ASTRONOMY (ASTRON)

ASTRON 103 – THE EVOLVING UNIVERSE: STARS, GALAXIES, AND COSMOLOGY
3 credits.

The cosmos is vast, mysterious, and beautiful. Join us on an exploration of the universe, from the big bang to the birth, life, and death of stars and the warped reality of black holes. Includes lifecycles of stars; supernovae and creation of elements; white dwarfs, pulsars and black holes; the Milky Way and galaxies; distances of stars and galaxies; quasars; expansion of universe; modern big bang cosmology, dark matter, dark energy.
Requisites: Satisfied Quantitative Reasoning (QR) A requirement. Not open to students with credit for ASTRON 200
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Apply quantitative reasoning to evaluate scientific hypotheses to explain astronomical observations Audience: Undergraduate

2. Understand and apply--quantitatively--the scientific basis of astronomical concepts such as the Hubble law, the inverse square law, and Newtonian gravity. Audience: Undergraduate

3. Understand--qualitatively--and be able to explain to a lay audience the scientific basis for the laws of stellar structure and evolution Audience: Undergraduate

4. Critically evaluate qualitative scientific arguments using the scientific method Audience: Undergraduate

5. Write basic scientific prose for a variety of lay audiences Audience: Undergraduate

ASTRON 104 – OUR EXPLORATION OF THE SOLAR SYSTEM
3 credits.

Humanity is linked to the solar system in countless ways. Our view of the solar system, how planets form, and how planetary systems evolve has fundamentally changed with the discovery of countless exoplanets around other stars. Join us in exploring the modern view of the solar system and its relation to other planetary worlds. Includes the sky and celestial motions; ancient astronomy; the Copernican revolution; gravity, orbits, and interplanetary travel; formation of solar system; survey of sun, planets and moons; asteroids, meteors and comets; origin of life.
Requisites: Satisfied Quantitative Reasoning (QR) A requirement. Not open to students with credit for ASTRON 200
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024
Learning Outcomes: 1. Apply quantitative reasoning to evaluate scientific hypotheses to explain astronomical observations Audience: Undergraduate

2. Understand and apply--quantitatively--the scientific basis of astronomical concepts such as the inverse square law, Newtonian gravity, and Kepler's laws. Audience: Undergraduate

3. Understand--qualitatively--and be able to explain to a lay audience the scientific basis for the laws of stellar structure and stellar and planetary accretion Audience: Undergraduate

4. Critically evaluate qualitative scientific arguments using the scientific method Audience: Undergraduate

5. Write basic scientific prose for a variety of lay audiences Audience: Undergraduate

ASTRON 140 – EARTH 2.0: THE EXOPLANET REVOLUTION
3 credits.

Our Galaxy contains about 100 billion stars. Most of these stars have planets as diverse and as fascinating as the worlds in our own neighborhood, the solar system. Learn about the study of planets and exoplanets, probing some of the deepest questions science and philosophy grapple with. Explore the ways in which scientists search for and analyze planets orbiting distant stars, both in the classroom and in hands-on laboratory experiences. From moons to super-Jupiters, this course provides an engrossing introduction into the brand new science of exoplanet research.
Requisites: Satisfied Quantitative Reasoning (QR) A requirement
Course Designation: Gen Ed - Quantitative Reasoning Part B
Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 150 – TOPICS IN ASTRONOMY
2 credits.

Intensively study selected topics of modern astronomy. Examples include missions to the planets, formation of stars and planets, end states of stellar evolution (supernovae, white dwarfs, pulsars, black holes), origin and evolution of the universe.
Requisites: ASTRON 103 or ASTRON 104
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2017

ASTRON/GEOSCI 160 – LIFE IN THE UNIVERSE
2 credits.

An examination of the origin and evolution of life in the universe based on our knowledge of astronomy, biology, and geology. Includes discussions on the search for extraterrestrial life and the history of life in our solar system.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 170 – THE DARK SIDE OF THE UNIVERSE: THE GREAT COSMIC MYSTERIES FROM BLACK HOLES TO DARK ENERGY
3 credits.

Some of the greatest mysteries of the cosmos reside in what astrophysicists call "the dark sector". This course explores the nature of black holes, dark matter, and dark energy, which show us nature at its most extreme, taking you from the warping of spacetime and the launching of plasma beams around black holes to the acceleration of the cosmos that indicates the presence of some yet unknown form of energy. Learn about the fundamental laws of nature that govern everything from GPS satellites that enable navigation apps on your cell phone to the birth and ultimate fate of the universe.
Requisites: None
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Evaluate hypotheses to explain astronomical observations Audience: Undergraduate

2. Write basic scientific prose for a variety of lay audiences Audience: Undergraduate

3. Understand and apply--qualitatively--the scientific basis of Newtonian Gravity and Relativity Audience: Undergraduate

4. Understand and apply the basics of cold-dark matter big-bang cosmology Audience: Undergraduate

5. Understand and articulate evidence for dark matter, dark energy, and black holes Audience: Undergraduate

ASTRON 199 – DIRECTED STUDY
1-3 credits.

