**General Education Course Inclusion Proposal**

**Quantitative Reasoning and Analysis**

*This proposal form is intended for departments proposing a course for inclusion in the Northern Michigan University General Education Program. Courses in a component satisfy both the Critical Thinking and the component learning outcomes. Departments should complete this form and submit it electronically through the General Education SHARE site.*

**Course Name and Number: Observational and Solar System Astronomy / AS 103**

**Home Department: Physics Department**

**Department Chair Name and Contact Information** (phone, email): Dr. David Lucas, 2517 West Science 227-2191

**Expected frequency of Offering of the course** (e.g. every semester, every fall): Every Fall and Summer

**Official Course Status**: Has this course been approved by CUP and Senate? YES

*Courses that have not yet been approved by CUP must be submitted to CUP prior to review by GEC. Note that GEC is able to review courses that are in the process of approval; however, inclusion in the General Education Program is dependent upon Senate and Academic Affairs approval of the course into the overall curriculum.*

**Overview of course** (please attach a current syllabus as well): *Please limit the overview to two pages (not including the syllabus)*

A. Overview of the course content

AS 103 is a survey course designed to expose students to astronomy from a perspective of what they can see from Earth. The course covers what we see in the sky and why those observations change due to the motions the Earth undergoes in space. A brief history of astronomy is joined with a few topics of background science (forces, gravity, light and optics), which are introduced and explored to help students understand why they see what they see in the sky. The second half of the course examines the origin of the solar system and more in depth information about the main objects of the solar system, planets, moons, rings, asteroids, comets, and other objects of the solar system.

B. Explain why this course satisfies the Component specified and significantly addresses both learning outcomes

**Critical Thinking Outcome:**

**Evidence:**

In AS 103 students assess the quality of information used in several ways. In laboratory exercises students have to examine a variety of experimental quantities and demonstrate that they understand which physical quantities are needed for the experiment and which are not. For example in one lab students are provided a number of photographs taken of the moon by various sources (satellites, astronauts and telescopes). They examine features from these photos and make decisions about how features on the moon “weather”, which features were formed first, etc. In another lab, students make optical measurements on several lenses and then choose the best ones to construct a telescope. They then use that telescope to make several measurements in the lab.

Exams and quizzes contain questions that require students to determine which pieces of information provided should be used to solve the question or to explain the question asked. For example a student may be provided with a planet’s mass, equatorial diameter, distance from the sun, and other quantities. The student must choose which of these are needed to determine the period of the planet’s orbit about the sun.

All students are required to submit an Astronomy Picture of the Day (APOD) form at each lab. This requires students to read and view the APOD website maintained by NASA and to reflect on and comment on a picture each week. Often students will comment on the information provided by the astronomer.

**Integrate:**

Exam and quiz questions require students to take basic information and use it to answer problems and questions that they have not been exposed to previously. For example the positions of the sun, moon, and earth are covered to demonstrate phases of the moon and eclipses. Students may be asked to draw the proper positions for phases of earth as seen from the moon.

Students in lab exercises often have to combine more than one measurement to completely solve or answer a question or task. For example measuring individual focal lengths are needed to determine the overall magnification of a telescope constructed from these lenses.

**Evaluate:**

Laboratory exercises provide opportunities for students to make calculations and actual measurements. These two sets of data can then be compared to see how valid either the calculations or the measurements are. Students often must consider how earlier measurements have affected results of experiments based on those measurements. For example in spectroscopy students make simplified calculations of hydrogen atomic energy levels and then determine spectral wavelengths. Then they measure hydrogen spectra in the lab and compare how close the calculations are to the measurements.

Quiz and exam questions often are asked to consider what a particular calculation implies for example a student might be asked to determine the distance an object is from the sun and based on that, determine whether the object is in orbit around the earth, within the solar system, or within our galaxy?

**Quantitative Reasoning and Analysis Outcome:**

**Calculation:**

Exam and quiz questions will have students making calculations to solve problems and answer questions. Students might be provided an object’s mass and asked what force would be required to accelerate the object on different planets and moons. Students may be given the diameter of an object and the angular size and asked to calculate how far away the object is.

All of the laboratory exercises require calculations to complete the work of the lab. For example students will calculate times when objects will be rise and set in Marquette’s sky. Students will determine the time required to travel to and from Mars. Students will calculate the heights of mountains on the moon.

**Analysis/Application:**

Laboratory exercises require students to make plots of data. From these plots determine slopes of lines or y-intercepts. Finally use those results to determine another quantity. For example, students use Tycho Brahe’s original data from the 1590’s to plot out Mercury’s orbit. From this plot they determine the semi-major axis of Mercury’s orbit and then from this they determine quantities such as orbital eccentricity, perihelion, etc. They also use this data to determine the easiest and the hardest days to observe Mercury.

Quiz and exam questions require students to consider the results of calculations to answer further questions. For example students can determine the thermal velocity of a particular molecule, and the escape velocity of a planet and make an estimate on the rate at which a molecule would leak out of a planet’s atmosphere.

