COURSES OF STUDIES

COURSE WORK SYLLABUS FOR Ph.D. (PHYSICS)

SCHOOL OF PHYSICS
GANGADHAR MEHER UNIVERSITY
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COURSE STRUCTURE OF Ph.D. PROGRAMME (PHYSICS)

The Ph.D. in Physics comprises one semester of course work with the following course structures. The course work will be assigned in semester-I only. In semester-I, each paper (PH-711A or PH-711B or PH-711C, PH-712, PH-713 and PH- 714) carries 100 marks out of which 20 marks are for internal assessment examination except for the paper PH- 714 i.e. the *Review work*, which does not have any internal examination. There will be one internal assessment examinations for each theory paper. There will be no internal examination in Semester-II. The duration of an examination for each theory is 3 hours. The pattern of teaching and examination in Ph.D. classes are displayed in the Table below for 2020-21 batches. In PH-714 (Review work), a PhD Scholar will prepare a review report on the basis of his/her research field perceived. The mark distribution for PH-714 is mentioned in the table.

A Brief Overview of PHD Syllabus

FIRST SEMESTER			
Course No.	Name of Course	Marks	Credit
PH-711 A PH-711 B PH-711 C	Experimental Physics	20+80	4
	Computational Physics	20+80	4
	Theoretical Physics	20+80	4
PH-712	Research Methodology-I	20+80	4
PH-713	Research Methodology-II	20+80	4
PH- 714	Review Work	200 (150+25+25) Report – 150 Seminar presentation- 25 Viva-- 25	8
		Total Marks=500	Total Credit=20

PHY-711 A: Experimental Physics

4 Hrs/week

Unit I **10 hours**

General Experiments in Physics: Four probe method, Hall effect for mobility, Ellipsometry, Gamma ray spectroscopy, Nuclear magnetic resonance, Electron spin resonance, G. M. Counter, Compton scattering, Photo-catalysis, Particle accelerator, Cyclotron, DC glow discharge plasma set-up, RF plasma set-up.

Unit II **10 hours**

Material properties: Classification of Engineering Materials: Metals, Polymers, ceramics, Nano Crystalline materials, Composite Materials, Applications.

Synthesis of Nanomaterial: Chemical Vapour deposition (CVD), Physical Vapour Deposition (PVD), Pulse LASER deposition (PLD), Hydro- thermal synthesis, Sol-Gel synthesis, High energy ball milling, microwave synthesis, combustion synthesis, Plasma sputtering technique, Spin coating, Lithography technique of nano fabrication.

Unit III **10 hours**

Characterization Technique: X-Ray Diffraction, Spectroscopic measurement: UV-visible spectrometer, Fourier transform infra-red spectrometer (FTIR), Raman Spectroscopy, General idea of Photo-Luminesce, Surface plasmons resonance.

Unit IV **10 hours**

Microscopic Techniques: Optical microscopy, scanning electron microscope (SEM), Energy dispersion spectroscopy (EDS), Transmission electron microscope (TEM), Scanning tunneling electron microscope (STEM), Atomic force microscope (AFM), SQUID, **Thermal properties**: DSC/DTA analysis, **Mechanical properties:** Hardness measurement (Rockwell and Vickers), Mechanical strength by Universal testing machine.

References

Text Books:

1. Introduction to solid state physics- C. Kittel, J (2016), John Wiley & Sons, 8th Edition.
2. Nano Materials (An Introduction to Synthesis, Properties and Applications)- D. Vollath (2013), Wiley-VCH, 2nd Edition.
3. Introduction to Nanoscience and Nano Materials-D. C. Agrawal, (2013), World Scientific, 1st Edition
4. Element of X-ray Diffraction-B. D. Cullity, (1978), Addison-Wiley, 2nd edition.
5. Electron microscopy and Analysis- P. J Goodhew, J Humphrey, R Beanland, (2001), Taylor and Francis, 3rd Edition.
6. Fundamental of materials science and Engineering- William D. Callister, (2001), Jr. John Wiley and Son, 5th Edition,

Reference Books:

1. Introduction to Nano (Basics to Nanoscience and Nanotechnology) – A. Sengupto and C. K. Sarkar, (2015), Springer, 1st Edition.
2. Materials science and engineering-V. Raghvan, (2011), Prentice-Hall Pvt. Ltd., 5th Edition.
3. Materials Characterization- Y Leng, (2008), Wiley-VCH, 2nd Edition.

COURSE OUTCOME

After completing this course, the students should be able to:

CO1: Understand various experiments Modern Physics

CO2: Learn the various synthesis techniques of materials.

CO3: Apply X-Ray and spectroscopic techniques for characterization of materials.

CO4: Identify various materials through microscopic, thermal and mechanical characterization techniques.

PHY-711 B: Computational Physics

Unit I **8 hours**

LINUX commands, Introduction to different programing language Python, Scilab, Latex for Scientific manuscript Preparation, GNU plot, Curve fitting, GIMP, Inkscape.

Unit II **8 hours**

Programming with FORTAN: Program solving on computers - algorithm and flow charts in FORTAN data types, expressions and statements, input/output commands, sub-program.

