M.Phil Course Syllabus (2010-2011)

TECHNIQUES IN THEORETICAL PHYSICS

PHYS. 611 40+12=52 Hrs.

M. Mrks: 30+70-100

Note: The question paper for end semester examination will consist of seven questions of equal marks. The first question will be compulsory and will consist of several short questions/problems covering the entire syllabus. The candidates will attempt five questions in all including the compulsory question.

Solitons and Chaos:

Discovery of solitary waves and soliton interactions, Importance of solitons, KdV equation and its elementary solutions. Solitons in field theories. Chaos and its examples, parameters, one dimensional maps.

Theoretical Techniques in Particle Physics:

Covariant Perturbation theory, Feynman Rules for spin 0 and spin ½ particles and their applications /Like groups: SU(2), SU(3) and SU(5) and their applications : Higgs Mechanism and Goldstone theorem and its application in gauge theories.

Theoretical Techniques In Nuclear Physics

Review of static properties, binding energy, density, nuclear forces, and potentials, shell model, collective models and energy levels, Hartree-Fock theory of nuclear shape and states with good J Quantum number and applications, correlations in nuclear matter and exclusive principle correlations, Bethe-Goldstone equation and G-matrix, heavy-ion physics at low and intermediate energies, simulations and QMD model, hot and dense matter and multi fragmentation.

Special Topics * Models for multi-bound complex systems Nuclear structure at higher angular momentum.

* to be covered depending upon the availability of relevant experts.

Theoretical Techniques in Condensed Matter Physics:

Theory of NMR techniques, Theory of Anharmonic solids, Theory of Liquid state. BCS theory.

TUTORIALS: Problems relevant to the topics covered in the course.

Books recommended:

1. Solitons an Introduction by P.G. Drazin and R.S. Johan (Cambridge Univ. Press, 1989)
2. Chaos in Dynamical Systems by E. Ott (Cambridge Univ., Press, 1993)
3. Solitons and Instantons byR. Rajaraman (North Polland. 1989)
4. Gauge theory of Elementary Particles by T.P. Cheng and Li (Oxford)2000
5. Structure of the Nucleus by M.A. Preston and R.K. Bhadhuri.
6. Quantum Theory of Solids by C.Kittel

7. Liquid State Physics by N.H. March and M.P. Tosi
8. Liquid State Physics by Engelsta
9. Quantum field theory by Lahiri and Pal

TECHNIQUES IN EXPERIMENTAL PHYSICS

PHYS.612 40+12=52 Hrs.
M. Marks: 30+70=100

Note: The question paper for and semester examination will consist of seven quotations of equal marks. The first question will be compulsory and will consist of several short questions/problems covering the entire syllabus. The candidate will attempt five questions in all, including the compulsory question.

Particle physics:

Relativistic kinematics
Four vectors & invariants, some practical examples for use of invariants.
Transformation of differential cross-section.

Monte Carlo calculations and its applications, typical uses of Monte Carlo techniques to High Energy particle physics.

Collider Physics:
Collisions in colliders: Reconstruction of events-examples
LHC collider, CMS detector, ALICE detector, Belle detector(brief), Extraction of signal – top Higgs, QGP, CP violation.

Experimental methods for probing nuclear structure:

Experimental methods for gamma-ray, conversion-electron and charged-particle spectroscopy associated with nuclear reactions and Coulomb excitation, Compton-suppressed Ge detectors, multiplicity filter, Neutron detectors, Sector field electron spectrometer, mini-range spectrometer, Recoll mass-separator, Advanced detector arrays-GAMMASPHERE and EUROBALL.

Lifetime measurements – DSAM and RDM techniques, coincidence method, pulsed beam method.

Hyperfine interactions – Static magnetic and quadrupole Interactions, Time differential orientation measurements.

Photon – atom Interactions – interaction processes in X-ray energy region, inner-shell photoionisation and subsequent processes, Elastic and inelastic scattering.

Solid State Physics:

1. High Vacuum: Diffusion Pump, Turbo Molecular Pump, Gauges for measuring high vacuum.
2. Preparation of Materials: Crystal Growth, Amorphous materials, Nano materials, Polymers by different techniques.
3. Device Fabrication: Oxidation Diffusion, Ion Implantation, Metallization, Lithography and Etching, Bipolar and MOS device fabrication.

4. Characterization Techniques: Impedance, TEP, AFM, TEM, SIMS, micro-Raman, Luminescence, Ellipsometry.

TUTORIALS: Problems relevant to the topics covered in the course.

