, colour centers.

Unit – III Super Conductivity 20 Marks

Experimental survey, Meissner effect, Type I and Type II superconductors, thermodynamics of super conductors, London's theory, Josephson effect. Cooper pair and BCS theory of super conductivity.

Unit – IV Solid State Devices 20 Marks

Tunnel diode, Solar cells, photo voltaic detectors and cells, Schottky barriers, gun effect oscillators, photo diode, photo resistors, Infrared and ultraviolet detector, Avalanche photodiode, photo transistor.

Home Assignment 20 Marks

BOOKS RECOMMENDED

1. Solid State Physics - Aschroft and Mermin
2. Solid State Physics - A. Omar
3. Solid State Physics - A.J. Dekker
4. Introduction to Solid State Physics - C. Kittel
5. Solid State Physics - A.O.E.Animalu
6. Physics of semiconductor devices - Michael Shur (PHI).
7. Quantum theory of solids - C. Kittel.

P – 205
PRACTICAL

Marks: 100
Duration: 3 hrs.

Optics, Electricity, Magnetism and Electronics

1. Experiments with Ballistic Galvanometer
   - i) Determination of constants of the Galvanometer by:
     - a) Hibbert magnetic standard
     - b) Solenoid Inductor
     - c) Condensor discharge method
   - ii) Measurement of magnetic field by search coil
2. Anderson's Bridge
3. Heaviside Bridge
4. Maxwell's Bridge
5. Carey-Foster Bridge
6. Rayleigh's Bridge
7. Owen's Bridge
8. Dielectric Constant of a liquid by electrically maintained tuning fork.
9. B-H Curve, Oscilloscopic display
10. Characteristics of vacuum tubes and transistors.
    - i) Diode, Triode and Pentode
11. Setting up an oscillator (A.F. & R.F.)
12. Setting up of an amplifier and study of its characteristics.
13. Setting of power supply
14. L C R Bridge
15. Michelson Interferometer
16. Fabry parot Interferometer.
17. Babimet's Compensator
18. Bimirror
19. Straight edge.

THIRD SEMESTER

P – 301
STATISTICAL MECHANICS - I

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I Classical Statistical Mechanics 20 Marks

Postulates of classical statistical mechanics, Liouville's theorem, Microcanonical ensemble, Derivation of thermodynamics, Equipartition theorem, classical ideal gas, Gibb's paradox.

Unit - II 20 Marks

Canonical ensemble and energy fluctuation, Grand canonical ensemble and density fluctuation, Equivalence of canonical and grand canonical ensemble.

Unit–III Quantum Statistical Mechanics 20 Marks

Postulates of Quantum statistical mechanics, The density matrix, Ensembles in quantum statistical mechanics.

Unit - IV 20 Marks

Third law of thermodynamics, Ideal gas in microcanonical, canonical and Grand canonical ensemble.

Internal Assessment (Seminar) 20 Marks

BOOKS RECOMMENDED

1. Statistical Mechanics - K. Huang
2. Statistical Mechanics - R.K. Patharia

P – 302
NUCLEAR PHYSICS - I

Marks: 100 (80+20)
Duration: 3 hrs.

Unit - I 20 Marks

Introduction: Brief discussion of Nuclear properties, The two body nuclear problem, the deuteron (ground and excited state), tensor forces, magnetic and quadrupole moments of deuteron, Exchange property of nuclear force.

Unit - II 20 Marks

Neutron proton scattering at low energies, scattering cross-section, scattering length, spin dependence of neutron-proton scattering. Effective range theory.

Unit - III 20 Marks

Semi empirical mass formula. Nuclear models, extreme single particle model, magic numbers, shell model, predictions of spin, parities, magnetic moments of nuclei Elementary ideas of rotational and vibrational levels.

Unit - IV 20 Marks

Nuclear fusion, Nuclear fission: Elementary ideas of fission and liquid drop model (Bohr and Wheeler theory), Nuclear disintegration studies: α decay, Gamow's theory of α decay, Geiger - Nuttal law, α ray energies and fine structure of α rays

Internal Assessment (Seminar) 20 Marks

BOOKS RECOMMENDED

1. Introductory Nuclear theory - Elton
2. Nuclear Physics - Roy and Nigam
3. Nuclear Physics - D.C. Tayal
4. Theoretical Nuclear Physics - Blatt & Weisskopf.
5. Atomic and Nuclear Physics Vol - II by - Ghoshal.
6. Introduction to Nuclear Physics - H.A. Enge.
7. Theory of Nuclear Structure - M.K. Pal
8. Introductory Nuclear Physics - Y. R. Waghmare.
9. Particle Physics - Qnnes
10. Elementary Particle Physics - Longo

P -303
RELATIVISTIC QUANTUM MECHANICS

Marks: 100 (80+20)
Duration: 3 hrs.

Unit - I 20 Marks

Klein – Gordon equation, continuity equation and probability density, K.G. particles in an e.m. field, Dirac equation and properties of Dirac matrices, Solutions of Dirac equation for a free particle, states with positive and negative enrgy, Dirac's hole theory, Bispinor plane-wave amplitudes u and v, Spin states,Helicity,projection operators for energy and spin.

