Astronomy (ASTR)

ASTR 100 - EXPLORING THE COSMOS
Short Title: EXPLORING THE COSMOS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Distribution Group: Distribution Group III
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: Introduction to celestial mechanics, radiative transfer, stellar structure, and stellar remnants (including black holes and neutron stars). Aspects of stellar atmospheres may also be explored. Together, ASTR 350 and ASTR 360 provide a comprehensive survey of modern astrophysics needed for senior research and graduate study in astronomy. Either ASTR 350 or 360 may be taken first. Recommended Prerequisite(s): MATH 211 and PHYS 202

ASTR 201 - STARS, GALAXIES, AND THE UNIVERSE
Short Title: STARS, GALAXIES & THE UNIVERSE
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Distribution Group: Distribution Group III
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introductory course for students in academic programs. The formation, evolution, and death of stars; the composition and evolution of galaxies; the structure and evolution of the universe.

ASTR 202 - EXPLORATION OF THE SOLAR SYSTEM
Short Title: EXPLORATION OF THE SOLAR SYSTEM
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Distribution Group: Distribution Group III
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: The physical processes governing the nature and behavior of the various Solar System bodies are discussed with a focus on the origins, evolution and fate of the Solar System and its parts. This broader context leads to a deeper understanding of the Earth as a life-supporting planet.

ASTR 220 - OBSERVING THE NIGHT SKY
Short Title: OBSERVING THE NIGHT SKY
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 2
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introduction to the celestial sphere and movements of the sun, moon, and planets. Students will gain hands-on experience using computerized telescopes, binoculars, digital imagers, and planetarium software to study astronomical objects. Intended for students in all types of academic programs.

ASTR 221 - OBSERVING THE NIGHT SKY
Short Title: OBSERVING THE NIGHT SKY
Department: Physics and Astronomy
Grade Mode: Seminar
Course Type: Seminar
Credit Hour: 1
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: Introduction to concepts, methods and discoveries of astronomy and astrophysics, with a theme to be chosen from the frontier topics of modern astrophysics. Will emphasize student presentations. Designed for first year students interested in science or engineering, but other majors are welcome.

ASTR 230 - ASTRONOMY LAB
Short Title: ASTRONOMY LAB
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: A hands-on introduction to modern techniques of observational astronomy. Students use telescopes, CCDs, and computers to obtain and analyze their own images and spectra of solar system, galactic, and extragalactic objects. The course employs the campus observatory, dark sky observing sites, and state of the art data analysis software. Instructor Permission Required.

ASTR 238 - SPECIAL TOPICS
Short Title: SPECIAL TOPICS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Internship/Practicum, Seminar, Lecture, Laboratory
Credit Hours: 1-4
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

ASTR 243 - LIVING WITH A STAR: THE PHYSICS OF THE SUN-EARTH CONNECTION
Short Title: LIVING WITH A STAR
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.

ASTR 350 - INTRODUCTION TO ASTROPHYSICS-STARS
Short Title: INTRO ASTROPHYSICS-STARS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introductory course for students in academic programs. The formation, evolution, and death of stars; the composition and evolution of galaxies; the structure and evolution of the universe.

ASTR 360 - INTRODUCTION TO ASTROPHYSICS-GALAXIES
Short Title: INTRO ASTROPHYSICS-GALAXIES
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introductory course for students in academic programs. The formation, evolution, and death of stars; the composition and evolution of galaxies; the structure and evolution of the universe.

ASTR 235 - ASTRONOMY LAB
Short Title: ASTRONOMY LAB
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: A hands-on introduction to modern techniques of observational astronomy. Students use telescopes, CCDs, and computers to obtain and analyze their own images and spectra of solar system, galactic, and extragalactic objects. The course employs the campus observatory, dark sky observing sites, and state of the art data analysis software. Instructor Permission Required.

ASTR 238 - SPECIAL TOPICS
Short Title: SPECIAL TOPICS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Internship/Practicum, Seminar, Lecture, Laboratory
Credit Hours: 1-4
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

ASTR 243 - LIVING WITH A STAR: THE PHYSICS OF THE SUN-EARTH CONNECTION
Short Title: LIVING WITH A STAR
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.

ASTR 350 - INTRODUCTION TO ASTROPHYSICS-STARS
Short Title: INTRO ASTROPHYSICS-STARS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introductory course for students in academic programs. The formation, evolution, and death of stars; the composition and evolution of galaxies; the structure and evolution of the universe.

