

## Astrophysics Syllabus

Center for Talented Youth  
Johns Hopkins University

**Text:** Astronomy Today: Stars and Galaxies, Volume II

**Author:** Chaisson and McMillan

**Course Objective:** The purpose of this course is to provide students with an overview of topics in astrophysics. This course focuses on stars, galaxies, and cosmology. While some introductory astronomy is included, topics such as the planets and solar system objects are not discussed.

**Content Overview:**

Day	Chapters	Topics/Activities
1	<p><b>Chapter 1:</b> Charting the Heavens: The Foundations of Astronomy</p> <p><b>Chapter 2:</b> The Copernican Revolution: The Birth of Modern Science</p>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Introductions – Honor Code</li> <li>• <b>Pre -Assessment</b></li> <li>• Our Place in Space - Understanding the Scale of the Universe</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• Basic Astronomical Motions – Earth’s Orbital Motion</li> <li>• <b>Mathematical Applications:</b> Angular Measure</li> <li>• Astronomical Timekeeping</li> <li>• The Measurement of Distance</li> <li>• <b>Mathematical Applications:</b> Measuring Distances with Geometry</li> <li>• The Laws of Planetary Motion</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• Newton’s Laws &amp; Newtonian Mechanics</li> <li>• <b>Mathematical Applications:</b> Orbits</li> <li>• Review Problems</li> </ul>
2	<p><b>Chapter 3:</b> Radiation: Information from the Cosmos</p> <p><b>Chapter 4:</b> Spectroscopy: The Inner Workings of Atoms</p>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Information from the Skies</li> <li>• Waves in What?</li> <li>• The Electromagnetic Spectrum</li> <li>• Thermal Radiation</li> <li>• <b>Mathematical Applications:</b> Wein’s Law and Stefan’s Law</li> </ul>

		<p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Doppler Effect</li> <li>• <b>Mathematical Applications:</b> Measuring Velocities with the Doppler Effect</li> <li>• Spectral Lines</li> <li>• Atoms and Radiation</li> <li>• <b>Mathematical Applications:</b> The Hydrogen Atom</li> <li>• The Formation of Spectral Lines</li> <li>• <b>Lab Exercise:</b> Observation of Spectra from Spectrometer and Gas Discharge Tube</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• Molecules</li> <li>• Spectral Line Analysis</li> <li>• Review Problems</li> </ul>
3	<b>Chapter 16: The Sun: Our Parent Star</b>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Physical Properties of the Sun</li> <li>• The Solar Interior</li> <li>• The Sun's Atmosphere</li> <li>• Solar Magnetism</li> <li>• The Active Sun</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Heart of the Sun</li> <li>• <b>Mathematical Applications:</b> Fundamental Forces</li> <li>• <b>Mathematical Applications:</b> Energy Generation in Proton-Proton Chain</li> <li>• <b>Lab Exercise:</b> Making Solar Observations with a Sun Spotter</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Discovery Readings &amp; Discussion:</b> SOHO: Eavesdropping on the Sun and Solar Terrestrial Relations</li> <li>• Review Problems</li> </ul>
4	<b>Chapter 17: The Stars: Giants, Dwarfs, and the Main Sequence</b>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• The Solar Neighborhood</li> <li>• Luminosity and Apparent Brightness</li> <li>• Stellar Temperatures</li> <li>• <b>Mathematical Applications:</b> The Magnitude Scale</li> <li>• Stellar Sizes</li> </ul>

		<ul style="list-style-type: none"> <li>• <b>Mathematical Applications:</b> Estimating Stellar Radii</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Hertzsprung-Russell Diagram</li> <li>• <b>Computer Simulated Lab Exercise:</b> The Classification of Stellar Spectra (Project CLEA)</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• Extending the Cosmic Distance Scale</li> <li>• Review Problems</li> </ul>
5	<p><b>Chapter 17:</b> The Stars: Giants, Dwarfs, and the Main Sequence (cont.)</p> <p><b>Chapter 18:</b> The Interstellar Medium: Gas and Dust among the Stars</p>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Stellar Masses</li> <li>• <b>Mathematical Applications:</b> Measuring Stellar Masses in Binary Stars</li> <li>• Mass and Other Stellar Properties</li> <li>• <b>Review for Quiz #1</b></li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• <b>Quiz #1</b> – Chapters 1 – 4, 16 – 17</li> <li>• Interstellar Matter</li> <li>• Emission Nebulae</li> <li>• Dark Dust Clouds</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• 21-Centimeter Radiation</li> <li>• Interstellar Molecules</li> <li>• <b>Discovery Readings &amp; Discussion:</b> Ultraviolet Astronomy and the “Local Bubble”</li> <li>• Review Problems</li> </ul>
6	<p><b>Chapter 19:</b> Star Formation: A Traumatic Birth</p>	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Star-Forming Regions</li> <li>• The Formation of Stars Like the Sun</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• Stars of Other Masses</li> <li>• Shock Waves and Star Formation</li> <li>• Star Clusters</li> </ul>

