SCHOOL OF PURE & APPLIED PHYSICS

MAHATMA GANDHI UNIVERSITY
KOTTAYAM

Ph.D COURSE WORK

SYLLABUS

(All the papers have four credits each)

Paper I. GENERAL PHYSICS

Paper II. RESEARCH METHODOLOGY

Paper III. SPECIALISATION:-

Paper	Supervisor
Foundations of Classical and Quantum Mechanics	Dr. Moncy V.John
Machine Learning Theory And Applications	Dr. Sajeeth Ninan Philip
Thin Film physics	Dr. Sunny Mathew & Dr. Raichel Reena Philip
Amorphous Materials and Glassy Thin films	Dr. Shajo Sebastian
Applied Photonics	Dr. N V Unnikrishnan & Dr. P R Biju
Nano Materials	Dr. E M Muhammed
Crystalline Materials	Dr. Cyriac Joseph
Biomaterials and sensors	Dr. C Sudarsana Kumar
Structure and Dynamics of Biomolecule	Dr. C Sudarsana Kumar

GENERAL PHYSICS

Unit I

Physics of Solitons:-
Non-topological solitons – the K-dV equation, solution of the K-dV equation, conservation rules, nonlinear electrical lines, blood pressure waves.
Topological solitons – the sine-Gordon equation, chain of coupled pendula, solution of the sine-Gordon equation
Envelope solitons and nonlinear localization - the nonlinear Schroedinger equation, properties of the NLS equation, Noether's theorem, nonlinear electrical lines
Modelling process – ion acoustic waves in a plasma, study of the linear dynamics, nonlinear study, derivation of the NLS equation, experimental observations.

(15 hours)

Unit II

Classical Mechanics:- Noether's Theorem -KAM Theorem- Quantum Mechanics:- Path Integral,Formulation of Quantum Mechanics – Statistical Mechanics:- The Boltzmann Transport Equation –H Theorem – Classical Field Theory:- Power Radiated from a Point Charge -Einstein Equation –Quantum Field Theory -Klein -Gordon Equation – Dirac Equation – Mathematical Methods for Physics:- Sturm Liouville Theory and Green's Functions

(15 hours)

Unit III

Laser resonator theory. Single and multimode operation of lasers. Q-switching and mode locking. Kerr lens mode locking. Principle of heterostrucure lasers, analysis of modal gain, threshold current density. Electromagnetic formulation of second harmonic generation. Non linear wave equation, self focusing phenomenon. Non linearity in optical fibres. Pulse compression mechanism. Optical parametric amplifiers and oscillators-Double resonant and single resonant oscillators.

(15 hours)

Unit IV

X-ray diffractometry, Fundamental of X-ray diffraction,Powder diffraction method,Quantitative determination of phases, strain and particle size.Scanning Probe Microscopy and Scanning. Tunneling Microscopy(Basic principle and applications) Atomic Force Microscopy (AFM) Basic principle and applications. Optical Microscopy, SEM & TEM (Operational principle) Instrumentations and application for analysis. UV-Vis-NIR Spectrophotometry, Principle of operation and applications for band gap measurements, FTIR Spectroscopy Basic principle and applications of **FTIR** spectroscopy

(15 hours)

References:-

Unit I

Unit II

Classical Mechanics Goldstein
Classical Mechanics Rana & Joag
Classical Theory of Fields Landau & Lifshitz
Chaos and Integrability in Nonlinear Dynamics Tabor
Quantum Mechanics Greiner
Quantum Field Theory Itszykson & Zuber
Statistical Mechanics Kerson Huang
Mathematical Methods in Classical & Quantum Physics Tulsi Dass &

Unit III

Principles of Lasers	Svelto
Quantum Electronics	Yariv
Principles on Non-linear Optics	Y. R. Shen
Non-linear Optics	N. Bloembergen
Optical Electronics	A. K. Ghatak & K. Thyagarajan
Semiconductor Optoelectronic Devices	Pallabh Bhattacharya

Unit IV

Scanning Probe Microscopy: Analytical Methods (NanoScience and Technology):- Roland Wiesendanger
Advanced X-ray Techniques in Research and Industries:- A. K. Singh (Editor)
X-Ray Diffraction Procedures: For Polycrystalline and Amorphous Materials, 2nd Edition:- Harold P. Klug, Leroy E. Alexander
Transmission Electron Microscopy: A Textbook for Materials Science (4-Vol Set):- David B. Williams and C. Barry Carter
Introduction of X-ray Crystallography:- M.M. Woolfson
Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AFM – Ray:- F. Egerton

Research Methodology

Unit I: Definition of problem and presentation of results

Overview of research methods involved – Identification of the problem, literature survey for assessing the current status, journals, books, making hypothesis and model building, testing a hypothesis for acceptance or rejection.
Introduction to presentation – poster, journals article, seminar, synopsis writing, Thesis writing.

Unit II : Mathematical methods

Complex numbers, Taylor series, Laurent series, singularities. Residue theorem. Evaluation of definite integrals, integral transforms, Greens function Fourier series and Fourier transforms, Laplace transforms. Generalized Distribution functions.

Unit III : Numerical Methods

Interpolation – Interpolating polynomials with difference operators, Interpolation with equal and unequal intervals.Numerical differentiation – Derivatives with interpolation formula. Numerical Integration – Newton Cote's formula, Trapezoidal rule, Simpson's rule. Numerical solution of ordinary differential equations – Euler's method, Runge-Kutta method, Predictor-Corrector methods. Numerical solution of partial differential equations.

Unit IV: Computational Tools

Introduction and scope of various programming techniques like FORTRAN, C, C++. Mathematica, Matlab – packages like LaTeX, Word, Power Point, Excel
Data Analysis – Systematic errors, plotting of error bars, Plotting, curve fitting.

References:-

Numerical Algorithms E.V.Krishnamuirthy & S.K.Sen

Numerical Methods E.Balaguruswamy

Introductory Methods of Numerical Analysis Sastry

Numerical Recipes Press, Flannery, Teukolsky, Vetterling

Programming with C++ J.R.Hubbard Schaum's Outline Series

C++ Primer Plus Stephen Prata 1992 Galgotia Publications New Delhi

Object Oriented Programming with C++ E.Balguruswamy