Ph.D. Course work

Pre-Ph.D. Examination Syllabus

DEPARTMENT OF PHYSICS

SCHOOL OF SCIENCES

MAULANA AZAD NATIONAL URDU UNIVERSITY

HYDERABAD – 500032.

Paper I : CORE COURSE – RESEARCH METHODOLOGY

(60 Hours – 04 Credits – 100 (70TE+30IA) Marks – 03 Hrs Exam.)

UNIT 1 **(15 Periods)**

Introduction to Research Mothodologies History, methodology and philosophy of Science; Evolutionary Epistemology, Scientific Methods, Hypotheses Generation and Evaluation, Code of Research Ethics, Definition and Objectives of Research, Various Steps in Scientific Research.

Types of Research Descriptive vs Analytical, Applied vs Fundamental, Quantitative vs Qualitative, Conceptual vs Empirical.

UNIT 2 **(15Periods)**

Formulation of Research Problem Defining and formulating the research problem - Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis.

Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models. Developing a research plan - Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs.

UNIT 3 **(15Periods)**

Data Collection and analysis: Execution of the research - Observation and Collection of data - Methods of data collection – Sampling Methods- Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Hypothesis-testing - Generalization and Interpretation. Scientific packages like Mathematica, Matlab etc.

UNIT 4 **(15Periods)**

Reporting and thesis writing – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation – Practice – Making presentation – Use of visual aids - Importance of effective communication .

Application of results and ethics - Environmental impacts - Ethical issues - ethical committees - Commercialisation – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism - Citation and acknowledgement - Reproducibility and accountability

Reference Books

1. . Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

3. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.

4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.

5. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.

6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.

5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

7. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Pub

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Paper II : CORE COURSE – ESSENTIALS OF PHYSICS

(60 Hours – 04 Credits – 100 (70TE+30IA) Marks – 03 Hrs Exam.)

UNIT 1 **(15 Periods)**

Classical Mechanics Rigid body dynamics, moment of inertia tensor, Non-inertial frames and pseudo forces, small oscillations, normal modes, variational principle, generalized coordinates, Lagrangian and Hamiltonian formalism and equations of motion, phase space dynamics.

Quantum Mechanics Schrodinger equation (time-dependent and time-independent), Hydrogen atom, Eigen value problems (particle in a box, harmonic oscillator in 3D etc.), Tunneling through a barrier, Time independent perturbation theory and applications, WKB approximation.

UNIT 2 **(15 Periods)**

Statistical Physics Phase space, micro and macro states, micro-canonical, canonical and grand-canonical ensembles and partition functions, thermo-dynamical functions, classical and quantum statistics, ideal Bose and Fermi gases, Bose-Einstein condensation.

Electrodynamics Electric fields, potentials, Maxwell's equations in free space and linear isotropic media, boundary conditions on the fields at interfaces, dynamics of charged particles in static and uniform electromagnetic fields, electromagnetic waves, radiation from moving charges and dipoles and retarded potentials.

UNIT 3 **(15 Periods)**

Mathematical Physics Vector calculus, special functions and applications (Hermite, Bessel, Laguerre and Legendre functions), Fourier series, Fourier and Laplace transforms, elements of complex analysis, analytic functions, Partial differential equations (Laplace, wave and heat equations in two and three dimensions).

Dielectric properties of Materials Polarization, local electric field at an atom. Depolarization field, electric susceptibility, polarizability.Clausius Mosotti equation, classical theory of electric polarizability, normal and anomalous dispersion. Cauchy and sellmeir relations, Langevin-Debye equation, complex dielectric constant, optical phenomena. Application, plasma frequency, plasmons.

Superconductivity Critical temperature, critical magnetic field, Meissner effect. Type I and Type II superconductors, London's equation and penetration depth. Isotope effect.

UNIT 4 **(15 Periods)**

Atomic and Molecular Physics Quantum states of an electron in an atom, spectrum of Helium and alkali atoms,hyperfine structure and isotope shift, width of spectrum lines. LS and JJ coupling, Zeeman, electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules, lasers and optical pumping.

