## Term Information

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| **Effective Term** | Spring 2017 |

## General Information

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| **Course Bulletin Listing/Subject Area** | Astronomy |
| **Fiscal Unit/Academic Org** | Astronomy - D0614 |
| **College/Academic Group** | Arts and Sciences |
| **Level/Career** | Undergraduate |
| **Course Number/Catalog** | 1102 |
| **Course Title** | From Planets to the Cosmos (No Lab) |
| **Transcript Abbreviation** | Planets to Cosmos |
| **Course Description** | Overview of the Copernican revolution, the discovery of the nature of our solar system, light, gravity, and planets around other stars; the nature and evolution of stars and origin of the chemical elements; the history of galaxies and the expanding universe. Not recommended for students who plan to major in astronomy or physics. |
| **Semester Credit Hours/Units** | Fixed: 3 |

## Offering Information

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| **Length Of Course** | 14 Week, 12 Week |
| **Flexibly Scheduled Course** | Never |
| **Does any section of this course have a distance education component?** | No |
| **Grading Basis** | Letter Grade |
| **Repeatable** | No |
| **Course Components** | Lecture |
| **Grade Roster Component** | Lecture |
| **Credit Available by Exam** | No |
| **Admission Condition Course** | No |
| **Off Campus** | Never |
| **Campus of Offering** | Columbus |

## Prerequisites and Exclusions

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| **Prerequisites/Corequisites** | Prereq: Math 1050 (075) or 102, or an ACT math subscore of 22 or higher that is less than two years old, or Math Placement R or higher; or permission of instructor. |
| **Exclusions** | Not open to students with credit for 1101, 1140, 1144, 1161H (H161), 1162H (H162), 2161H, 2162H, 2291 (291), or 2292 (292). |

## Cross-Listings

**Cross-Listings**

## Subject/CIP Code

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| **Subject/CIP Code** | 40.0201 |
| **Subsidy Level** | Baccalaureate Course |
| **Intended Rank** | Freshman, Sophomore, Junior, Senior |

## Requirement/Elective Designation

General Education course:
Physical Science

## Course Details

**Course goals or learning objectives/outcomes**

- Quantitative Reasoning: Students will understand how quantitative measurements and predictions are used to test scientific ideas and to draw new conclusions.
- Scientific Process: Students will understand the scientific method, interplay between theory and empirical evidence, notions of incremental science and scientific revolutions, and the simultaneous existence of established knowledge and open questions
- Physical Laws: Students will understand that the universe is governed by a set of physical laws and principles that determine the appearance, behavior, and evolution of astrophysical systems.
- Evolution: Students will understand how we infer the evolution of astrophysical systems and the universe from observations at the present day.
- Relevance: Students will identify ways in which science in general and astrophysics in particular are relevant to global issues, US politics, advances in technology, and understanding humanity's place in the universe.

**Content Topic List**

- The Long Copernican Revolution. "We are not the center of the Universe." Solar system, heliocentric model, orbits. Gravity and the Newtonian revolution. Extrasolar planets: detection (emphasis on transit method), atmospheres, habitability.
- Stars. "We are star stuff." Distances and masses of stars. Nuclear fusion and the origin of the elements, nucleosynthesis, stellar lifetimes. Supernovae, white dwarfs, neutron stars, black holes.
- Galaxies. "Space is big, time is long." Dark matter, evolution and growth of structure. Evidence for the Big Bang.

## Attachments

- Astro1102_Syllabus.pdf
  *(Syllabus. Owner: Martini,Louis Paul)*
- Astro1102_GEassessment.pdf
  *(GEC Course Assessment Plan. Owner: Martini,Louis Paul)*
- Astro1102_GErationale.pdf: GE Course Rationale
  *(Other Supporting Documentation. Owner: Martini,Louis Paul)*

## Comments

- This course is intended to to have the same content as Astronomy 1101, except that it will not include the laboratory component. *(by Martini,Louis Paul on 03/17/2016 09:57 AM)*

## Workflow Information

| Status | User(s) | Date/Time | Step |
|---|---|---|---|
| Submitted | Martini,Louis Paul | 03/17/2016 09:58 AM | Submitted for Approval |
| Approved | Weinberg,David Hal | 03/17/2016 10:27 AM | Unit Approval |
| Approved | Haddad,Deborah Moore | 03/17/2016 11:27 AM | College Approval |
| Pending Approval | Nolen,Dawn<br>Vankeerbergen,Bernadette Chantal<br>Hanlin,Deborah Kay<br>Jenkins,Mary Ellen Bigler<br>Hogle,Danielle Nicole | 03/17/2016 11:27 AM | ASCCAO Approval |

