Course: Department Specific Elective 5 – HPHDS6052T & HPHDS6052P

Semester	VI
Paper Number	HPHDS6052T & HPHDS6052P
Paper Title	Astrophysics and Cosmology
No. of Credits	06 (Theory – 4, Lab – 2)
Theory/ Composite	Composite
No. of periods assigned	Th:4 periods/week Pr:3 periods/week
Name of Faculty member(s)	
Course description/ objective	This course aims to introduce the subject of Astrophysics and Cosmology at the undergraduate level. 2. It gives the student an exposition to the idea of scales, masses and measurements of these in the near and far Universe, starting from our Solar System to the far reaches of our Universe. 3. The idea that the metric system is extremely different since the scales involved to the nearest star like the Sun or to the Galactic centre or to extragalactic objects is something which a student should be able to appreciate at the end of this course. 4. The course aims at exposing a student to the beauty of order of magnitude physics and how this can facilitate the understanding of many important truths about the evolution of stars and the background homogenenous Universe. 5. This course exposes the students to the physics of galaxies and the interstellar medium and how stars are born from the ISM. 6. Finally, it also gives the student a short exposition to the different exotic components of our Universe like the dark matter and dark energy and how their existence is predicted through observations.
Syllabus	As enclosed
Texts	As enclosed
Reading/ Reference Lists	As enclosed
Evaluation	Total – 100 (Theory – 60, Practical – 40) Theory – CIA – 10 Semester Examination – 50 Group A (25 marks) Group B (25 marks)

	One 10 marks qs out of two qs Three 5 mark qs out of five qs	One 10 mark qs out of two qs Three 5 mark qs out of five qs

Syllabus:

HPHDS6022T – Astrophysics and Cosmology (Credits – Theory – 4, Practicals – 2)

Module A:Astrophysics [26 lectures]

Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities: Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.

[4 lectures]

Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram. [7 lectures]

Stellar Structure and Stellar Classification : Qualitative discussion of Stellar Spectra (Boltzmann equation, Saha-ionization equation), Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification; Stellar Structure (Main Sequence):Assumptions and validity, Virial Theorem, basic equations, qualitative discussion of the Eddington model for MS stars. [9 lectures]

Galaxies and The Milky Way: Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Galaxy Morphology. [6 lectures]

Module B: Physical Cosmology [26 lectures]

Observational overview: Homogeneity and Isotropy: The cosmological principle; Olbers' paradox: Hubble expansion of the universe and cosmological redshift; Particles in the universe. [4 lectures]
Describing curvature: Equivalence principle; Curved spaces and the FRW metric; proper distance. [3 lectures]
Cosmic dynamics: Friedman equation, fluid and acceleration equations, equations of state of matter, radiation and Lambda. [4 lectures]
Single component universes: Evolution of energy density; curvature only, flat, matter only, radiation only and Lambda only universes. [4 lectures]

Introduction to multiple component universes: Matter + Curvature Matter + Lambda, Matter + Radiation; the Benchmark model [4 lectures]

Measuring cosmological parameters, Visible vs. Dark matter (in galaxies), Evidence for Dark Energy, Gravitational lensing. [4 lectures]
The early universe: Elementary ideas about Inflation, Nucleosynthesis, and Cosmic Microwave Background Radiation. [3 lectures]

Reference Books:

1. Astronomy, A physical perspective by Mark L. Kutner
2. Astrophysics for Physicists by ArnabRaichaudhuri
3. Introduction to Modern Cosmology by Andrew Liddle
4. Introduction to Cosmology by Barbara Ryden

HPHDS6022P - Astrophysics and Cosmology Lab (Credits-2) [39 lectures]

1.Positional astronomy**:** Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars,

Conversion of Coordinates. Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equationof Time

2.Astronomical Temperatures and relation to Local thermodynamic equilibrium

3.Solar and Stellar Experiments: Observing the solar limb, understanding the concept of color temperature using an artificial star, locating bright stars and prominent planets using telescope and relevant softwares.

Reference Books:

1. Fundamental Astronomy by H. Karttunen and others.

DSE Paper Structure for laboratory

(a) Marks for experiment : **30 marks**
   (i) Class performance on any one expt. – 8
   (ii) Lab. Viva on the same experiment as (i) - 7
   (iii) LNB for each of the three experiments - 5 x 3 = 15

(b) Grand Viva – **8 marks**

(c) Attendance – **2 marks**

[Students are to complete 3 experiments]