Texas A&M University
Core Curriculum

Initial Request for a Course Addition to the Fall 2016 Core Curriculum

Foundational Component Area: Life and Physical Sciences

In the box below, describe how this course meets the Foundational Component Area description for Life and Physical Sciences. Courses in this category focus on describing, explaining, and predicting natural phenomena using the scientific method. Courses involve the understanding of interactions among natural phenomena and the implications of scientific principles on the physical world and on human experiences.

The proposed course must contain all elements of the Foundational Component Area. How does the proposed course specifically address the Foundational Component Area definition above?

ASTRONOMY 103 (3 credits): Introduction to Stars & Exoplanets
A qualitative study of stellar birth, stellar structure and evolution, stellar nucleosynthesis, the Hertzsprung-Russell Diagram, white dwarfs, neutron stars, supernovae, black holes, proto-planetary systems, origin of the solar system, and the search for exoplanets; utilizes active learning methods that incorporate observations from the current generation of ground and space-based telescopes. Open to all students.

ASTR 103 enables students to understand, construct, and evaluate relationships in the natural world by understanding the basis for building and testing scientific theory. The course goal is to inculcate the students with an understanding and appreciation of the basic scientific method and principles, thus allowing students an opportunity for a better understanding and appreciation of our physical place in the Universe. The course provides an in-depth study of stars and extrasolar planetary systems, their properties, and how stars and planets; an understanding of our Sun, how it formed, and what it will become; the formation and structure of stars spanning a wide range in masses; the remnants of dead stars including black holes, neutron stars, and white dwarfs; the process of stellar nucleosynthesis that forms heavy elements such as oxygen, nitrogen, and iron; the enrichment of the inter-stellar medium through stellar death; the formation of our own Solar System in the context of planetary formation; and the requirements for life. Through the material covered in ASTR 103, the students are introduced to nearly all fundamental topics of modern stellar astronomy and planetary formation.

Core Objectives

Describe how the proposed course develops the required core objectives below by indicating how each learning objective will be addressed, what specific strategies will be used for each objective and how student learning of each objective will be evaluated.

The proposed course is required to contain each element of the Core Objective.

Critical Thinking (to include creative thinking, innovation, inquiry, and analysis, evaluation and synthesis of information):

Astronomy 103 is structured around general questions about science and its place in our world. We stress the use of the scientific method in answering questions. We give instruction in astronomy specifically, but give an appreciation of the broader context of that knowledge. In particular, we will show that gaining a scientific body of knowledge involves mastery of concepts and specific viewpoints, much more than simply learning a set of facts. We show what types of questions can be posed and how they are answered in a scientific context; this necessarily involves explanation of how scientific theories are developed and tested and the nature of science and limits of empirical knowledge. Astronomy is well tuned to this sort of instruction; both due to its intrinsic interest, but also because the span of time and spatial scales involved are so much greater than human experience.
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Astronomy 103 includes instruction in issues that connect astronomical knowledge and associated scientific methodology more generally to concepts that unify the natural sciences and that are related to a broader cultural context. We show the importance of cause and effect reasoning in the scientific world view, demonstrate the characteristic scales and proportions of natural phenomena, explain the ways in which the stars and solar systems form and evolve, reveal the general applicability of natural laws, illustrate the role of mathematics in science, and discuss the historical development of science and impact on culture and general intellectual progress. Individual student progress is assessed regularly throughout the semester using metrics that include homework, in-class participation via polling, and exams.

Communication (to include effective development, interpretation and expression of ideas through written, oral and visual communication):

Communication is key to science and the students develop communication skills on multiple levels including analytic and written skills as part of the assignments as well as verbal skills during lectures, specifically with the lecture tutorials and in-class polling (see the following sections). Astronomy also is particularly attuned to teaching students visual interpretation and understanding, specifically by using figures and images of astronomical objects to infer empirical relations and thus learn universal physical concepts. The course components are designed to teach students how to explain the scientific process, describe basic physical concepts and general characteristics of astronomical objects, apply scientific thinking to the natural world, and formulate a scientific hypothesis. Individual student progress is assessed regularly throughout the semester using metrics that include homework, and exams. In-class tutorials and exams include written, oral, and visual communication. For example, the tutorials require the students to discuss with each other and provide written answers to questions. Several tutorials also require sketching a description of the subject, e.g. relative positions of objects given a gravitational field.

Empirical and Quantitative Skills (to include the manipulation and analysis of numerical data or observable facts resulting in informed conclusions):

ASTR 103 teaches students how to identify the differences among competing scientific theories, recognize scientific and quantitative methods and the differences between these approaches and other methods of inquiry, apply their analytical skills to understand the physical nature of the universe, and communicate their findings, analyses, and interpretation both orally and in writing. Specifically, there are regular homework sets (12 in total) and exams that are coordinated with the lecture material. The assigned questions include mathematical problems that develop familiarity with data analysis and numerical manipulation as well as short answer, discussion-style problems that utilize higher level cognitive skills.

Teamwork (to include the ability to consider different points of view and to work effectively with others to support a shared purpose or goal):

The ASTR 103 lectures incorporate two strategies to promote active learning through teamwork: (1) in-class polling with iClickers (during each lecture) and (2) lecture tutorials for group work (6-8 tutorials per course). With in-class polling, the lecturers are able to determine if students are understanding the new material. If a majority of the class answers a poll question incorrectly, the students are encouraged to discuss with each other using scientific arguments about which answer is most likely to be correct. Once discussion has ended, the poll is taken again. The process is repeated until through evaluation of the different points of view, the majority of the class has selected the correct answer.

Lecture-tutorials are an effective tool for promoting active learning through discussion and collaborative teamwork. During a lecture, the students work in small groups (2-3) on an astronomy tutorial that reinforces the introduction of new concepts by applying these concepts in a series of questions; students typically require 15-20 minutes to complete a tutorial. The tutorials have multiple discussion-style questions that the students evaluate using the
Texas A&M University

Core Curriculum

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scientific method and answer as a team. The class then reviews the tutorial which often promotes further discussion of the material.

Please be aware that instructors should be prepared to submit samples/examples of student work as part of the future course recertification process.