Course Name: Astronomy 201: The Cosmic Theory

Contact Hours: 27 hours

Pre-requisite: Astronomy 101 recommended but not required. Applicants need to have a general interest in space/science and a basic understanding of scientific principles and logical reasoning.

Abstract

This course introduces modern astrophysics, moving from the properties of light to the evolution of the universe. Students begin with the electromagnetic spectrum and spectroscopy as tools for probing celestial phenomena, then examine stellar life cycles, nuclear fusion and the creation of heavy elements.

The study extends to compact objects—white dwarfs, neutron stars, and black holes—and methods of detection. Learners explore galactic structure, classification, and evidence for dark matter, followed by the expanding universe, cosmic distance measurements and Big Bang evidence.

The course concludes with cosmological concepts such as dark energy, active galactic nuclei, and recent discoveries. By the end, participants gain a conceptual framework for interpreting astrophysical data and understanding the processes shaping the cosmos.

Target Audience

This course is geared towards:

- Students
- Educators
- Science / STEM enthusiasts
- Hobbyist
- Educators

Learning Outcomes

On completion of this course, learners will be able to:

- Interpret light through the electromagnetic spectrum and spectroscopy to understand celestial properties.
- Explain stellar processes, including stability, energy production, and classification using the H-R diagram.
- Differentiate stellar evolution, highlighting life cycles, supernova mechanisms, and nucleosynthesis.
- Analyze compact objects, their properties, and detection methods.
- Summarize galactic structures, classifications, and evidence for dark matter.
- Evaluate cosmological concepts, including expansion, distance measurement, Big Bang evidence, dark energy, and current research.

Course Content

Module 1: Light

- Electromagnetic Spectrum: In-depth review of light as the primary data source (radio to gamma rays).
- Spectroscopy: How light reveals composition, temperature (Wien's Law simplified), and velocity (Doppler effect conceptual).

Module 2 – Stellar Life and Death

- Stellar Stability: The concept of Hydrostatic Equilibrium (gravity vs. pressure) without complex derivation.
- Stellar Energy: Nuclear fusion (P-P Chain and CNO Cycle) as the engine that powers stars.
- The H-R Diagram: Using the diagram to classify stars and track their path through life.
- The Death of Stars: Evolution of low and high-mass stars (Red Giants, Planetary Nebulae).
- Supernovae: Conceptual difference between Type Ia and Type II explosions.
- Element Creation: Nucleosynthesis as the source of all elements heavier than Hydrogen and Helium.

Module 3 – Extreme Gravity – Compact objects

- White Dwarfs and Neutron Stars: Introduction to degeneracy pressure (Electron and Neutron). The phenomenon of Pulsars.
- Black Hole Geometry: Event Horizon, Schwarzschild Radius, and the Singularity (conceptual).
- Detection: How we find compact objects (e.g., in binary systems, gravitational waves - conceptual).

Module 4 – Galactic structure and Dark matter

- Galactic Architecture: Detailed structure and components of the Milky Way.
- Galaxy Classification: The Hubble Tuning Fork diagram.
- Dark Matter: The compelling evidence from galactic rotation curves and gravitational lensing (visual and conceptual).

Module 5 – The Expanding Universe and its origin

- Hubble's Law: The concept of an expanding universe and redshift (using the analogy of a stretching rubber band).
- Cosmic Distance Ladder: Conceptual overview of the sequence of methods used to measure cosmic distances (Standard Candles like Type Ia Supernovae).
- The Big Bang Evidence: Focus on the three key observational pillars: Cosmic Microwave Background (CMB), Primordial Nucleosynthesis, and Large-Scale Structure.

Module 6 – Cosmology

- Dark Energy: The concept of accelerated expansion.
- Discussion of current research (e.g., JWST discoveries) and Active Galactic Nuclei (AGN).

Project presentation and the Future of Astronomy.