COURSES OF STUDIES

SYLLABUS FOR Ph.D. (PHYSICS)

SCHOOL OF PHYSICS
GANGADHAR MEHER UNIVERSITY
AMRUTA VIHAR, SAMBALPUR-768004, ODISHA

18 Sept 2020

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 Teaching Assignment and Assessment, 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.

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-Materials Science	20+80	4
	Computational Methods	20+80	4
	LASER and Photonics	20+80	4
PH-712	Research Methodology-I	20+80	4
PH-713	Research Methodology-II	20+80	4
PH- 714	Teaching Assignment and Assessment	100 (50+50) Seminar-50 Assignment-50	4
PH721	Dissertation	200	8
		Total Marks=600	Total Credit=24

PHY-711 A: Experimental Physics-Materials Science

4 Hrs/week

Unit I — 10 hours

Superconducting Materials: Superconducting Materials: BCS Theory, Flux quantization, Josephson effect, High-Tc Superconductors and applications.

Magnetic Materials: Different Types of magnetic materials and their properties, Weiss-Molecular field Theory of Ferromagnetism, Ferrimagnetism, anti-ferrimagnetism, Applications.

Dielectric Materials: Polarization mechanism, Dielectric constant, temperature dependence of dielectric constant, behavior of dielectric AC field, AC and DC conductivity, Dielectric loss, Dielectric breakdown, ferro- electric, piezoelectric, pyroelectric materials, Applications.

Unit II — 10 hours

General Aspects of Material Science: Material properties and Requirements, Classification of Engineering Materials: Metals, Polymers, ceramics, Nano Crystalline materials, biomaterials, definition of ceramics, ceramic microstructure, Traditional verses advanced ceramics, General characteristic properties of ceramics, Applications, Composite crystal structure, Structure of covalent ceramics, Composite Materials, Applications.

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

Unit III — 10 hours

Characterization Technique: X-Ray Diffraction. Optical Microscopy, Scanning Electron Microscopy, Spec-troscopic measurement: UV-visible spectrometer, Fourier transform infra-red spectrometer (FTIR) , Raman Spectroscopy.

Unit IV — 10 hours

Advanced Mathematical methods: Green functions Green function integral - differential equation, Green function and Dirac delta functions, Non-homogeneous differential equation by Green' Function.

Relativistic Tensor Formulations: Tensor in special relativity, Covariant and contravariant vector, Four vector Minkowski Space time, the velocity four vector, covariant force, covariant formalism for E & M. Tensor in general relativity, derivative in curve space, covarient derivatives, Christoffel symbol and metric tensor, Geodesic equation.

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,
7. Mathematical Methods for Physicists: George Arfken Hans, Weber Frank, E. Harris, (2012), Academic Press. 7th Edition.

Reference Books:

1. Solid State Physics- Ashcroft Mermin, (2011), Cengage Learning, India Edition, 10th Edition
2. Introduction to Nano (Basics to Nanoscience and Nanotechnology) – A. Sengupto and C. K. Sarkar, (2015), Springer, 1st Edition.
3. Materials science and engineering, V. Raghvan, (2011), Prentice-Hall Pvt. Ltd., 5th Edition.

4. Materials Characterization: Y Leng, (2008), Wiley-VCH, 2nd Edition.
5. Mathematical Methods for Physics and Engineering: K. F. Riley, M. P. Hobson and S. J. Bence, (2006), Cambridge University Press, 3rd Edition.

PHY-711 B: Computational Physics

Unit I **10 hours**

Basic Computational Skills

LINUX commands, Familiar with Mathematica, Matlab, Python, Scilab, Origin, qtiplot, GIMP, Inkscape.

Unit II **10 hours**

Latex for Scientific manuscript Preparation, GNU plot, Curve fitting, Labview for computer interfacing, XRD graph analysis by JCPDS and by X'pert Hiscore Plus.

