

Curriculum and Syllabus for PhD course-work

School of Astrophysics, Presidency University

Duration : One semester

Sem	Paper	Code	FM	Credit
I	Research Methodology (Sessional**)	ASTPC1	50	4
	Research Ethics (Sessional) Module A: Research and Publication Ethics (2 credit) Module B: Literature Review and Presentation (2 credit)	ASTPC2	50	4
	Elective-I* (Sessional) ASTPE1A : Computational Techniques in Astrophysics	ASTPE1	50	4
	Elective-II* (Sessional) ASTPE2A: Astrophysics and Cosmology ASTPE2B: Research Project in Astrophysics ***	ASTPE2	50	4

*Electives can be taken in institutions which have an existing CRPI program/MOU with Presidency University or equivalent online courses (to be approved by the PhD committee).

** All sessional papers will be evaluated in the continuous evaluation mode.

***Research Project can be performed with a faculty member from the School of Astrophysics/Any other department of the University/Faculty members from the CRPI institutes. For projects outside of the School of Astrophysics, approval from the Departmental PhD committee is required. It is encouraged that the student undertakes the research project with their prospective PhD supervisor.

ASTPC1: Research Methodology

Statistical Methods [30]

Different types of uncertainties emphasizing the random error and its propagation; distribution functions: normal distribution; mean, standard deviation, standard deviation of mean; confidence limits: 1,2,3-sigma; Acceptability of a measured quantity; rejection of data; Least square fitting and uncertainty in derived parameters; covariance and correlation: covariance matrix; Chi-square distribution : Chi-square test for goodness of fit; estimates of parameters using chi-square analysis and their confidence limits; marginalization; Poisson distribution and its applications on photon statistics: background analysis;

Oral and Presentation Skills [8]

Bibliographic and database search. Assessing the significance of published work. Writing and Presentational skills: Use of TeX/LaTeX to write a report, Scientific language skills, presenting talks of various lengths

Observational Skills [12]

Hands on sessions with telescope; state of the art telescope facilities across the globe; Accessing different archival astronomical data and data analysis software related to astronomy

ASTPC2: Research Ethics

Module A: Research and Publication Ethics (as per UGC directives)

RPE-01 PHILOSOPHY AND ETHICS:

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

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

RPE-03 PUBLICATION ETHICS

1. Definition, introduction and importance
 2. Best practices/ standards setting initiative 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 contributorship
 6. Identification of publication misconduct, complaints and appeals
 7. Predatory publishers and journals
- Practice

RPE-04 OPEN ACCESS PUBLISHING

1. Open access publications and initiatives
2. SHERPA/RoMEO online resource to check publisher copyright & 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.

RPE-05 PUBLICATION MISCONDUCT

A. Group Discussion (2 hrs.)

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 (2 hrs.)

Use of plagiarism detecting software like Turnitin, Urkund and other open source software tools

RPE-06 DATABASES AND RESEARCH METRICS

A. Databases (4 hrs.)

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

B. Research Metrics (3 hrs.)

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

Module B: Practicum: Literature Review work on a Potential Research Topic

Literature Review Report (within 2000 words)

Presentation and Viva Voce

ASTPE1A: Computational Techniques in Astrophysics

Numerical Methods and Computational Implementation [20]

Higher Order Approximations for Derivatives; Partial Derivatives; Romberg Integration; Monte Carlo Integration with Importance Sampling; Discrete Fourier Transform; Fast Fourier Transform; LU Decomposition for Solving Algebraic Equations; QR Algorithm for Eigenvalue Problems; Leapfrog, Verlet, and Shooting Method for Solving ODE; Spectral and Crank–Nicolson Method for Solving PDE.

Astrophysical Software and Data Analyses [15]

Solving Numerical Problems using Numerical Python and Scientific Python; Data Fitting; Use of astropy to Analyze Astrophysical Data; Application of Neural Network in Astrophysics, One or More Astrophysical Software for Specific Problems, e.g., IRAF, ds9, XSPEC, ISIS, HEASOFT, CAMB, GADGET.

N-Body Problem [10]

Particle-Particle (PP) Method; Particle-Mesh (PM) Method; Particle-Particle-Particle-Mesh (P3M) Method; Tree Method; Application to Solar and Planetary Systems, Star Clusters, Cosmological Simulation.

Interfacing Instruments with Computers [5]

Computer interfacing for observational data acquisition.

ASTPE2A: Astrophysics and Cosmology

Traditional and Modern Observational Techniques [10]

Photometric Systems and color, Magnitude systems, Astronomical coordinate systems, Positional Astronomy and time measurements, Fundamentals of astronomical imaging, CCDs, gain of a CCD, dark current, noise characterizations, Spectroscopic techniques, image reduction and astronomical databases, optical, UV, radio, infrared observations, High energy astrophysical observations, Ground based and space telescopes, astronomical softwares

Instrumentation Projects**[10]**

characterization of CCD and studying a radio antenna prototype, Observations with an Optical telescope

Stellar and Galactic Astrophysics**[12]**

Stellar evolution and stellar population synthesis models, Compact objects and end stages of stellar evolution, extra-solar planets, galaxy classification, morphology and galaxy dynamics

Extragalactic Astrophysics and Cosmology**[18]**

Galaxies in clusters and groups, X-ray emission from clusters (observation, model, cooling flow problem, SZ effect; Mass-Observable relation in clusters, active galaxies, AGN-ICM interaction, large scale structure in the Universe, FRW cosmology, dark matter and gravitational instability, Perturbation theory and the growth of structures, spherical collapse model, cosmological simulations, Thermal history of the Universe: BBN, Recombination, Reionization, current accelerated phase of the Universe and Dark energy