ASTR 360 - INTRODUCTION TO ASTROPHYSICS-GALAXIES
Short Title: INTRO ASTROPHYSICS-GALAXIES
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture/Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: An introductory course for students in academic programs. The formation, evolution, and death of stars; the composition and evolution of galaxies; the structure and evolution of the universe.

ASTR 235 - ASTRONOMY LAB
Short Title: ASTRONOMY LAB
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Laboratory
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Professional or Visiting Undergraduate level students.
Description: A hands-on introduction to modern techniques of observational astronomy. Students use telescopes, CCDs, and computers to obtain and analyze their own images and spectra of solar system, galactic, and extragalactic objects. The course employs the campus observatory, dark sky observing sites, and state of the art data analysis software. Instructor Permission Required.
ASTR 360 - INTRODUCTION TO ASTROPHYSICS-GALAXY AND COSMO
Short Title: INTRO ASTROPHYSIC-GALAXY&COSMO
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Prerequisite(s): MATH 211 and PHYS 202 (may be taken concurrently)
Description: Morphology, kinematics, and dynamics of the Milky Way and external galaxies, including interstellar matter and evidence for dark matter. Peculiar and active galaxies, including interacting systems and evidence for super massive black holes in active galactic nuclei such as quasars. Large-scale structure and expansion of the universe, including various cosmologies ranging from the inflationary big bang theory to steady state and anthropic concepts. Either ASTR 350 or 360 may be taken first. PHYS 202 may be taken as a prereq or concurrently with ASTR 360.

ASTR 400 - UNDERGRADUATE RESEARCH SEMINAR
Short Title: UNDERGRADUATE RESEARCH SEMINAR
Department: Physics and Astronomy
Grade Mode: Satisfactory/Unsatisfactory
Course Type: Seminar
Credit Hour: 1
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Description: Seminar on current research topics in astronomy, astrophysics, and space physics for juniors and seniors. Students will be expected to give one oral presentation each semester. Graduate/Undergraduate Equivalency: ASTR 500. Repeatable for Credit.

ASTR 451 - ASTROPHYSICS I: SUN AND STARS
Short Title: ASTROPHYSICS I: SUN AND STARS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Prerequisite(s): (ASTR 350 or ASTR 360) and (PHYS 301 and PHYS 302)
Description: Physics of stellar atmospheres, interiors and evolution. Polytropes, nucleosynthesis, radiative transfer, convection, oscillations, opacities, curves of growth, spectral line theory and observation.

ASTR 452 - ASTROPHYSICS II: GALAXIES AND COSMOLOGY
Short Title: ASTROPHYSII:GALAXY&COSMOLOGY
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Prerequisite(s): (ASTR 350 or ASTR 360) and (PHYS 301 and PHYS 302)
Description: Study of physical cosmology models. Description of the evolution of the universe, including nucleosynthesis, cosmic background radiation, large-scale structure, galaxy formation and evolution, and high redshift phenomena.

ASTR 470 - SOLAR SYSTEM PHYSICS
Short Title: SOLAR SYSTEM PHYSICS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Prerequisite(s): PHYS 301 and PHYS 302
Description: The Sun, solar-terrestrial relationships, solar wind; planetary atmospheres, ionospheres and magnetospheres. Graduate/Undergraduate Equivalency: ASTR 570. Mutually Exclusive: Credit cannot be earned for ASTR 470 and ASTR 570.

ASTR 477 - SPECIAL TOPICS
Short Title: SPECIAL TOPICS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Internship/Practicum, Lecture, Seminar, Laboratory
Credit Hours: 1-4
Restrictions: Enrollment is limited to Undergraduate, Undergraduate Professional or Visiting Undergraduate level students.
Course Level: Undergraduate Upper-Level
Description: Topics and credit hours may vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.

ASTR 500 - GRADUATE RESEARCH SEMINAR
Short Title: GRADUATE RESEARCH SEMINAR
Department: Physics and Astronomy
Grade Mode: Satisfactory/Unsatisfactory
Course Type: Seminar
Credit Hour: 1
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: A presentation of current research programs in the department. Graduate/Undergraduate Equivalency: ASTR 400. Repeatable for Credit.