Unit - II 20 Marks

Non-relativistic correspondence, Gordon's decompoition, Existence of spin for electron, total angular momentum, zitter bewiing, Spin-orbit coupling energy, Covariant form of K.G.equation and Dirac equation, Algebra of Dirac gamma matrices.

Unit - III 20 Marks

Dirac equation for a particle in external spherically symmetric field, Stationary states, Separation of angular and radial variables, Solution of radial equation in the case of Coulomb potential, Energy Spectrum of hydrogen-like atom, Degree of degenracy and fine structure of energy levels.

Unit - IV 20 Marks

Equivalence of representations, Standard repreentation, Trace identities, Invariance of Dirac equation under proper Lorentz transformations, Space inversion,time inversion, charge conjuction,bilinear covariants.

Internal Assesment 20 Marks

BOOKS RECOMMENDED

1. Relativitic Qquantum Mechanics – Jorken and Drell
2. Relativitic Qquantum Mechanics – J.G. Sackurai.

P – 304
Special Paper (Electronics) - I

Marks: 100 (80+20)
Duration: 3 hrs.

Unit - I 20 Marks
Feedback amplifiers - series current and voltage feedback amplifier, Oscillators: Negative resistance oscillators - dynatron tunnel – diodes.

Unit - II 20 Marks
Modulation: Amplitude modulation, frequency modulation and phase modulation, Collector modulated class amplifier, outline of AM and FM transmitters, Demodulation: diode detectors, FM detection Discriminator-ratio detectors.

Unit–III Digital Electronics and Operational Amplifiers 20 Marks
Operational amplifier - inverting, non inverting and differential operational amplifiers-measurement of operational amplifier parameters, A/D and D/A convertors - Basic idea of digital modulation.

Unit – IV Microwaves and Antenna theory 20 Marks
Microwaves - principle of velocity modulation theory and operation of Klystron. Magnetron. Characteristic of micro wave diodes and cavity resonator, AFC (Automatic Frequency Control) of micro waves.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Operational Amplifier - Trunde
2. Digital Principles and Application - Malvino
3. Functional Electronics - Ramana
4. Microwave Technology - Sarkar
5. Hand Book of electronics - Gupta and Kumar

P – 305
PRACTICAL (MODERN PHYSICS)

Marks: 100
Duration: 6 hrs.

(Each examinee has to pickup one experiment by lot)

1. e/m by Millikan's oil drop experiment
2. e/m by various methods: a) Braun Tube method b) Magnetron valve method c) Helical method
3. Determination of 'h' by various methods: a) Photoelectric effect method b) Total Radiation Method using optical Pyrometers
4. Measurement of velocity of light and dielectric constant by Lecher wire.
5. G. M. counter experiments: a) Determination of characteristics of Geiger tube b) Determination of absorption coefficient
6. Study of liquids by ultrasonic spectrometer Velocity of ultrasonic waves in liquids
7. Verification of Richardson's Law-Thermionic emission.
8. Determination of magnetic susceptibility of different samples by Helmholtz coil method.
9. Setting up and studying an amplifier.
10. Study of Mossbauer Effect.

FOURTH SEMESTER

P – 401
STATISTICAL MECHANICS - II

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I Ideal Fermi gas 20 Marks

Equation of state of an Ideal Fermigas, Theory of white dwarf stars, Landau diamagnetism, Pauli para magnetism.

Unit – II Ideal Bose gas 20 Marks

Ideal Bose gas, Photons and Plank's law, phonons and Debye's theory of specific heat, Bose-Einstein condensation, liquid He.

Unit - III 20 Marks

Phase Transitions: Landau theory of phasetransition, Theory of YANG and Lee, condensation of vander Waals gas.

Unit - IV 20 Marks

The Ising Model: Definition of the Ising model, One-dimensional Ising model.

Internal Assessment (Seminar) 20 Marks

BOOKS RECOMMENDED

1. Statistical Mechanics - K. Huang
2. Statistical Mechanics - R.K. Patharia

P – 402
NUCLEAR PHYSICS & PARTICLE PHYSICS - II

Marks: 100 (80+20)
Duration: 3 hrs.

Unit - I 20 Marks

β decay, Fermi's theory of β decay, Kurie plot and β - ray spectrum, Parity violation of - decay, allowed and forbidden transitions, selection rules, γ transition, interaction of γ rays with matter, Pair production, internal conversions.

Unit - II 20 Marks

Nuclear reaction, reaction energetics, Q-value equation. Direct compound nuclear reaction.

Mechanism: Cross sections in terms of partial wave, amplitudes. Compound nucleus - Scattering matrix, Reciprocity theorem - Breit Wigner one level formula Resonance Seattering.

Unit - III Particle Physics 20 Marks

Classification of elementary particles and different types of interaction, Conservation laws, Baryon Number, Lepton number, Gellmann Nishijma scheme, isospin and isospin quantum numbers, Hypercharge, strangeness.

