GENERAL EDUCATION COURSE PROPOSAL

WEBER STATE UNIVERSITY

**PHYSICAL SCIENCE EMPHASIS**

Area: **PHYSICAL SCIENCE**

Date: \_\_\_\_\_\_October 15, 2012\_\_\_\_\_\_\_\_\_\_\_

College: \_\_\_\_\_Honors Program\_\_\_\_\_\_\_\_\_\_

Department: \_\_\_Honors Program\_\_\_\_\_\_\_

Catalog Abbreviation: \_\_\_HNRS\_\_\_\_\_\_\_\_

Title of Course for Catalog: Exploring Key Concepts in the Physical Sciences: “Are We Alone? The Science of Astrobiology.”

Course Number: \_\_2030\_\_\_\_\_\_\_\_\_

Credit Hours: \_\_3\_

New: \_\_\_X\_\_

Course description as you want it to appear in the catalog: This course will focus on a central topic in the Physical Sciences, using original sources as the primary class texts.

This course investigates the nature of science by asking (and trying to answer) a particular question: Are We Alone? The effort to answer this question is called ‘Astrobiology’, and it is an interdisciplinary investigation involving physics, astronomy, chemistry, geology, and microbiology.

Justification:

The Natural Science Learning Outcomes and Physical Science Learning Outcomes are as follows. For brevity, I have designated these outcomes as F1 through F4 and P1 through P4, as annotated. Particular readings and exercises have been chosen and developed to address each of these learning outcomes, as is indicated in detail on the attached syllabus. For your convenience, I have organized them the other way here, grouping the assignments, readings and lectures under each outcome.

**NATURAL SCIENCES GENERAL EDUCATION MISSION STATEMENT**

*The mission of the natural sciences general education program is to provide students with an understanding and appreciation of the natural world from a scientific perspective.*

*Science is a way of knowing. Its purpose is to describe and explain the natural world, to investigate the mechanisms that govern nature, and to identify ways in which all natural phenomena are interrelated. Science produces knowledge that is based on evidence and that knowledge is repeatedly tested against observations of nature. The strength of science is that ideas and explanations that are inconsistent with evidence are refined or discarded and replaced by those that are more consistent.*

*Science provides personal fulfillment that comes from understanding the natural world. In addition, experience with the process of science develops skills that are increasingly important in the modern world. These include creativity, critical thinking, problem solving, and communication of ideas. A person who is scientifically literate is able to evaluate and propose explanations appropriately. The scientifically literate individual can assess whether or not a claim is scientific, and distinguish scientific explanations from those that are not scientific.*

**PHYSICAL SCIENCE GENERAL EDUCATION COURSES**

An approved physical science general education course will prepare a student to **fulfill all** of the natural science and physical science learning outcomes outlined below.

**NATURAL SCIENCES LEARNING OUTCOMES**

After completing the natural sciences general education requirements, students will demonstrate their understanding of general principles of science:

F1:

1. **Nature of science**. Scientific knowledge is based on evidence that is repeatedly examined, and can change with new information. Scientific explanations differ fundamentally from those that are not scientific.  
Readings:

* + Sagan, Carl and Druyan, Ann The Demon-Haunted World: Science as a Candle in the Dark, Ballantine Books, 1997
  + Lin, D. et al.; Orbital migration of the planetary companion of 51 Pegasi to its present location, Nature, 1996
  + Lowell, Percival The Habitability of Mars, Nature, 1908
  + deVera, et al. The Adaptation Potential of Extremophiles to Martian Surface Conditions and its Implications for the Habitability of Mars, EGUGA, 2012
  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925
  + Wolfe-Simon, et al. Did nature also choose arsenic? IJAsB, 2009
  + Whatever is the latest article attacking the arsenic bacteria paper…

Activities:

* + The Drake Equation
  + Scientific Method
  + Field trip to the Great Salt Lake
  + Microbial Life and Death
  + Great Salt Lake Halophiles

F2:

2. **Integration of science**. All natural phenomena are interrelated and share basic organizational principles. Scientific explanations obtained from different disciplines should be cohesive and integrated.

