Key to Course Listings

Catalog numbers are part of a University-wide numbering system. Generally, courses numbered 100 to 199 are introductory, 200-299 are intermediate, and 300-499 are advanced (upper-level).

Reorganized or renumbered courses are denoted by a parenthetical number in boldface following the course number. When renumbering or reorganization has left the SUBJECT unchanged, only the previous catalog number is given; if the SUBJECT has also changed, the previous SUBJECT name and course number appear. A reorganized or renumbered course cannot be repeated for credit without special permission.

Cross-listed courses are sponsored by more than one department or program and may be elected in any of the participating units. Cross-listings appear in boldface and are denoted by a slash between the participating units.

Course titles appear in boldface after the catalog number.

Prerequisites appear in italics after the course title. Some prerequisites are advisory. They suggest the assumed background or level of academic experience, and students should be guided by these statements. Some prerequisites are mandatory and are enforced at the point of registration. The *Course Guide* and the *LS&A Bulletin* indicate the cases when prerequisites are enforced.

Prerequisites are of three types:

- *Courses.* Unless otherwise stated, the phrase "or equivalent" may be considered an implicit part of the prerequisite for any course. When a student has satisfactorily completed a course(s) at the required level of competency and when that course is believed to be substantially equivalent to one listed as a prerequisite, the student must consult the instructor or department. If equivalency is determined to have been satisfied, election may be approved by issuance of electronic permission.
- *Class standing* (first year, sophomore, junior, senior). A course might be appropriate for "first and second year students only," or for "juniors and seniors."
- *Permission of instructor.* The phrase "or permission of instructor" may be considered an implicit part of the statement of prerequisites for any course. When permission is a stated requirement, or when a student does not have the stated prerequisite for a course but can give evidence of sufficient background, the student should obtain approval from the instructor or department concerned and an electronic permission issued.

The Credit Symbol, an Arabic numeral in parentheses, denotes the credits earned for the course. Credit is granted in semester hours. Except for small seminars where the reading and/or writing requirements are intensive, one credit represents no less than one hour of class meeting time each week of the term, and usually represents two hours of work outside of class for each class hour.

Area distribution designation is approved by the LS&A Curriculum Committee on a yearly basis. A course may be approved with the designation natural science *(NS),* social science *(SS),* humanities *(HU),* mathematical and symbolic analysis *(MSA),* creative expression *(CE),* interdisciplinary *(ID),* or excluded from distribution *(Excl).*

Courses meeting certain college requirements are so listed. Language other than English *(LR)* courses may be used toward meeting the Language Requirement. The First-Year Writing Requirement may be met by courses designated (Introductory Composition). Courses approved with the designation "Language Requirement" or "Introductory Composition" may not be used as part of an area distribution plan. If an introductory language course is designated "Excluded" *(Excl),* it may not be used to satisfy the LS&A language requirement. *(BS)* means that the course may be used toward the 60 approved credits required for the B.S. degree. Courses meeting or partially meeting the Quantitative Reasoning requirement are designated *(QR/1)* or *(QR/2).* Courses with standard approval for meeting the Race & Ethnicity *(R&E)* requirement are so indicated. Other courses may meet the R&E or QR requirements on a term-by-term basis and are listed on the LS&A website (http://www.lsa.umich.edu/).

Experiential, Independent Study, and Tutorial courses are so designated. (See Experiential and Directed Reading/Independent Study Courses in *Chapter IV.*)

Repetition of a course that varies in content from term to term is permitted only under certain conditions. When a department or program has a policy about the repetition of a course for credit, that policy is included in the course listing. The general statement "May be repeated for credit with permission" usually means "With permission of a concentration advisor." In all other instances, a student must get permission from both the department or program and the Academic Standards Board to repeat a course for credit. Generally, a course may be elected for credit once only.

Excluded combinations of course elections are designated in the listing of affected courses.

Special Grading pattern for a course is indicated in the course listing. Some LS&A courses are offered *mandatory credit/no credit.* (See Non-Graded Courses in *Chapter IV.*)

The Term Symbol, a Roman numeral, denotes the term(s) some courses are offered. The University year is divided into three terms: Fall (I), Winter (II), and Spring-Summer (III). The Spring-Summer Term is further divided: Spring-Half (IIIa) and Summer-Half (IIIb).