Unit III **12 hours**

Programming with C++: Structure of C++ program, compilation, Data types, variable and constant, declaration of variables, initializing variables, arithmetic operators, Increment and Decrement operators, I/O statements, arithmetic expressions, functions, Control statements: decision making and looping statements, array.

Unit IV **12 hours**

Numerical analysis & **Programming:**
Interpolation by Lagrange method, Numerical solution of simple algebraic equation by Newton- Raphson method, Least Square fit using rational functions, Numerical integration: Trapezoidal method, Simpons method, Romberg integration, Gauss quadrature method, Eigenvalues and eigenvectors of a matrix, Solution of linear homogeneous equations, Trace of a matrix, Matrix inversion, Solution of ordinary differential equation by Runge-Kutta Method, Introductory Monte Carlo techniques.

References

Text Books

1. Fortran 77 and Numerical methods - C. Xavier, (1994), New Age International, (1st Edition)
2. The LINUX Command line- W. E. Shotts Jr. (2012) No starch Press, 3rd Edition
3. Computer Programming in FORTRAN 90 and 95: V. Rajaraman, (2018), PHI Learning Private Limited, 18th Edition
4. LaTeX- F. Raid , (2005), Printellegra company, 1st Edition.
4. A Guide to MATLAB- Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Kevin R. Coombes, John E. Osborn, Garrett J. Stuck, (2006), Cambridge University Press, 1st Edition.
5. Powder diffraction : proceedings of the II International School on Powder Diffraction ; January 20 - 23, 2002, IACS, Kolkata, India ; (as part of 125 years of celebration) By Indian Association for the Cultivation of Science
6. Programming with C++: J. R. Hubbard, (2000), MCGRAW-HILL, 2nd Edition.
7. Introductory methods for Numerical Analysis", S. S. Sastry, , PHI publication 5th Edition (2012).

Reference Books

1. Fundamentals of Computers- V. Rajaraman, (2015), PHI Learning Private Limited, 6th Edition.
2. Computer Oriented Numerical Methods- R.S.Salaria, Khanna Book Publishing co. (P) LTD. 5th Edition.
3. Introduction to MATLAB 7.4- J Palm William III, (2004), Tata Mc Graw-Hill Publications, New Delhi, 2nd Edition
4. Pragramming with C++ :D. Ravichandran, (2011), Tata McGraw Hill, 3rd Edition.
5. Digital Topography using LaTeX- Apostolos Syropoulos, Antonis Tsolomitis, Nick Sofroniou, (2007), Springer, 3rd Edition
6. Numerical Methods for Engineers- Steven Chapra and Raymond Canale, (2009), McGraw-Hill, 6th Edition.

7. X-Ray Diffraction: A Practical Approach- C. Suryanarayana, M. Grant Norton, (2013), Springer, 1st Edition.

COURSE OUTCOME

After completing this course, the students should be able to:
CO1: Learn various computational skills.
CO2: Apply various scientific software for computational analysis and research.
CO3: Apply Fortran and C++ Language for various computational analysis.
CO4: Compute numerical differentiation and integration using interpolation.

PHY-711 C: Theoretical Physics

4 Hrs/week

Unit I **10 hours**

Solution of inhomogeneous partial differential equation by Green's function. Tensor Analysis: Covariant derivatives, Covariant formalism of E & M, Geodesic equation, Hamilton Jacobi equation, action-angle variable, general theory of small oscillations.

Unit II **10 hours**

Addition of angular momenta and C.G. Coefficients, WKB approximation and connection formulae, Harmonic perturbation, application to LASER and MASER, Quantum scattering theory and differential cross-section by Partial wave analysis, classical fields and quantum field theory, second quantization.

Unit III **10 hours**

Central and non-central forces, deuteron and its magnetic and quadrupole moment, Parity, time reversal, Charge conjugation and CPT theorem and its consequences, SU(2) and SU(3) group representation, application to quark model.

Unit IV **10 hours**

Quantum Hall effect, magneto resistance, Giant magneto resistance and colossal magneto resistance, Hartree-Fock equation, Thomas Fermi theory of dielectric function Superconductivity: London equation and BCS theory, Cooper pair and BCS Hamiltonian, High Tc superconductor, Ising model and Landau theory of phase transition.

References

Text Books

1. Mathematical Methods for Physicists: George Arfken Hans, Weber Frank, E. Harris, (2012), Academic Press. 7th Edition.
2. Classical Mechanics, H. Goldstein, C. P. Poole and J. L. Safko, (2011), Addison Wesley, 3rd edition.
3. Quantum Mechanics Concepts and Applications - Nouredine Zettili, (2009), Wiley, 2nd Edition.
4. Advanced Quantum Mechanics- J. J. Sakurai (2002), Pearson Education India, 4th Edition
5. Nuclear Physics- Dr. S. N. Ghosal, (2016), S. Chand, Revised Enlarged edition.
6. Introduction to elementary particles: D. Griffiths (2008), Wiley-VCH, 2nd Edition.
7. Quantum Theory of Solid state- Joseph Callaway (2012), Academic Press, 1st Edition
8. Statistical Mechanics, R.K. Pathria, Paul D. Beale, Elsevier Science, 4th Edition.