Introductory mentored independent study as arranged with faculty.
Requisites: Consent of instructor
Course Designation: Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ASTRON 200 – THE PHYSICAL UNIVERSE
3 credits.

Modern astrophysics involves applying physical principles to understand astronomical phenomena. Includes the solar system, stars, nebulae, galaxies, and cosmology, with emphasis on origins and evolution. Some nighttime observation with telescopes required.
Requisites: PHYSICS 201, 207, 247 or MATH 222
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON/HIST SCI 206 – HISTORY OF ASTRONOMY AND COSMOLOGY
3 credits.

The development of astronomical knowledge and cosmological views from the earliest times to the present, viewed in their social, philosophical, and technological contexts.
Requisites: None
Course Designation: Breadth - Humanities
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Summer 2023

ASTRON 236 – THE HISTORY OF MATTER IN THE UNIVERSE
3 credits.

Multidisciplinary study of how the distribution of elements in the Universe has changed over the last 10-15 billion years by tracing the history of matter from the Big Bang to the present composition of the Earth. Emphasizes connections between astronomy, geology, and chemistry. Readings will draw both on scientific journals and the popular press to allow us to engage the material on multiple levels.
Requisites: None
Course Designation: Gen Ed - Communication Part B
Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Elementary
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 310 – STELLAR ASTROPHYSICS
3 credits.

Properties of normal and peculiar stars as found from an analysis of the radiation they emit; introduction to radiation transfer. Theory of stellar atmospheres, interiors, and evolution.
Requisites: MATH 222 and (PHYSICS 205, 241, or 249, or concurrent enrollment)
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 320 – THE INTERSTELLAR MEDIUM
3 credits.

Properties of neutral and ionized interstellar gas, giant molecular clouds, the warm and hot intercloud medium, supernova remnants, and interstellar dust. Physical processes in low density gases including radiation transfer, excitation and ionization of interstellar atoms and molecules, and the interaction between gas and dust.
Requisites: MATH 222 and (PHYSICS 205, 241, or 249, or concurrent enrollment)
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 330 – GALAXIES
3 credits.

Distribution of stars, gas, and dust within our Milky Way, and their motions. Nearby galaxies: our Local Group. Optical, radio, and other techniques for observing galaxies. Composition and motions of other galaxies; galaxies with active nuclei; galaxy formation.
Requisites: ASTRON 310
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 335 – COSMOLOGY
3 credits.

Introduction to the study of our Universe as a whole. Distribution of matter on the largest scales. Equations for cosmic expansion; making observations in an expanding curved spacetime. Nucleosynthesis and other tests of the Big Bang hypothesis. Gravitational collapse and the growth of structure.
Requisites: MATH 222 and (PHYSICS 205, 241, or 249, or concurrent enrollment)
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 340 – SOLAR SYSTEM ASTROPHYSICS
3 credits.

Properties of solar system objects, solar atmospheric phenomena, physics of planetary atmospheres, results of recent planetary missions, comets, origin of the solar system.
Requisites: MATH 222 and (PHYSICS 205, 241, or 249, or concurrent enrollment)
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 460 – EXPERIENCES IN ASTRONOMICAL OBSERVING
1 credit.

A basic introduction into astronomical research by undertaking a small observing project with optical and/or radio telescopes. Topics covered are: understanding the astronomical literature, observing and data reduction, writing scientific reports and papers, presenting scientific results, and basics of scientific ethics.
Requisites: Declared in Astronomy-Physics
Course Designation: Level - Intermediate
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2022

ASTRON 465 – OBSERVATIONAL ASTRONOMY AND DATA ANALYSIS
3 credits.