Readings:

* + The Drake Equation by Frank Drake
  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925
  + Wolfe-Simon, et al. Did nature also choose arsenic? IJAsB, 2009
  + Whatever is the latest article attacking the arsenic bacteria paper…

Activities:

* + The Drake Equation
  + Field trip to the Great Salt Lake
  + Microbial Life and Death
  + Great Salt Lake Halophiles
  + Extracting DNA

F3:

3. **Science and society**. The study of science provides explanations that have significant impact on society, including technological advancements, improvement of human life, and better understanding of human and other influences on the earths environment.

Readings:

* + The Drake Equation by Frank Drake
  + Sagan, Carl and Druyan, Ann The Demon-Haunted World: Science as a Candle in the Dark, Ballantine Books, 1997
  + Landsman, Simon, et al.; 51 Peg; IAUC 6268 (IUE follow-up observations of 51 Peg in November 1995)
  + Marcy and Butler: AAS: The Planet around 51 Pegasi BAAS, 27, 1379 (poster abstract confirming discovery in December 1995)
  + Sagar, Ram; Discovery of a planetary system around 51 Pegasus BASI 1996
  + Boss, A. P.; Forming a Jupiter-like Companion for 51 Pegasi LPI, 27, 1996
  + Lin, D. et al.; Orbital migration of the planetary companion of 51 Pegasi to its present location, Nature, 1996
  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925
  + Wolfe-Simon, et al. Did nature also choose arsenic? IJAsB, 2009
  + Whatever is the latest article attacking the arsenic bacteria paper…

Activities:

* + The Drake Equation
  + Presentations: The Demon-Haunted World
  + Field Trip to the Great Salt Lake
  + Latest data from Mars Science Laboratory
  + When it all goes wrong

F4:

4. **Problem solving and data analysis.** Science relies on empirical data, and such data must be analyzed, interpreted, and generalized in a rigorous manner.

Justification:

Readings:

* + The Drake Equation by Frank Drake
  + Sagan, Carl and Druyan, Ann The Demon-Haunted World: Science as a Candle in the Dark, Ballantine Books, 1997
  + Lin, D. et al.; Orbital migration of the planetary companion of 51 Pegasi to its present location, Nature, 1996
  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925
  + Wolfe-Simon, et al. Did nature also choose arsenic? IJAsB, 2009
  + Whatever is the latest article attacking the arsenic bacteria paper…

Activities:

* + The Drake Equation
  + Scientific Method
  + Presentations: The Demon-Haunted World
  + Emission and Absorption
  + Stars and Atoms
  + R\*
  + 51 Peg
  + Microbial Life and Death
  + Great Salt Lake Halophiles
  + Latest data from Mars Science Laboratory
  + Extracting DNA

**PHYSICAL SCIENCE SPECIFIC LEARNING OUTCOMES**

Students will demonstrate their understanding of the following feature of the physical world:

P1:

1. O**rganization of systems**: The universe is scientifically understandable in terms of interconnected systems. The systems evolve over time according to basic physical laws.

Justification:

Readings:

* + The Drake Equation by Frank Drake
  + Mayor, Queloz, et al.; 51 Peg; IAUC 6251 (the discovery announcement of 51 Peg b in October 1995)
  + Landsman, Simon, et al.; 51 Peg; IAUC 6268 (IUE follow-up observations of 51 Peg in November 1995)
  + Marcy and Butler: AAS: The Planet around 51 Pegasi BAAS, 27, 1379 (poster abstract confirming discovery in December 1995)
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  + Lin, D. et al.; Orbital migration of the planetary companion of 51 Pegasi to its present location, Nature, 1996
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  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925

Activities:

* + The Drake Equation
  + Emission and Absorption
  + Stars and Atoms
  + R\*
  + 51 Peg
  + Microbial Life and Death
  + Great Salt Lake Halophiles
  + Latest data from Mars Science Laboratory

P2:

2. **Matter**: Matter comprises an important component of the universe, and has physical properties that can be described over a range of scales.

