Indira Gandhi University, Meerpur, Rewari
Scheme of Examination
Ph.D. Course Work (Physics)
(2025-26)

Paper-I (Core Courses)

Course Code	Title of the Course	Theory Marks	Internal Marks	Max Marks	Credits
25L8.0- PHY-101	Paper-1 Research Methodology	70	30	100	4

Paper-II Subject Specific Courses (Opt any one)

Course Code	Title of the Course	Theory Marks	Internal Marks	Max Marks	Credits
25L8.0- PHY-102(A)	Nanomaterials: Synthesis, Properties, and Applications	70	30	100	4
25L8.0- PHY PHY-102(B)	Energy and Environment	70	30	100	4

Paper-III Core Course provided by the University

Course Code	Title of the Course	Theory Marks	Internal Marks	Max Marks	Credits
25L8.0- RPE-103	Research and Publication Ethics	40	10	50	2

Paper-IV

Course Code	Title of the Course	Max Marks	Credits
25L8.0- PHY-104	Review of Literature and Seminar	50	2

Total Credits: 12

Note: **1.** The internal assessment of 30 marks in each paper will comprise one written test (10 marks), one written assignment (10 marks), and one presentation (10 marks). The internal assessment of research and publication ethics will comprise one written assignment of 10 marks.

* The record of internal assessment must be maintained for at least six months after the result declaration.

2. The syllabus is divided into four units. Nine questions will be set in all. Question No.1 will be compulsory, with seven parts covering the whole syllabus. In addition, there will be two questions from each unit, and the student will answer one question from each unit. All questions carry equal marks.
3. Subject-specific courses will be offered, subject to the availability of the requisite resources/faculty.

25L8.0-PHY 101: Research Methodology

Time: 3 hours

Max. Marks: 100
Theory Marks: 70
Internal Marks: 30
Credits: 4

Note: The question paper will contain nine questions in all. Question No.1 will be compulsory, with seven parts covering the whole syllabus. In addition, there will be two questions from each unit, and the students are required to attempt four questions in all, selecting at least one from each section. All questions carry equal marks.

COURSE OBJECTIVES

1. The research students are enabled to explore the complexities of research proposals and implications.
2. The students become well versed with the skills of writing research papers and the conclusion of the research problem.
3. The students will learn the research process, design, and Implementation.

UNIT - I

Introduction of research methodology: meaning of research, objectives of research, types of research, significance of research, research and scientific method, research process; research problem: definition, necessity, and techniques of defining research problem, formulation of research problem, objectives of research problem.

UNIT - II

Scientific communications: publishing research papers, selection of a journal, writing of research papers: abstract, introduction/ formulation of problem, experimental details, results &discussion, references, submission of manuscript and handling of reviewer's comment; writing of thesis: format of a thesis, review of literature, writing methods, preparation of tables and figures, writing discussion; conclusions, summary and synopsis, research ethics: copyright, plagiarism.

UNIT - III

Presentation: poster and oral, presentation tools, introduction to presentation tool, MS PowerPoint, features and functions, creating presentation, customizing presentation, presentation, reference citing and listing bibliography,

UNIT-IV

Research Process: Steps involved in the research process, Problems encountered by researchers in India. Research Design: Meaning and need for research design, Different research designs. Data collection through experimental techniques and theoretical calculations, Types of data, and various methods of data collection and compilation.

Preparation of Dissertation: Types and layout of research, Precautions in preparing the research Dissertations. Bibliography and annexure, discussion of results, drawing conclusions, giving suggestions and recommendations to the concerned persons

Text and Reference Books:

1. Scientific Thesis Writing and Paper Presentation by N. Gurumani (2010) MJP Publishers
2. Research Methodology (Methods and Techniques) by C.R.Kothari, New Age International Publishers

25L8.0- PHY 102(A): Nanomaterials: Synthesis, Properties, and Applications

Time: 3 hours

Max. Marks: 100
Theory Marks: 70
Internal Marks: 30
Credits: 4

Note: The question paper will contain nine questions in all. Question No.1 will be compulsory, with seven parts covering the whole syllabus. In addition, there will be two questions from each unit, and the students are required to attempt four questions in all selecting at least one from each section. All questions carry equal marks.

Course Objectives:

1. To understand the influence of the dimensionality of the object at the nanoscale on its properties
2. To understand the Quantum size effect on energy and density of states with the size of crystal
3. To learn techniques for the characterization of nanostructured materials
4. To learn size and shape-controlled synthesis of Nano materials and their future application

Unit 1

Free electron theory (qualitative idea) and its features, Idea of band structure, Metals, insulators, and semiconductors, Direct and indirect transitions. Density of states in bands. Variation of density of states with energy, Variation of density of states and band gap with size of crystal. Electron confinement in an infinitely deep square well, confinement in two and one-dimensional wells, the Idea of quantum well structure, Quantum dots, Quantum wires.

Unit II

Semiconducting Properties: semiconductors, free carrier concentrations, Fermi level, mobility of charge carriers, effect of temperature on mobility, electrical conductivity of semiconductors, junction properties. Optical properties of materials: Absorption processes, photoconductivity, Photoelectric effect, Photovoltaic effect, Photoluminescence, color centers-types and generation.

Unit III

Different methods of preparation of nanomaterials, Bottom up: Chemical Precipitation Technique, Template Synthesis Technique, Hydrothermal and Solvothermal techniques, Chemical bath deposition etc Top down: Ball Milling. Lithography etc. Special carbon solids; fullerenes and tubules; formation and characterization of fullerenes and tubules. Single-wall and multi-wall carbon tubules. Electronic properties of tubules. Carbon nanotubule based electronic based electronic devices.

