Astronomy 301G: Revolutionary Ideas in Science
Fall 2008

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Text Materials What's the Matter? Readings in Physics
D.H. Whitfield & J.L. Hicks, Editors
and
The Nature of Life: Readings in Biology
N. Carr, *et al*. Editors
...both published by the Great Books Foundation (www.greatbooks.org)

Web Page: http://astronomy.nmsu.edu/kurt/Astronomy301G/

Prerequisites Any 100 - level general education science course

Location & Time Class meets in Biology Annex Room 102 (BX 102)
Mondays, Wednesdays, and Fridays from 9:30 AM to 10:20 AM

Calendar

22 August:	First Class Meets
1 September:	Labor Day Holiday
3 September:	Course addition deadline
26 September:	Examination #1
15 October:	Drop date
31 October:	Examination #2
24-28 November:	Thanksgiving Holiday
5 December:	Examination #3
8 December:	Final Class Meeting BX 102: 8:00-10:)) AM (Official final exam date.)

Goals and Objectives
Science attempts to explain natural phenomena in terms of basic physical processes which are governed by underlying fundamental laws or principles. Indeed, determining these laws is a major part of the scientific effort. We wish to convey an understanding of how science works. To this end we will examine some of the ideas and discoveries which have revolutionized the ways in which we view our universe. Our examples will be drawn from the physical and biological sciences.

General Information

Class Format

There are three lecture sessions per week. Some time will be allocated for questions, quizzes, and review of earlier materials but lectures and class discussions should occupy most of the period. Note that the assigned readings are intended to provide background for the lectures and discussions; lectures are not intended to simply repeat or review text materials. Do the assigned reading before class; this is particularly important. Be prepared to participate in discussions and address the end-of-chapter questions. Questions in class are strongly encouraged; if you don't understand what I'm saying, the reading material, or what other students are saying, there is a good chance some others are equally mystified. Ask.

Office Hours

The instructor and teaching assistant will have scheduled office hours. Make use of them. Other times can usually be arranged by appointment. See above for 'phone numbers, *etc*.

Attendance Policies

Attendance will usually be taken at lectures, and your presence and participation will influence your final grade. Moreover, there will be occasional in-class quizzes, and quiz results will also determine part of your grade for the class; therefore regular and prompt attendance is strongly advised. There will generally be no provisions for making up missed quizzes and exams, nor for late homework. Note, again, that the lectures (and the quizzes and examinations) will cover materials not always included in the textbook or other reading material. If you do miss a class, get notes and assignments from a classmate.

Homework

Providing written responses to some of the textbook's end-of-selection questions will be a part of your homework obligation. Additional assignments might involve do-it-yourself observational exercises or brief essays on some topic. Turned-in homework materials should represent your own work. Late homework, if not too late, will usually be accepted if accompanied by a reasonably convincing story.

Examinations and Grades

There will be three scheduled written examinations; each will contribute about 10% to your final grade for a total of 30%. The total for the (unscheduled) in-class quizzes will contribute another 10%, written homework assignments 25%, and class participation (including attendance) attendance 20%. Finally, special projects, probably in the form of longer writing assignments, will make up the last 15%.

Exam and quiz questions will usually be of the objective type, requiring answers consisting of some sentences accompanied by sketches, *etc*. Examinations will be comprehensive; you will be responsible for all lecture, text assignments, and handout material. I might allow you to bring some of your own notes to each of the major examinations. Textbooks and other forms of assistance are not permitted during exams or quizzes. Makeup examinations are normally offered only for university-excused absences and require adequate prior notification. There are no other makeup provisions for missed classes or quizzes.

Grading System

Grading will be on a class-based curve, with final letter grade assignments following the University Grading System. (See the current Undergraduate Catalog, p.18.) Your final grade will depend upon your performance relative to your classmates; those near the top of the class will get A's and B's, those near the bottom, D's and F's. Class standings will be posted periodically.

Academic Misconduct

Plagiarism is defined as the passing off as one's own the ideas, writings, work, etc., of another. This includes the copying someone else's exam, quiz, or homework materials - or using forbidden aids such as crib sheets or electronic media during quizzes and examinations. Plagiarism is cheating - and shouldn't be tolerated. For NMSU's views on plagiarism and other forms of academic misconduct, see http://www.nmsu.edu/%7Evpsa/SCOC/misconduct.html.

