VC/RO/CO
12/6/23

Chaudhary Charan Singh University, Meerut
(NAAC A++ Accredited)

Syllabus

Pre - Ph.D. Course Work

Physics

(For both University Campus and Affiliated Colleges of the University)

(As per Guidelines of University Grants Commission)

(w.e.f. the session 2023-24)

CHAUDHARY CHARAN SINGH UNIVERSITY, MEERUT

Proceedings of the meeting of Board of Studies in Physics held on 09 – 06 - 2023

A meeting of Board of Studies (University Campus and Affiliated Colleges) in the subject of Physics in Chaudhary Charan Singh University, Meerut was held on June 09, 2023 at 10.00 AM in hybrid mode through Zoom App. The following members of the Board of Studies, Department of Physics, Ch. Charan Singh University Meerut were present:

1. Prof. Hare Krishna — Dean, Science faculty
2. Prof. Anil Kumar Malik — Convener-I
3. Prof. Beer Pal Singh — Member
4. Prof. S K Sharma -I — Convener-II
5. Prof. S K Sharma -II — Member
6. Prof. B S Yadav — Member
7. Prof. Sushil Kumar — External Expert
8. Prof. Ashwani Kumar Srivastava — External Expert
9. Prof. K R Patel — External Expert
10. Dr. Sunil Singh Kushvaha — Principal Scientist, NPL Delhi
11. Prof. Vijay Garg — Principal

The Board met for the formulation of the syllabus of the subject Physics for Pre Ph.D. courses. The Board unanimously prepared and approved the syllabus for the same after thorough discussions. The revised courses are applicable to both university campus and affiliated colleges of the University. A copy of the finalized syllabus is enclosed herewith. The research methodology course will be common for all faculties and will be developed at the University level.

S. No.	Name	Designation	College/ University	Signature
1.	Prof. Hare Krishna	Dean, Science Faculty	C.C.S. University Campus, Meerut	
2.	Prof. Anil K. Malik	Convener-I	C.C.S. University Campus, Meerut	09.06.2023
3.	Prof. Beer Pal Singh	Member	C.C.S. University Campus, Meerut	09/06/2023
4.	Prof. S K Sharma - I	Convener-II	N.A.S. (PG) College, Meerut	
5.	Prof. S K Sharma - II	Member	N.A.S. (PG) College, Meerut	
6.	Prof. B.S. Yadav	Member	D.N. College, Meerut	
7.	Prof. Sushil Kumar	External Subject Expert	Ch. Devi Lal University, Sirsa,	

			Haryana	
8.	Prof. Ashwani Kumar Srivastava	External Subject Expert	Jiwaji University, Gwalior, MP	
9.	Prof. K.R. Patel	External Subject Expert	Jai Narain Vyas University, Jodhpur, Rajasthan	
10.	Prof. Vijay Garg	Principal	Kisan P.G. College, Simbhaoli	
11.	Dr. Sunil Singh Kushvaha	Principal Scientist	CSIR-National Physical Laboratory, New Delhi	

Hon'ble Vice Chancellor

Kindly allow the enclosed syllabus to put in Academic Council for approval and to implement from the academic session 2023-2024.

(Hon'ble Vice Chancellor)

SUBJECT: PHYSICS

Titles of the Papers for Pre - Ph.D. Courses in Physics

Year	Course Code	Paper Title	Core Compulsory/ Elective/ Value added	Credits
2023-2024	PHZ701	Experimental Research Techniques in Physics	Core Compulsory	04
	PHZ702	Advanced Computational Methods	Core Compulsory	04
		Research Methodology	Core Compulsory	04
	PHZ703	Dissertation / Term Paper	Core Compulsory	04

Note: There will fifteen hrs per credit for theory course.

Experimental Research Techniques in Physics

Subject: Physics		
Course Code: **PHZ101**	**Course Title:** Experimental Research Techniques in Physics	Theory

Course Objectives: The objectives of this course are;

- To learn about Vacuum science & Technology.
- To know about the synthesis techniques of nanomaterials/thin films.
- To understand the characterization tools and their applications to analyze the materials.
- To analysis surface, composition and structure of materials.
- To evaluate the physical properties of materials.
- To learn the basic procedure of device fabrication and measurements.