Justification:

Readings:

* + The Drake Equation by Frank Drake
  + Boss, A. P.; Forming a Jupiter-like Companion for 51 Pegasi LPI, 27, 1996
  + Lin, D. et al.; Orbital migration of the planetary companion of 51 Pegasi to its present location, Nature, 1996
  + Payne, Cecilia “Astrophysical Data Bearing on the Relative Abundance of the Elements” PNAS 1925

Activities:

* + Emission and Absorption
  + Stars and Atoms
  + R\*

P3:

3. **Energy**: Interactions within the universe can be described in terms of energy exchange and conservation.

Justification:

Readings:

* + Mayor, Queloz, et al.; 51 Peg; IAUC 6251 (the discovery announcement of 51 Peg b in October 1995)
  + Landsman, Simon, et al.; 51 Peg; IAUC 6268 (IUE follow-up observations of 51 Peg in November 1995)
  + Marcy and Butler: AAS: The Planet around 51 Pegasi BAAS, 27, 1379 (poster abstract confirming discovery in December 1995)
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Activities:

* + Emission and Absorption
  + Stars and Atoms
  + R\*
  + 51 Peg
  + Microbial Life and Death
  + Great Salt Lake Halophiles
  + Latest data from Mars Science Laboratory

P4:

4. **Forces**: Equilibrium and change are determined by forces acting at all organizational levels.

Readings:

* + Mayor, Queloz, et al.; 51 Peg; IAUC 6251 (the discovery announcement of 51 Peg b in October 1995)
  + Landsman, Simon, et al.; 51 Peg; IAUC 6268 (IUE follow-up observations of 51 Peg in November 1995)
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Activities:

* + Stars and Atoms
  + R\*
  + 51 Peg
  + Latest data from Mars Science Laboratory

**COMPLETE THE FOLLOWING**

1. Has this proposal been discussed with and approved by the department?

Yes.

2. List those general education courses in other departments with similar subject matter and explain how this course differs.

Because this course is an interdisciplinary course, it contains elements that are often taught in many other courses, but assembles them in a different way than any of those courses. Most of these other courses are survey courses that do not reference primary texts. Given that one of the Learning Outcomes is to show that sciences are interconnected, overlap between this and courses in other departments is not only inevitable, but decidedly desirable.

Astronomy: ASTR/PHYS 1040 has the strongest overlap with this course. ASTR 1040 overlaps with portions of the content from weeks 1, 4, 5, 6, 7, 8, 12 and 13. But this honors course goes more into depth in stellar spectra and planet detection. This course references the source data. It also leaves out, for example, the larger Universe.

Chemistry: CHEM 1010 also covers emission/absorption and information about spectral classification of elements. This honors course extends this information into the realm of stars, to explore how we know what stars are made of. Some organic chemistry is necessary to discuss DNA, microbial life and the arsenic bacteria fiasco. Introductory chemistry does not, in general, apply these concepts to the question of life in the universe.

Geosciences: GEO 1020 covers the fossil record and the history of life on Earth. This honors course will briefly address the beginning of life on Earth. The overlap is minimal. GEO 1030 focuses on earthquakes and volcanoes. We will address the impact of volcanoes on Mars, Venus and Earth, but in the sense of comparative planetology, not in the sense of a detailed understanding of the underlying geology. Earth as a special locale for life due to plate tectonics will also be discussed.

Mathematics: several concepts and techniques from mathematics (arithmetic, graphing, algebra, geometry, spherical geometry, curve fitting, Gaussian distributions, statistics, etc.) will be used in this course, in context. These concepts are covered widely in several different math courses.

