

**Paper 501 (2 credit)**  
**Research and Publication Ethics (RPE)**

**UNIT-1 RPE 01: PHILOSOPHY AND ETHICS**

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

**UNIT-II RPE 02: SCIENTIFIC CONDUCT**

1. Ethics with respect to science and research
2. Intellectual honesty and research integrity
3. Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP)
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data

**UNIT-III RPE 03: PUBLICATION ETHICS**

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

**PRACTICE:**

**UNIT-IV RPE 04: OPEN ACCESS PUBLISHING**

1. Open access publications and initiatives
2. SHEPRA/ROMEO online resource 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 suggester, etc.

**UNIT-V RPE 05: PUBLICATION MISCONDUCT**

- A. Group Discussions
  1. Subject specific ethical issues, FFP, authorship
  2. Conflicts of interest
  3. Complaints and appeals: examples and fraud from India and abroad
- B. Software tools  
Use of plagiarism software like Turnitin, Urkund and other open source software tools

## **UNIT-VI RPE 06: DATA BASES AND RESEARCH METRICS**

### **A. Databases**

1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

### **B. Research Metrics**

1. Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics

## **References**

Bird, A. (2006), philosophy of Science, Routledge

MacIntyre, Alasdair (1967) A short History of Ethics, London

P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped, do not get plagiarized, ISBN:978-9387480865

National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition, National Academic Press

Resnik, D.B. (2011), What is ethics in research and why is it important, National Institute of Environmental health Sciences, 1-10, Retrieved from <http://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>

Indian national Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-1. [http://www.insaindia.res.in/pdf/Ethics\\_Book.pdf](http://www.insaindia.res.in/pdf/Ethics_Book.pdf)

## Paper 502 (4 credit)

### UNIT –I:

Research: Meaning, objectives, types, approaches. Criteria of good research, research problems, research design. Review of literature: Meaning, objectives, principles and procedure. Report writing: Meaning, significance, types, techniques, essentials of writing scientific article.

### UNIT – II:

Quantitative methods of research: Methods of data collection – experimental data, field data, data from secondary sources. Relation between variables: correlation (both continuous & binary data), regression (both linear & non-linear) for two variables. Test of significance including one-way-ANOVA. Errors and analysis of errors.

### UNIT – III:

Computer application in research: Data analysis – use of software like Excel/Matlab/Mathematica/SPSS/R package etc., Word processing – use of software like MS Word/LATEX/End Note etc., Data bases – use of software like MS Access/My SQL etc. Introduction to Computer Network: Network Protocol and topology. Computer simulations: Introduction to mathematical and simulation models, deterministic and stochastic simulation models, continuous and discrete simulation.

### UNIT – IV:

Intellectual Property Rights (IPR) – concept and definition, types - patents, trademarks, copyrights and trade secrets. Salient aspects of :National Science, Technology and Innovation Policy 2013 (STI 2013),National Education policy 2020 (NEP 2020) : introduction (p.1-6), Part-II-Higher Education (p. 33-49), Role of different national level GoI Funding Agency (CSIR, DST, DBT, DAE, DRDO, DOS etc.) for promotion of scientific research.

Suggested readings:

1. Research Methodology-Methods and Techniques, New Age International, C. R. Kothari, 2<sup>nd</sup> Ed. (New Delhi), 2008.
2. Research Methodology: A step-by-step guide for beginners, SAGE Publications, Ranjit Kumar, 2005.
3. Mastering MATLAB by Duane C. Hanselman and Bruce L. Littlefield, 2011.
4. Queuing system-vol.2-D, Kleinrock, John Wiley & Sons Inc New York, 1976.
5. Computer Network by A. Tanenbaum. Prentice Hall Ind. Englewood cliffs N.J., 1981.
6. Data and computer communications by W. Stallings, Mc Millan Pub. Co. New York, 1976.
7. Document (pdf) on NEP 2020 :  
[https://www.mhrd.gov.in/sites/upload\\_files/mhrd/files/NEP\\_Final\\_English\\_0.pdf](https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf)
8. Writing and Presenting Scientific Papers (2nd edition), B. Malmfors, P. Garnsworthy and M. Grossman, Publications from USDA-ARS / UNL Faculty, 2005

## **Paper 503 (4 credit)**

### **Paper-III: Physics (Advance)**

**Credit: 2+2=4**

### **Part-A (Compulsory)**

#### **UNIT-I: Mathematical Techniques**

Selected topics in Mathematical Physics: Green Function, Second order partial differential equations (Laplace, Wave and Heat equations in two and three dimensions), Laplace and Fourier transforms, Complex analysis: Evaluation of Integrals, Symmetry groups SU(2) and O(3).

#### **UNIT-II: Computational techniques**

Introduction to numerical methods and FORTRAN programming, direct solution of linear equations, interpolation, curve fitting, numerical integration and solution of differential equations, simple simulation.

### **Part-B (Optional)**

#### **Group-A: Astrophysics and Cosmology**

#### **UNIT-III:**

##### **Observational Astronomy:**

Celestial sphere and co-ordinate system-Stellar Colour: Magnitude, spectral types- HR Diagram.

Telescopes and Observational techniques: Photometry- Spectrometry and Polarimetry-Optical, X-ray, UV, Radio Astronomy

##### **Stellar evolution:**

Star Formation in Molecular clouds, Jean's Condition.

Stellar Evolution: Pre-main sequence contraction- Stars in main sequence; Nucleosynthesis- Energy generation- p-p Chain Reaction-CNO-Cycle, Post main sequence evolution, Supernova, late type stars, White Dwarf-Chandrasekhar's Limit, Neutron Stars and Pulsars, Black Holes.