		<p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Discovery Readings &amp; Discussion:</b> Observations of Brown Dwarfs; Eta Carinae</li> <li>• Review Problems</li> </ul>
7	<b>Chapter 20:</b> Stellar Evaluation: The Life and Death of a Star	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Leaving the Main Sequence</li> <li>• Evolution of a Sun-like Star</li> <li>• <b>Mathematical Applications:</b> The CNO Cycle</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Death of a Low-Mass Star</li> <li>• Observing Stellar Evolution in Star Clusters</li> <li>• Stellar Evolution in Binary Systems</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Discovery Readings &amp; Discussion:</b> Learning Astronomy; History and Mass Loss from Giant Stars</li> <li>• Review Problems</li> </ul>
8	<b>Chapter 21:</b> Stellar Explosions: Novae, Supernovae, and the Formation of the Elements	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Life and Death for White Dwarfs</li> <li>• The End of High-Mass Stars</li> <li>• Supernovae</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Formation of the Elements</li> <li>• The Cycle of Stellar Evolution</li> <li>• <b>Computer Simulated Lab Exercise:</b> Dying Stars and the Birth of the Elements (Project CLEA)</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Discovery Readings &amp; Discussion:</b> Supernova 1987A; The Crab Nebula in Motion</li> <li>• Review Problems</li> </ul>
9	<b>Chapter 22:</b> Neutron Stars and Black Holes: Strange States of Matter	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Neutron Stars</li> <li>• Pulsars</li> <li>• Neutron-Star Binaries</li> </ul>

		<ul style="list-style-type: none"> <li>• Gamma-Ray Bursts</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• Black Holes</li> <li>• Einstein's Theory of Relativity</li> <li>• <b>Mathematical Applications:</b> Special Relativity</li> <li>• Space Travel Near Black Holes</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• Observational Evidence for Black Holes</li> <li>• <b>Discovery Readings &amp; Discussion:</b> Gravity Waves: A New Window on the Universe</li> <li>• <b>Mathematical Applications:</b> Tests of General Relativity</li> <li>• Review Problems</li> </ul>
10	<b>Chapter 23:</b> The Milky Way Galaxy: A Spiral in Space	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Our Parent Galaxy</li> <li>• Measuring the Milky Way</li> <li>• Galactic Structure</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Formation of the Milky Way</li> <li>• Galactic Spiral Arms</li> <li>• The Mass of the Milky Way</li> <li>• The Galactic Center</li> <li>• <b>Review for Quiz #2</b></li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Quiz #2</b> – Chapters 18 – 23</li> </ul>
11	<b>Chapter 24:</b> Galaxies: Building Blocks of the Universe	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Hubble's Galaxy Classification</li> <li>• The Distribution of Galaxies in Space</li> <li>• Hubble's Law</li> <li>• Active Galactic Nuclei</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• <b>Mathematical Applications:</b> Relativistic Redshifts and Look-Back Time</li> </ul>

		<ul style="list-style-type: none"> <li>• The Central Engine of an Active Galaxy</li> <li>• <b>Computer Simulated Lab Exercise:</b> The Hubble Redshift Distance Relation (Project CLEA)</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• Review Problems</li> </ul>
12	<b>Chapter 25:</b> Galaxies and Dark matter: The Large-Scale Structure of the Cosmos	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Dark Matter in the Universe</li> <li>• Galaxy Collisions</li> <li>• Galaxy Formation and Evolution</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• Black Holes in Galaxies</li> <li>• The Universe on Large Scales</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Discovery Readings &amp; Discussion:</b> The Sloan Digital Sky Survey</li> <li>• Review Problems</li> </ul>
13	<b>Chapter 26:</b> Cosmology: The Big Bang and the Fate of the Universe	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• The Universe on the Largest Scales</li> <li>• The Expanding Universe</li> <li>• The Fate of the Cosmos</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Geometry of Space</li> <li>• <b>Mathematical Applications:</b> Curved Space</li> <li>• Will the Universe Expand Forever?</li> <li>• Dark Energy and Cosmology</li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• The Cosmic Microwave Background</li> <li>• <b>Discovery Readings &amp; Discussion:</b> A Stunning View of Deep Space; Einstein and the Cosmological Constant</li> <li>• Review Problems</li> </ul>

14	<b>Chapter 27:</b> The Early Universe: Toward the Beginning of Time	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Back to the Big Bang</li> <li>• The Evolution of the Universe</li> <li>• <b>Mathematical Applications:</b> More on Fundamental Forces</li> </ul> <p><u>Afternoon</u></p> <ul style="list-style-type: none"> <li>• The Formation of Nuclei and Atoms</li> <li>• The Inflationary Universe</li> <li>• The Formation of the Structure of the Universe</li> <li>• Cosmic Structure and the Microwave Background</li> <li>• <b>Review for Post-Assessment</b></li> </ul> <p><u>Evening</u></p> <ul style="list-style-type: none"> <li>• <b>Post-Assessment</b></li> </ul>
15	<b>Chapter 28:</b> Life in the Universe: Are We Alone?	<p><u>Morning</u></p> <ul style="list-style-type: none"> <li>• Cosmic Evolution</li> <li>• Intelligent Life in the Galaxy</li> <li>• <b>Mathematical Applications:</b> The Drake Equation</li> <li>• The Search of Extraterrestrial Intelligence</li> </ul>