Department of Physics, Presidency University

Syllabus for Ph D Coursework (16 Credit 200 Marks spanned over two semesters)

Even Semester (January-May): 8 Credit, 100 Marks

Subject and Credit	Type of Assessment	Marks
Literature survey and presentation (4 credit)	Internal assessment by Supervisor and External Examiner	50
Research Methodology Part-I (4 credit)	Written test of 2 hours	50

Odd Semester (July-November): 8 Credit, 100 Marks

Subject and Credit	Type of Assessment	Marks
Research Methodology Part-II (4 credit)	1. Numerical method and computation Practical Examination of 2 hours	25
	2. Laboratory skills: Internal assessment	25
Optional Module (4 credit)	Option-1: Written test of 2 hours and 35 marks plus internal assessment of 15 marks	50
	Option-2: Internal assessment of 50 marks	

Research Methodology Part-I

(a) Principles of Statistical Inference: formal mathematical basis of statistical inference, which is used in scientific data analysis and hypothesis testing will be covered. This includes testing hypotheses, regression, distribution functions, multivariate data analysis (12 lectures)

Bayesian statistics (5 lectures), Monte-Carlo methods (8 lectures)

(b) Self-study and Bibliography: bibliographics and database search. Assessing the significance of published work (3 lectures)

(c) Order of magnitude calculations (9 lectures)

(d) Writing and Presentational skills: Use of TeX/LaTex to write a long report (2 lectures)

Scientific language skills, presenting talks of various lengths (6 lectures)

(e) Research Ethics: Laboratory ethics (2 lectures)

Working in collaboration. Plagiarism (3 lectures)

Research Methodology Part-II

(a) Advanced Numerical Methods: Theoretical basis of advanced numerical methods (beyond those covered at the M.Sc. Level) for solving Ordinary and Partial Differential equations. Matrix Analysis, FFT (20 lectures including lab)

(b) Laboratory Skills: Basic skills common to Physics labs. Specific skills for sub-fields. Familiarity with major instruments in the field. Recording experimental research. Time Management (10 lectures)

(c) Computational Skills: hands-on advanced computational physics laboratory, to familiarize students with statistical data analysis package *R* and also teach them the basics of scientific programming in *PYTHON* (20 lectures)

Department of Physics, Presidency University
Optional Module (4 credit) of Ph D Coursework

Option-1: Written test of 2 hours and 35 marks plus internal assessment of 15 marks
A course of M. Sc. level at the University normally as an elective or special paper in the last two semesters that the student has not previously attended.

The following topic was followed in the last course work with the syllabus given.

PHYS0904A: Physics of Nanostructured materials

Introduction to Nanostructured Materials [8]
Introduction. Size dependence of properties. Metal nanoclusters, bulk to nanotransition, semiconducting nanoparticles. Carbon nanostructures: carbon clusters, carbon nanotubes (CNT), fullerenes and graphenes, nanocomposites and hybrids.

Growth, fabrication and measurement techniques for nanostructures [12]
Spontaneous formation and ordering of nanostructures. Top-down and bottom-up approach and templates. Methods of synthesis of nanostructures: RF plasma, chemical methods, Sol-Gel technique, electrochemical methods, thermolysis, pulsed laser methods, Physical vapor deposition, ball milling, vapour-liquid-solid (VLS) method. Methods of carbon nanotube growth. Nanostructures determination: atomic structures, X-ray diffraction and crystallography, small angle X- ray scattering (SAXS), particle size determination, surface structure. Microscopy: Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Field Ion Microscopy (FIM), Scanning Tunneling Electron Microscopy (STEM). Spectroscopy: Infrared and Raman spectroscopy, Photoluminescence, Photoemission and X-ray spectroscopy. Magnetic Resonance.

Electron transport in semiconductors and nanostructures [14]
Time and length scales of electrons in solids. Statistics of electrons in solids and nanostructures. The density of states (DOS) of electrons in nanostructures. Electron transport in nanostructures: dissipative transport in short structures, hot electrons, quantum ballistic transport and Landauer formula, single electron transport. Electrons in traditional low-dimentional structures (quantum wells, quantum wires & quantum dots).

Nanostructured ferromagnetism: [6]

Magnetic properties of nanostructured materials. Dynamics of nanomagnets. Dilute magnetic semiconductor (DMS), Spintronics. Nanocarbon ferromagnets. Ferrofluids. Super paramagnetism. Ferromagnetic resonance (FMR).

Self-assembly and catalysis: [4]

Self-assembly: process of self-assembly, semiconductor islands, monolayers. Catalysis: nature of catalysis, surface area of nanoparticles, porous materials, pillared clays and colloids.

Applications and future of nanomaterials: [6]

Nanoelectronics: single electron transistor, resonant tunneling diodes. Micro and nano-electromechanical systems. Nanosensors. Nanocatalysis. Role of nanomaterials in food and agriculture industry & water treatment. Nano-medical applications. Defence and space applications. Nanomaterials for non conventional energy source and energy storage.

Option-2: Internal assessment of 50 marks

Either a guided research project normally to be undertaken with a supervisor not going to be the eventual Ph D supervisor or an equivalent course at an external research institute to be approved by the departmental Ph D Committee who will also set the evaluation norms.