**Sample Syllabus**
**Astronomy 1102: From Planets to the Cosmos (No Lab)**
**Professor Name**

**Professor:**
Office: 4### McPherson Lab (614-292-####)
Office Hours: Days, Times, or by appointment
E-Mail: name.#@osu.edu

**TA:**
Office: 4### McPherson Lab (614-292-####)
Office Hours: Days, Times, or by appointment
E-Mail: name.#@osu.edu

**Format of Instruction:**
This is a three credit hour course that will consist of three hours of lecture per week. Lectures will take place on: (TBD days, times)

**Textbook**: *Astronomy Today*, 7th Edition, by Chaisson & McMillan (recommended, not required)

**Course Web Page**: http://carmen.osu.edu

**Course Goals & Learning Objectives**
Astronomy 1102 is an overview of astronomy from our solar system to the universe as a whole. It is a General Education (GE) Physical Science course in the Natural Science category. For Arts and Sciences students in a Bachelor of Arts program, this course meets the Arts and Sciences GE requirement of a natural sciences course.

The goals of courses in this category are: students understand the principles, theories, and methods of modern science, the relationship between science and technology, the implications of scientific discoveries and the potential of science and technology to address problems of the contemporary world.

The expected learning outcomes for GE courses in the Natural Science category are as follows:

1. Students understand the basic facts, principles, theories and methods of modern science.
2. Students understand key events in the development of science and recognize that science is an evolving body of knowledge.
3. Students describe the inter-dependence of scientific and technological developments.
4. Students recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world.

**Course Description**
Astronomy 1102 will meet these expected outcomes through coverage of three overarching and interconnected themes: (1) the Copernican revolution, the discovery of the nature of our solar system and planetary systems around other stars, the physics of light and gravity; (2) the nature and evolution of stars and black holes and the origin of the elements we find in nature; (3) the history of galaxies and the universe, evidence for the Big Bang, and the structure of the universe on its largest scales. We will attempt to convey a number of the facts that astronomers and astrophysicists have learned about these topics, to describe the outstanding scientific problems that are the focus of current research, to illustrate ways in which physical principles are used to understand the universe, and to show how scientific theories are developed and tested against observations.

Among the questions that you should be able to answer by the end of the course are the following: What is the architecture of our solar system, and how do we find other planetary systems? What is a star? What is a galaxy? What is the evidence for dark matter? What is the Big Bang theory? What empirical evidence supports and/or challenges our explanations for the physical nature of stars, galaxies, and the cosmos?

**Course Evaluation**
*Homework***:** Homework will include multiple choice and/or short answer questions that follow from the lectures. There will be four homework assignments distributed evenly throughout the semester. Homework will collectively account for 40% of the total grade.

*In-Class Exams*: There will be several in-class quizzes or a midterm exam. Each exam will cover the material in the lectures since the previous exam. All exams are closed-book, closed-notes multiple-choice tests. In-class exams will collectively account for 30% of the total grade.

Makeup exams are only offered by advance arrangement with the professor. Exceptions are for legitimate, documentable emergencies. If you will be away on an official University-sponsored activity (e.g., sports teams, band, etc.), please bring the professor a letter from your coach, director, etc. in advance of the exam. Exams must be made up within a week of the missed exam date.

*Final Exam***:** The final will be comprehensive, covering all lectures, and has the same format as the in-class quizzes or midterm. It will be approximately twice as long. The final exam will collectively account for 30% of the total grade.

Students who miss the final exam will be given an incomplete (I) with an alternative grade equal to getting a zero on the final, and have to make it up early the following Semester, as per University policy, to avoid the alternative grade. In keeping with official University policy, early finals will not be available for those persons who wish to depart early for break. Please plan ahead and make your travel plans accordingly.

**Grading Policy**

- The homework assignments collectively account for 40% of the final grade.
- The in-class exams collectively account for 30% of the final grade.
- The final exam accounts for 30% of the final grade, and must be taken by all students.
- Attendance at lectures is strongly encouraged and will have a large impact on performance on tests and thus on the final grade.
- Participation is strongly encouraged. The professor will often ask if there are any questions or comments on the topics covered, or on sample exam questions we discuss in class.
- Participation counts towards your final grade, and will be used to bump it up (e.g., from a B+ to an A-) in the event that your calculated final grade is within approximately 1% of the higher score.
- The course will use the standard Ohio State grading scale.