Unit - IV Particle Physics 20 Marks

Invariance principles and symmetries, conservation of parity, charge conjugation symmetry, time reversal, CPT theorem and its consequence, elementary ideas about quark model, Color quantum number, SU(3) symmetry, Baryon and Meson octet.

Internal Assessment (Seminar) 20 Marks

BOOKS RECOMMENDED

1. Introductory Nuclear theory - Elton
2. Nuclear Physics - Roy and Nigam
3. Nuclear Physics - D.C. Tayal
4. Theoretical Nuclear Physics - Blatt & Weisskopf.
5. Atomic and Nuclear Physics Vol - II by - Ghoshal.
6. Introduction to Nuclear Physics by - H.A. Enge.
7. Theory of Nuclear structure by - M.K. Pal

8. Introductory Nuclear Physics by - Y. R. Waghmare.
9. Particle Physics - Qnnes
10. Elementary Particle Physics – Longo

P -403
QUANTUM FIELD THEORY

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I 20 Marks

Lagrange formatism for relativistic classical field: Variation principle and Euler – Lagrange equations, Definition of field, Second quantization, Symmetrics and conservation laws, Noether's theorem, energy-momentum tensor, angular momentum.

Unit - II 20 Marks

Lagrangian density for Klein – Gordon, Dirac and Maxwell fields, Internal symmetry, Invariance under phase transformations and conservation of vector current(charge), Local gauge transformations.

Unit - III 20 Marks

Quantization of free fields and particle interpretation: Real and Complex K – G field, Canonical quantization and commutation relations for creation and annihilation operators, Energy, momentum and charge of the quantized field, Dirac field, positivity of energy and anticommutation relations, Bosons and Fermions, antiparticles, Relativisitic covariance of canonical quantization.

Unit - IV 20 Marks

Interaction of quantized fields: Unequal space-time commutation and anti-commutation relations, Properties of delta function and its integral representations, vacuum expection value, normal order, Time-ordered product, Dyson's chronological product and Wick's chronological product, S-matrix, Wick's theorem, Feynman diagram and Rules, electron-photon interaction, Compton Scattering, Coulomb Scattering.

Internal Assesment 20 Marks

BOOKS RECOMMENDED

1. Quantum Field Theory – Itzykson and Zuber
2. Quantum Field Theory – L. H. Ryder
3. Quantum Field Theory - Schweber
4. Quantum Field Theory – Mandel and Shaw

P – 404
Special Paper (Electronics) -II

Marks: 100 (80+20)
Duration: 3 hrs.

Unit – I Antenna theory 20 Marks

Radiations from doublet antenna, Radiation field of a dipole vertical wire antenna, image antennas, Directivity of antenna array, Yogi and Rhombic antenna, Radiation resistance and power impedance matching.

Unit – II Quantum Electronics 20 Marks

Fibre optics - Principles of optical communication.

Basic Principle of Maser action, spontaneous and stimulated emission - important Maser devices optical masers (Lasers) Laser oscillation condition and population inversion - Oscillation frequency, uses of Lasers.

Unit – III Theory of Lasers and Laser Systems 20 Marks

Einstein's prediction and relations, conditions for stimulated emission and light amplifications. Line shape function, population inversion, Metastable states, Pumping schemes amplification and gain. Critical population inversion, Conditions for steady state Oscillation, cavity resonance line broadening, Gain saturation and gain band width modes, properties of laser modes, laser rate equation.

Unit - IV 20 Marks

Types of Lasers - Solid state & gas lasers, Dye laser semiconductor laser, Free electron laser.

Internal Assessment 20 Marks

BOOKS RECOMMENDED

1. Fibre Optics and Optoelectronics - R.P. Khare
2. Microwave Principle - Reich

3. An introduction to Laser - M.N. Avadhanulu
4. Laser Fundamentals - William, S.Chand & Co. selfvast.
5. Optical Electronics - Yariv
6. Physics of Semiconductor Devices - Michael Shur (PHI).

P – 405

PRACTICAL(Special Paper (Electronics))

Marks: 100
Duration: 3 hrs.

Each student must complete at least fifteen experiments with electron tubes.
(Each examinee has to pick up one experiment by lot).

1. Study of two stage RC amplifier with frequency compensator.
2. Study of two stage tuned r. f. amplifier.
3. Study of negative feed back amplifier.
4. Study of square wave response of a video amplifier.
5. Study of VTVM
6. Study of Q meter
7. Copitt's Oscillator
8. An Hortley Oscillator
9. Study of gates.
10. Zener diode.

Experiment with Transistor:

11. F E T Characteristics
12. Study of input and output resistance in amplifiers.
13. Study of Bloc3king oscillator.
14. Study of TRF receiver and signal tracer.
15. Study of Pulse generation
16. Study of scaling units.
17. Study of clipping and clamping circuits.
18. Study of Video amplifier

Design and Construction of:

19. Scaling Unit
20. Preamplifier
21. Public address system amplifier.
22. Phase sensitive detector.
23. Pulse generator.
24. Noise generator.
25. Narrow band width amplifiers.
26. study of Oscilloscope & plotting of A.C. cycle using analog instrument.

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