Courses That Count Toward Graduate Programs

Courses Approved for Regular Rackham Graduate Credit. All courses taken in fulfillment of Rackham degree requirements must be approved for Rackham graduate credit. Be certain that any courses you plan to take--especially those numbered in the 400s--are approved for Rackham credit before you enroll in them. The Graduate School policy on courses is as follows: Courses at the 400 level and above are acceptable for graduate credit if they have been approved by the Graduate School.

If you are uncertain whether or not a course is approved for Rackham credit, check with the department offering the course or with the Rackham Course Approval Officer (764-8221).

If you elect a course that has not been approved for Rackham graduate credit, the course will appear on your university transcript with the notation "Not for Graduate Credit. The course grade will appear on the transcript, but it will not be averaged into your cumulative grade point average or your credit toward program (CTP) total.

Courses Not Approved for Graduate Credit. Courses at the 300 level and below are not acceptable for graduate credit, without exception. Undergraduate level foreign language courses may occasionally be used in fulfillment of some departmental foreign language requirements.

Under unusual circumstances you may petition to receive graduate credit for a course not normally approved for graduate credit *(e.g.,* such as an undergraduate course where you will be expected to perform more advanced work than the undergraduates). Because there is no guarantee of approval, you should submit your petition to the Graduate School's Office of Academic Records and Dissertations (OARD) before taking the course. Your petition must be endorsed by the course instructor and by the graduate chair of your department or program, and it must include an explanation for requesting the exception. You will be expected to perform graduate level work in the course, and the petition must show how this will be accomplished. You may obtain a petition form from your department, from OARD, or online .

Astronomy

Astronomy

Astronomy ASTRO 326

LSA
Astronomy
Astronomy

http://www.astro.lsa.umich.edu/

Undergraduate Courses

101 **ASTRO 101.**

Introductory Astronomy: The Solar System and the Search for Life Beyond Earth.

(4,4) : May not be repeated for credit.

(NS). (BS). (QR/2).

A basic high school math and science background. No credit granted to those who have completed or are enrolled in ASTRO 111, 115, 130, or 160. I and II.

This course introduces astronomy and astrophysics with an emphasis on discoveries from space exploration. First, it deals with understanding the history of astronomy, orbits, gravitation, optics and the properties of light and matter. Second, it investigates the properties, origin, and evolution of the major planets, asteroids, comets, the Sun and other components of the Solar System with particular emphasis on comparative aspects with respect to the Earth. Third, it explores the developing field of Astrobiology (the origins, evolution, distribution, and future of life in the universe) highlighting recent discoveries of extrasolar planets and the intensifying search for life on Mars.

102 **ASTRO 102.**

Introductory Astronomy: Stars, Galaxies, and the Universe.

(4,4) : May not be repeated for credit.

(NS). (BS). (QR/2).

A basic high school math and science background. No credit granted to those who have completed or are enrolled in ASTRO 112, 120, 130, or 160. I and II.

Three lectures and a one-hour discussion period each week. Lecture topics include properties and evolution of stars; interstellar luminous nebulae; recent discoveries involving galaxies, quasars, and black holes in space; and the present state of our knowledge regarding the origin and ultimate fate of the universe and possibilities of finding and communicating with life outside the solar system. Discussion section format is similar to that in ASTRO 101 but concentrates on the universe beyond the solar system.

111 **ASTRO 111.**

Introductory Astronomy: The Solar System and the Search for Life Beyond Earth.

(4,4) : May not be repeated for credit.

(NS). (BS). (QR/2).

A basic high school math and science background. No credit granted to those who have completed or are enrolled in ASTRO 101, 115, 120, 130, or 160. I, II, and IIIa.

This course introduces astronomy and astrophysics with an emphasis on discoveries from space exploration. First, it deals with understanding the history of astronomy, orbits, gravitation, optics and the properties of light and matter. Second, it investigates the properties, origin, and evolution of the major planets, asteroids, comets, the Sun and other components of the Solar System with particular emphasis on comparative aspects with respect to the Earth. Third, it explores the developing field of Astrobiology (the origins, evolution, distribution, and future of life in the universe) highlighting recent discoveries of extrasolar planets and the intensifying search for life on Mars. Two-hour lab section weekly includes observations with telescopes.

