

ASTRONOMY (ASTR)

Graduate course offerings consist of formal lecture courses, six of which are designated as "core courses" (ASTR 5400, ASTR 5410, ASTR 5420, ASTR 5500, ASTR 5510, and ASTR 5600), research courses including Master's Thesis and Ph.D. Dissertation, and seminars such as "Journal Club".

ASTR 5210 Computational Methods

3 credit hours

This course introduces students to the details of computational numerical approaches used for solving theoretical problems in astrophysical research. The methods covered are those that students can expect to use for computationally-oriented modeling in theoretical astrophysics. Students should expect to obtain extensive "hands-on" experience and must be able to program in one or more scientific computing languages (preferably FORTRAN or C). Specific approaches discussed include Monte Carlo, finite element, finite difference, and smoothed particle hydrodynamics.

ASTR 5400 Stellar Astrophysics I

3 credit hours

An introduction to the theory of stellar atmospheres and interiors. Topics include: the basic equations of stellar structure, nuclear processes, radiative transfer theory, pre-main-sequence evolution, white dwarfs, neutron stars, and black holes.

ASTR 5410 Stellar Atmospheres and Spectra

3 credit hours

Prerequisite: graduating standing

The astrophysics necessary for modeling the structure and spectra of equilibrium gaseous structures, such as stellar and planetary atmospheres are introduced. Topics may include radiative transfer, statistical mechanics, atomic processes and opacity, structure equations and their solutions, atomic line profiles, and the application of modeling to the determination of stellar parameters and chemical composition.

ASTR 5420 The Interstellar Medium

3 credit hours

Topics covered include: the phases of the interstellar medium, neutral clouds, ionized hydrogen regions, interstellar molecules, dust grains, shocks, gravitational collapse, bipolar outflows, and accretion disks.

ASTR 5500 Galactic Astronomy

3 credit hours

Students explore the contents, structure, and dynamics of the Milky Way Galaxy, based on observational surveys and theoretical tools.

Topics include the interstellar medium, stellar populations, star clusters, chemical evolution and Galactic archeology, the Galactic centre, the Milky Way halo, and an introduction to galactic dynamics.

ASTR 5510 Extragalactic Astronomy

3 credit hours

This course summarizes our understanding of nearby galaxies, and of how these galaxies evolved to the objects we see today. A review of our concept of the nebulae introduces the main topics, which include galaxy classification, the nature of the present stellar population and interstellar medium in galaxies, and galaxies as they were in the remote past. The presentation will reflect our growing awareness of the importance of interactions between and among galaxies as an agent of their evolution.

ASTR 5600 Cosmology

3 credit hours

Cosmology-the study of the large-scale structure and evolution of the universe-is one of the most exciting and active fields of astronomy today. This course presents a broad overview of observational and theoretical cosmology. Emphasis is on how basic physics, guided by observations, is used to construct a remarkably successful model of the universe. Topics include the Big Bang model, formation of galaxies and clusters of galaxies, the large-scale structure of the universe, quasars and radio galaxies, and dark matter.

ASTR 5610 High-energy Astrophysics

3 credit hours

Students study the astrophysical processes that create high-energy photons (X-rays and γ -rays) and the emission created from very energetic electrons (synchrotron and inverse Compton). Topics include gas and radiative processes, high-energy instrumentation, and astrophysical processes from the solar system to black holes and gamma-ray bursts responsible for high-energy emission.

ASTR 5617 Stellar Astrophysics

3 credit hours

This course introduces general physical principles that apply to the understanding of astronomical objects generally in the context of stellar interior and atmospheric structure, and stellar spectrum formation. Topics include gas phase equilibrium, thermodynamics, radiation, opacity, atomic physics and spectral line formation, nuclear energy generation, and computational modelling considerations.

ASTR 5620 Astrophysical Data Analytics

3 credit hours

Students discuss statistical and computational techniques common to all astronomy research subfields with an emphasis on state-of-the-art techniques in data mining and machine learning. Topics include a review of probability and statistical distributions, classical and Bayesian statistical inference, density estimation, clustering, principal component analysis, regression, and classification.

ASTR 5900 Graduate Seminar I

3 credit hours

Articles of interest from the current literature are discussed and critiqued. Students are expected to read articles chosen for discussion, contribute to the critiquing process, and make several presentations during the course. All graduate students must normally enrol in this course in the first year of the Master of Science program. Seminar 1 1/2 hrs. a week. 2 semesters.

ASTR 5980 Research Project I

3 credit hours

Prerequisite: graduating standing.

This course prepares students in the M.Sc. Astronomy program for basic scientific research. Students will normally complete background readings from the current literature and undertake preparatory training in research methods.

ASTR 5981 Research Project II

3 credit hours

This course introduces students in the M.Sc. Astronomy program to the basic principles and techniques of research. Students will be introduced to a research project, normally, but not necessarily, related to their thesis topic.

ASTR 6800-6809 Selected Topics in Astronomy and Astrophysics

3 credit hours

One or more selected specialty areas in astronomy will be examined in greater detail than is possible within the broader scope of other courses. Topics will be chosen by the Department and made available to interested students prior to registration. Seminar 3 hrs. a week.

ASTR 6810-6819 Directed Readings in Current Literature

3 credit hours

A topic of current interest in astronomy will be chosen in consultation with a faculty member. After a thorough study of recent work on the topic, a detailed written report with references will be submitted. Extensive use will be made of available research journals.

ASTR 6900 Graduate Seminar II

3 credit hours

A continuation of ASTR 5695 normally taken by graduate students in the second year of the Master of Science program. Seminar 1 1/2 hrs. a week. 2 semesters.

ASTR 6990 Master of Science Thesis

6 credit hours

Normally taken during the second year of enrolment in the Master of Science program after successful completion of the comprehensive oral examination. The research will be conducted under the supervision of a faculty member.

ASTR 8990 Doctoral Dissertation

6 credit hours

The dissertation consists of an original research topic in astronomy undertaken by the student and prepared as a formal written treatment of their research, which is then defended publicly. The course is normally taken during the third through fifth years of enrolment in the doctoral program after successful completion of the Ph.D. written comprehensive examination and approval of the dissertation proposal. The research is conducted under the supervision of a faculty member. Registration must be approved by a Chair or Supervisor prior to registration and in writing.