# SCHEME OF EXAMINATION & SYLLABI

**Pre-Ph.D. Course in Physics (Choice Based Credit System)**

**(One Semester Course)**

**w.e.f. SESSION 2020-21**


## DEPARTMENT OF PHYSICS

## CHAUDHARY DEVI LAL UNIVERSITY, SIRSA

# Semester-I

| Sr. No. | Type of Course | Course Code | Title of Course | Teaching Hours per week | Credits | Internal Assessment Marks | End term Examination Marks | Total Marks | Duration of Exam. (Hours.) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Core | PHY-701 | Research Methodology | 4 | 4 | 30 | 70 | 100 | 3 |
| 2 | Core | PHY-702 | Experimental Techniques & Soft Tools in Physics | 4 | 4 | 30 | 70 | 100 | 3 |
| Choose any one of the following Discipline Elective Courses (PHY-703A, PHY-703B, PHY-703C or PHY-703D) | | | | | | | | | |
| 3 | Discipline elective | PHY-703A | Laser and Spectroscopy | 4 | 4 | 30 | 70 | 100 | 3 |
| | | PHY-703B | Nano Science and Technology | 4 | 4 | 30 | 70 | 100 | 3 |
| | | PHY-703C | Non-linear Dynamics | 4 | 4 | 30 | 70 | 100 | 3 |
| | | PHY-703D | MOOC available on SWAYAM portal | - | 4 | - | - | 100 | - |
| 4 | Core | RPE-04 | Research and Publication Ethics | 2 | 2 | 20 | 30 | 50 | 3 |
| | **Total** | | | | **14** | | | **350** | |

## PHY-701: RESEARCH METHODOLOGY

**Credits: 4** **Max. Marks: 70**
**Periods per week: 4 Hrs.** **Duration of Exam.: 3 Hrs.**

**Note:** There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all including compulsory question, selecting one question from each unit.

**Unit-I**

Introduction: Concept of research; characteristics features of research, Types of research, objectives of research, Review of Literature. Scope of research, validity and reliability of research, Process of research: steps involved in research process, Selecting a research topic, Planning and designing research, Criteria of good research, Rules and principles of scientific methods, Hypothesis, Data collection, Analysis and interpretation of data, Experimental techniques.

**Unit II:**

Errors & Curve Fitting: Errors- Round off error, Truncation error, Machine error, Random error, Propagation of errors. Loss of Significance: Significant digits, Computer caused loss of significance, Avoiding loss of significance in subtraction, Least square curve fitting: The principle of least square fitting, Linear regression, Polynomial regression, Fitting exponential and trigonometric functions.

**Unit III**

Hypothesis: Meaning of hypothesis, Importance of hypothesis, Types of hypothesis, Source of hypothesis, Characteristics of hypothesis, Use of hypothesis in research, Different form of hypothesis, Difficulties in the formation of hypothesis, Testing of hypothesis, Test of significance, Steps in testing, Student's t- distribution, F-test, Chi-Square ($\chi^2$) test.

**Unit-IV**

Preparation of Dissertation: writing a scientific paper, Journal impact factor, citation index, seminar, conference and workshops, Types and layout of research, Precautions in preparing the research dissertation, Bibliography and annexure, Discussion of results, Draw conclusions, Giving suggestions and recommendations to the concerned persons.

**Text and Reference Books:**


1. K. Prathapan : Research Methodology for Scientific Research (IK International)
2. C.R. Kothari : Research Methods, Methods & Techniques (Second Revised Edition)
3. P.B. Patil and U.P. Verma : Numerical Computational Methods (Narosa Pub. House)
4. S.S. Sastry : Introductory Methods of Numerical Analysis (PHI)
5. Santosh Gupta : Research Methodology and Statistical Techniques (Deep Publication)

# PHY-702: ADVANCES IN PHYSICS

**Credits: 4** **Max. Marks: 70**
**Periods per week: 4 Hrs.** **Duration of Exam.: 3 Hrs.**

**Note:** There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all including compulsory question, selecting one question from each unit.

**Unit-I**

Thin film deposition processes: Resistive heating, R.F. heating, Electron bombardment heating, Laser ablation, RF, DC & Ion beam sputtering, Electrodeposition, Chemical vapor deposition, MOCVD, PECVD, Choice of thin film substrates.