112 **ASTRO 112.**

Introductory Astronomy: Stars, Galaxies, and the Universe.

(4,4) : May not be repeated for credit.

(NS). (BS). (QR/2).

A basic high school math and science background. No credit granted to those who have completed or are enrolled in ASTRO 102, 120, 130, or 160. I, II, IIIa, and IIIb.

Three lectures and a two-hour evening laboratory section each week. Lectures deal with such topics as the properties and evolution of stars, interstellar luminous nebulae, and recent discoveries involving galaxies, quasars, and black holes in space. Also the present state of our knowledge regarding the origin and ultimate fate of the universe and possibilities of finding and communicating with life outside the solar system. The laboratories and discussions feature planetarium demonstrations, observation with telescopes, astronomical photography, and student-inspired dialogue. Two years of high school mathematics or equivalent are recommended.

115 **ASTRO 115.**

Modern Planetary Astronomy.

(4) : May not be repeated for credit.

(Excl). (BS). (QR/2).

Basic high school math and science background. No credit granted to those who have completed or are enrolled in ASTRO 101 or 111.

This course covers the recent advances in our knowledge of the sun, Earth, and planets. It presents the Earth as a planet, and the planets and their satellites as bodies with similarities as well as differences with the Earth. The course also covers modern developments in molecular and biochemistry and the ever-relevant question of life on other worlds.

120 **ASTRO 120.**

Frontiers of Astronomy.

(3,3) : May not be repeated for credit.

(NS). (BS).

Only first-year students, including those with sophomore standing, may pre-register for First-Year Seminars. All others need permission of instructor. No credit granted to those who have completed or are enrolled in ASTRO 102, 112, 125, or 160. I.

Topics emphasized stem from modern extragalactic astronomy, with a stress on areas that are still emerging, such as dark matter, expansion of the universe, and formation of structures in the universe.

122 **ASTRO 122.**

The Origin of the Elements and the History of Matter.

(3,3) : May not be repeated for credit.

(NS). (BS).

Only first-year students, including those with sophomore standing, may pre-register for First-Year Seminars. All others need permission of instructor.

Seminar focusing on the creation of the elements, which were made in the Big Bang and in the center of stars. Students learn how clues to the history of matter were found in abundance patterns in a variety of astronomical objects.

127 **ASTRO 127.**

Naked Eye Astronomy.

(1,1) : May not be repeated for credit.

(NS). (BS).

Students learn about the nature of the most common astronomical objects that can be observed by eye, such as the Sun, Moon, planets, stars, comets, and meteors. The motion of these objects in the sky is studied along with their influence on the Earth

160 **ASTRO 160.**

Introduction to Astrophysics.

(4) : May not be repeated for credit.

(NS). (BS). (QR/2).

MATH 115, and prior or concurrent enrollment in PHYSICS 140 or 160. No credit granted to those who have completed or are enrolled in ASTRO 102, 112, 120, or 130. I and II.

A survey of astronomy and astrophysics. We explore several of the most exciting phenomenon in astrophysics. Fundamental astrophysical processes are explained as are the telescopes and instruments used for the observation of astronomical objects. A major theme is stars, with emphasis on their structure, evolution, and the transfer of radiation. We study the evolution of stars from their birth in giant molecular clouds through their death, which leads to the creation of white dwarfs, neutron stars, and black holes. Galaxies and their distribution is the last theme. Among the topics discussed are the missing or dark matter in galaxies, interactions between galaxies, and the large-scale distribution of galaxies in the Universe.

204 **ASTRO 204 / AOSS 204 / GEOSCI 204.**

The Planets: Their Geology and Climates.

(3,3) : May not be repeated for credit.

(NS). (BS).

High school mathematics through plane geometry and trigonometry. Those with credit for GEOSCI 113 may only elect ASTRO 204 for 2 credits.

Structure, composition and evolutionary history of the surfaces and atmospheres of the planets and their satellites, with special emphasis given to comparative aspects of geology and climatology. Intended for non-science concentrators with a background in high school math and science.