Evaluations

I'll ask you for your formal evaluation of the course near the end of the semester. In the meantime please give me your comments, complaints, and suggestions as they arise. E-mail is an easy way to do this. Comments can also be placed (anonymously or otherwise) in my mailbox in the Astronomy Building.

Disabilities and Discrimination

I f you have special needs, require assistance with exams, reading, *etc.*, please see me. Call Michael Armendariz, Coordinator of Services for Students with Disabilities at 575 646-6840 if you have questions about the Americans with Disabilities Act and/or Section 504 of the Rehabilitation Act of 1973. For questions about NMSU's Non-Discrimination Policy, concerns about discrimination, sexual harassment, *etc.*, contact Jerry Nevarez, Director of Institutional Equity at 575-646-3635.

Astronomy 301G and the General Education Core Curriculum

Astronomy 301G has been certified as a part of NMSU's General Education Core Curriculum (GECC). What does that mean? Consider the following:

"The GECC attempts to foster intelligent inquiry, abstract logical thinking, critical analysis, and the integration and synthesis of knowledge; it strives for literacy in writing, reading, speaking, and listening; it teaches mathematical structures, acquainting students with precise abstract thought about numbers and space; it encourages an understanding of science and scientific inquiry; it provides a historical consciousness, including an understanding of one's own heritage as well as a respect for other peoples and cultures; it includes an examination of values and stresses the importance of a carefully considered values system; it fosters an appreciation of the arts; and general education provides the breadth necessary to have a familiarity with the various branches of human understanding."

These are very ambitious goals - and only a committee could produce a single sentence that long! Nonetheless, the aims are commendable, and a course built around scientific ideas and the history of science can succeed in approaching most of them. In keeping with these goals Astronomy 301G will not emphasize the rote memorization of "facts and formulae" relating to the natural world but, rather, try to emphasize how what we observe in nature generally results from the action of relatively simple underlying physical laws acting in consistent and predictable ways. Physical laws, in effect, provide the "connections" between "facts" and provide the basis for understanding natural phenomena.

Communicating factual information and understanding is part of the learning process. Communication to the student can be by lecture, text materials, or other means. Homework and laboratory exercises are intended to further the learning process, while examinations and quizzes are intended to monitor the success or failure of these endeavors. Most of these materials, as provided by students to the instructors, will be in the form of written materials; you will be asked to answer questions with sentences, essays, and sketches. (You will not encounter many true/false or multiple-choice questions in this course - nor will you find many in the real world!) Communication fails if the material is unreadable or lost in static. For homework, quizzes, and examinations you should take some time to organize your responses and then try to present them in a readable and coherent manner. Handwritten materials are perfectly acceptable, so long as they are readable.

Study and Learning Hints

The skills and knowledge necessary to successfully compete and survive in a sometimes harsh world have always been changing, but the pace of that change is rapidly increasing. An explosion of knowledge was the outstanding characteristic of the twentieth century; it has accelerated in the twenty-first. As a consequence, the most useful thing a university can now impart to its students is not simple factual knowledge but, rather, the tools and skills needed to obtain, manage, process, and apply new information - and to acquire new skills. These requirements will dominate human endeavors in the twenty-first century. Don't get left behind.

Reading and Writing:

***** Read the assigned or suggested text materials before, not after, the subject materials are presented or discussed in class. Think about the material and come to class with your questions and prepared to discuss the material. If you are really shy, see me (or the Teaching Assistant) during office hours, telephone, sent me a note, or use e-mail. Reread.

* Make notes as you read. Don't highlight; this is usually a waste of time and money. (Besides, it reduces the resale value of your textbooks!) It is useful to identify key sentences and ideas; then write them out, on paper, in your own words. Don't underline either! Good note taking is a skill acquired only with practice; so practice.

*Learn to properly use the text's Table of Contents or its Index. Most things in the Universe are connected, linked, or otherwise 'cross-referenced' at some level; textual materials are also. Organization of facts and the discovery of interrelations and connections is an important part of science. It is also an important learning tool. Of course, it always pays to occasionally stop and actually think about the material.

* Compose your own glossary, adding entries as you encounter new or unfamiliar terms.

* Answer, in writing, end of chapter questions. (Who knows? You might see some of them on quizzes or exams!) If you have trouble answering a question, review the text materials, consult your instructor, a teaching assistant, or a classmate. Use your written answers for reviewing the materials.