Books recommended:

1. Relativistic Kinematics by R. Hagedon.
2. Statistics for Nuclear and Particle Physicists by Louis Lyons. 500726
3. CMS – Technical Proposal
4. ALICE – Technical
5. In beam gamma-ray spectroscopy by II, Morinaga and T. Yamazaki.
6. Nuclear spectroscopy and reactions (part A & C) edited by Joseph Cerny.
7. Radiation detection and measurements by Glenn. F. Knoll.
8. Gamma-ray and electron spectroscopy in Nuclear Physics by H. Ejiri and M.J.A. de Voigt.
9. The electromagnetic interaction in Nuclear Spectroscopy, Edited by W.D. Hamliton.
10. Alpha, Beta-and Gamma-ray Spectroscopy, Vol 1 and 2, Edited by Kal Siegbahn.
11. X-rays in Atomic and Nuclear Physics by N.A. Dyson
12. Elastic scattering of gamma-rays and X-rays by atoms – Phys, Reports 140 (1986-75 by P.P. Kane, L. Kissel, R.H. Pratt and S.C. Roy.
13. Inelastic scattering of X-rays and gamma-rayus by Inner shell electrons-Phys. Reports 218 (1992) 67 by P.P. Kane,L. Kissel, R.H. Pratt and S.C. Roy.
14. Thin Films Phenomena by K.L. Chopra
15. Science of Engineering Materials by C.M. Srivastava and C. Srinivasan, Wiley East. Ltd.
16. Nanoparticles and Nanostructured Films-Preparation, Characterization and Applications: J.H. Fender (Wiley).
17. Microelectronic Processing by W. Scot Ruska, McGraw-Hill.
18. Characterization of Semiconductor Materials by Philips F. Kare and Greydon B. Lausbee, Mc Graw Hill.
19. Physical methods for Materials Characterization by P.E.J. Fiewitt & R.K. Wild.
20. Optical Properties of Solids by M. Fox, Oxford University Press.
21. Fractals and Chaos – Pauls Addison
22. Introduction of Chaos – H Nagashima and Y BABA
23. Chaos, Dynamics and Fractals – J.L.McCauley
24. Chaos in dynamical systems – Edward Ott

PHYS 613 Computational Techniques

26+26=52 hours
MM: 30+70=100

Note: In all seven questions will be set in the end-semester examination.. Candidate is required to attempt five questions including compulsory question, which will be of short answer types. All questions will carry equal marks.

Resume of Practical approach of learning operating systems (DOS,UNIX, Windows) and Graphical packages (Origin, Gnuplot), Latex. INTERNET.

Fortran Programming using Fortran 90.

Mathematica: Running mathematica, Numerical calculations, Graphics, 3D plots. Equation solving, matrices, mathematical relations, complex numbers, simplifications, algebraic expressions, Mathematical operations, in built functions, differentiation, integration, series, limits, Advanced Mathematics: Procedural programming, loops conditional programming, producing output, linking external programme, functional programming, numerical operation on data, statistical calculations, minimization. Derivatives of unknown functions.

Matrices: products of matrices, inversion using iterative methods and accuracy, Numerical Linear Algebra: Solution of systems of linear equations, direct methods, error analysis, Curve Fitting: least squares fitting method etc., iterative methods. Numerical differentiation and integration methods: Numerical methods for derivatives, minima and maxima of a function, numerical integration methods for one dimension to multi-dimensional integrations using Simpson's rule, quadrature formula and Monte Carlo methods. Interpolation: splines, Numerical methods for Ordinary and partial differential equations: Euler's method, Runge- Kutta method for ordinary differential equations: stability and convergence.

Partial differential equations using matrix method for difference equation, relaxation method, initial value problems, stability, convergence and qualitative properties and qualitative properties.

Random numbers, Monte Carlo Integral methods, Importance sampling, Fast Fourier Transform.

Physical Simulations: N body methods and particle simulations, Verlet algorithm, Molecular dynamics and Monte Carlo methods.

C: Unstructured, procedural and modular programming, data structures.
C++: Introduction to Object Oriented Programming.

Tutorials and Lab. work:

Solving Problems related to topics covered in the course by actual programming and obtaining results (Called lab work).

Books:

1. Fortran Programming – V. Rajaraman
2. Numerical Methods: A Computer Oriented Approach, BPB Publ. 1996 R.S. Salaria
3. Computer based Numerical Methods 3rd Ed. Prentice Hall India 1980, V. Rajaraman
4. The C++ Programming Language/Addison Wesely
5. Mathematica, S. Wolfram, Addison. Wesely
6. Application of the Monte Carlo Method, K. Binder, Springer Veriag
7. Numerical Recipes in Fortran: The Art of Scientific Computing, W.H. Press et al., Cambridge Press.
8. Numerical Recipes in Fortran: the Art of Scientific Computing, W.H. Press et. al, Cambridge Press
9. An Introduction to Computer Simulation Methods, H.Gould and J. Toobochnlik, Addison Wesley, 1996.
10. Computational Physics by S.E. Koonin