**Lectures, Notes, & Readings**

The lectures are your primary resource for this course. The textbook is used as a secondary reference from which related readings will be suggested. These readings will approximately amount to the equivalent of a chapter per week.

In between these two resources in importance are the lecture notes available on the web. These notes are meant to be useful aids for studying and following along during lectures; they are no substitute for attendance. Most students find that the best strategy is to print out the notes, bring them to class, and then add their own notes in the margins. Remember, these are only outlines of what is covered each day in class, not comprehensive transcripts of the lectures.

The topics covered in this course are:

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| Week 1 | Scientific notation, units, motions in the sky |
| Week 2 | Classical astronomy, measurements of the Earth |
| Week 3 | Copernicus, Tycho, Kepler, and Gallileo |
| Week 4 | Newton and Newton's laws, gravity, and orbits |
| Week 5 | Exoplanets, the habitable zone |
| Week 6 | Properties of stars, internal structure |
| Week 7 | The Sun, energy generation and transport |
| Week 8 | Star formation and evolution |
| Week 9 | Supernovae, white dwarfs, neutron stars, and black holes |
| Week 10 | Tests of stellar evolution, chemical enrichment |
| Week 11 | Galaxies, the cosmic distance scale |
| Week 12 | Special and general relativity, homogeneity and isotropy |
| Week 13 | Expansion of the universe, dark matter, dark energy |
| Week 14 | Big bang, the first three minutes, fate of the universe |

**Textbook**
Because introductory astronomy textbooks designed for non-majors are rarely organized exactly the same as our courses, we will not strictly follow the order of topics in the book. You can expect to jump around as the course progresses. As such, instead of specific reading assignments, each section of the course has related reading suggestions from the text. Not all topics in this course are covered by the book, and similarly not all topics covered in the book will be discussed in class. You are only responsible for the contents of the lectures.

**Academic Misconduct**
It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct http://studentlife.osu.edu/csc/.

## Students with Disabilities

Students with disabilities that have been certified by the Office for Disability Services (ODS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

## GENERAL EDUCATION RATIONALE FOR
## ASTRON 1102 "FROM PLANETS TO THE COSMOS (NO LAB)"

**Background**

Astronomy 1102 is an overview of astronomy from our solar system to the universe as a whole. This course is identical to Astronomy 1101, except that it does not include the laboratory component, and therefore this document is very similar to the rationale for Astronomy 1101.

Astronomy 1102 is a General Education (GE) Physical Science course in the Natural Science category that is intended for BA students. While the course is numbered at the 1000-level, students at all ranks take Astronomy GE courses (approximately half of the enrollments are rank 3 or higher in Astronomy 1000-level courses).

The expected learning outcomes for GE courses in the Natural Science category are as follows:

1. Students understand the basic facts, principles, theories and methods of modern science.
2. Students understand key events in the development of science and recognize that science is an evolving body of knowledge.
3. Students describe the inter-dependence of scientific and technological developments.
4. Students recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world.

Astronomy 1101 was designed in collaboration with UCAT, starting by defining the course-specific objectives and designing assignments to achieve these objectives. Astronomy 1102 has the same course-specific objectives.

**The GE course goals are addressed as follows:**

(a) Quantitative reasoning. Students will understand how quantitative measurements and predictions are used to test scientific ideas and to draw new conclusions. Maps to GE Goal #1.
(b) Scientific process: Students will understand the scientific method, interplay between theory and empirical evidence, notions of incremental science and scientific revolutions, and the simultaneous existence of established knowledge and open questions. Maps to GE goals #1 and #2.
(c) Physical laws. Students will understand that the universe is governed by a set of physical laws and principles that determine the appearance, behavior, and evolution of astronomical systems. Maps to GE goal #1 and somewhat to goal #3.

(d) Evolution. Students will understand how we infer the evolution of astrophysical systems and the universe from observations at the present day. Maps to GE goals #1 and #4.
(e) Relevance. Students will identify ways in which science in general (and astrophysics in particular) are relevant to global issues, US politics, advances in technology, and understanding humanity's place in the universe. Maps to GE goals #3 and #4.