#### **UNIT-IV:**

##### **General Theory of Relativity:**

Tensors - Covariant Derivatives; Metric tensors- Christoffel symbol; Non-inertial frames; Principle of equivalence; accelerated frames; Geodesic motion; Ricci and Riemann tensor; Bianchi Identities; Einstein Equation ( derivation) -- Schwarzschild and Kerr solutions.

##### **Cosmology:**

Standard Model of Cosmology, Early Universe, Radiation and Matter dominated era.

Problems of hot Big Bang Scenario, Inflationary paradigm -- solution to Big Bang problems.

Cosmic perturbation and large scale structure.

Late time acceleration -- Dark Energy

## **Group-B: Condensed Matter Physics**

### UNIT-III: Condensed Matter (Theory)

Molecular mechanics, Molecular dynamics, Ab-initio methods, DFT methods, Application of molecular simulation methods, molecular properties, charge density distribution in molecules, dipole moments, geometry optimization, intermolecular interactions, chemical reactions.

### UNIT-IV: Condensed Matter (Experiment-Nanoscience)

Nano Synthesis: Chemical vapour Deposition (CVD); Physical vapour deposition (PVD); Electron beam lithography; Ball milling; Sol-gel technique; Chemical bath deposition etc.

Vacuum technology: Rotary pump, Diffusion pump, Turbo Molecular pump; Vacuum gauges: Pirani gauge, Penning gauge.

Characterization techniques: X-ray diffractometer, UV-Vis spectrometer, FTIR spectrometer; Surface enhanced Raman spectroscopy, NMR, EDX.

Microscopy techniques: SEM, TEM, AFM.

## **Group-C: Atmospheric Physics**

### UNIT-III:

Atmospheric Thermodynamics: Application of thermodynamics in atmospheric processes, Adiabatic process, Potential temperature, Temperature lapse rate and inversion, Hydrostatic equation and atmospheric stability.

Atmospheric Dynamics: Coordinate systems, Forces acting in atmospheric motion, Horizontal equation of motion, Vertical equation of motion, Thermal wind, Thermodynamic energy equation, The continuity equation.

Clouds and Precipitation: Different types of clouds, Formation of clouds, Cloud seeding, Different kinds of precipitation, Rainfall distribution pattern in Northeast India, Seasonal variation of rainfall.

### UNIT-IV:

Monsoon Circulation: Origin and mechanism of Asiatic monsoon, Role of monsoon circulation on Indian agriculture. Some Important atmospheric circulation: El-Nino and La-Nina – mechanism of formation and impact on climate, Southern Oscillation, ENSO

Weather and climate: Climatic extremes - environmental implications, Climate of Northeast India, Global climate change and its impact on environment.

Satellite Meteorology: Introduction, Types of satellites, Meteorological satellites, Sensors for monitoring weather, Indian meteorological satellites

## **Group-D: Non-Linear Optics**

### UNIT-III:

#### Intensity Dependent Refractive Index (IDRI)

Description of IDRI and processes arising from IDRI : self-focusing and other self-action effects (self -trapping, filamentation , self -phase modulation), theory and their influence on propagation of optical field .Pulse propagation and solitons.

### UNIT-IV:

#### Non-linear Characterization

Nonlinearities: electronic, semiconductor and molecular orientation origin. Thermal non- linear effects.

Z-scan technique: theory and its application for determination of non-linear optical properties.

## Group-E: Theoretical Physics

### UNIT-III:

QED: Feynman rules, Compton scattering, bhabha scattering,  $e^+e^-$  annihilation,  $e-\mu$  scattering.  
Deep Inelastic Scattering: structure functions, parton model, Bjorken scaling, parton distribution functions, scaling violation, gluons, QCD evolution.

### UNIT-IV:

Standard model of electroweak interactions: GWS theory, W & Z bosons, charged and neutral currents, spontaneous symmetry breaking, Higgs mechanism.

Neutrino Physics: Solar and atmospheric neutrino problems, neutrino mass and mixing, neutrino oscillation in vacuum and matter (MSW effect), neutrino phenomenology.

### References:

#### Group A:

1. Classical Theory of Fields, Vol 2 – Landau and Lifshitz (Butterworth –Heinemann)
2. Gravitation and Cosmology – S Weinberg (John Wiley and Sons, UK)
3. Cosmology – Steven Weinberg (John Wiley and Sons, UK)
4. The Physical Universe—An Introduction to Astrophysics – F Shu (University Science Books Sausalite, California)
5. Fundamentals of Special and General Relativity –K D Krori( PHI Learning)

#### GroupB:

1. Density Functional Theory of Atoms and Molecules  
Robert G. Parr and Weitao Yang (Oxford Science Publications)
2. Electronic Structure and the Properties of Solids  
The Physics of Chemical bond  
Walter A. Harrison (Dover Publications)
3. Introduction of Solid State Physics by C Kittel
4. Solid State Physics by N W Ashcroft and N D Marmin
5. Quantum Chemistry by Lavin
6. Essentials of Biophysics by P. Narayan (New Age International Publishers)

#### Group C:

1. The Atmosphere: An introduction to Meteorology, Authors: Frederick K. Lutgens, (Emeritus)  
Illinois Central College, Edward J. Tarbuck, Emeritus) Illinois Central College, Dennis Tasa, Illustrator

#### Group E:

1. W Greiner and J Reinhardt, Field Quantization (Springer, Berlin, 1996)
2. D H Perkins, Introduction to High Energy Physics (Cambridge University Press, Cambridge, 2000)
3. F Halzen and A D Martin, Quarks and Leptons (John Wiley, 1984)
4. T P Cheng and L F Li, Gauge Theory of elementary particle physics (Clarendon Press, Oxford,2000)
5. C Gunti and C W Kim, Fundamentals of Neutrino Physics and Astrophysics, (Oxford University Press, Oxford, 2007)