MAHATMA GANDHI UNIVERSITY

Ph.D COURSE WORK IN PHYSICS

COURSE II – RECENT DEVELOPMENTS IN PHYSICS

Unit I:

X-ray diffraction methods, Free electron theory in 3 dimensions, Fermi-Dirac distribution, Electrical conductivity and ohms law, Motion in magnetic fields-Hall effect, origin of energy gap, Kronig-Penny model, effective masses of electrons and holes in semiconductors, intrinsic carrier concentration, mobility, impurity conductivity, thermal ionization of donor and acceptor, Excitons: Frenkel and Mott-Wannier excitons, diamagnetism, paramagnetism, quantum theory or paramagnetism, Ferromagnetism: Ferromagnetic order-Curie point and exchange integral - spin waves - Ferromagnetic domains - coercivity and hysteresis, Ferroelectricity **(reference 1)** single domain particles: blocking temperature – superparamagnetism **(reference 2)**

(16 hours)

Unit II:

Optical processes in semiconductors-Electron-hole pair formation and recombination-radiative and no radiative recombination-band to band recombination, Absorption in semiconductors, indirect intrinsic transitions-exciton absorption, donor-acceptor and impurity-band absorption, low energy absorption, stokes shift in optical transitions of semiconductors, Near bandgap radiative transitions- Exciton recombination - Band to band recombination - donor acceptor and impurity band transitions, deep level transitions (reference 3)

Nonlinear optics- second order and third order non linear phenomena, propagation of electromagnetic wave through nonlinear media, second harmonic generation, optical parametric oscillator and four wave mixing. Two photon absorption, Stimulated Raman Scattering, Coherent anti-Stokes Raman scattering, **(reference 4, 5, 6)**

(16 hours)

Unit III

Nuclear Physics: Particle Physics: The quark model - Colored quarks and gluons – Reaction and decays in the quark model – Charm beauty and truth, quark dynamics, Grand unified theories. **(reference 7)**

Astrophysics: Cosmology, redshift and the expansion of the universe, Matter density in the universe and the deceleration parameter, The perfect cosmological principle, Fundamental equations of cosmology, Some important models of the universe – The static model of Einstein – The Lemaitre Universe- The Friedmann model – The Steady state Universe – The Scalar-tensor theory, Observation tests of cosmological models **(reference 8)**

(16 hours)

Unit IV:

Classical Mechanics:- Relativistic field theories- examples of relativistic field theories, Noether's Theorem **(reference 9) Statistical Mechanics:-** The Boltzmann Transport Equation –H Theorem **(reference 10), Quantum Field Theory -** Klein-Gordon Equation – K-G interpretation of negative energies, Dirac Equation- conserved current- interpretation of negative energy **(reference 11) Electrodynamics:-** Structure of spacetime, space-time diagrams, Relativistic Electrodynamics-Magnetism as a relativistic phenomenon, How the field transforms, electromagnetic field tensor **(reference 12)**

(16 hours)

References:-

Unit I

1. Introduction to Solid State Physics (7^{th} edition) - Charles Kittel
2. Magnetism in condensed matter (Oxford) - Stephen Blundell

Unit II

3. Semiconductor optoelectronic devices (2^{nd} edition) - P. Bhattacharya
4. Non-linear Optics - N. Bloembergen
5. Contemporary nonlinear optics - G P Agarwal and R R Boyd
6. Molecular Structure and Spectroscopy - G. Aruldhas

Unit III

7. Introductory Nuclear Physics - Kenneth S Krane
8. An Introduction to Astrophysics - Baidyanath Basu

Unit IV

9. Classical Mechanics (2^{nd} edition) - Herbert Goldstein
10. Fundamentals of Statistical Mechanics - B. B. Laud
11. Moder Quantum Mechanics (2^{nd} edition) - J J Sakurai and J Napolitano
12. Introduction to Electrodynamics (3^{rd} edition) - David j. Griffiths