ASTR 502 - TEACHING EARTH AND SPACE SCIENCE
Short Title: TEACHING EARTH & SPACE SCIENCE
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Lecture
Credit Hours: 3
Restrictions: Enrollment is limited to Graduate level students.
Course Level: Graduate
Description: Overview of the Earth and the solar system: structure, evolution, and dynamics. Includes non-calculus mathematics: algebra, logarithms and simple trigonometry, including Kepler's laws. Observing sessions at campus observatory and George Observatory TBD. Designed for inservice and preservice science teachers (grades 4-12), but open to undergraduates considering a teaching career. Mutually Exclusive: Credit cannot be earned for ASTR 502 and ASTR 402.
ASTR 503 - ASTRONOMY FOR TEACHERS  
Short Title: ASTRONOMY FOR TEACHERS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Description: Overview of the Sun, stars, galaxies, and the Universe at a non-calculus level. Methods to help students master content, including lab activities suitable for K-12. Observing sessions at Rice campus observatory and George Observatory TBD. Designed for inservice and preservice teachers (grades 5-12), but open to undergraduates considering a teaching career.

ASTR 505 - PROCESSES IN COSMIC PLASMAS  
Short Title: PROCESSES IN COSMIC PLASMAS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Prerequisite(s): ASTR 470 and PHYS 480  
Description: Study of plasma phenomena that occur widely in nature. May include quasi-static equilibrium, magnetic equilibrium, magnetic reconnection, particle acceleration, plasma winds and jets, and interchange instabilities.

ASTR 530 - TEACHING ASTRONOMY LABORATORY  
Short Title: TEACHING ASTRONOMY LABORATORY  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Laboratory  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Prerequisite(s): ASTR 230 or ASTR 350 or ASTR 360 or ASTR 402 or ASTR 403 or ASTR 502 or ASTR 503  
Description: Methods of observational astronomy for public education: telescopes, astronomical binoculars, portable planetariums, digital cameras, and photography (still, 3D, and time lapse). Students will train beginners in the use of telescopes and carry out a modest observational program. The course requires one public presentation. Topics vary with each offering. Mutually Exclusive: Credit cannot be earned for ASTR 530 and ASTR 430.

ASTR 542 - NEBULAR ASTROPHYSICS  
Short Title: NEBULAR ASTROPHYSICS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Prerequisite(s): ASTR 451  
Description: The physics of emission nebulae, including radiative transfer, photo ionization and thermal equilibria, and internal gaseous dynamics. Physical processes in the interstellar medium. Recommended Prerequisite(s): PHYS 541.

ASTR 544 - ASTROPHYSICS OF THE SUN  
Short Title: ASTROPHYSICS OF THE SUN  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Description: Analysis of physical processes at work in the sun, such as heliosseismology, solar variability, solar activity, magnetic reconnection, heliosphere interactions and modern observational techniques.

ASTR 555 - PROTOSTARS AND PLANETS  
Short Title: PROTOSTARS AND PLANETS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Prerequisite(s): ASTR 451  
Description: Physics of star and planet information, including molecular cloud dynamics and chemistry, circumstellar accretion disks, jets, dust, debris disks, atmospheres rotation, and magnetic fields of young stars, binaries, brown dwarfs, comets, Kuiper belt objects, giant planet formation and discoveries of extra solar planets.

ASTR 556 - COMPACT OBJECTS  
Short Title: COMPACT OBJECTS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Description: Selected topics involving white dwarfs, neutron stars, black holes and their environments, e.g., pulsars, supernova remnants, and accretion disks.

ASTR 570 - SOLAR SYSTEM PHYSICS  
Short Title: SOLAR SYSTEM PHYSICS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Lecture  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Description: The Sun, solar-terrestrial relationships, solar wind; planetary atmospheres, ionospheres and magnetospheres. Includes a research paper and presentation on a physical process in the solar system. Graduate/Undergraduate Equivalency: ASTR 470. Mutually Exclusive: Credit cannot be earned for ASTR 570 and ASTR 470.

ASTR 600 - ADVANCED TOPICS IN ASTROPHYSICS  
Short Title: ADV TOPICS IN ASTROPHYSICS  
Department: Physics and Astronomy  
Grade Mode: Standard Letter  
Course Type: Seminar  
Credit Hours: 3  
Restrictions: Enrollment is limited to Graduate level students.  
Course Level: Graduate  
Description: Lecture/seminars which treat topics of departmental interest. Not offered every year. Repeatable for Credit.
ASTR 677 - SPECIAL TOPICS
Short Title: SPECIAL TOPICS
Department: Physics and Astronomy
Grade Mode: Standard Letter
Course Type: Internship/Practicum, Lecture, Seminar, Laboratory
Credit Hours: 1-4
Restrictions: Enrollment is limited to Graduate or Visiting Graduate level students.
Course Level: Graduate
Description: Topics and credit hours vary each semester. Contact department for current semester's topic(s). Repeatable for Credit.