Ch. Charan Singh University, Meerut
DEPARTMENT OF PHYSICS

Syllabus
for
Master of Philosophy (M.Phil)
(Physics)

w.e.f
Academic Session 2010-11 and Onward

Course Offered
Experimental Techniques in Physics (Code: MP PHYS-101) 100
Unified Theory of Nucleus (Code: MP PHYS-102) 100
Atomic Collision Theory (Code: MP-PHYS-103) 100
Advanced Microelectronics Processing (Code: MP PHYS-104) 100
Computer Programming in Fortran 77 (Code: MP PHYS-105) 100
Quantum Field Theory (Code: MP PHYS-106) 100
Project Thesis

Notes:
1. **60- Lectures** of 1-Hour Duration shall comprise each Theory Course.
2. Each Semester shall comprise of 2- Credit Course. There shall be 12-Lecture per week for theory teaching. Any 4-Courses out of 6-courses listed above will be offered during the 2-semester depending upon availability of the expert faculty.
3. Each Course is of 100 Marks. Student will be evaluated with semester end Examination (External) for 80 Marks and 20 Marks Internal assessments by the Course Instructor through quiz/seminar/assignments.
4. Student will compulsorily engage themselves in project thesis work for 6-Hours per week.
5. Student is required to secure 75% attendance in each theory course to qualify for appearing in Semester End Examination.
M.Phil. Physics (Course no.-1) Experimental Techniques in Physics

Vacuum Science: Introduction, Important areas of applications, Gas kinetics, Gas flow, Viscous, molecular and transition flow regimes, Vacuum technology-pumping speed, throughput & pumpdown time, Measurements of pressure, Production of vacuum-Mechanical pump, Diffusion pump, Getter and Ion pumps, Cryopumps, High vacuum and Ultra high vacuum systems.

Materials preparation Techniques: Fundamentals of Film growth, Physical Vapor Deposition (PVD)- Evaporation, Flash evaporation, Electron beam evaporation, Laser evaporation technique, arc evaporation, Molecular beam epitaxy (MBE), Sputtering, Chemical Vapor Deposition (CVD), PECVD, Characterization of thin films, Properties and applications of Thin films, Synthesis of NSM's, Top down and Bottom up approaches, Crystal Growth techniques.

Spectroscopic studies: Basic components of spectrograph, Raman spectrometer, Spectroscopic techniques: Study of Transmission, Absorption and Reflection spectra, Determination of thickness, refractive index, energy band gap of semiconductor thin films, Auger Electron spectroscopy (AES).

Electrical and Magnetic properties: Conductivity Measurements, Dielectric measurements, Molecular mechanism of polarization, Structure and dielectric response of molecules, Behavior of dielectrics in alternating fields, Frequency dependence of the several contribution of the polarizability, Dipolar relaxation, Dielectric losses, Hall Effect, Quantum Hall effect, Susceptibility Measurements.


References:

2. Introduction to Solid State Physics by Charles Kittel.
4. Dielectric Materials and Application by Von Hippel.
7. Methods of Experimental Physics, Vol. 17, Editor L. Marton.
8. Experiments in Modern Physics by H. Mark and N. Thomas Olson.
M.Phil Course No.2: Unified Theory of Nucleus

Introductory Treatment of Various Microscopic Methods: The Microscopic structure of the nucleus; Multinucleon systems, the method of second quantization; Hartree-Fock Methods; The random phase approximation; The Bethe-Goldstone equation; Brueckner Theory; Rotation states in deformed nuclei and other collective modes; the Unified model; Two-nucleon interactions.

Cluster Representation of Nuclear States: Oscillator cluster representation, qualitative discussion of alpha cluster states in nuclei; generalized cluster wave functions, effects of antisymmetrization, Jacobi coordinates parameter coordinates Jastrow factors.

The Resonating Group Method (RGM): Reformulation of the Schrodinger equation as a projection equation; basis wavefunctions in cluster representation; derivation of coupled equations channel calculations; complex generator coordinate technique; solution of the RGM equations for bound states and scattering. Simple applications such as neutron-deuteron scattering and the alpha plus neutron system.

The Generator coordinate Method (GCM): Basis wave functions in the GCM; Hill-Wheeler equations and equivalence between, RGM and GCM; methods for the solution of Hill-Wheeler equation, computation Techniques; the orthogonality condition model; Simple applications, alpha-alpha scattering using R-Matrix method.

Further Applications of RGM and GCM: Briet-Wigner Formulae; Optical Model potential by RGM; Two-channel calculation for five nucleon system and its reduction to plane wave approximation; collective states in Be nucleus.