A basic introduction into astronomical observations and data analysis techniques by undertaking observational projects with optical and radio telescopes. Topics covered include observation and data reduction, basic calibration of radio and optical telescopes, basics of data analysis and statistics, presenting scientific results, and basics of scientific ethics. Although specific to observational astrophysics, these methods are applicable to any of the physical sciences disciplines.
Requisites: PHYSICS 205, 241, or 249
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2023
Learning Outcomes: 1. Understand how astronomical observations are obtained, processed and analyzed. Audience: Undergraduate

2. Use simple scientific computing methods to plan astronomical observations and analyze astronomical data. Audience: Undergraduate

3. Understand uncertainties in astronomical measurements to draw meaningful conclusions from the conducted experiments. Audience: Undergraduate

4. Demonstrate the basics of oral and written scientific presentations. Audience: Undergraduate

5. Practice principles and standards of professional and ethical conduct. Learn when and how to cite references and when it is appropriate to credit the contributions of others or claim credit for one's own work. Audience: Undergraduate

ASTRON 500 – TECHNIQUES OF MODERN OBSERVATIONAL ASTROPHYSICS
3 credits.

An introduction to astrophysics data collection. Students will be familiarized with the concepts, techniques, skills and resources needed to plan, obtain, reduce and interpret observations of astronomical objects.
Requisites: ASTRON 310, 320, 330, 335, 340, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2022

ASTRON/E M A 550 – ASTRODYNAMICS
3 credits.

Coordinate system transformations, central force motion, two body problem, three and n-body problem, theory of orbital perturbations, artificial satellites, elementary transfer orbits, and elementary rocket dynamics.
Requisites: (E M A 202, M E 240, or PHYSICS 311, or concurrent enrollment), or member of Engineering Guest Students
Course Designation: Breadth - Physical Sci. Counts toward the Natural Sci req
Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 620 – SEMINAR IN ASTROPHYSICAL TOPICS
1-3 credits.

Current problems; topic changes.
Requisites: ASTRON 310, 320, 330, 335, 340, or graduate/professional standing
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2017

ASTRON 681 – SENIOR HONORS THESIS
3 credits.

Individual study for seniors completing theses for honors in the major as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 682 – SENIOR HONORS THESIS
3 credits.

Individual study for seniors completing theses for honors in the major as arranged with a faculty member; continuation of ASTRON 681.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Honors - Honors Only Courses (H)
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 691 – SENIOR THESIS
2-3 credits.

Individual study for seniors completing theses as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 692 – SENIOR THESIS
2-3 credits.

Individual study for seniors completing theses as arranged with a faculty member; continuation of ASTRON 691.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 699 – DIRECTED STUDY
1-6 credits.

Directed study projects for juniors and seniors as arranged with a faculty member.
Requisites: Consent of instructor
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ASTRON 700 – BASIC ASTROPHYSICS I
2 credits.

Thermodynamics, atomic and molecular spectra, ionization and excitation, line and continuum opacities. Synchrotron radiation, Compton scattering, X-ray spectra. Radiative transfer, simple model atmospheres, radiative and convective energy transport.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 702 – BASIC ASTROPHYSICS II
2 credits.

Basic particle and fluid dynamics of stellar and gaseous systems in astrophysics. Review of gravitational dynamics, 2-body relaxation, phase space, basic equations of fluid dynamics, waves, shocks, winds accretion, instabilities.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 715 – STELLAR INTERIORS AND EVOLUTION
2 credits.

Physical principles, equilibrium of gaseous spheres, energy transport, energy generation, nucleosynthesis, main sequence red giant and electron degenerate stars. Advanced topics such as origins of stellar variability, binary star evolution, star formation, supernovae explosions, evolution with mass loss.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

ASTRON 720 – THE INTERSTELLAR MEDIUM I: BASIC PROCESSES
2 credits.

Observational techniques for interstellar medium studies, overview of the role of interstellar gas in galaxies, dynamics, energetics, major theories of structure and evolution, introduction to star formations and supernova remnant evolution.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2024

ASTRON 730 – GALAXIES
2 credits.

Stellar content and dynamics of the Milky Way and other galaxies; galaxy types, evolution of normal galaxies, active nuclei, quasars, radio galaxies.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2023

ASTRON 735 – OBSERVATIONAL COSMOLOGY
2 credits.

Extragalactic distance scale; groups and clusters of galaxies; distribution of galaxies and radio sources. Introduction to general relativity, cosmological models, microwave background, early universe, galaxy formation.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2023

ASTRON/PHYSICS 910 – SEMINAR IN ASTROPHYSICS
0-1 credits.

Current topics in astrophysics.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ASTRON 920 – SEMINAR-ASTROPHYSICAL TOPICS
1-3 credits.

Current problems; topic changes.
Requisites: Graduate/professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ASTRON 990 – RESEARCH AND THESIS
1-12 credits.

Advanced level mentored reading and research for graduate students.
Requisites: Declared in Astronomy PhD
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2024

ASTRON 999 – ADVANCED INDEPENDENT READING
1-2 credits.

Advanced level mentored reading and research for graduate students.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Summer 2022