Krishnaguru Adhyatmik Visvavidyalaya

Nasatra, Barpeta, Assam, PIN:781307

Ph. D. Coursework Syllabus

Department of Physics

KAV, NASATRA, PIN:781307

Course Structure in Ph.D. Coursework:

Coursework						
Course: core/optional	Marks		Credits Distribution			
	Theory + Internal Assessment	Total	Lecture (L)	Tutorial & Assignment (T)	Practical (P)	Total Credits
Paper: Research Methodology(core) Code: PHD-C-5014	80+20	100	3	1	0	4
Paper: Research and Publication Ethics(core) Code: PHD-C-5022	40+10	50	1	1	0	2
Paper: Krishnaguru Studies(core) Code: KGS-5032	40+10	50	1	1	0	2
Paper: General Physics & Experimental Techniques (Core) Code: PHD-PHY-5044	80+20	100	3	1	0	4
Paper: Advanced Materials Science(optional) Code: PHD-PHY-5054	80+20	100	3	1	0	4
Paper: Basics of Computer Programming and Statistical Analysis(core) Code: PHD-PHY-5062	40+10	50	1	1	0	2

Paper: General Physics & Experimental Techniques (Core)
Paper Code: PHD-PHY-5044

Credit: (3+1) =4

Course Objective:

i. Develop a deep understanding of fundamental and advanced concepts in physics, including theoretical and experimental approaches.
ii. Train students to conduct original, high-quality research that contributes to the advanced of physics.
iii. Equip students with expertise in analytical techniques, computational tools, and laboratory methods relevant to their specialization.
iv. Develop an overall understanding of the different experimental techniques used to determine various behavior/ properties of material.

A. General Physics:

Vector, Eigenvalues and eigen vectors, Laplace Transform, Fourier Transform, Partial differential equation (Laplace transform).

Semiconductor devices, diodes, junctions, opto-electronic devices, operational Amplifiers and their applications, Digital Techniques and applications.

B. Experimental Techniques:

Vacuum Techniques: Simple description and working principles of vacuum pumps (Rotary, Diffusion) Penning and Pirani gauges, leak detection Techniques.

Optical characterization and spectroscopic Techniques: Infrared and ultraviolet/visible (IR, UV/Vis) absorption spectroscopy/spectrometer; RAMAN Spectroscopy/spectrometer; Fourier Transform Infrared (FT-IR) spectrometer, principles and characteristics of LASERs.

Structural characterization and Imaging Techniques: Principle and applications of powder X-ray diffraction (XRD), Scanning electron microscopy (SEM). transmission electron microscopy (TEM), Atomic force microscopy (AFM).

Accelerator based Techniques: Proton-induced x-ray emission (PEXE), Particle induced g-ray emission (PIGE)

Physical property Measurements: Intensive and extensive properties, physical property measurements (DSC, DTA, TGA), Magnetic properties of bulk and nano-phase of material (VSM & SQUID), low conductivity measurement (Dielectric spectroscopy)

Detection Techniques: Particle and radiation interaction with material, detectors, Analyzers, computation.

Suggested Readings:

[1]. Springer Handbook of Crystal Growth, Eds: G. Dhanraj, K Bynappa, V. Prasad, M. Dudley, Springer verlag (2010)

[2]. Willard, Merritt, Dean, settle, Instrumental Methods -Analysis, CBS publishers & Distributors, Delhi, Sixth Edition, 1986

[3]. Sam Zhong, Lin Li and Ashok Kumar, Materials Characterization Techniques, CRC Press, (2008)

[4]. JM. Hollas, (1986), Modern Spectroscopy, John Wiley & Sons.

[5]. B. D. Cullify, (1956), Elements of X-ray diffraction, Addison-Wesley Publishing Company.

Paper: Advanced Materials Science (Optional)
Paper Code: PHD-PHY-5054

Credit: (3+1) =4

Course Objectives:

i. Develop a comprehensive understanding of the structure, properties, and behavior of advanced materials, such as neon material, biomaterials, etc.
ii. Cultivate the ability to design and execute original research focused on the synthesis, processing sing and application of advanced materials.
iii. Promote collaboration across disciplines such as physics, chemistry, engineering and biology to address complex challenges in material science.
iv. Enhance the ability to identify gaps in existing knowledge, propose innovative solutions and develop new materials with desired functionalities.

Introduction: Materials and classification

Nanomaterials and Nanoscience: Various types of Nanomaterials - Quantum dots, Quantum well, Quantum wire, Metal clusters, Metal oxide nanocrystals, semiconductor nanocrystals, Assemblies of Nanocrystals, Carbon nanotubes

Synthesis of Nanomaterials: Bottom up and Top-down approaches, solid state routes; mechanical grinding; mixing, solid solution techniques, precipitation, sol-gel method/techniques, Evaporation, hydrothermal, solvothermal methods, Electrochemical deposition and electrochemical oxidation using two and three electrode, Laser ablation, Vapor phase methods, biological synthesis.

Composite and nano composites: Different types of composites, Raw materials, Nano composites; their properties and applications.

Application of Nanotechnology in different fields: Solar cells, hydrogen production and fuel cells, Renewable cells, Biomedical science, diagnostics, medicine, pharma, Biotechnology, Environmental Sciences, Food technology.

Suggested Readings:

[1]. Springer Handbook of Nanotechnology; Eds: Bharat Bhushan, Springer Verlag, 2nd Edition (2009)
[2]. Charles P. Poole Jr and Frank J Owens, (2007), Introduction to Nanotechnology, John Wiley & Sons (Asia) Pvt. Ltd.
[3]. Sulbha K. Kulkarni (2007), Nanotechnology: Principles and practices, Capital Publishing Company, New Delhi.
[4]. B.K. Parthasarathi, (2007), Nanostructure and Nanomaterials, Gyan, Books Pvt.Ltd.5 AnsariRoad, Darya Ganj, New Delhi-110002
[5]. D.K. Singh, S.Singh, P.Singh, Nanomaterials: Advances and Applications, Springer Verlag.

Term-Paper/Project Work/Other
Paper: Basics of Computer Programming and Statistical Analysis
Paper Code: PHD-PHY-6062
Credit: 2

Course objectives:

I. To provide students with a fundamental understanding of computers, their components, software and basic operations.
II. To develop students' ability to design, write, test and debug programs using programming languages.
III. To develop students' ability to collect, analyse, interpret and present data using statistical methods.

1. Computer Basics: Basics of computer, Hardware and Software, writing scientific documents with Latex, graphic and visualization, GNU plot, introduction to some essential software, mathematics, MATLAB, origin, etc.

2. Computer programming: Programming language(s): Python, FORTRAN

3. Statistical Analysis: Different types of errors and error estimation, curve fitting, least square method, sampling and parameter estimation and any other topics and in physics researches.

Suggested Reading:

1. P.K. Sinha & Priti Sinha, Computer Fundamentals
2. Stephen J. Chapman, 'Fortran for Scientists and Engineers'.
3. Eric Mathes, Python Crash Course
4. Luca Lista, Statistical Methods for Data Analysis, Springer
5. Massimiliano Bonamente, Statistics and Analysis of Scientific Data, Springer