DEPARTMENT OF APPLIED PHYSICS

INDIAN SCHOOL OF MINES, DHANBAD

COURSE STRUCTURE & SYLLABUS

FOR

1-YEAR M.PHIL.

IN

APPLIED PHYSICS

Effective from 2007-2008

Course structure for M.Phil. (Applied Physics)

First Semester

Core Course	L T P	Credit Hours
1. (i) Object Oriented Programming and Advanced Numerical Methods (AMC 61104)	4 0 0	8
(ii) Object oriented programming and Advanced Numerical Methods Practical (AMC 61204)	0 0 2	2
2. (i) Digital Electronics (EIR 13101)	3 0 0	6
(ii) Digital Circuits Lab (EIC 13202)	0 0 3	3
Optional course (any two)		
1. (i) Solid State Electronics & Devices (APE 61101)	4 0 0	8
(ii) Solid State Electronics & Devices Practical (APE 61201)	0 0 2	2
2. Laser and Non-linear optics (APE 61102)	4 2 0	10
3. (i) Material Science and Engineering (APE 61103)	4 0 0	8
(ii) Material Science and Engineering Practical (APE 61203)	0 0 2	2
Seminar I (APC 61401) (on a subject of student choice)	0 0 0	3
	Total	**42**

Second Semester

1.	Seminar-II (APC 62401)	4
2.	Dissertation (APC 62801)	26
3.	Viva – voce (External) (APC 62501)	10
	Total	**40**

(AMC61104) OBJECT ORIENTED PROGRAMMING & ADVANCED NUMERICAL METHODS PROGRAMMING (4-0-0)

Part A. Computer Programming

OOPs: Basic concepts of OOPs: CC^{++} preliminaries. data types, arrays, function classes and objects, constructors and destructors, function overloading, operator overloading and Type conversions: inheritance, pointers polymorphism, console oriented I/O operations, file management, templates, exception handing.

JAVA: Introduction to Java.

Part B: Advanced Numerical Methods

Review of solution of system of linear simultaneous equation. Solution of tridiagonal system. III conditioned system and iterative method to improve accuracy of an ill conditioned system. Evaluation of double and triple integrals by numerical method and its application, solution of non-linear simultaneous equations, Numerical solution of integral equations, Advanced method of interpolation, Spline interpolation. Numerical solution of simultaneous first order ordinary differential equations and higher order O.D.E. (Initial and Boundary value problems). Numerical solution of partial differential equations. Laplace and Poissons equation. Heat conduction and wave equations. Writing computer program of the above methods in F– 77.

(EIR 13101) DIGITAL ELECTRONICS (3-0-0)

Boolean algebra, logic gates and switching functions, truth tables and switching expressions; Minimization of completely and incompletely specified functions - Karnaugh map and Quine-McCluskey method;

Decoders, Multiplexers, Clocks, Flip-flops, Latches, Counters, and shift registers, synthesis of synchronous sequential circuits, minimization and state assignment;

Timing circuits

(APE 61101) SOLID STATE ELECTRONICS & DEVICES (4-0-0)

Crystal Lattice Dynamics:

Vibrations of monoatomic lattices, vibrations of lattice with two atoms per unit cell, quantisation of lattice vibrations, interaction of electromagnetic waves and particle waves with phonons.

Dielectric properties:

Static, electronic, ionic and orientational polarization, Lorentz internal field, dielectric loss and relaxation time, absorption of solids including coal and rocks., Piezo, Pyro, Ferro electric properties and applications.

Superconductivity and Devices:

Phenomenon of superconductivity, Meissner effect, heat capacity and energy gap of superconductors, London equation, BCS theory, Bose-Einstein's condensation, Laser cooling, Super Conducting Quantum Interference Devices (SQUIDS).

Semi-conductor Devices :

Charge carrier density in intrinsic semiconductors, doping of semi-conductors, carrier densities in doped semiconductors, conductivity of semiconductors, Hall effect, (classical and quantum), semi-conductor Hetro-structures and Super lattices. P.N. junction, metal – semiconductor junction, Transistors, MOS devices, Photoconductor, photovoltaic detector, LED, PIN – diode lasers.

Opto-electronic Properties:

Lattice imperfections, equilibrium concentration of point defects, diffusion, color centers, luminescence, geometry of dislocations, interaction between dislocations, mechanism of dislocation multiplication, Color-center Laser applications.

Material Preparation and Characterization:

Crystal growing. After-growth quality improvement, Thin film deposition and Electro-ceramics, Analytical techniques like X-ray diffraction, Infra-red and Atomic absorption spectroscopy, Synthesis & characterisation of Nano-materials and properties, CVD, MBE.

(APE 61102) LASER AND NON-LINEAR OPTICS (4-2-0)

Basics of Laser:
Spontaneous and stimulated Emission, Absorption, Laser idea & characteristics.