Measurement of thickness of thin films: Basic principle involved in optical, electrical, mechanical and radiation based thickness measurement techniques.

**Unit-II**

Laser mode's characteristics: spatial and frequency dependence, Mode competition, Effect of modes on gain medium profile: spatial and spectral hole burning, Properties of Gaussian and real laser beams, Pulse shortening techniques: Self phase modulation and pulse compression, Intensity dependent refractive index, Nonlinear optical materials, Phase matching, Saturable absorption.

**Unit-III**

Photochoromic and electrochromic materials, Optical properties of semiconductors, Second –order optical nonlinearity, Third order optical nonlinearity, Second order susceptibility, Perovskites, Poled ploymers, Photosensitive and photothermal materials, brief idea of multiferroic materials and their applications.Photo refractive materials and their applications.

**Unit IV**

Field Quantization: Introduction, Classical and Quantum field equations: Coordinates of the field, Time derivatives, Classical Lagrangian equation, Classical Hamiltonian equations; Quantum equation of the field, Field with more than one component, Complex field, Quantization of the non relativistic Schrodinger equation (Second quantization): Classical Lagrangian and Hamiltonian equations, Quantum field equations.

**Text and Reference Books:**


1. K. Thyagarajan and A.K. Ghatak : Laser: Theory and Applications
2. C.C. Davis : Laser and Electro-optics
3. Willian T. Silfvast : Laser Fundamentals
4. Joseph H.Simmons and Kelly S. Potter : Optical Materials
5. L.I. Maissel and R. Glang : Hand book of thin film technology
6. K.L. Chopra : Thim film phenomena
7. Milton Ohring : Materials Science of Thin Films.
8. L.C. Feldman & J.W. Mayer : Fundamentals of Surface & Thin Film Analysis.
9. L.I. Schiff : Quantum Mechanics ($3^{rd}$ Edition)
10. J.J. Sakurai : Advanced Quantum Mechanics

## PHY-703A: LASER AND SPECTROSCOPY

**Credits: 4** **Max. Marks: 70**
**Periods per week: 4 Hrs.** **Duration of Exam.: 3 Hrs.**

**Note:** There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all including compulsory question, selecting one question from each unit.

**Unit – I**

Properties of laser radiation and laser safety; Laser systems: Er-doped silica fiber laser, Ti: Sapphire laser, Review of Semiconductor lasers; Double heterostructure and quantum-well lasers, Distributed feedback laser, Diode laser array, Applications of lasers in data storage, Conventional holography.

**Unit – II**

Maxwell's equation in non-linear medium, Steady state nonlinear optical effects, Slowly varying envelope approximation, Classical, Semi-classical and Quantum approaches (Elementary Idea only), Nonlinear polarization & susceptibilities, Three wave mixing phenomenon, sum & difference frequency generation, Phase matching conditions, Parametric amplification and oscillation, Second harmonic generation, and its conversion efficiency.

**Unit – III**

Stimulated Brillouin scattering, Optical phase conjugation, Real time holography, Two photon absorption, Z-scan technique, Self-focusing and self-defocusing phenomena and its applications, Group velocity dispersion, Interaction between ideal two level atoms (semi classical approach), Induced dipole moment.

**Unit – IV**

Principle, construction and applications of techniques: Laser Raman spectroscopy, High sensitivity methods of absorption spectroscopy; frequency modulation and intracavity absorption (using single and multimode operation), fluorescence excitation spectroscopy, Fabry-Perot spectroscopy, Laser induced fluorescence spectroscopy.

**Text and Reference Books:**


1. J.T. Verdeyen : Laser Electronics
2. C. C. Davis : Lasers and Electro-optics
3. W. T. Silfwast : Lasers Fundamentals
4. O. Svelto : Principles of Lasers
5. D.S. Ahlawat : Basics Concepts of Laser Physics
6. A. Ghatak & K. Tayagrajan : Laser (Theory & Applications)
7. R. W. Boyd : Nonlinear Optics
8. Y. R. Sen : Principle of Nonlinear Optics
9. R. Syms and J. Cozens : Optical Guided Waves and Device

## PHY-703B: NANO SCIENCE AND TECHNOLOGY

**Credits: 4** **Max. Marks: 70**
**Periods per week: 4 Hrs.** **Duration of Exam.: 3 Hrs.**

**Note:** There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all including compulsory question, selecting one question from each unit.

