PhD Nanotechnology Course Work Syllabus

PAPER-I

(Research Methodology)

UNIT-I

Scientific Writing and Statistical tools for data analysis: History of development of science and the influence of philosophy, Forming a Hypothesis, Techniques of Scientific Measurement; Testing of hypothesis; Methods of Theoretical Research; The Art of Scientific Communication; Presentation in Seminars and Conferences; Sponsored Research.

Types of research, exploratory research, conclusive research, modelling research, algorithmic research, Research process- steps. Data collection methods - Primary data – observation method, personal interview, telephonic interview, mail survey, questionnaire design. Secondary data - internal sources of data, external sources of data.

UNIT-II

Data Analysis: Data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis- Cross tabulations and Chi-square test including testing hypothesis of association.

Statistical average, variance, standard deviation, frequency distribution, histograms and scatter plots.

Averages and mixtures – mean, median and mode, measure of central tendency, concept of assumed average and weighted average, AM, GM and HM – relationship between AM, GM and HM.

Basics of equations- introduction to simple and quadratic equations, roots of an equation, word problems, problems on ages, consistency of equations.

UNIT-III

Research Ethics and Lab Safety: Ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copyright, royalty, trade related aspects of intellectual property rights (TRIPS). Laboratory safety issues: Related to various labs and workshops, electrical, health and fire hazards.

Scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, Reference Management Software like EndNote/ Mendeley. Plagiarism, reproducibility, research misconduct, and accountability.

UNIT-IV

Characterization Techniques for Nanomaterials: XRD – operational principle and applications. Nano Perspective. Peak broadening and crystallite size- The Scherrer equation. Particle size determination by light scattering and surface charge on nanoparticles - Zeta potential analysis.

Chromatography and Cell Culture: Theory of Chromatography. Chromatographic Resolution. Affinity Chromatography. Basic cell culture techniques: Media requirements and sterilization techniques: Primary and established cell lines, Culture methods.

PhD Nanotechnology Course Work Syllabus

PAPER-II

(Recent Advances in Nanotechnology)

UNIT-I

Nanomaterials Synthesis: synthetic routes: top down and bottom-up approaches. Solvothermal, Sol-gel, laser ablation, chemical vapor Deposition, Ball milling, Lithographic techniques, Pyrolysis. Biological systems like fungi, plants, purified enzymes and biological templates for synthesis of nanomaterials. Nanofibers synthesis by Electrospinning method- factors influencing nanofiber morphology. Sonochemical and Microwave assisted synthesis, Micelles and microemulsions.

Techniques for detection and analysis of biological macromolecules: ELISA. Polymerase chain reaction, Reverse Transcription PCR (RT- PCR), Real-Time PCR: Principle and methodology and applications. DNA microarray: Principle and methodology Electrophoresis and Blotting Techniques: Basic principles & types of electrophoresis; Blotting techniques: Southern; Northern, Western; and their applications.

Unit-II

Characterization and Analysis: Electron probe characterization methods. Optics and resolution, Electron-matter interactions. Scanning Electron Microscopy and Transmission Electron Microscopy - operational principle and applications. Auger electron spectroscopy (AES) and Low energy electron spectroscopy (LEED). Elemental dispersive spectroscopy (EDS).

Microscopy and whole cell profiling assays: Basic principles, fluorescence based, Confocal imaging. RNA-Seq, ChIP-Seq, metabolic profiling. Omics technology- uses and importance

UNIT-III

Thermal analysis methods and Spectral characterization of Nanomaterials : Principle and Instrumentation of Thermogravimetry; Differential Thermal Analysis and Differential scanning calorimetry- Nanoindentation principles- elastic and plastic deformation -mechanical properties of materials in small dimensions. Vibrating sample Magnetometer, and Electrochemical Characterization measurements. Spectroscopy – Raman, Infra-Red, UV-Vis - operational principle and applications. Photoluminescence (PL) spectroscopy. X-ray photoelectron spectroscopy (XPS). Surface area and porosity-BET Equation.

Flow Cytometry and Centrifugation: Basic principles, methods and Applications. Basic principles of centrifugation, Types of centrifugations. Ultra centrifugation. Mass spectrometry, basics technique, Size determination and charge.

UNIT-IV

Carbon based Nanomaterials- Carbon Nanotube (CNT), Graphene, Carbon Nanofoam and Buckminster Fullerenes. Electronic properties of CNT's. Applications of CNT's and their composites, Applications of Fullerenes, Graphene and Carbon Nanofoam. Toxicity issues associated with Carbon based nanomaterials.

Nanotheranostics, Tissue Engineering and Regenerative Medicine: Targeted drug delivery, Approaches in Nanoformulation, Nanoparticle delivery for Cancer and other disease Treatment, Nanoarrays for diagnostics, detection of single DNA, self-assembled protein nanoarrays. Natural and Degradable polymers in tissue engineering applications, Scaffold/Bio-scaffold design and fabrication. Nano-based Stem Cell therapies and Regenerative Medicine. 3D Bioprinting.

Gene modulation and Bioinformatics: RNAi, TALEN system, CRISPR-Cas9 system, gene knockouts, prime editing. Concept of databases and databanks. Data analyses tools. Data mining-methods and online resources.