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, moralphilosophy, 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, Scopous, etc.

    B. Research Metrics
        1. Impact Factor of journal as per Jpurnal 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 Competetive 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 Enviromental health Sciences, 1-10, Retrived 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

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/Mat lab/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, 2nd 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. Tanebaum. 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
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-μ scattering. Deep Inelastic Scattering: structure functions, parton model, Bjorken scaling, parton distribution functions, scaling violation, gluons, QCD evolution.

UNIT-IV:

Standard model of elctroweak 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. Cosmolgy – 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 Aschroft 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 Guinti and C W Kim, Fundamentals of Neutrino Physics and Astrophysics, (Oxford UniversityPress, Oxford, 2007)