**Unit-I**

Introduction to Nanoscience, 1D, 2D and 3D confinements, Density of states, Exciton, Surface plasmon, Energy bands; Size dependence of properties; Classification of nanomaterials/nanostructures; Semiconductor quantum well, wire and dot; Structural, Optical Chemical, Mechanical, Magnetic properties of nanoparticles; Emergence of nanotechnology and its applications.

**Unit-II**

Preparation/Synthesis of Nanostructured materials: Top-down and Bottom-up approaches, Idea of some important physical and chemical techniques: Ball milling, Ion beam sputtering, Pulsed laser deposition, Chemical vapor deposition, Sol-gel, Co-precipitation, Electro-deposition.

**Unit-III**

Principle, instrumentation, methodology and applications of following techniques:
Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Atomic force microscopy (AFM), Energy dispersive X-ray fluorescence (EDX/EDS), X-ray photoelectron spectroscopy (XPS/ESCA).

**Unit-IV**

Principle, instrumentation, methodology and applications of following techniques:
X-ray diffraction (XRD), UV-Visible spectroscopy, Fourier transform infrared spectroscopy (FTIR), Raman spectroscopy, Photoluminescence (PL), Vibrating Sample Magnetometry (VSM).

**Text and Reference Books:**


1. M. Wilson et al : Nanotechnology
2. Guozhong Cao : Nanostructures & Nanomaterials
3. C.P. Poole & F.J. Qwens : Introduction to Nanotechnology
4. N. Peyghambarian et.al : Introduction to Semiconductor Optics
5. K.P. Jain : Physics of Semiconductor Nano Structures
6. John H. Davies : Physics of Low Dimensional Semiconductors
7. J. H. Fendler (Ed.) : Nanoparticles and Nanostructured Films
8. Paul Harrison : Quantum Wells, Wires and Dots
9. A.S. Edelstein & R.C. Cammarata :Nanomaterials: Synthesis, Properties & Applications
10. C.R. Brunde & A.D Baker : Electron spectroscopy: Theory, Technique & Applications
11. Lakowic : Principle of Fluorescence Spectroscopy.

**PHY-703C NON-LINEAR DYNAMICS**

**Credits: 4** **Max. Marks: 70**
**Periods per week: 4 Hrs.** **Duration of Exam.: 3 Hrs.**

**Note:** There are **nine** questions in all. Question No. 1 is compulsory consisting of 5 short questions of 2 marks each. Students have to attempt **five** questions in all including compulsory question, selecting one question from each unit.

**Unit-I**

**Linear and Nonlinear Systems :** Introduction, Dynamical systems, Mathematical Implications of Nonlinearity, Effects of Nonlinearity, History of Dynamics, Importance of being nonlinear, Linear oscillators and Predictability - Free Oscillations, Forced Oscillations and Damped oscillations, Damped and Driven Nonlinear Oscillators- Free Oscillations, Forced Oscillations and Damped oscillations.

**Unit-II**

**Integrability :** Introduction, Integrable and Nonintegrable systems, Different types of Invariants, some formal remarks about the dynamical invariants, Forms of Second invariants, Construction of the Second invariants, Superintegrable systems, Classical and Quantum Integrable Systems, Complete integrability-Complex analytical integrability, Symmetries and Integrability, Integrable Discrete Systems.

**Unit-III**

**Chaos and Fractals:** Introduction, A Chaoitic waterwheel, Simple Properties of the Lorentz Equation, Chaos on a Strange Attractor, Lorentz Map, One dimensional Maps, Logistic Map: Numerics, Liapunov exponent, Probabilistic Construction of Fractals, Fractal and Deterministic Systems, Fractal Basin Boundaries, Fractal Dimensions, Chaoitic attractors, Lorentz attractor.

