Course Outcomes:

1. Explain concepts such as flux, luminosity, magnitudes, and stellar spectra and apply them to determine stellar distances, temperatures, and classifications.

2. Analyze the physical conditions of the interstellar medium and evaluate mechanisms of star formation.

3. Apply principles of hydrostatic equilibrium, thermodynamics, and nuclear physics to stellar evolution and interpret the Hertzsprung–Russell diagram.

4. Interpret galactic rotation curves for the evidence for dark matter and evaluate observational evidence for the expansion of the universe, cosmic microwave background radiation, and dark energy.

Unit 1 Stellar properties

Basic terms in astronomy - flux, luminosity, specific flux, specific luminosity, bolometric luminosity, inverse square law of light, the magnitude system for quantifying brightness, trigonometric parallax as a means to measure distances to nearby stars, definition of a light year, definition of a parsec, apparent magnitude – absolute magnitude – distance relation.

Stars as blackbody - Blackbody radiation - Planck's theory of black body radiation - Planck function - Rayleigh-Jeans and Wien approximations - Stefan-Boltzmann equation connecting stellar luminosity, radius, and surface temperature; Spectral classification of stars - absorption and emission spectra - description of how they are produced - understanding stellar spectra through Boltzmann equation - Saha equation of thermal ionization - Harvard system of classifying stars based on their spectra - spectral classes of stars and luminosity classes of stars.

Unit 2 Interstellar medium

Phases of the interstellar medium - their physicalproperties - a brief qualitative description of the distribution of interstellar gas within the Galaxy; Interstellar dust composition - its distribution within the Galaxy - extinction and reddeningof starlight due to dust; Jeans criterion for gravitational collapse leading to star formation, free-fall time scale as time-scale for star formation.

Unit 3 Stellar Structure and Evolution

Energy generation mechanism in stars - nuclear fusion - mass defect- p-p chain - CNO cycle - energy generated from pp chain and CNO cycle; Energy transport within stars (conduction, convection, radiation) - time-scale for energy transport within stars - Nuclear time scale.

Hydrostatic equilibrium in stars - pressure equation of state; The Hertz- sprung – Russell diagram, and the concept of main sequence; Post main-sequence evolution (qualitative) - He burning, and subsequent stages of nuclear burning in stars; Evolution of lowmass stars – electron degeneracy pressure - white dwarfs – planetary nebulae; Evolution of high mass stars – supernova – neutron degeneracy pressure - neutron star – black holes, and Schwarzschild radius.

Unit 4: Galaxies and Cosmology

Distances to the nearest galaxies; Morphological classification of galaxies – the Hubble tuning form - trends in the Hubble sequence of galaxies based on color, stellar populations, gas fractions, dust, and star formation rates from spectra; Galaxy groups and galaxy clusters - Mass and size scales of groups and clusters – the Local Group galaxies - velocity dispersion measures of galaxies in clusters, virilization, comparison of luminous mass of galaxy clusters with dynamical mass, and the evidence for Dark Matter.

Milky Way Galaxy: The components of the Milky Way (qualitative based on observational evidence) – the Galactic Disk (young thin disk, old thin disk, thick disk, scale height, the distribution of stars and interstellar gas) - Galactic bulge - stellar halo - underlying stellar populations – size and shape of the Galaxy; Open star clusters and Globular star clusters - Kinematics of the Galaxy – differential rotation - rotation curve of the Galaxy – evidence for Dark Matter Halo; Galactic center – observational evidences for the presence of Super Massive Black Hole in the Galactic center.

Expansion of the Universe based on observations of redshifts of galaxies - redshift expression in terms of wavelength and recession velocity
- Hubble's constant - Hubble time as a value for the age of the universe - scale factor – the concept of metric - cosmological redshift as due to expansion of space; Friedman equation based on Newtonian cosmology, critical density and density parameter, open, closed and flat universes; Cosmic Microwave Background - observations and the origin of the CMB, evidence for Dark Energy.

Textbook

1. Bradley W. Carroll, and Dale A. Ostlie: Introduction to Modern Astrophysics, AddisonWesley Pearson 2006

Reference Books

1. Baidyanath Basu, Tanuka Chattopadhyay, Sudhindra Nath Biswas - An Introduction to Astrophysics - Prentice Hall India Learning Private Limited, 2013
2. Hannu Karttunen, Pekka Kröger, Heikki Oja - Fundamental Astronomy - Springer 2007
3. Arnab Rai Choudhuri – Astrophysics for Physicists, Cambridge University Press, 2010

Evaluation policy

Category	Marks
Continuous Assessment (Assignments/quizzes/tests)	20
Mid-Term	30
End Semester	50
Total	**100**

CO-PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	2		
CO2	3	2	-	-	-	-	-	2		
CO3	2	2	-	-	-	-	-	2		
CO4	2	2	-	-	-	-	-	2		