Properties of Laser Beams:
Monochromaticity, Coherence – first order & higher order, Directionality, Brightness, Laser speckles.

Pumping processes:
Pumping schemes, Optical pumping, Electrical pumping.

Beams & Resonators:
Plane Parallel resonator, Spherical resonator, Stable and unstable resonators, Gaussian beams & propagation, Directionality.

Types of Lasers:
Solid State Lasers - Ruby Laser and Nd-YAG Laser, Titanium sapphire laser, Gas Lasers - Neutral atom gas Lasers, Ion Lasers, Molecular Gas Lasers, Excimer Lasers, Dye Lasers, Chemical Lasers, Semiconductor Lasers, Free-electron laser.

Applications of Lasers:
Fiber-optics, Holography, Optical data Processing, Laser surgery Instrumentation Distance, Direction, Velocity.

Nonlinear Optics:
Introduction, Polarisability, hyperpolarisability and other higher order polarisability tensors, Nonlinear optical processes – 2^{nd} harmonic generations, sum-frequency & difference – frequency generation, Nonlinear optic crystals, Stimulated Raman and hyper-Raman processes, Higher order Raman processes, multi-wave mixing processes, Applications of nonlinear optical processes in spectroscopy.

(APE 61103) MATERIAL SCIENCE AND ENGINEERING (4-0-0)

A. X-RAY & CRYSTALLOGRAPHY (50 Marks)

X–ray emission and absorption spectra, Fine structure of absorption edges (recent theories) Chemical effects in X-ray spectra, Soft X-ray spectroscopy of the solid state, X-ray fluorescence and analysis, X-ray photoelectron Spectroscopy and its applications, Auger Spectroscopy radiation and its applications, Advanced techniques of X- ray spectroscopy. Point groups and space groups, Reciprocal lattice, structure factors, X-ray methods of crystal structure analysis, structure of metals, alloys and minerals- diffraction of X-ray by solids, crystal orientation.

B. PHYSICS OF ROCKS AND MINERALS (50 Marks)

General
Minerals and rocks as solid state of matter, Structure and properties of rocks, Diamond Fullerences.

Physical Properties
(Mechanical, Electrical, Thermal, Optical, Acoustical Properties and Radiation effects)
Elastic behaviour of rocks, strength of rocks, plastic and rheological properties of rocks. Thermal parameters of rocks, Acoustic properties of rocks. Employment of acousties in mining industry. Ultrasonic techniques, Rocks and Minerals as dielectrics, Polarization, Dielectric constant, dielectric relaxation. Electrical conductivity. Breakdown of dielectric, Piezo, Pyro, Ferro, Triboelectric effects, UV and IR transmission, example quartz, Chalcopyrites as Non-linear devices.

Physical techniques
Elements of thermal analysis of minerals, XRD, DTA, DSC, Infrared spectroscopy in rocks and minerals, tracers techniques, Nuclear techniques. Laser microsample analysis, Anvil cell for change of structure.

(AMC 61204) OBJECT ORIENTED PROGRAMMING & ADVANCED NUMERICAL METHODS PROGRAMMING PRACTICAL (0-0-2)

Part A. Computer Programming Practical

Execution of programs using the following:
Control Structures, Arrays: Function subroutine and Subroutine subprogram, File Processing.

Part B. Advanced Numerical Methods Practical

Solution of tridiagonal system, solution of simultaneous non-linear equations, Iteration and Newton Raphson methods. Solution of simultaneous first order O.D.E. higher order O.D.E. by Range- Kutta and Miline's methods, Solution of Laplace and Poisson equation. Solution of heat conduction equations and Solution of wave equations.

(EIC 13202) DIGITAL CIRCUITS LAB (0-0-3)

1. Verification of IC 7400 and implementation of standard Gates
2. Realisation of Boolean expressions using only NAND gates
3. Binary adder
4. Binary Subtractor
5. BCD adder
6. Binary Comparator
7. Cascading of MUX
8. Latches and Flip-Flops using Gates and ICs
9. Counters
10. Multivibrators using NE555

(APE 61201) SOLID STATE ELECTRONICS & DEVICES PRACTICAL (0-0-2)

Typical experiments on Thermally Stimulated Luminescence studies of solids, Electrical conductivity studies of semi-conducting materials, Thermal conductivity of insulating materials, Dielectric properties of insulating materials, X-ray emission & absorption studies and crystal structure analysis.

(APE 61203) MATERIALS SCIENCE & ENGINEERING PRACTICAL (0-0-2)

Typical experiments on study of X-ray emission spectrum of copper, tungsten etc., Study of absorption edge of Cu in tungsten spectra, Crystal structure analysis by Debye-Scherrer Powder method, Study of dielectric properties, thermal conductivity and electrical conductivity of rocks, minerals and coal.