Nuclear Physics Basic nuclear properties, binding energy, alpha, beta and gamma decays, liquid drop model, nucleon-nucleon potential, deuteron problem, shell model, rotational spectra, fission and fusion, nuclear reactions, compound nuclei and direct reactions.

(Additional references can be provided by the concerned teacher/tutor)

Paper III : SPECIALISATION COURSE – ADVANCED PHYSICS (SPACE/ATMOSPHERIC SCIENCE)

(60 Hours – 04 Credits – 100 (70TE+30IA) Marks – 03 Hrs Exam.)

UNIT 1 **(15 Periods)**

Introduction, survey of atmosphere, physical properties of the atmosphere – atmospheric composition, atmospheric dynamics, atmospheric energetic, atmospheric layers and relation to temperature.

UNIT 2 **(15 Periods)**

Earth system and interaction of energetic solar photons with the upper atmosphere, History of Climate and the Earth system, components of the Earth system, Hydrologic & carbon cycles, Solar irradiance, optical depth, photo-ionization, photo dissociation, photoelectrons.

UNIT 3 **(15 Periods)**

Atmospheric Thermodynamics Gas Laws, Hydrostatic Equation, First Law of Thermodynamics, Adiabatic Processes, Water Vapor in Air, Static Stability, Second Law of Thermodynamics and Entropy.

UNIT 4 **(15 Periods)**

Radiative Transfer Spectrum of Radiation, Quantitative Description of Radiation, Blackbody Radiation, Physics of Scattering and Absorption and Emission, Radiative Transfer in Planetary Atmospheres, Radiation Balance at the Top of the Atmosphere. Various kinds of atmospheric oscillations.

References

1. Physics and Chemistry of the upper atmosphere by M.H.Rees.
2. Atmospheric Science by John M.Wallace, Peter V.Hobbs.

Ph.D(Physics) Course Work

Paper-III: Advanced Physics - General theory of relativity and Cosmology

(60 Hours – 04 Credits – 100 (70TE+30IA) Marks – 03 Hrs Exam.)

Unit-I:

Introduction, special relativity(just review some experiments like Michelson-morley and Lorentz transformation etc), Why GR, Gravity as geometry.

Riemannian Geometry: Vectors and Tensors; parallel transport, covariant differentiation; Geodesics; Riemann-Christoffel curvature tensor - its symmetry properties, Ricci tensor; Bianchi identities; vanishing of the curvature tensor as a condition for flatness, Geodesic deviation equation. **(15 Periods)**

Unit-II:

The equivalence principle, Principle of general covariance. Einstein's field equation, Schwarzschild solution, tests of general relativity - perihelion shif Precession of the perihelion and Bending of light. Basic cosmology: Friedmann-Lemaˆıtre-Robertson-Walker (FRW) universe. Friedmann equations.

(15 Periods)

Unit-III:

The Standard Model-Hubble's law, redshift, composition and history of the Universe, cosmological parameters. Cosmic Microwave Background radiation. Observational cosmology- discuss various surveys like WMAP, Planck, DES etc. Data analysis tools.

(15 Periods)

Unit-IV:

Inflation, Why inflation, Slow-parameters, reheating, Inflationary cosmological perturbations, different models of inflation.

Late time acceleration of the universe, dark energy, different models of Dark energy. Observational status of inflation and DE.

(15 Periods)

References:

1. Introduction to Cosmology, Jayant V. Narlikar, Cambridge University Press.

2. Classical Fields: General Relativity and Gauge Theory, M. Carmelli, World Scientific Publishing, Singapore.

3. Modern Cosmology, Scott Dodelson, Elsevier.

4. The Early Universe. Edward W. Kolb and Michael S. Turner. Addison-Wesley.

5. Cosmology, Steven Weinberg, Oxford University Press.