Reference Books

1. Mathematical Physics: H K Das, Dr. R. Verma, (2012) S. Chand Publications, 1st Edition
2. Mechanics, L.D. Landau and E.M. Lifshitz, (2000), Butterworth-Heinenann, 1st Edition
3. Quantum Mechanics - J. J. Sakurai, J. Napolitano, (2011), Cambridge University Press, 2nd Edition.
4. Relativistic Quantum Mechanics- J. D. Bjorken and S. D. Drell (1964), Mc-Graw Hill, 1ST Edition
5. Nuclear Physics - R. R. Roy and B. P. Nigam, (1996), New Age International, 2nd Edition.
6. Introduction to High energy Physics, Donald H Perkins (2000), CAMBRIDGE UNIVERSITY, 4th Edition.
7. Principles of the theory of solids – J.M.Ziman, (1979), Cambridge University Press, 1st Edition
8. Statistical physics, K. Huang, (2014), Willy Student edition , 2nd Edition.

COURSE OUTCOME

After completing this course, the students should be able to:
CO1: Apply theory of Green's function and Tensor to solve various problems in Physical Sciences.
CO2: Analyze the critical aspects of Hamilton's Jacobi equation and theory of small oscillation in classical Mechanics.
CO3: Apply the basic theories of Quantum mechanics for various Physical applications.
CO4: Apply theory of nuclear physics and group theory to understand the behavior of elementary particles
CO5: Analyze the properties of superconducting material through Quantum mechanics and theory of solids.

PHY-712: RESEARCH METHODOLOGY-I

Unit-I

SCOPE, PHILOSOPHY AND ETHICS OF RESEARCH AND ETHICS

Introduction and Scope
Introduction to philosophy: definition, nature and scope, concept, branches
Ethics: definition, moral philosophy, nature of moral judgments and reactions, Research ethics, Institutional ethics committee.
Ethics with respect to science and research
Intellectual honesty and research integrity

Unit-II

SCIENTIFIC CONDUCT

Research problem: Identification, Selection, Formulation of research objectives
Research design: Components, Types and Importance
Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
Redundant publications: duplicate and overlapping publications, salami slicing
Selective reporting and misrepresentation of data

Unit-III

TECHNICAL WRITING

Literature search technique, using SCOPUS, Google Scholar, PUBMED, Web of science, Indian Citation Index, and RG
Types of technical documents; Full length research paper, Short/Brief communications, Letters to editor, Book chapter, Review, Conference report, Project proposal Components of a full length research paper; , Rationale of the paper, Aims and objectives, Hypothesis building, Work plan, Materials and methodology, Results and discussion, Conflict of interest statement,
Components of a research proposal; Project summary Key words, Origin of the proposal, Major objectives Methodology, Instrument facility available in the PI's department, Overview of status of Research and Development in the subject, Importance of the proposed project in the context of current status.
Styles of referencing; APA, MLA, Oxford, Harvard, Chicago, Annotated bibliography, Tools for citing and referencing, Grammarly, Endnote etc, How to cite and how to do referencing

Unit-IV

PUBLICATION ETHICS

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, Subject specific ethical issues, FFP, authorship,
Identification of publication misconduct, complaints and appeals
Predatory publishers and journals
Plagiarism-Pitfall
Use of plagiarism software like Turnitin, Urkund and other open source software tools. Complaints and appeals: examples and fraud from India and abroad

PHY-713: RESEARCH METHODOLOGY-II

Unit I: IPR AND CYBER LAW.

(i) Patents, Patent laws, process of patenting research findings

(ii) Intellectual property (IP), Intellectual property right (IPR)

(iii) Copyright, Trademarks, GI

(iv) Cyber laws

(v) COPE

Unit II QUANTITATIVE DATA ANALYSIS

(i) Types of Data, Data Collection - Methods and Tools

(ii) Hypothesis testing

(iii) Normal and Binomial distributions and their property

(iv) Tests of significance: Student t- test, F- test, Chi-square test

(v) Correlation and Regression

(vi) ANOVA - One-way and Two-way, Multiple-range test

Unit III COMPUTER FUNDAMENTALS

(i) Introduction to MS-Office software: MS-Word(Track change)

(ii) MS-Excel

(iii) MS-Power Point

(iv) Features for Statistical Data Analysis Tool Pack, SPSS

(v) Tables, Figures and Pictures using Excel

(vi) Preparation of Posters

(vii) Electronic submission of manuscripts

(viii) Communication skills, oral and poster

Unit IV ADVANCED TOOLS & TECHNIQUES IN RESEARCH

(i) Indexing databases

(ii) Citation databases: Web of Science, Scopus, etc.

(iii) Research Metrics

(iv) Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score

(v) Metrics: h-index, g index, i10 index, altmetrics

(vi) Open access publications and initiatives

(vii) SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies

(viii) Software tool to identify predatory publications developed by SPPU

(ix) Journal finder /journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.