* "Sample questions" might be provided as part of pre-exam reviews. Review these and, again, write out your answers.

*Keep up: Don't use the day before an exam for the first reading of the text, nor for reviewing your notes. The best activity for the eve of an exam is eight hours of sleep, not an all-night "cramming" session. Really.

Resources:

* Ask questions in class. If you don't understand something, chances are that others are similarly lost. (This also keeps the instructor on his toes and provides him with an ego boost if he can answer intelligibly. Most teachers actually like to be asked questions. At least it usually shows that someone is listening. Honest!)

* Get your money's worth: Attend class. Take advantage of the posted office hours of the instructor and/or teaching assistants. This is an alternative to in-class questions, if you are shy, and provides an opportunity for inquiries which might require greater explication. (Your three credit hours of state-subsidized Astr301G is costing someone about $500!)

* Study groups are a good idea for any class; consider forming one. Post a recruiting notice on the bulletin board. Get a group together to go over the end-of-chapter questions in the text and compare notes.

* One of the most useful survival skills in higher education, as well as in the "real world", is knowing how to use library facilities, including electronic and web-based resources. The NMSU Library can provide assistance; ask at the Reference Desk. Time spent learning to use library resources is time well spent.

* All NMSU students should have a computer account providing access to electronic mail and a host of other services; such services are the libraries of the future. A working familiarity with the side roads of the "information highway" (a.k.a., the internet or the "web") has become a necessary academic survival skill. An on-line encyclopedia like Wikipedia is often a good starting point for any new subject. So go Google.

* NMSU provides drop-in and learning labs and a variety of other resources. These include tutoring services, assistance for those with disabilities, etc. Again, get your money's worth and use them!

Revolutionary Ideas in Science: A Preamble

Natural science is the systematized study of the physical world. Science begins with the assumption that the universe is basically rational, that effects are produced by causes, and that natural processes are governed by underlying laws.

The practice of science begins with observations of the natural world and the formulation of hypotheses to explain those events which are seen to occur in nature. A proper scientific hypothesis must be consistent with what is already known, must offer a rational explanation for some observed phenomena, and must also provide predictions through which the hypothesis can be tested by further observation or by experiment. The last item is fundamental to the construction of scientific theories. Indeed, the very assumptions which are the basis for the scientific endeavor, *i.e.*, that the universe is both rational and causal, can be tested by the methods of science.

The ultimate goal of science is to ascertain and understand the most fundamental laws of nature. However, the knowledge gained through the study of nature can also be used to extend our knowledge in other directions and be applied to everyday human wants and needs.

Science progresses, and our understanding of our universe increases, through the appearance of new ideas which, formulated as hypotheses, serve to widen our knowledge. On occasion, an idea appears which requires that we change the way in which we view some aspect of the the universe. This occurs if the new hypotheses supplants the old by offering greater explanatory and predictive power and/or succeeding where the previous hypothesis fails. If an existing idea, hypothesis, or theory has to be discarded for the new, the latter might be considered "revolutionary" even if only some small aspect of our view of nature is affected. However, on occasion, a truly revolutionary idea appears which changes the way in which we view the universe in a major way. Examples include the Copernican Revolution which deposed the Earth from its position as the center of the universe, the Theories of Relativity which fundamentally altered the ways in which we view the very fabric of space and time, and the Quantum Theory which led to the realization that our universe can behave very strangely, particularly at the very small scales of atoms. In the realm of the biological sciences we have Darwinian Evolution which offers an explanation of why species evolve and why new species appear. This has led to a greater understanding of the very processes involved in that phenomenon we call life.

A Tentative Sequence of Topic Areas (Subject to change as time and circumstances permit.)

- What is Science? - Scientific ideas and science in theory and practice
- Our Place in the Universe - The Copernican Revolution
- Mathematical Physics - Newton's Mechanics & Gravitation
- The Nature of Matter - Atoms and elements, molecules and chemistry. The Conservation of Mass
- The Nature of Energy - Heat, light, and thermodynamics. The Conservation of Energy
- Maxwell's Electromagnetism: Electricity, Magnetism, and Light
- The Nature of Life - Darwinian Evolution & Mendelian Genetics
- Matter and Energy Revisited - Einstein's Special Theory of Relativity
- Space, Time, and Gravity: Einstein's General Theory of Relativity
- The Quantum World: Particles, waves, and the Uncertainty Principle