**GE Learning Outcomes are addressed as follows:**

(a) How do the course objectives address the expected learning outcomes?

Astronomy 1102 will meet these expected outcomes through coverage of three overarching and interconnected themes: (1) the Copernican revolution, the discovery of the nature of our solar system and planetary systems around other stars, the physics of light and gravity; (2) the nature and evolution of stars and black holes and the origin of the elements we find in nature; (3) the history of galaxies and the universe, evidence for the Big Bang, and the structure of the universe on its largest scales. Students will learn basic observational facts (motions of bodies in the Solar System and proof of the Earth's motion; nature and composition of stars; fossil evidence of the Big Bang, including elemental abundances and cosmic background radiation), the methodology used in astronomy (measurement of positions and brightness of celestial sources and principles of spectroscopy), and the theories derived from the observations (the Copernican Solar System, universal gravitation, stellar evolution, and the Big Bang). It is worth emphasizing that the near-identical course Astronomy 1101 was designed in collaboration with UCAT personnel following the "Understanding by Design" framework, beginning with the high-level goals that are listed in the Course Request and proceeding to more specific objectives. The high-level goals, though constructed specifically for this course, map well to the four expected learning outcomes for GE courses in the Natural Science category. While the content and context of the course is defined by the astronomical themes above, the associated assignments are intended specifically to achieve the learning objectives described in the Course Request and to assess the degree to which students are attaining the desired learning outcomes.

(b) How do the readings address the expected learning outcomes?

Readings are selected to reinforce lessons learned in lecture.

(c) How do the topics address the expected learning outcomes?

The three themes that will be covered form the underpinnings of modern astronomy and astrophysics. The first topic, "The Long Copernican Revolution" is the on-going development of humanity's place in the universe. Copernicus first elucidated our modern view of the Earth in the Solar System. In the last 100 years, we have come to understand that we are on the outskirts of an undistinguished galaxy that is in turn on the outskirts of a large, but typical, supercluster comprised of thousands of galaxies. The second topic, the evolution of stars, leads to an understanding of the origin of elements heavier than helium, i.e. the elements that are common on Earth, yet cosmically relatively rare. The third topic, history of the universe, affords an explanation for the origin of the universe that is consistent with a wide variety of basic data and amenable to rigorous tests. In each instance, understanding how we came to this realization requires understanding of the methodology, observations, and underlying physics.

(d) How do the written assignments address the learning outcomes?

1) How do students gain significant writing experiences and other related skills involving effective written and oral communication?
2) How does the syllabus include opportunities for feedback on writing and revision?
3) How are students encouraged to develop information literacy?

Homework assignments are designed to reinforce how the basic data are assembled coherently and then lead to hypotheses that are amenable to tests.

(e) How do the prerequisites provide an appropriate level of preparation for the proposed course?

Only very basic geometry, algebra, and trigonometry are required to execute and understand the assignments.

**GENERAL EDUCATION ASSESSMENT FOR**
**ASTRON 1102 "FROM PLANETS TO THE COSMOS (NO LAB)"**

**Background**
Astronomy 1102 is an overview of astronomy from our solar system to the universe as a whole. It is a General Education (GE) Physical Science course in the Natural Science category that is intended for BA students. Astronomy 1102 contains the same content as Astronomy 1101, with the exception that it does not contain a laboratory component. (Astronomy 1102 is also intended for both BA and BS students.)

Astronomy 1102 is not intended to be a comprehensive survey of astronomy, but will instead cover a limited number of astronomical topics to illustrate general principles of physical science and the scientific method.

**Assessment Strategy**
We will employ rubrics to assess student understanding through homework assignments and in-class exams. We will also use pre- and post-assessment short quizzes to determine how student understanding has changed as a result of the course.

Another direct method of assessment that we will employ is embedded testing. The final examination will include multiple-choice questions that address specific concepts that were emphasized in the course. Examples of embedded questions that address the specific GE goals appear in the assessment plan below.

As an indirect method of assessment, we will employ exit surveys that will include the specific course objectives and the GE learning objectives and students will be asked whether they strongly agree, agree, disagree, strongly disagree, or neither agree nor disagree that these goals were met. We will also seek narrative responses.