Course Outcomes: At the completion of this course, students will learn about;

CO-1: Students will know about the vacuum synthesis and characterization of nanomaterials
CO-2: Students will understand the concepts of preparation of nanomaterials by chemical and physical methods and basics of device fabrication.
CO-3: Students will learn to characterize the synthesized nanomaterials by most commonly used characterization techniques such as UV-Vis, XRD, FE-SEM, XPS, HR-TEM, Infrared, Raman, and Nuclear Magnetic Resonance.
CO-4: Students will analyze the structural and surface properties of materials (atomic level structure and microscopic level structure)
CO-5: Students will be able to evaluate the physical properties of materials.
CO-6: Students will be able to exercises the structure-properties correlation and engineer the materials for different applications.

Credits: 4	**Core Compulsory**
Max. Marks: 100	**Min. Passing Marks: As per Ph.D. ordinance/guidelines of University**
Total No. of Lectures-Tutorial (in hours per week): L-P-T: 4-0-0	

Unit	Topics	No. of Lectures 60
I	**Vacuum Science & Technology**: Introduction, Important areas of applications, Gas kinetics, Gas flow, Viscous, Molecular and transition flow regimes, Vacuum technology-pumping speed, throughput & pump down time, Measurements of pressure: Pirani and Penning Gauge. Production of vacuum- Mechanical pump, Diffusion pump, Turbo molecular pump, Getter and Ion pumps, Cryo-pumps, High vacuum and ultra-high vacuum systems, Materials for vacuum and de-gassing properties, controls and leak detection techniques.	12
II	**Thin Films & Nanomaterials synthesis techniques** Thin films deposition using Physical Vapour Deposition (PVD): Thermal evaporation, Electron beam evaporation, DC/RF magnetron sputtering, Pulsed laser deposition (PLD), Molecular beam epitaxy (MBE), Thin films.	12

	using chemical method: Sol-gel spin coating, Spray pyrolysis, Chemical bath deposition (CBD), Dip coating, Chemical vapor deposition (CVD). Synthesis of NSM's, Top down and Bottom-up approaches, Physical & Chemical methods.	
III	**Characterization Techniques** X-ray Diffraction (XRD): XRD, structural analysis: Lattice constants, Crystallite size, Residual stress, Dislocation density. UV-VIS spectroscopy; determination of optical constants, determination of particle size using EMA, Fourier-transform infrared spectroscopy (FTIR) and Raman Spectroscopy; X-ray photoluminescence spectroscopy (XPS).	12
IV	**Surface Analysis** Electron Microscopy, Field emission-scanning electron microscopy (FE-SEM), Energy-dispersive X-ray analysis (EDAX); Transmission Electron Microscope (TEM), SAED, HR-TEM, Preparation of samples for SEM and TEM, scanning probe microscopy (SPM), Scanning Tunnelling Microscope (STM), Atomic Force Microscopy (AFM): Contact/non-contact/tapping mode of measurement for grain size, surface roughness.	12
V	**Device Fabrication and Measurements** Brief overview of device fabrication: Photolithography, Mask aligner, Photoresist coatings, Positive and negative Photoresists, Pre-post-baking, Patterns alignment and printing, Developers, Etching, Stripping, Contacts; Measurement of voltage-current characteristics of thin films or devices; Hall measurements, Electrical resistivity; Dielectric properties; Magnetic properties; Gas sensing; Electrochemical sensing, Cyclic voltammetry (CV).	12

Teaching Learning Modes: Class Lectures, Class discussions, Laboratory demonstrations, Hands on training, Power point presentations, Class activities/ assignments, etc.

Suggested Readings:

1. Vacuum technology by Andrew Guthrie
2. Vacuum Physics and Techniques by T.A. Delchar
3. Elements of X –ray differection, B. D. Culity, S. R. Stock, Prentics Hall Publication.
4. Thin Film Phenomena- K.L. Chopra
5. Fundamentals of molecular Spectroscopy, C. N. Banwell, Tata Mc-Graw- Hill Publishing company.
6. Infrared Spectroscopy: Fundamentals and Applications, Barbara Stuart, Wiley
7. Instrumental Methods of analysis Willard, Merrit, Dean, Settle, CBS Publisher.
8. Handbook of Analytical Mathods, R. S. Khandpur, Mc graw-Hill Publication.
9. Electron Microscopy and analysis, *P.J. Goodhew, J. Humphreys, R. Beanland,* Taylor & Fransis.
10. Materials Science of Thin Films: Deposition and Structure by Milton Ohring
11. VLSI Technology- S.M. Sze.
12. Silicon VLSI Technology: Fundamentals, Practice, and Modeling by J.D. Plummer
13. Scanning and Transmission Electron Microscopy: An Introduction by Stanley L. Flegler