Unit IV

Determination of particle size by XRD, Increase in width of XRD peaks of nanoparticles, Strain effect, Shape and size measurements by SEM, FESEM, TEM, HRTEM and AFM etc. Measurement of Band gap by UV-visible spectroscopy, Tauc relation excitation and emission spectra studies by Photoluminescence, Shift in photoluminescence peaks. Study of functional groups by FTIR. Other special techniques like Raman, XPS etc. Applications of nanomaterials in various sectors such as electronics, energy and environment.

Text and Reference Books:

1. Nanotechnology Molecularly designed matrials by Gan -Moog Chow, Kenneth E. Gonsalves, American Chemical Society
2. Quantum dot heterostructures by D. Bimerg, M. Grundmann and N.N. Ledenstov, John Wiley & Sons, 1988.
3. Nano technology : :molecular speculations on global abundance by B.C. Crandall, MIT Press 1996.
4. Physics of low dimensional semiconductors by John H. Davies, Cambridge Univ. Press 1997.
5. Physics of Semiconductors nano structures by K.P. Jain, Narosa 1997.
6. Nano fabrication and bio system : Integrating materials science engineering science and biology by Harvey C. Hoch, Harold G. Craighead and Lynn Jelinskii, Cambridge Univ. Press 1996.
7. Nano particles and nano structured films ; Preparation characterization and applications Ed. J.H. Fendler, John Wiley & Sons 1998.
8. Solid State Physics: Structure, and Properties of Materials by M.A.Wahab, Narosa Publication third edition 2015

25L8.0- PHY-102 (B): Energy & Environment

Time: 3 hours

Max. Marks: 100
Theory Marks: 70
Internal Marks: 30
Credits: 4

Note: The question paper will contain nine questions in all. Question No.1 will be compulsory, with seven parts covering the whole syllabus. In addition, there will be two questions from each unit, and the students are required to attempt four questions in all, selecting at least one from each section. All questions carry equal marks.

Course Objective:

1. To learn and understand the importance of alternative energy resources.
2. To study the fundamentals of renewable energy resources.
3. To provide basic knowledge in the interface between chemistry, physics, and biology on the nanostructure level, with a focus on Environmental usage.

Unit I

Limitations of conventional energy sources, need and growth of alternative energy sources. basic scheme, and application of direct energy conservation. Solar Cells: Solar energy: Introduction. The characteristics of the sun, Definitions related to solar radiation, solar radiation geometry, Estimation of daily solar radiation. Theory of solar cells. Solar cell materials, solar drying, solar furnaces, Solar cooking, solar greenhouse technology, solar thermal power generation, solar cell array.

Unit II

Fuel Cells: Principle, working of various types of fuel cells, performance, and limitations.
Bio-mass: Introduction of biogas, Availability of bio-mass and its conversion theory, classification of biogas plants, principle & working of floating drum plant & fixed dome type plant-advantages & disadvantages. Biogas from plant waste, community biogas plants, and the utilization of biogas.

Unit 1II

Introduction to Green Nanotechnology: Introduction to Nano-biotechnology. Synthesis techniques of various types of nanostructured materials and their application within biotechnology. Using biomaterials and biomolecules as bases for inorganic structures i.e, CNT, Graphene, conducting polymer etc. Synthesis of nanomaterial using green chemistry from plants and microbes. Characterization and application of Nanostructures materials produced by the green route for environmental applications.

Unit IV

Application of bio-nanotechnology: Environmental application of bio-nanotechnology, Waste -water treatment, Waste to energy conversion, Environmental Quality Monitoring, Medical: Treatment, drug delivery, Diagnostics

Text and Reference Books

1. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006

2. M.V.R. Koteswara Rao, "Energy Resources: Conventional & Non-Conventional" BSP Publications, 2006.
3. D.S. Chauhan, "Non-Conventional Energy Resources" New Age International.
4. C.S. Solanki, "Renewal Energy Technologies: A Practical Guide for Beginners" PHI Learning.
5. Peter Auer, "Advances in energy system and Technology" Vol I & II Edited by Academic Press.
6. G.D. Rai, "Non-conventional Energy sources" Khanna Publishers
7. Raja A.K., "Introduction to Non-Conventional Energy Resources" Scitech Publications. Fahrenbruch and Bube, "Fundamentals of Solar cells. Photovoltaic Solar Energy"
8. David S. Goodsell , Bio-nanotechnology: Lessons from Nature. Willy press, 2004
9. Rakesh Tekade, Biomaterials and Bio-nanotechnology - 1st Edition. Elsevier
10. Pierfrancesco Morganti Bio-nanotechnology to save the environment, MDPI, 2019
11. Ljiljana. Fruk and Antonia Kerbs, Bio-nanotechnology, Concept and applications, Cambridge University Press

25L8.0-RPE-103: RESEARCH AND PUBLICATION ETHICS

Maximum Marks: 50
Theory Marks: 40
Internal Marks: 10
Credit - 02

Time: 2 Hrs.

The core course is provided by the university. The syllabus content and exam pattern will be followed as per university guidelines.

25L8.0-PHY-104: Review of Literature and Seminar

Max. Marks: 50
Credits: 2

Note: Students shall review 15 to 20 research papers in their field. The evaluation shall be done by one internal examiner and one external examiner.