We will evaluate this feedback to determine which parts of the course were effective or ineffective and whether or not some of the homework and exam questions were too difficult or too easy. We will also use this feedback to assess whether or not the areas of selected emphasis are achieving the goals outlined in our GE rationale documents.

The content of Astronomy 1102 will benefit from assessment-based improvements to Astronomy 1101, which has been offered every semester since Autumn 2014. We will also use the same embedded questions in Astronomy 1101 and 1102 to evaluate the lab component in Astronomy 1101.

**Table: Sample Rubrics for Homework**

| Homework Exercise | Does Not Yet Meet Expectations | Minimally Meets Expectations | Fully Meets Expectations | Exceeds Expectations |
|---|---|---|---|---|
| Eclipses (part of week 2) | Can explain eclipse | Correctly explains | Can articulate why there are | Understands precession and |

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| | phenomenon, but not eclipse conditions | solar/lunar eclipses and conditions where they occur | “eclipses seasons” rather than eclipses every month | why interval between eclipses seasons is less than half a year |
| Hubble Law (week 11) | Understands correlation between distance and recession velocity, but cannot explain clearly underlying assumptions and the correlation between luminosity and redshift | Can correctly explain variables used in the Hubble diagram, underlying assumptions, and their implications | Can correctly explain implications of the Hubble diagram for the age of the universe | Can correctly connect with Copernican principle and implications of homogeneity and isotropy. |

**Assessment Plan**

**a) Specific Methods used to demonstrate student achievement of the GE expected learning outcomes**

| GE Expected Learning Outcomes | Direct Methods (*assess student performance related to the expected learning outcomes. Examples of direct assessments are: pre/post test; course-embedded questions; standardized exams; portfolio evaluation; videotape/audiotape of performance*) | Indirect Methods (*assess opinions or thoughts about student knowledge, skills, attitudes, learning experiences, and perceptions. Examples of indirect measures are: student surveys about instruction; focus groups; student self-evaluations*) |
|---|---|---|
| 1. Students understand the basic facts, principles, theories and methods of modern science. | Embedded questions on exams[1]<br>Pre- and post testing. | Opinion survey[2] |
| 2. Students understand key events in the development of science and recognize that science is an evolving body of knowledge. | Embedded questions on exams[1]<br><br>Pre- and post testing | Opinion survey |
| 3. Students describe the inter-dependence of scientific and technological developments. | Embedded questions on exams[1]<br><br>Pre- and post testing | Opinion survey |
| 4. Students recognize social and philosophical implications of scientific discoveries and understand the potential of science and technology to address problems of the contemporary world. | Embedded questions on exams[1]<br><br>Pre- and post testing | Opinion survey |

[1]On each lecture exam and the final, several questions will be written specifically to assess student achievement of each GE expected learning outcome. The scores on these questions will be included in the totals for the exam but will also be analyzed separately so that the data can be used in revising the course and for GE assessment reporting purposes. Examples of *specific* embedded questions follow.

GE Goal 1: "A Cepheid variable with a pulsation period of 10 days is observed in a galaxy at a distance of 50 Mpc. Another Cepheid with the same period is observed in another galaxy, but is 10,000 times fainter. What is the distance to the second galaxy?" Multiple choice: correct answer is 0.5 Mpc = 500 kpc.

GE Goal #2: "Give an example of a historically important observation that supported the Copernican picture of our solar system." Multiple choice: correct answers include "Phases of Venus" and "Orbital motions of the moons of Jupiter."

GE Goal #3: "The telescope was a key technological development that enabled experimental confirmation that the Earth orbits the Sun by detection of what effects?" Multiple choice: correct answer includes "parallax of stars, aberration of starlight, and stellar radial velocities."

GE Goal #4:"Observations have shown that:" Multiple choice: correct answer is "there are no special places or directions in the universe."

[2] At the end of the semester, each student will be asked to fill out an opinion survey comprised of specific questions asking to what extent each student has achieved the four GE expected learning outcomes in this course.

b) **Explanation of level of student achievement expected:**
   Success means that students will answer 75% of the embedded GE exam questions correctly.

c) **Description of follow-up/feedback processes:**
   At the end of the course, we will use an analysis of the embedded exam questions to identify problem spots and how we might change the course and the presentation of materials to insure better fulfillment of the four GE Natural Science-Physical Science expected learning outcomes. We will also analyze the self-evaluation questions carefully to judge how students evaluated their own progress and to determine whether student perception meshed with performance.