**Unit-IV**

**KdV equation and Solitons :** The Scott Russel Phenomena and KdV equation, The Birth of Solitons, Bilinerization method for Soliton solutions of KdV equation, Explicit Soliton solutions(for N=1,2), The Nonlinear Schrodinger Equation in Optical Fiber, Solitary wave solutions and Basic Solutions- Pulse soliton, Envelope solitons, Spin solitons, The Sine-Gordan equation-Kink, Antikink and Breathers

**Text and Reference Books:**


1. M. Lakshmanan and S. Rajasekar : Nonlinear Dynamics
2. R.S. Kaushal : Classical and Quantum Mechanics of Noncentral Potentials
3. Steven H. Strogatz : Nonlinear Dynamics and Chaos
4. Kaithleen T. Alligood, Tim. D Sauer and James A. Yorke : Chaos – An Introduction to Dynamical Systems

Annexure-I

Common for All Ph.D. Research scholars
RPE-04 (Research and Publication Ethics)

Credits: 2
Time: 3 Hrs.

Marks: 50
Theory: 30
IA: 20

**Note for the paper setter:** The question paper will consist of nine questions in all. The first question will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition, eight more questions will be set unit-wise comprising of two questions from each of the four units. The candidates are required to attempt four more questions selecting at least one question from each unit.

**Course Objectives:**

1. Provide students with the fundamental knowledge of research methods and design used in.
2. Facilitate students understanding for how using valid scientific methods of measurement and scaling can improve and create knowledge
3. Analyse and interpret methods of quantitative and qualitative data
4. Guide and mentor students in developing, completing, writing, and presenting a valid and ethical research report
5. To know about the University Grants Commission (UGC) has launched a Consortium of Academic and Research Ethics (CARE) to "identify, continuously monitor and maintain" UGC-CARE Reference List of Quality Journals across disciplines

**Course Outcomes:**

1. Students will be familiar with the fundamental knowledge of basics of philosophy of science and ethics, research integrity, publication ethics.
2. Students will know about predatory journals/pseudo journals and fabrication of data
3. Understand the Subject specific ethical issues, FFP, authorship, Conflicts of interest. Complaints and appeals: examples and fraud from India and abroad
4. Understand the major and authentic databases of reputed journals like Web of Science, Scopus, PubMed, ICI
5. Understand the importance of SCI impact factor, SNIP, SJR, IPP, h-index, g index, i10 index

**UNIT-I**

Introduction to philosophy: definition, nature and scope, concept, branches, Ethics: definition, moral philosophy, nature of moral judgements and reactions, Ethics with respect to science and research, Intellectual honesty and research integrity, Scientific misconduct: Falsification, Fabrication, and Plagiarism (FFP), Redundant publication: duplicate and overlapping publications, salami slicing, Selective reporting and misrepresentation of data

**UNIT-II**

Publication ethics: definition, introduction and importance, Best practices standards setting initiatives and guidelines: COPE, WAME, etc., Conflicts of interest, Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types, Violation of publication ethics, authorship and contributorship, Identification of publication misconduct, complaints and appeals, Predatory publishers and journals, Open access publications and initiatives, SHERPA/ROMEO online resource to check publisher copyright & self-archiving policies.

## UNIT-III

Software tool to identify predatory publications developed by SPPU, Journal finder/ Journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Suggester, etc., Subject specific ethical issues, FFP, authorship, Conflicts of interest, Complaints and appeals: examples and fraud from India and abroad, Use of plagiarism software like Turnitin, Urkund and other open source software tools

## UNIT-IV

Indexing databases; Citation databases: Web of Science, Scopus, Pubmed, ICI etc., Impact Factor of journal as per Journal Citation Reports. SNIP, SJR, IPP: Cite Score, Metrics: h-index, g index, i10 index, altmetrics.

**References:**


1. Bird, A. (2006). Philosophy of Science. Routledge.
2. MacIntyre, Alasdair (1967) A Short History of Ethics. London.
3. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
4. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
5. Resnik, D. B. (2011). What is ethics in research & why is it Important. National Institute of Environmental Health Sciences, 1-10. Retrieved from*
6. https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489179a
7. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019). ISBN:978-81-939482-1-7. http://www.insaindia.res.in/pdf/Ethics Book.pdf