Department: Physics

Course number: 1020Q

Course title: Introductory Astronomy

Credits: 3

Contact Person:G. Rawitscher

Content Area: CA 3

Q/W: Q

Catalog Copy: -PHYS 154Q. Introductory Astronomy Either semester. Three credits. Recommended preparation: MATH 101 or equivalent. Not open for credit for students who have passed PHYS 155Q. A basic introductory astronomy course without laboratories, including principles of celestial coordinate systems and telescope design; applications of fundamental physical laws to the sun, planets, stars and galaxies; evolution of stars, galaxies and the universe; recent space probe results, modern cosmology, and astrobiology. Night observing sessions are an integral part of the course.

Course Information:

a)This course has the same content and objectives as the PHYS 155, including night observing sessions, the only difference being that it does not involve laboratory work. The reason for proposing this course is to enable Regional Campuses to teach astronomy when they do not have suitable equipment to offer astronomy laboratories at a comparable level of quality as the astronomy 155 course taught at Storrs. This course should also qualify for the Gen. Ed. category #3. In order to differentiate the PHYS 154Q from PHYS 155Q, the title of PHYS 155Q will be modified from: "Introductory Astronomy" to "Introductory Astronomy with Laboratory", and the additional stipulation will be made that 155 is not open for credit to students who have passed 154Q.

b) The course requirements are the same as for the PHYS 155Q, including night observations but excluding laboratory work. As already stated for PHYS 155Q, the course typically requires reading of a text chapter each week, along with the electronic course notes available on the course website. The students are also expected to supplement the electronic notes and fill in necessary details for the notes taken in class. Typically eight or nine homework problems (from the text or supplemental to the text) are assigned each week; solutions are posted electronically and exam questions are often taken from these assignments. In addition students can discuss the problems (and other aspects of the course) with the professor in her/his office or go to the Physics Resource Learning Center for help from a graduate student (there is typically at least one student available there who has been a TA in astronomy). There are three hour exams given during the semester. The hour exams (as well as the final exam) consist of problems taken from the assigned homework problems (or minor modifications of them) as well as questions from the class notes.

c). This course is aimed at providing a basic understanding of astronomical phenomena, by application of fundamental physics and elementary mathematics, to both students studying the sciences and to non-science students. Major themes are 1) observational astronomy, coordinates , use of star globes, star designations and magnitudes, apparent motions of earth and sky, systems of time reckoning, calendars 2) properties of light, lenses and mirrors, telescopes 3) solar system: earth's moon, motions, phases, lunar space results, eclipses; survey of planetary properties and phases; classic cosmological models 4) Kepler's Laws, Newton's Laws, celestial mechanics 5) Sun: properties , stellar models, nuclear fusion, laws of radiation (Stefan-Boltzman, Wien) 6) Stars: distances (trigonometric parallax), magnitude (apparent and absolute), spectra, masses, temperatures, radii; binary stars, dynamic parallax 7) HR diagram, including mass, radius, evolution, star birth and death, stellar corpses, post- main sequence evolution, variable stars, Period-Luminosity Law 8) Groups of stars: open and globular clusters, characteristics and evolution; Milky Way and other normal galaxies; active galactic nuclei, quasars 9) Cosmology, evolution of the universe, Hubble's Law, dark energy and dark matter; astro- biology and life in the universe.

How Meets Goals of Gen Ed .:

The students taking the course do acquire intellectual breadth and versatility. Students are expected to acquire knowledge about astronomical phenomena, and basic physics laws determining the behavior of electromagnetic waves, bodies moving under the influence of gravity from planetary moons to galaxy rotation and expansion of the universe, particles undergoing nuclear fusion in the stars, the evolution of stars, star clusters, galaxies and the universe. The course covers a wide range of topics, and uses primarily algebra and geometry for the solution of astronomical questions such as determination of standard time from a sundial, transit time of a planet with known celestial coordinates, distance to a star with known trigonometric parallax, distance to a supernova remnant from measurements of proper motion and Doppler shift of the fragments observed, and life expectancy of a normal main sequence star from any one of the following properties: mass, absolute magnitude, radius, spectrum, temperature or color. Acquire critical judgement. An important point of the course involves discussions on the range of validity of the physical theories presented and limitations of diverse models. As an example they should be able to critically compare the proposed cosmologies of Ptolemy, Brahe and Copernicus. On a larger theme, they will evaluate current models for the future universe in terms of observations from recent satellite probes. Students will learn that the physical world can be studied and understood in a testable, quantitative way using basic mathematics and rigorous scientific analysis. Acquire consciousness of the diversity of human culture and experience As the oldest science, astronomy spans the cultures of the earth, from fossil lunar calendars chipped onto bone, to seasonal calendars based on heliacal rising of stars, to star catalogues preserved by the Arab cultures during the dark ages in Europe, to culturally diverse cosmological models and beliefs, to today's multi-cultural space missions with differing agendas. Man has studied the stars as long as man has existed; the study of astronomy has common physical connections across different cultures and historical times. Acquire a working understanding of the processes by which they can continue to acquire and use knowledge. Although the course presents fundamental astronomy, in many cases it shows how to extend the concepts to more sophisticated problems using basic physics and mathematics. It will be useful in life-long observation of

the skies, on a daily basis and for exceptional occasions like lunar eclipses, aurora, and meteor showers. A study of astronomy also has useful applications in other fields, such as environmental chemistry, primitive life forms, space engineering, and solar energy.

