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. Enroll Info: None
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 2020

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. Enroll Info: None
Requisites: Satisfied Quantitative Reasoning (QR) A requirement. Not open to students with credit for ASTRON 100.
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 2020

ASTRON 113 — HANDS ON THE UNIVERSE
1 credit.

Exploration of the universe via computer simulation of astronomical observations. Examples of topics include telescopes, the distances to stars, the spectra of the stars, star clusters, the Hubble expansion, and the large scale structure of the universe. Discovery through observation, hypothesis, and quantitative analysis is emphasized. Enroll Info: Open to all Undergrads. Intended to be taken concurrently with ASTRON 103. Prev ASTRON 100 or ASTRON 103 or cons inst acceptable. Satisfies QR-B only if ASTRON 100 or ASTRON 103 is also completed. Not open to stdts who have taken ASTRON 110
Requisites: ASTRON 100 or ASTRON 103 or concurrent enrollment
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 2020

ASTRON 114 — HANDS ON THE SOLAR SYSTEM
1 credit.

Exploration via computer simulation of astronomical observations. Examples of topics include the sky and celestial motions, Jupiter's moons, rocketry, colonization, and extra-solar planets. Naked-eye and telescope observations will also be made. Discovery through observation, hypothesis, and quantitative analysis is emphasized. Enroll Info: Open to all Undergrads. Intended to be taken concurrently with ASTRON 104. Prev ASTRON 100 or ASTRON 104 or cons inst acceptable. Satisfies QR-B only if ASTRON 104 is also completed. Not open to stdts who have taken ASTRON 110
Requisites: Must have taken or are currently taking Astronomy 104.
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 2015

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. Enroll Info: Satisfied Quantitative Reasoning A requirement
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 2020
ASTRON 150 — TOPICS IN ASTRONOMY
2 credits.
This course will 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. Enroll Info: None
Requisites: ASTRON 100, 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. Enroll Info: None
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 2020

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. Enroll Info: None
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 2019

ASTRON 199 — DIRECTED STUDY
1-3 credits.
Enroll Info: Astron 100 or equiv or cons inst. Open to Fr
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 2017

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. Enroll Info: PHYSICS 202 or 208 or cons inst. Not open to stdts who have taken Astron 100 or 103. Simple calculus required
Requisites: None
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 2020

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. Enroll Info: So st
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 2019

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. The course will emphasize 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. This course meets the University's Com-B requirement. Enroll Info: 1 yr college chem or physics, or cons inst. Open to Fr
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 2018

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. Enroll Info: MATH 222 PHYSICS 205 or 241
Requisites: None
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 2019
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. Enroll Info: None
Requisites: MATH 222 and (PHYSICS 205 or 241)
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2019

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. Enroll Info: ASTRON 310
Requisites: None
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Fall 2018

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. Enroll Info: ASTRON 310
Requisites: None
Course Designation: Level - Advanced
L&S Credit - Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2020

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. Enroll Info: MATH 222 PHYSICS 205 or 241
Requisites: None
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 2019

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. Enroll Info: Cons inst. One of ASTRON 310, 320, 330, or 500 advised
Requisites: Consent of instructor
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 2018

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. Enroll Info: Grad st or ASTRON 310 cons inst
Requisites: None
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 2018

ASTRON 510 — RADIO ASTRONOMY LABORATORY
2 credits.

An introduction to the techniques of modern observational radio astronomy. The course covers fundamentals of radio astronomy, modern radio instrumentation, and observing techniques, through a mixture of classroom lectures, discussions, and hands-on observational projects with a small radio telescope. Enroll Info: None
Requisites: None
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: Spring 2012

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. Enroll Info: None
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 2020
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<th>Course Title</th>
<th>Credits</th>
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<td>ASTRON 700</td>
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<td>THE INTERSTELLAR MEDIUM I: BASIC PROCESSES</td>
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**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. Enroll Info: Grad st in Astron or cons inst  
**Requisites:** Graduate/professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Fall 2019

**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. Enroll Info: Grad st in Astron or cons inst  
**Requisites:** Graduate/professional standing  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** No  
**Last Taught:** Spring 2019

**ASTRON/PHYSICS 910 — SEMINAR IN ASTROPHYSICS**  
0-1 credits.  
Current topics in astrophysics. Enroll Info: None  
**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 2020

**ASTRON 920 — SEMINAR-ASTROPHYSICAL TOPICS**  
1-3 credits.  
Current problems; topic changes. Enroll Info: Grad st in astron or cons inst  
**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 2016

**ASTRON 990 — RESEARCH AND THESIS**  
1-12 credits.  
Enroll Info: Grad st in astron  
**Requisites:** Consent of instructor  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** Yes, unlimited number of completions  
**Last Taught:** Spring 2020

**ASTRON 999 — ADVANCED INDEPENDENT READING**  
1-2 credits.  
Enroll Info: Grad st in astron  
**Requisites:** Consent of instructor  
**Course Designation:** Grad 50% - Counts toward 50% graduate coursework requirement  
**Repeatable for Credit:** Yes, unlimited number of completions  
**Last Taught:** Spring 2008