

Introduction: This document outlines the structure of the Astronomy Minor, as we intend to offer it for the Fall 2016- Summer II 2018 interval and beyond. Unless otherwise noted, all the courses are 3-hour lecture courses. The expected timing of each course is listed in parentheses after each course title.

Context: This document was written to help advisors and students with course choices, for the revised ASTR minor that is being put into place for Fall 2016 and beyond. It includes one course (Planetary Geology) that is still in development. To find the program requirements as *currently* implemented and approved, see the separate Program Requirements document or visit the Registration & Records website.

Pre-requisites: All courses require Physics II and Calculus I (i.e., PHYS 126/151 and MATH 113/115), or their equivalent courses in the case of transfer students. These pre-reqs are common to a number of disciplines on campus, including much of the Engineering curriculum.

Requirements: Twelve (12) credit-hours, 3-6 at the 300+ level and 6-9 at the 400+ level.

I. Gateway courses: Three (3) to six (6) credit-hours are required from 300-level ASTR or PHYS courses. At the present date, the Gateway courses are:

- **PHYS 305 – Contemporary Physics** (Winter and Summer I each year) 3 credit-hours
 - MATH 114/116 required
- **ASTR 301 – Astrophysical Concepts** (Fall, even-numbered years) 3 credit-hours
 - MATH 114/116 required
- **ASTR 330 – The Cosmic Distance Ladder** (Fall, odd-numbered years) 3 credit-hours
 - No additional pre-requisites
- **ASTR 361 – Observational Techniques** (Summer I each year) 3 credit-hours
 - 2h lecture + 3h lab & Observing
 - ASTR 130/PHYS 130 required, or instructor’s permission

II. Advanced courses: Six (6) to nine (9) credit-hours are required from 400-level ASTR courses, including up to three (3) credit hours of directed research or independent study. The planned course in Planetary Geology will also count as an Advanced course. At the present date, however, the Advanced courses are:

- **ASTR 421 – Stellar Astrophysics** (Winter, odd-numbered years) 3 credit-hours
 - MATH 205/215 required, or instructor’s permission
 - PHYS 305 or ASTR 301 or ASTR 330 required, or instructor’s permission**
- **ASTR 445 – Galaxies & Cosmology** (Winter, even-numbered years) 3 credit-hours
 - MATH 114/116 required, or instructor’s permission
 - PHYS 305 or ASTR 301 or ASTR 330 required, or instructor’s permission**
- **ASTR 495, 498, 499 – Directed research** Up to 3 credit-hours
 - Hours and requirements: by arrangement with faculty
 - PHYS 495, 498 or 499 may be substituted with ASTR faculty permission

** A student taking an ASTR course for credit but *NOT* pursuing the minor, may waive the PHYS 305/ASTR 301/ASTR 330 requirement for this course.

Timing of the course offerings: We anticipate offering ASTR courses at the 300+ level in a two-year cycle, usually at one course per semester. For the next two academic years, the sequence would be as follows (with “→” indicating the most natural pairing of content for a student who has taken Calculus-II):

- **Year 1: ASTR 301** (2016 Fall) → **ASTR 421** (2017 Winter); also **Planetary Geology** (under development; expected 2017 Winter); also **ASTR 361** (2017 Summer)
- **Year 2: ASTR 330** (2017 Fall) → **ASTR 445** (2018 Winter); also **ASTR 361** (2018 Summer)

Notes about the Astronomy Minor in the context of an undergraduate career:

The ASTR Minor has been devised to meet the needs of three (somewhat distinct) groups of students:

1. Students with math training at the Calculus-II level or above, who may become interested in graduate school in a physical science, and thus require sufficient preparation to make graduate-level coursework feasible (example: Physics, Chemistry, Math, Geology majors);
2. Students with math training at the Calculus-II level or above, who have an interest in Astronomy, but for whom an undergraduate minor is likely to be their terminal science training and for whom the introductory-level courses (e.g. ASTR 130) are unlikely to be intellectually satisfactory (for example: Computer Science majors with an interest in Astronomy);
3. Students with deep interest in aspects of planetary science who wish to further their understanding of the interplay between geological/environmental and planetary viewpoints, but for whom Calculus-II is not required as part of the major (e.g. some Geology majors; Environmental science majors; education majors).

Below we give three example tracks through the ASTR minor as we envisage it. Note that of course these options are not exclusive: for example a Track 3 student might take ASTR 330 and ASTR 361 and then any two of ASTR 421, 445, or 449.

Example path 1 – students with Calc-II training:

- First course: PHYS 305, ASTR 301 or ASTR 330
 - One of these three courses available every Fall and Winter semester.
- Follow-on courses: ASTR 421, ASTR 445, Planetary Geology.

Example path 2 – students who never take Calc-II:

- First course: ASTR 330 or ASTR 361
 - Fall every other year (ASTR 330), Summer-I every year (ASTR 361)
- Follow-on courses: Planetary Geology¹, ASTR495/498/499, whichever of ASTR 330 or ASTR 361 not taken as a First course.
 - Note: in this path, one of the independent study courses is required in order to accumulate sufficient credit to achieve the ASTR minor.

Example path 3 – students who discover they want to take Calc-II after starting the minor:

- First course: ASTR 330 or ASTR 361
 - Fall every other year (ASTR 330), Summer-I every year (ASTR 361)
- Follow-on courses:
 - ASTR 301, ASTR 421, ASTR 445, Planetary Geology
- A student entering the minor through ASTR 330 could achieve the math requirement for ASTR 421 and ASTR 445 by:
 - taking MATH 114/116 at the same time as ASTR 330 or ASTR 361;
 - taking MATH 114/116 and then MATH 205/215 in the intervening four semesters between ASTR 330 being offered, and ASTR 421 next being offered in Winter 2017.

ASTR courses as cognates: We are highly interested in arranging for ASTR courses at the 300-400 level to count towards elective/cognate requirements in other disciplines. We recommend that interested students contact their discipline advisors if they are interested in applying ASTR credit in this manner.

¹ The planned Planetary Geology course is expected to run at the same time as ASTR 421 (Stellar Astrophysics). This may be an attractive option for students without Calculus-II at the time of entry to the minor.