Unit III **10 hours**

Programming with FORTAN: Program solving on computers - algorithm and flow charts in FORTAN data types, expressions and statements, input/output commands, sub-program,
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 **10 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.

PHY-711 C: LASER and Photonics

4 Hrs/week

Unit I **10 hours**

Nonlinear optics: Nonlinear Optical Interactions - Polarization response of materials to light, Nonlinear susceptibility tensor, nonlinear coefficient, Second Harmonic generation, sum and difference frequency generation, Coupled amplitude equation, Third-Order Nonlinear Susceptibility, Self phase modulation, Optical Kerr Effect, Phase conjugation, application of nonlinear optics in modern science

Unit II **10 hours**

Ultrafast laser: Light-matter interactions and laser fundamental, CW and pulsed laser, Q switching, Active and Passive Mode Locking for ultrafast laser pulse generation, Characterization of Ultrafast laser pulses, Chirped pulse amplification, Applications of ultrafast laser in basic science, engineering and medical science

Unit III **10 hours**

Plasmonic: Plasmonic metamaterials, Topological insulators, Semimetals, Dirac metals, Smart materials, Nano materials, tunable materials, characteristic properties and their applications.

Unit IV **10 hours**

Photovoltaics and Semiconductor Photonics : Fundamental of photovoltaic cell, LED, photo diode and Semiconductor laser, Dye sensitized solar cell, Black Si, photocatalysis

References

Text Books

1. Introduction to Non-Linear Optics- Geoffrey New, (2011), Cambridge University Press, 1st Edition.
2. Ultrafast LASERS: Technology and Applications – Edited by Almantas Galvanauskas, Gregg Sucha, Martin E. Fermann, (2002), CRC Press, 1st Edition.
3. Plasmonics: Fundamentals and Applications- Stefan A. Maier, (2007), Springer, 1st Edition.
4. Compound Semiconductor Photonics- Edited by Aaron Danner, Chua Soo-Jin, Teng Jinghua, (2020), CRC Press, 1st Edition.

Reference Books

1. Nonlinear Optics - Robert W. Boyd, (2003), Academic Press, 2nd Edition.
2. Industrial Applications of Ultrafast LASERS- Richard A Haight, Adra Carr, (2018), World Scientific, 2nd Edition.
6. PLASMONICS: From Basics to Advanced Topics, (2012), Springer, 1st Edition.
7. Semiconductor Nanophotonics: Materials, Models and Devices- Edited by Andreas Knorr, Axel Hoffmann, Michael Kneissl, Stephan Reitzenstein, (2020), Springer, 1st Edition.

PHY-712: RESEARCH METHODOLOGY-I

Unit I: SCOPE, PHILOSOPHY AND ETHICS OF RESEARCH AND ETHICS

(i) Introduction and Scope

(ii) Introduction to philosophy: definition, nature and scope, concept, branches

(iii) Ethics: definition, moral philosophy, nature of moral judgments and reactions, Research ethics, Institutional ethics committee.

(iv) Ethics with respect to science and research

(v) Intellectual honesty and research integrity

Unit II SCIENTIFIC CONDUCT

(i) Research problem: Identification, Selection, Formulation of research objectives

(ii) Research design: Components, Types and Importance

(iii) Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)

(iv) Redundant publications: duplicate and overlapping publications, salami slicing

(v) Selective reporting and misrepresentation of data

Unit III TECHNICAL WRITING

(i) Literature search technique, using SCOPUS, Google Scholar, PUBMED, Web of science, Indian Citation Index, and RG

(ii) 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,

(iii) 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.

(iv) 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

(i) Publication ethics: definition, introduction and importance

(ii) Best practices / standards setting initiatives and guidelines: COPE, WAME, etc.

(iii) Conflicts of interest

(iv) Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types

(v) Violation of publication ethics, Subject specific ethical issues, FFP, authorship,

(vi) Identification of publication misconduct, complaints and appeals

(vii) Predatory publishers and journals

(viii) Plagiarism-Pitfall

(ix) 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 a research finding

(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.