Microbiology: MICR 1113 is an introduction to microorganisms, their biology and their relationships to health, technology and the environment. This honors course overlaps only in the relationship to the environment. We will look specifically at microbes in extreme environments, and compare the locations in which extremophiles flourish on Earth to possible environments elsewhere in the Solar System and the Milky Way.

3. If the proposed new general education course affects course requirements or enrollments in other departments, list the departments and programs involved and attach comments from each.

It is unlikely that the enrollment of this course will ever rise above 20. The impact on other departments will be negligible.

4. Attach a topical outline of the course. Include the number of contact hours per week and the format of these hours (e.g., lecture, lab, field trip, etc.).

Attached, in the syllabus.

**New Courses Only:**

5. Discuss how you will assess student learning outcomes associated with this course

For your convenience, I enclose the portion of the syllabus that covers this issue.

**The Points:** (How am I going to figure out how we're doing?)

* **Activities:**   Each week, usually on Friday, we will do an activity in class, about the material from the current week.  This can be as simple as measuring the distances to objects using parallax, or as complex as detecting dark matter from the rotation curves of galaxies.  The purpose of these activities varies, from exploring a difficult conceptual concept from a new angle, to giving you a sense of what the scientific data and process look like. The majority of these activities will be completed entirely during class time. (30%)
* **Homework:**  Each week, due on Wednesday, we will have homework assignments due.  Some of these will be quantitative (graph, calculate or measure), and some will be qualitative (explain, compare and contrast, research).   Some will be a little of both. The purpose of these assignments is to give you a chance to spend a little more time with the background material, so that you can explore subtleties that you might otherwise miss.  (30%)
* **Projects:**  In some weeks, we will have short student presentations covering the non-technical aspects of the course.  These will be group projects, and are expected to be short---ten minutes maximum.  Each student will present at least once. These short projects will be presented on Wednesdays.  The purpose of these projects is to give you some experience doing 'research' into the topic in a less directed manner.  Generally, you will be asked to answer a particular question---hopefully one that you might have running around in your head anyway.  (10%)
* **Paper:**  The culminating project is a paper about one of the pillars of Big Bang cosmology (by the end of day one, you will understand what this means!).  You will be expected to *synthesize* the information in class with information from other sources, and to *evaluate* the scientific evidence.  A discussion of alternative interpretations is appropriate in some cases, but the focus should be on the accepted scientific interpretation.  I expect that a *thorough*, *well-reasoned* and *insightful* assessment can not be written in fewer than fifteen pages. The purpose of this paper is to 'put it all together', to step back and look at the subject from a little distance, and see how it fits into the larger picture.  (30%)

**Current General Education Courses and Existing Courses Seeking General Education Status:**

6. Discuss how you have assessed the applicable or identified student learning outcomes associated with this course.

The learning outcomes associated with this course are those approved by the Curriculum Committee and the General Education Committee for Physical Science courses.

7. How has this assessment information been used to improve student learning?

Honors faculty teaching Gen Ed Honors classes are required to state the Gen Ed learning outcomes in their syllabi. They are asked to administer assessments at the beginning and end of the semester. These tests are used as the basis for an end-of-semester report indicating how effectively students achieve the stated learning outcomes. Faculty find this report a useful way to see what worked and what didn’t in their particular class. We keep those reports and related artifacts on file.

Honors also administer student evaluations at the end of every semester. The Honors Director reads all the student assessments, and then writes a formal letter to the faculty member, quoting from the student comments period. The student assessment opens the door to conversations with faculty about needs for change or improvement to a course, and lets our program know if there are courses that are not reaching an acceptable level and should be dropped. They also encourage faculty who are enriching students through their courses.

GENERAL EDUCATION COURSE APPROVAL PAGE

**Approval Sequence:**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Department Chair/Date

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Dean of College/Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

University Curriculum Committee/Date

Passed by Faculty Senate\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date