**Interpretation:**

Quiz and exam questions involve determining what a plot tells us about a physical quantity. For example showing them a plot of temperature as a function of radius from the sun and then having them use this to explain why terrestrial planets have different properties than gas giants.

Laboratory exercises provide opportunities for students examine plots of microwaves reflecting from Mercury to determine phase shifts. These phase shifts are then used to calculate the planet’s rotation rate about its own axis.

C. Describe the target audience (level, student groups, etc.)

The primary audience for AS 103 has been and we expect it to be students who wish to satisfy the Laboratory graduation requirement by taking a science course which has slightly less mathematical rigor or scientific depth than the traditional introductory lab courses in physics, chemistry, biology, etc. AS 103 has also been a required course for some education majors and some earth science majors. There is also a small but consistent core of students who just are curious about astronomy and want to learn more about it.

D. Give information on other roles this course may serve (e.g. University Requirement, required for a major(s), etc.)

As mentioned above this course is required for some education majors and some earth science majors. It is also used often for the university lab graduation requirement. Physics majors may take the course but it will not satisfy physics credits required for the major or minor.

E. Provide any other information that may be relevant to the review of the course by GEC

N/A.

**PLAN FOR LEARNING OUTCOMES
CRITICAL THINKING**

*Attainment of the CRITICAL THINKING Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Critical Thinking Rubric for more information on student performance/proficiency in this area. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **DIMENSION GUIDANCE** | **PLAN FOR ASSESSMENT** |
| **Evidence** | Assesses quality of information that may be integrated into an argument | **Type:** Quiz and Exam questions**Relation to Dimension:** Students decide what information to use to solve problems and answer questions.**Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students choose how to make measurements and to select which measurements to make. **Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Astronomy Picture of the Day (APOD)**Relation to Dimension:** Students comment on the astronomer’s comments about where the information comes from and the value of it. **Frequency:** Weekly**Importance:** APODs are 20% of Lab Grade, so 4% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |
| **Integrate** | Integrates insight and or reasoning with previous understanding to reach informed conclusions and/or understanding | **Type:** Quiz and Exam questions**Relation to Dimension:** Students must combine the results of parts of questions and problems to complete solutions and answers.**Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students have to make measurements to use in future/additional measurements.**Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |
| **Evaluate** | Evaluates information, ideas, and activities according to established principles and guidelines | **Type:** Quiz and Exam questions**Relation to Dimension:** Students answer questions about the results they obtained in other parts of problems/questions.**Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students make judgments on the quality of their work by comparison with accepted results.**Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |

**PLAN FOR LEARNING OUTCOMES
QUANTITATIVE REASONING AND ANALYSIS**

*Attainment of the QUANTITATIVE REASONING AND ANALYSIS Learning Outcome is required for courses in this component. There are several dimensions to this learning outcome. Please complete the following Plan for Assessment with information regarding course assignments (type, frequency, importance) that will be used by the department to assess the attainment of students in each of the dimensions of the learning outcome. Type refers to the types of assignments used for assessment such as written work, presentations, etc. Frequency refers to the number of assignments included such as a single paper or multiple papers. Importance refers to the relative emphasis or weight of the assignment to the entire course. For each dimension, please specify the expected success rate for students completing the course that meet the proficiency level and explain your reasoning. Please refer to the Rubric for more information on student performance/proficiency in this learning outcome. Note that courses are expected to meaningfully address all dimensions of the learning outcome.*

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| **DIMENSION** | **DIMENSION GUIDANCE** | **PLAN FOR ASSESSMENT** |
| **Calculation** | Ability to perform mathematical/numerical operations. | **Type:** Quiz and Exam questions**Relation to Dimension:** Students solve mathematical problems. **Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students perform calculations with experimentally obtained values to determine desired quantities which the experiment was to provide.**Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |
| **Analysis/Application** | Ability to manipulate quantitative data to produce new data.Ability to use data to make judgments and draw conclusions. | **Type:** Quiz and Exam questions**Relation to Dimension:** Students combine work and results from other parts of questions or problems to find solutions to current questions or problems.**Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students use results of one set of measurements to create another set of measurements.**Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |
| **Interpretation** | Ability to explain information presented in mathematical forms (e.g. equations, graphs, diagrams, tables, and words) | **Type:** Quiz and Exam questions**Relation to Dimension:** Students consider how their answers allow them to expand on and to finalize the answer to questions or problems.**Frequency:** Quizzes Weekly, Exams 2-3 in semester, 1 Final Exam**Importance:** Quiz and Exams are 55% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%.**Type:** Laboratory Exercises**Relation to Dimension:** Students answer questions about graphs and mathematical models they have created in the lab exercise. **Frequency:** Weekly**Importance:** Labs are 20% of overall grade**Success Rate:** Approximately 65% of students get a C- or better in AS 103, so the anticipated success rate is 65%. |