ISLAMIC UNIVERSITY OF SEICENCE & TECHNOLOGY
AWANTIPORA, KASHMIR

DEPARTMENT OF PHYSICS

Ph. D

Coursework Syllabus

Approved by BORS (Board of Research Studies 2020-21)

Department of Physics

Islamic University of Science and Technology

Overview of the Course Scheme for Ph. D Programme

As per the university ordinance and new guidelines, the research scholars who are provisionally registered under the Ph. D programme will have to undergo a pre-Ph. D coursework. The pre-Ph. D coursework shall have three components. Every student admitted to the PhD programme (Physics) will have to pass a 'coursework' with minimum 14 credits. The candidate can submit his/her thesis only after passing the course work.

Component one (Core Courses)

This component will comprise of two courses of 08 credits which are general to a Ph. D programme in Physics and every research scholar will have to opt for these courses mandatorily. It will have following courses:

1. Research and Publication Ethics
2. Research Methodology
3. Advanced Physics

Component Two (Research Centric)

The course is based on review of the literature on the particular research topic assigned to the research student to envisage the recent developments in the available literature.

Component three (Discipline Centric Elective Courses)

This component will comprise of a basket of courses belonging to different research fields offered by the Department of Physics. Each course will be of 4 credits and out of the available basket of courses students will have to opt for at least one course that will be mandatory for completion of the Ph. D course work.

Semester	Course Code	Course Title	Course Type	Maximum Marks			Credit Distribution			Credits
				Internal*	Final	Total	L	T	P	
Core	RPE900C	Research and Publication Ethics	Core	25	25	50	2	0	0	2
	PHY901C	Research Methodology	Core	50	50	100	3	1	0	4
	PHY902C	Advanced Physics	Core	25	25	50	2	0	0	2
Research Centric	PHY903C	Seminar on recent Developments in the area of Research	Core	Write up-50, Presentation-30, Viva-voce-20						02
Discipline Centric Elective	PHY904E	Advanced Nuclear Physics	Elective	50	50	100	3	1	0	4
	PHY905E	Advanced Solid-State Physics and Electronics	Elective	50	50	100	3	1	0	4
Total Credits										**14**

*(Midterm 30 marks +Assignment/Attendance 20 marks)

Common Course for all disciplines
Course Title: Research and Publication Ethics

Course Code: RPE900C
Credits: 2
Marks: 50

UNIT-I

Part A: Philosophy and Ethics

1. Introduction to philosophy: definition, nature and scope, concept, branches.
2. Ethics: definition, moral philosophy, nature of moral judgments and relations.

Part B: Scientific Conduct

1. Ethics with respect to science and research.
2. Intellectual honesty and research integrity.
3. Scientific misconducts: falsification, fabrication, and plagiarism.
4. Redundant publications: duplicate and overlapping publications, salami slicing.
5. Selective reporting and misrepresentation of data.

UNIT 2: Publication Ethics

1. Publication ethics: definition, introduction and importance.
2. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest.
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types.
5. Violation of publication ethics, authorship and contributor ship.
6. Identification of publication misconduct, complaints and appeals.
7. Predatory publishers and journals.

UNIT 3

Part A: Open Access Publishing

1. Open access publications and initiatives.
2. SHERPA/RoMEO online resources to check publisher copyright and self-archiving policies.
3. Software tool to identify predatory publications developed by SPPU.
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggested, etc.

Part B: Publication Misconduct

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 4:

Part A: Databases
Indexing databases, Citation databases: Web of Science, Scopus, etc.

Part B:
Research Metrics
Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score. Metrics: h-index, g index, i10 index, altmetrics.

Books Recommended:

1. Bird,A. (2006) Philosophy of Science, Routledge.
2. Maclntyre, Alasdair (1967) A short story 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 a scientist: guide to Responsible conduct in research: Third Edition, National Academies Press.
5. Resnik, D.B(2011) What is ethics in research and why it is important , National Institute of Environmental Health Sciences , 1-10, retrieved from, http://niehs.nih.gov/research/resources/bioethics/whatis/index.cfm.
6. Beall, J (2012). Predatory publishers are corrupting open access, Nature, (489 (7415), 179-179, http://doi.org/10.1038/489179a.
7. Indian National Science Academy (INSA) Ethics in Science and Education, research and government (2019) ISBN: 978-81939482-1-7 http://www.insaindia.res.in/pdf/Ethics_Books.pdf.

Core (C) Courses
Course Title: Research Methodology

Course Code: PHY901C
Credits: 4
Marks: 100

Unit – I: Research Methodology
Introduction to research: Types and identification of research problem, formulation of a problem, Data collection: data analysis, interpretation of results.
Literature survey, abstract surveys. Formulation of research problem and its methodology. Art of research paper and thesis writing.

Unit – II: Numerical methods and Computer Skills
Monte Carlo Simulation, Error analysis, Least Square Fitting of linear and non-linear functions, numerical solutions of the first and second order differential equations; Euler's method and Runge-Kutta methods, Integration of a given function using trapezoidal, Sympson, Gauss quadrature rules. Open Source softwares/ codes, Linux operating system, GNU, Latex etc.