210 **ASTRO 210.**

The Universe Through the Eyes of Magellan.

(3) : May not be repeated for credit.

(NS). (BS). (QR/2).

ASTRO 101/111, 102/112, 160, or any 300- or 400-level ASTRO course.

The University of Michigan is a major partner of the Magellan Observatory which consists of two 6.5 meter diameter telescopes located at the Las Campanas Observatory in Northern Chile. These instruments offer a unique and powerful tool with which UM Astronomers can study the Universe. This course provides a detailed look at Magellan and the science being carried out with this observatory by UM researchers. The course is based on topics currently being studied with the Magellan telescopes. Readings, background information and guest lectures are tailored to these projects, the mix of which change from semester to semester.

261 **ASTRO 261 / NAVSCI 301.**

Navigation.

(3,3) : May not be repeated for credit.

(Excl). (BS).

I.

Theory and practice of celestial navigation, elements of piloting, dead reckoning, and the sailings.

361 **ASTRO 361.**

Astronomical Techniques.

(4,4) : May not be repeated for credit.

(Excl). (BS).

ASTRO 160. II.

Topics include astronomical instrumentation, techniques for obtaining observational data, and the reduction and analysis of observations. Emphasis is placed upon obtaining and analyzing data in such fields as astrometry, radio astronomy, and spectroscopy. Three lectures and two hours of laboratory or observing weekly.

389 **ASTRO 389.**

Individual Studies in Astronomy.

(1-3,1-3) : May be repeated for credit.

(Excl). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration).

Individual reading and study in astronomy under the guidance of the instructor.

399 **ASTRO 399.**

Introduction to Research.

(1-3,1-3) : May be repeated for credit.

(Excl). (BS). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration). Continuing Course. Y grade can be reported at end of the first-term to indicate work in progress. At the end of the second term of ASTRO 399, the final grade is posted for both term's elections.

For students in astronomy who are prepared to undertake a limited research project under the guidance of a member of the staff of the Department of Astronomy. Open to qualified students in other departments subject to approval by concentration advisors and members of the staff of the Department of Astronomy.

429 **ASTRO 429.**

Senior Seminar.

(2,2) : May not be repeated for credit.

(Excl). (BS).

ASTRO 402 and 404. Open only to senior Astronomy and Astrophysics concentrators. I.

Student-faculty discussion of selected problems in two or three currently active areas. This is also the Astronomy Department's senior writing course. Attendance at weekly department colloquia is required.

Undergraduate and Graduate Courses

401 **ASTRO 401.**

Solar System Astrophysics.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

PHYSICS 140 (or 160) and MATH 116, and prior or concurrent enrollment in PHYSICS 240 (or 260). A knowledge of one or more high-level languages (FORTRAN, C, Pascal) will be useful. II.

Studies the properties of the planets, comets and asteroids, their formation, composition, chemistry, geology, and atmospheric activity.

402 **ASTRO 402.**

Stellar Astrophysics.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

MATH 216, and prior or concurrent enrollment in PHYSICS 340. I.

This course examines the appearance, structure, and evolution of stars. We examine the basic physical processes that cause stars to have their observed structures; a study of the energy generation through nucleosynthesis; the basic physical laws that lead to the structure of stars; the transfer of radiation through the outer parts of the star; how spectroscopic information informs us as to the composition and motion of stars; and an in-depth look at the late stages of stellar evolution and stellar death.

403 **ASTRO 403.**

Astrophysics of the Interstellar Medium.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

MATH 216, and prior or concurrent enrollment in PHYSICS 340 (or 260) and PHYSICS 390. I.

The interstellar medium (the gas between stars) comprises a wide variety of material that interacts closely, and often violently, with individual stars and the host galaxy. The underlying atomic and molecular physics is developed; we examine how gas is ionized by hot stars and supernova remnants; we analyze the content of the cold pervasive atomic and molecular gas in the galaxy, how it often lies in spiral arms, and why giant molecular clouds are the most active sites of star formation. Recent discoveries are highlighted.