References

1. Theoretical Nuclear Physics, Vol. 1 by Amos de Shalit and Herman Feshbach.
2. Theoretical Nuclear Physics-Blatt and Weisskopf.
M.Phil COURSE No.3: ATOMIC COLLISION THEORY


Electron-Atom scattering: Basic scattering equation, Role of Pauli exclusion principle, High energy (Weak interaction) approximation, Glauber, Born, Bethe, Born-Oppenheimer, Ochur, Ochur-Rudge approximations, Low energy approximations, close coupling, pseudo-state expansion and polarized orbital methods, adiabatic and non-adiabatic polarization potentials, semiclassical exchange potential, intermediate energy approximation, plane wave, optical eikonal Born series methods, non-spherical potentials, Elastic and inelastic scattering of electrons by H and H₂ molecules.

Polarization effects in electron scattering: Concept of polarized electrons, pure spin states, density matrices and polarization, scattering of relativistic electrons with spin by a central field, Polarization and Lorentz transformation, Sherman function, Left-right asymmetry, the role of spin polarization in scattering and simple physical description of polarization phenomena, Polarization phenomena in elastic and inelastic exchange scattering, Møller scattering, Fano effect, Autoionizing transitions and multiphoton ionization, Collisional ionization of polarized atoms, Penning ionization.

Textbooks and Reference Books

Quantum collision Theory by C.J.Joachain
Theory of collisions of electrons with atoms and molecules by S.P.Khare
Topics in Atomic Collision by S.Geltman
Electrons and Photons interaction with atoms ed. Kleppickep and McDowell
Atomic Collision Theory by Bransden
Theory of Ion-Atom Collision by McDaniel and McDowell
Polarizes Electrons by Kessler
Theory of Atomic Collisions by Mott and Massey
Potential scattering by Burke
M.Phil Course No. 4 - Advanced Microelectronic Processing*


Relevant techniques in advanced metallization, including process requirements for gigabit devices, state of the art metal deposition approaches, multi-level interconnects, ultra-thin diffusion barrier technology, advanced dielectrics, metal-dielectric integration, MEMS (microelectromechanical systems) and microelectronic technology and applications. Material issues for MEMS/microelectronics, microsensors, microactuators.

Text Book:
3. VLSI Fabrication Principles by S.K. Ghandhi; VLSI Technology editor S.M. Sze
4. Device Electronics for Integrated Circuits by R.S. Muller and T.I. Kamins
5. MOS Physics and Technology by E.H. Nicollian and J.R. Brews
7. 

* This course has been introduced from Academic session 2004-05 second semester.
Introduction to computer programming languages, algorithm, flow chart, FORTRAN language fundamentals, FORTRAN character set, constants and variables, IMPLICIT and EXPLICIT type statements, expressions and assignment statements, arithmetic expressions, arithmetic assignment statement, character expression and character assignment, logical expressions, problems due to rounding of real numbers, mixed mode expressions, special functions.

Input/Output statements: List directed I/O statements, format directed I/O statements, FORMAT statement, lw, Fw.d, Ew.d, Gw.d, Wx, slash(/), Aw,Lw specifications, specifications for carriage control of line printer

Control statements: relational operators, unconditional, computed and assigned GO TO statements, arithmetic IF statement, logical IF statement, structured IF statement, DO statements, STOP, RETURN and END statements.

Subscripted variables: use of multiple subscripts, subscript expressions, DIMENSION statement, DO type notation for I/O statements.

Subprograms: Program structure, main program, statement function, function subprograms, subroutines, CALL statement, COMMON statement, labeled COMMON statement, placement of array elements in COMMON, EQUIVALENCE statement.

Files and general I/O statements, OPEN statement, CLOSE statement, DATA statement, double precision facility, use of complex quantities.

Simple Computer programs for numerical integration, matrix operations, straight line curve fitting, solution of ordinary differential equations by Runge Kutta Method.

Books Recommended

Computer Programming in FORTRAN 77 by V. Rajaraman
Computer Programming and Numerical Analysis by N. Datta
M Phil Course 6 QUANTUM FIELD THEORY


Relativistic Wave Equations: The Klein-Gordon Equation, SU(2) and O(3), SL(2,C) and Lorentz Groups, Dirac and Weyl Equations, Prediction of Antiparticles, Dirac Spinors; Algebra of \( \gamma \)-Materials, Non Relativistic Limit of Dirac Equations, Poincare, Group, Maxwell and Proca Equations, Maxwell Equations and Differential Geometry.


TEXT BOOKS AND REFERENCES:

2. A.Lahiri and P.B.Pal; Quantum Field Theory, Narosa Publishing house ,New Delhi, 2001