UNIT III: Fortran Programming 90/95
Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration, Operators and Expressions, Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program. Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops).

UNIT IV: Fortran Programming Applications
Numerical solution of Ordinary Differential equations: Taylor series method, Euler's method, Runge – Kutta Methods, Boundary value and Eigen value problems: Shooting method, finite difference method, solving Eigen value problems, Polynomial method, Power Method, Solution of Partial Differential Equations: Laplace equation, Poisson equation, Heat equation, Schrodinger's equation.

Books Recommended:

1. Research Methodology: Methods and Techniques: C R Kothari, Gaurav Garg, 4th Edition, New Age International Publishers.
2. A Modern Approach to Programming in FORTRAN: R. S. Salaria. Edition 4th, Khanna Book Publishing Company.
3. A student's guide to Data and Error Analysis: Herman J. C. Berendsen. Cambridge University Press (2012).
4. Essentials of Monte Carlo Simulation, Statistical Models for Simulation: Nick T. Thomopoulos, Springer Publications.
5. Introductory methods of Numerical Analysis, S. S Sastry, Edition 5th, PHILearning Private Limited.
6. Fortran 90/95 for scientists and engineers: Stephen J. Chapman McGraw Hill, 1998.
7. Numerical Methods, E Balagurusamy Mc Graw Hill. Education (1999).
8. Numerical Recipes in Fortran, W H Press, S. A Teukolsky, Edition 2nd Cambridge University Press.

Course Title: Advanced Physics

Course Code: PHY902C
Credits: 2
Marks: 50

Unit I

Partial Differential Equations, Classes and Characteristics, First-order, Separable variables. Bessel functions of First kind, Orthogonality, Neuman Functions, Hankel Functions, Modified Bessel Functions, Spherical Bessel Function; Legendre Functions, Orthogonality, Associated Legendre Function, Spherical Harmonics, Hermite Functions; Laguerre Functions.

Green's Functions in One Dimension: Green's function for regular S-L problems via Eigen function expansion, Dirac delta function and the Green's function, Generalized Green's identity, Green's function for non S-A BVPs, Existence of a zero Eigen value – modified Green's function.

Descriptive analysis: Measure of central tendency, Dispersion, Graphical representation; Normal probability curve: Meaning, characteristics, applications; Inferential Statistics: Parametric and non-parametric testing, correlation, Regression; Non parametric statistics: Chi Square test.

Unit II

Review of Special theory of Relativity and Relativistic Electrodynamics.

Scattering theory: Introduction, Lippmann-Schwinger equation and its applications, scattering cross-section for Coulomb and Yukawa potentials.

Relativistic Quantum Mechanics: Klein Gordon equation, Dirac equation in covariant form and its solution, concept of Dirac spinors.

Quantum Information: Quantum coherence and entanglement, coherent and collective phenomenon in quantum transport.

Books Recommended:

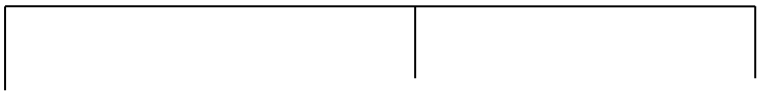
1. Mathematical Methods for Physicists, G. B. Arfken and H. J. Weber, Acad. Press, 7th ed.
2. Mathematical Methods for Students of Physics and Related Fields, Sadri Hassani, Springer, 2nd ed.
3. Advanced Engineering Mathematics, E. Kreyszig, John Wiley, 10th ed. • Mathematical Physics, M. L. Boas, John Wiley, 3rd ed.,
4. Principles of Quantum Mechanics: R. Shankar, Springer, Second Edition.
5. Relativistic Quantum Mechanics: W. Greiner, Reprint 2000.
6. Optical Coherence and Quantum Optics: L. Mandel and E. Wolf, Cambridge University Press, New York, 1995.
7. Nonlinear Optics R.W. Boyd, Academic Press, New York, 2008.

Course Title: Seminar on Recent Developments in the Area of Research

Course Code: PHY903C
Credits: 2
Marks: 100

Review of published literature: Preparation of a comprehensive and critical review of the already published literature in his/her proposed field of study in same may be submitted to a refereed/reputed journal as notified by UGC. The candidate will be evaluated on the basis of a comprehensive report to be submitted and a seminar to be delivered at the end of the semester.

100 Marks



Write-up-50 Presentation-30 Viva-20

Discipline Centric Elective (E) Courses

Course Title: Advanced Nuclear Physics

Course Code: PHY904E
Credits: 4
Marks: 100

Unit I

Review of the Deuteron Problem, Harmonic Oscillator in various coordinate systems, Deformation and Spherical Harmonics: parametrization of the nuclear surface, Types of the multipole deformations, Quadrupole deformation, Shell model of nucleus and the LS coupling.

Unit I

Nilsson model of nucleus: Introduction, the potential, qualitative treatment, exact treatment, Symmetries: General Remarks, Translation, Rotation, Isospin, Parity, Time reversal. Group theory in nuclear physics, Lie groups and Lie algebras, Group chains.