404 **ASTRO 404.**

Galaxies and the Universe.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

MATH 216, and prior or concurrent enrollment in PHYSICS 340 and PHYSICS 390. II.

Examines the properties of galaxies, large-scale structure in the universe, and cosmological models. The basic aspects of galaxies are explained, orbital theory, spiral arms, the missing mass in galaxies, galaxy evolution, and the starburst phenomenon. The clustering of galaxies, the hot intracluster medium and the dynamical evolution of clusters. Expansion of the universe, the cosmic microwave background, the inflationary universe, Big Bang nucleosynthesis, and the origin and growth of structure in the universe.

405 **ASTRO 405.**

High Energy Astrophysics.

(3,3;3,3) : May not be repeated for credit.

(Excl). (BS).

MATH 216, and prior or concurrent enrollment in PHYSICS 340 and PHYSICS 390. I.

Examines the accretion disk and jets of plasma around black holes and other compact objects. How stellar-mass black holes form the rapidly variable x-ray binary sources and how supermassive black holes at the centers of galaxies produce quasars. The explosions of massive stars (supernovae) and the possibly resulting neutron star or black hole. The origin of X-ray and gamma-ray background radiation fields, the origin of gamma-ray bursts, and the nature of cosmic rays.

Graduate Courses

500 **ASTRO 500.**

Theoretical Astrophysics: Light and Matter.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

The major theme of this course is the physical basis behind much of modern astrophysics, emphasizing thermal and non-thermal radiation mechanisms, radiative transfer, fluid mechanics and plasma physics. Atomic and molecular structure will be developed, along with the variety of transitions that occur and are observed, while the treatment of non-thermal radiation fill focus on synchrotron and Compton scattering.

501 **ASTRO 501.**

Modern Astronomical Techniques.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

The physical, mathematical, and practical methods of modern astronomical observations at all wavelengths are covered at a level that prepares students to comprehend published data and prepare for their own observations. Major topics include: noise sources and astrophysical backgrounds; astronomical optics and aberrations; the physical basis of coherent and incoherent photon detectors; design and use of imaging, spectroscopic, and polarimetric instruments; coordinate and filter systems; antenna theory; aperture synthesis and image reconstruction techniques; and further topics of interest at the discretion of the instructor.

531 **ASTRO 531.**

Stellar Astrophysics.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

This course deals with the internal structure and evolution of stars and with stellar atmospheres, the interpretation of stellar spectra. The first part surveys observations and theory relevant to stellar interiors. Then follow the physics of stellar models -- equations of state, energy transport, energy production; model computations; and stellar evolution from the main sequence to final states. The second part of the course treats the basic hydrostatic equation in optical depth, stellar hydrodynamics, opacity and the continuum, the physics of absorption-line profiles, model atmosphere computations, and the construction of spectral syntheses to obtain abundance of the chemical elements in stars.

532 **ASTRO 532.**

The High Energy Universe.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

The most energetic phenomena in the universe arise either through dramatic explosions of compact stars or through the infall of material into deep gravitational potentials. One theme of the course is the nature of accretion disks, which play a central role in the release of energy as material is accreted onto white dwarfs, neutron stars, and black holes. In these compact objects, magnetic fields are of critical importance in producing the observed radiation through a variety of processes, which will be explored. Another theme is the nature of exploding stars, supernovae, and the particles accelerated in their shocks. Gamma-ray bursts, the most extreme shock events known, and a rapidly moving field, will be discussed. Among the other topics will be the X-ray emission from very hot gas in galaxies and galaxy clusters, as well as the X-ray and gamma-ray backgrounds.

533 **ASTRO 533.**

The Structure and Content of Galaxies.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

This course provides a detailed introduction to the stellar content gaseous content, and kinematics and dynamics of the Milky Way and of other external galaxies. The course offers an introduction on the basic properties and demographics of normal galaxies in the local Universe, including systems within the Local Group and Local Supercluster. The taxonomy and fundamental physical properties of Active Galactic Nuclei are also presented. The course also provides a rigorous introduction to galactic dynamics, including basic properties of the collisionless Boltzmann equation, relaxation processes, orbits in a galactic potential, the Virial theorem, epicyclic orbits, and realistic stellar distribution functions. The course also explores fundamental issues regarding galaxy-scale dynamical instabilities and resonances.