Advanced Computational Methods

Subject: Physics		
Course Code: **PHZ102**	Course Title: Advanced Computational Methods	Theory

Course Objectives: The objectives of this course are;

- To get knowledge of numerical techniques for differential and integration using various suitable methods.
- To learn handling of complex Fourier integrals and Numerical double integration in numerical method.
- To learn numerical methods to solve ordinary differential equations.
- To learn numerical methods to solve ordinary partial differential equations.
- To learn basic MATLAB commands to writing programs
- To learn writing small MATLAB programmes for various numerical methods

Course Outcomes: At the completion of this course,

- CO1: Students will understand to solve the numerical differentiation and integration. problems simply by computational methods
- CO2: Students will be able to solve complex Fourier integrals and Numerical double integration in numerical method.
- CO3: Students will be able to solve of ordinary differential equations using numerical techniques.
- CO4: Students will be able to solve of ordinary differential equations using numerical techniques and partial differential equations
- CO5: Students will understand the basic concept of programming in MATLAB
- CO6: Students will be able to write Programmes in MATLAB

Credits: 4	**Core Compulsory**
Max. Marks: 100	**Min. Passing Marks:** **As per Ph.D. ordinance/guidelines of University**

Total No. of Lectures-Tutorial (in hours per week): L-P-T: 4-0-0

Unit	Topics	No. of Lectures 60
I	**Differentiation, Integration and curve fitting using numerical techniques:** Numerical Differentiation and Integration Introduction, Numerical Differentiation, Numerical Integration, Adaptive Quadrature Methods, Gauss Quadrature, Singular Integrals, Fourier Integrals, Numerical Double Integration, curve fitting of linear and nonlinear functions using least square fitting method.	12

II	**Numerical Methods for Ordinary Differential Equations** Introduction, initial value problems, Euler's Method, Runge-Kutta Methods, Boundary Value Problems: Jacobi's Method, Gauss-Seidel Method,Finite-Difference Method, The Shooting Method, Finite-Difference Approximations, and Laplace's Equation. .	12
III	**Numerical Methods for partial Differential equations** Finite-Difference Approximations, Functional- Base Function Methods of Approximation- The Rayleigh –Ritz Method –The Galerkin Method, Application to two dimensional problems Finite element Method for one- and two-dimensional problems.	12
IV	**Matlab programming** Introduction to MATLAB, Creating Variables, some useful MATLAB functions, Data types, script files, plotting, Input and output statements, Conditional statements: logical operators, if else and else if, switch, Introduction to loops, for loops, while loops, nested loops, break statement, Arrays, arrays functions,	12
V	**Writing Programmes with Matlab** Adaptive Quadrature Methods, Gauss Quadrature, Fourier Integrals, Runge Kutte method for, finite difference method, finite element method	12

Teaching Learning Modes: Class lectures/discussions/ demonstrations, Power point presentations, Class activities/ assignments, etc.

Suggested Readings:

1. "Numerical Analysis and Algorithms", S S Sashtri Tata McGraw Hill.
2. "Numerical Methods", E. Balagurusamy, Tata McGraw –Hill.
3. Numerical Method by Jain & Iyangar, New Age International.
4. "Introduction Methods of Numerical Analysis", S.S. Sastry, PHI.
5. "Numerical Methods for Engineers", S.C. Chapra and R. P. Canale, Tata McGraw –Hill.
6. Introduction to MATLAB by Rudra Pratap.
7. "MATLAB: A Practical Introduction to Programming and Problem Solving", 3rd edition, Stormy Attaway, Elsevier, 2013.
8. "An Introduction to Numerical Methods: A MATLAB Approach, 4th edition", Abdel wahab Kharab, Ronald B. Guenther, CRC Press, Inc. 2019.