CA3 Criteria:

1. Explore an area of science or technology by introducing students to a broad, coherent body of knowledge and contemporary scientific or technical methods; The subject of astronomy embraces most of the rest of science including physics, chemistry, geology and parts of biology, combined with instrumentation ranging from space probes and robotic telescopes to laboratory investigations of extra-terrestrial material from the Moon, Mars and asteroids, and model atmospheres of solar system planets, Titan, and evolved comets. An understanding of the subjects presented in astronomy will certainly lead to an appreciation of current science advances as presented daily in the media.

2. Promote an understanding of the nature of modern scientific inquiry, the process of investigation, and the interplay of data, hypotheses, and principles in the development and application of scientific knowledge; The study of astronomy throughout history is a fascinating example of the interplay of the scientific method and objective reasoning via experimentation, contrasted with earlier abstract idealizations downplaying testing of hypotheses and swayed by religious dogma of the day. An illustrative example is the contrasting geocentric and heliocentric solar system models, where a single telescopic observation by Galileo destroyed 16 centuries of Ptolemaic cosmology. More recent examples include the question of water and life on Mars, origins of jovian planetary rings, expansion of the universe, and the physical basis of the luminosity function which gives the mass distribution of stars in typical galaxies.

3. Introduce students to unresolved questions in some area of science or technology and discuss how progress might be made in answering these questions; and Unsolved questions abound in astronomy. For example the causes of the magnetic cycles in the sun, nature of quasistellar objects and active galactic nuclei, and overall evolution of the universe are topics of frontier research today. A specific example concerns twentieth century models for the evolution of the universe, which have been called into question with the discovery that the deduced universe expansion has included acceleration in the distant path rather than slowing down; recent evidence from distant supernovae is used for this argument. Controversial "results", such as the putative discovery of fossil life in a Martian meteorite announced by President Clinton in 1996, are discussed in class and it is pointed out this conclusion has not been substantiated.

4. Promote interest, competence, and commitment to continued learning about contemporary science and technology and their impact upon the world and human society. Important discoveries in astronomy are mentioned in lecture when they appear in the news. This is intended to promote interest, keep the students abreast of recent results and alert them to upcoming astronomical events such as lunar eclipses, meteor showers, unexpected aurora displays..

Q Criteria

1. Include mathematics and/or statistics at or above the basic algebra level as an integral part of the course. Using basic mathematics and geometry is central to the presentation of this course; many homework, quiz and exam questions require numerical answers. The level of the problems varies with context, from simple algebraic manipulation of an equation to solve for the correct variable, to solutions of simultaneous equations in the case of binary stars, in order to get individual masses from their orbits. Other examples include calculation of visibility of a star or planet and its zenith distance at transit, determination of moon's phase knowing time of day and the moon's altitude, use of stellar azimuth and altitude with local time for celestial navigation, use of luminosity laws with stellar masses to determine stellar lifetimes, and use of the distance-modulus equation to determine stellar distances.

2. Include use of basic algebraic concepts such as: formulas and functions, linear and quadratic equations and their graphs, systems of equations, polynomials, fractional expressions, exponents, powers and roots, problem solving and word problems. Formal abstract structures used in symbolic logic and other algebraic analyses are acceptable; Geometrical tools are used in this course, such as using a celestial sphere as an analogue computer to transform equatorial coordinates to horizon coordinates of altitude and azimuth, or to convert between sidereal and solar time. Scaling laws are also important, whereby a student is given a formula and an applied example, and is then expected to scale the result when one of the parameters is changed, for relationships including power laws, simple inverse linear and more complicated logarithmic equations.

3. Require the student to understand and carry out actual mathematical and/or statistical manipulations, and relate them to whatever data might be provided in order to draw conclusions. Merely feeding numerical data into a program on a computer or a calculator to obtain a numerical result does not satisfy this requirement. Technology should be viewed as a tool to aid understanding and not as a driver of content. The labs are quantitative -- students acquire data from measurements on an optical bench, telescopes, the celestial sphere , spectroscopes, cross staffs and astronomical images of double stars or time-delayed photographs of a supernova explosion. These data are then used to deduce focal lengths of lenses, resolving power of a telescope, size of the sun, distances to astronomical objects, spectral wavelengths and Doppler shifts for stars and galaxies, and time since explosion of a supernova as well as its distance. The numerical homework problems all require the use of mathematics. Most of the problems require careful thought and generally cannot be properly solved by "plugging" into a formula.

Role of Grad Students: -Since there are no laboratory sessions, the TA assigned to the course will be available for questions by the students during office hours, and help with the grading of the homework assignmnets

Supplementary Information: -The increse of credits from 3 to 4 for the PHYS 155 course, approved by the Senate 12/08/03, together with the fact that the Regional Campuses do not have available the equipment necessary for astronomical observations or measurements of the same quality as the Storrs Campus, is what prompted the Physics Department to introduce the 3 credit-no laboratory 154 course. Since astronomy is currently a very interesting and fast progressing subject, it was important to make

the astronomy course available at the Regional Campuses via the 154 modus, and not deny it to the regional students.