

# Paper-13A

## Introduction to Astrophysics and Cosmology

### Group A:

#### Physics of Astrophysics and Stellar Astrophysics [36 Lectures]

Overview of Astrophysics: different scales and orders of magnitude in astrophysics and cosmology: mass, distances (distance ladder) and time. The Celestial sphere: Celestial coordinates, Celestial times, Conversion between two coordinate systems

[6L]

Photometry: Magnitude scales, Distance modulus. Determination of luminosity, radius and distance of a star: Stellar Parallax, Blackbody radiation (Recap), Color Index, Characteristic temperature in astrophysics, Extinction of light.

[4L]

Stellar spectral classification: Observed Hertzsprung-Russel diagram, Physical basis of the classification---Boltzmann's equation and Saha equation.

[3L]

Stellar atmospheres: Radiation Transfer: Description of Radiation Fields, Transfer Equation, Plane parallel atmosphere, Gray atmosphere, Eddington approximation and formation of spectral lines.

[6L]

Stellar structure: Structure of Main Sequence stars, Virial theorem and Stellar energy sources. Nuclear burning in stars: H burning, He burning, Core collapse. Polytropic Stars, Convection in stars and their stability, Chandrasekhar Mass.

[9L]

Theory of Main Sequence (MS) stars: Homologous model, Eddington luminosity: Radiative stability, Evolution of low and high mass MS stars, Post MS Evolution.

[4L]

Binary Systems and Stellar Parameters: Classification of Binary stars, Mass determination using Visual, Eclipsing and Spectroscopic Binaries, Search for Extrasolar planets

[4L]

Reference Books:

1. Fundamental Astronomy by H. Karttunen et. Al (Springer, 2013)
2. An Introduction to Modern Astrophysics by B. W. Carrol and D. A. Ostlie (Pearson, 2006)
3. Astrophysics for Physicists by Arnab Rai Choudhuri (CUP, 2010)
4. Radiative Processes in Astrophysics by G. B. Lightman and A. P. Lightman (Wiley, VCH, 1985)
5. Stellar Interiors –Physics Principles, Structure amd Evolution by C. J. Hansen, S. D. Kawaler and V. Pringle (Springer)
6. Astronomy: A Physical Perspective by M. L Kutner (CUP, 2003)

## **Group B: Introduction to Cosmology**

**[36 Lectures]**

### **Cosmological Models**

Review of Special and General Relativity: Equivalence Principle, Coordinates and Metric, Einstein's Equation. De Sitter Space, FLRW Spacetime: Friedman Equation: Continuity and acceleration equations - Study of Single and Multicomponent Universes.

[12L]

### **Particles and Fields**

Particle Components and Particle Phenomenology relevant to cosmology, Thermodynamics in the Early Universe: Decoupling and Freezeout. Thermal Relics from the Big Bang, Dark Matter, Nucleosynthesis, Photon Recombination and Decoupling.

[8L]

### **Accelerating Universe**

Problems of the standard B.B Cosmology, Inflation, Dark Energy

[8L]

### **CMBR and the Growth of Structures**

Thermal nature of CMBR, Anisotropy, Density Perturbations, Jeans mass, Results from WMAP.

[8L]

### **Reference Books:**

1. Barbara Ryden : Introduction to cosmology
2. Andrew Liddle : Modern Cosmology (2e / 3e)
3. Bergstrom and Goobar : Particle Astrophysics
4. V. Mukhanov : Physical Foundations of Cosmology
5. Scott Dodelson : Modern Cosmology