534 **ASTRO 534.**

The Extragalactic Universe.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

This course provides an overview of the study of the physical universe as a whole and in terms of its component structures (galaxies and larger structures). It focuses particularly on the universe in the matter dominated epoch, and places emphasis on the dark matter component of the universe. Topics will include the structure and dynamics of the matter dominated universe, classical tests of the model, the early universe and the microwave epoch, probes of dark matter, estimation of cosmological parameters, gravitational lensing, clustering and large scale structure and formation and evolution of structure.

535 **ASTRO 535.**

Astrophysics of the Interstellar Medium.

(3,3) : May not be repeated for credit.

(Excl). (BS).

Graduate standing and permission of instructor.

In this course, we will discuss atomic and molecular processes, along with interactions of radiation and matter and the latest pertinent observations, will be applied toward understanding the physical, ionization, thermal, chemical, emission, and absorption properties of the interstellar medium. Attention will be given to fill regions, planetary nebulae, supernova remnants, cool neutral gas, molecular clouds, hot or X-ray-emitting gas, and particulate "dust" grains. In addition, the global and evolutionary properties of gas and dust in our Galaxy will be carefully examined.

690 **ASTRO 690.**

Theoretical Astrophysics.

(1-4,1-4) : May not be repeated for credit.

(Excl).

Consent of instructor required (Prerequisites enforced at registration). Graduate standing and permission of instructor.

Special topics in Theoretical Astrophysics. Topics to be decided by instructor.

691 **ASTRO 691.**

Observational Astrophysics.

(1-4,1-4) : May not be repeated for credit.

(Excl).

Consent of instructor required (Prerequisites enforced at registration). Graduate standing and permission of instructor.

Special topics in Observational Astrophysics. Topics to be decided by instructor.

699 **ASTRO 699.**

Special Problems.

(1-8,1-8) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration). Graduate standing and permission of instructor.

A course on problems in astronomy. Content varies by term and instructor.

901 **ASTRO 901.**

Research in Theoretical Astrophysics.

(1-8,1-8) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration). Graduate standing. Permission of instructor required.

Research in theoretical astrophysics. The universe displays a wonderful diversity of structure spanning an enormous range of scales in mass, length, and time. The physical character and dynamic history of many of these astrophysical systems – stars, galaxies, the entire Universe – are not fully understood. Michigan theoretical astrophysicists are working to improve our understanding of how the Universe, and the structures within it, came to be. Topics of interest include development of the early Universe, inflation, formation of galaxies and clusters of galaxies, star formation and cosmology, and dynamics of astrophysical fluids. Much work is guided by observations from optical telescopes, such as the Michigan-Dartmouth-MIT telescope, as well as several NASA missions.

902 **ASTRO 902.**

Research in Observational Astrophysics.

(1-8,1-8) : May not be repeated for credit.

(Excl). (INDEPENDENT).

Consent of instructor required (Prerequisites enforced at registration). Graduate standing. Permission of instructor required.

Using large telescope facilities, research is done in observational astrophysics at the two 6.5 m telescopes of the Magellan Project at the Las Campanas Observatory in Chile, the 2.4-m Hiltner and 1.3-m McGraw-Hill telescopes of the MDM Observatory in Arizona, and the 26 m radio telescope at Peach Mountain Observatory near Ann Arbor.

990 **ASTRO 990.**

Dissertation/Precandidate.

(1-8,1-4) : May be repeated for credit.

(Excl). (INDEPENDENT).

Election for dissertation work by doctoral student not yet admitted as a Candidate. Graduate Standing. This course has a grading basis of "S" or "U."

Election for dissertation work by doctoral student not yet admitted as a Candidate.

995 **ASTRO 995.**

Dissertation/Candidate.

(8,4) : May be repeated for credit.

(Excl). (INDEPENDENT).

Graduate School authorization for admission as a doctoral Candidate (Prerequisites enforced at registration). This course has a grading basis of "S" or "U."

Graduate School authorization for admission as a doctoral Candidate. N.B. The defense of the dissertation (the final oral examination) must be held under a full term Candidacy enrollment period.