Unit III

Second Quantisation: General formalism, Motivation, Second quantisation for bosons, second quantisation for fermions, Representation of operators (one and two particle), evaluation of matrix elements, Particle-hole picture, Density functional theory in nuclear physics.

Unit IV

Microscopic models: The nucleon-nucleon interaction, general properties, functional form, interactions from nucleon-nucleon scattering, effective interactions, The Hartree-Fock approximation, the variational principle, Slater determinant approximation, The Hartree-Fock equations, Applications, Hartree-Fock-Bogolyubov theory and it's application in nuclear physics (Triaxial Projected Shell Model).

Pairing, Motivation, The seniority model, The quasi-spin model, The BCS model.

Books Recommended:

1. Nuclear Models: Greiner and Maruhan, Springer Publications (Reprint 2010).
2. Theory of Nuclear Structure, M. K. Pal, East-West Press, First Edition.
3. The Nuclear Many-Body Problem: Ring and Schuck, Springer Publications, First Edition.
4. Nuclear structure from a simple perspective: R. F. Casten, Oxford University Press, Second Edition.
5. Concepts of Nuclear Physics: B. L. Cohen, Tata Mcgraw Hill, First Edition.

Course Title: Advanced Solid-State Physics and Electronics

Course Code: PHY905E
Credits: 4
Marks: 100

UNIT-I: Solid State Physics
Quantum theory and the origin of electronic structure, electronic ground state: bonding and characteristic structures, Basic equations for interacting electrons and nuclei, Coulomb interaction in condensed matter, independent - electron approximations. Periodic solids and electron bands: Structures of crystals, The reciprocal lattice and Brillouin zone, Excitations and the Bloch theorem, Point symmetries, Integration over the Brillouin zone and special points, Density of states. Uniform electron gas and simple metals: Non-interacting and Hartree-Fock approximations, Phonons and displacive transitions, lattice dynamics from electronic structure theory. Frozen phonons, magnons, Green's function formulation, Dielectric response functions, Electron-phonon interaction and superconductivity.

Nanophysics: Quantum Confinement, Electronic structure of 1D and 0D systems: Energy sub bands, Coluomb interactions and lattice couplings, charge states, Electrical transport in 1D and 0D systems: Coluomb oscillations, spin and Mott insulators.

UNIT-II: Device Technology and Processing
Direct and Indirect bands in semiconductor, Deep Impurity states in semiconductors, Carrier Trapping, and recombination/generation in semiconductors. Inter-subband Impurity Absorption.
Solar cell materials (single crystalline, amorphous, and thin films) – surface acoustic wave and sonar transducer materials and applications - introduction to nanophase materials and their properties.
Oxidation: Oxidation process, Modelling of oxidation, Diffusion of dopants: Constant source diffusion: Junction formation, Ion implantation of dopants: Ion generation, Parameters of ion implantation, Ion range distribution. Homogeneous nucleation and heterogeneous nucleation.

Unit III: Electrical and Magnetic Properties of Materials
Electrical Properties: Conductivity—Quantum Mechanical Considerations, Experimental Results and Their Interpretation- Pure Metals, Alloys, Ordering. Thermoelectric Phenomena, Dielectric Properties, Ferroelectricity, Piezoelectricity.
Magnetic Properties: Diamagnetism, Paramagnetism, Ferromagnetism, Antiferromagnetism, Ferrimagnetism, Langevin Theory of Diamagnetism, Langevin Theory of (Electron Orbit) Paramagnetism, Molecular Field Theory, Magnetic Recording and Magnetic Memories.

Unit IV: Optical and Thermal Properties of Materials
Optical Properties: Fluorescence and Phosphorescence, Energy Transfer and Charge Injection, Absorption of Light by Interband and Intraband Transitions, Optical Spectra of Materials, Dispersion, Light-Emitting Diodes (LED).

Thermal Properties: Thermal Conductivity, Heat Capacity: Quantum Mechanical Considerations—The Phonon, Electronic Contribution to the Heat Capacity, Thermal Conduction in Metals and Alloys—Classical Approach, Thermal Conduction in Metals and Alloys—Quantum Mechanical Considerations, Thermal Conduction in Dielectric Materials. Thermal Expansion.

Books Recommended:

1. Electronic Structure Basic Theory and Practical Methods, Richard M. Martin, Cambridge University Press.
2. Introduction to Solid State Physics: VIII Edn., C. Kittel" John-Wiley and Sons.

3. Solid State Physics: Aschroft and Mermin, Holt, Rinehart and Winston. Methods of Metallurgical experiment: B. Linchevsky, Mir Publishers, Moscow.
4. X-ray Diffraction: S.K. Chatterjee, Prentice-Hall of India Pvt. Ltd.
5. Elements of X-ray diffraction: B. D. Cullity, Addison Wesley Publication.
6. Fundamentals of Solid-State Engineering: Second Edn., Manijeh Razeghi, Springer (India) Private Ltd.
7. Semiconductor Devices: SimaDimitrijev, Oxford University Press.
8. Introduction to Semiconductor Materials and Devices: M. S. Tyagi, wiley publications.