General Education Course Proposal

Proposed Course: P Sci 131 (Prefix, No.) — Concepts of Classical Physics from Babylon to Maxwell (Title) **Units** 3

Department: Physics **School:** Natural Sciences

GE Category (Indicate one category only):

Foundation: A1___; A2___; A3___; B4___

Breadth: B1___; B2___; C1___; C2___; D___; E___

Integration: B X ; C___; D___; International/Multicultural___

Existing Course___; **Revised Course**___; **New Course** X

Course Included in Current GE Program___

New courses require the Undergraduate Course Proposal form in addition to this form.
Revised courses require the Undergraduate Course Change Request in addition to this form.

Proposed catalog description: Limit course description to 40 words using succinct phrases. Include prerequisites, limitations, lecture/lab hours. Indicate former course number, e.g., (Former Biol 105)

Prerequisites: General Education Quantitative Reasoning and Area B Breadth Requirements. Concepts, theories, and laws of classical physics. Mathematics, astronomy, mechanics, light, electricity, magnetism, thermodynamics, chemistry, the atom. Satisfies general education upper division science requirement Integration Area B. (3 lecture hours)

Enrollment limit per section: 40

Expected number of sections per semester – Year 1 1 **; Year 3** 2

Attachments:

1. A statement presenting the ways in which this course meets the Specifications provided in the appropriate section of the General Education Policy as well as in the Policies for Inclusion and Evaluation of General Education Courses.
2. A statement of elements common to all sections of this course, identifying content, objectives, required student activities, grading policy, representative texts, and an approximate schedule for the course. Required student activities include such things as papers, research projects, homework, laboratory and/or studio performance, recitations, participation, attendance, and exams.
3. A typical syllabus for a particular offering of the course.
4. Any special cost factors associated with this course.

Approval for Inclusion in General Education

M. J. Zender	9/11/98	[signature]	9/21/98
Department Chair	Date	School Curriculum Committee	Date
Stanley M. Ziegl	9/22/98	[signature]	12/15/98
School Dean	Date	General Education Subcommittee	Date
Brandt Kehoe	12/22/98		
Associate Provost	Date		

1/14/98

September 11, 1998
Department of Physics

Attachment #2: Statement of common elements

Proposed Course: Physical Science 131
Concepts of Classical Physics from Babylon to Maxwell

Course Topics

All sections of Physical Science 131 will chart the development of the concepts of classical physics from the earliest surviving written record of mathematics and astronomy left by the Babylonians to Maxwell's unification of electricity and magnetism at the middle of the nineteenth century. The course topics will be dealt with through lectures, reading and writing assignments, and in-class discussions. A suggested list of course topics is given here, however, the emphasis given to particular topics will depend on the instructor.

Physical Science 131 Course Topics

I. Prelude: Physics, Astronomy and Mathematics in the Ancient World

Mathematics and astronomy in Babylon
Early Greek Science: Thales to Plato
Observation of the motions of the heavenly bodies: sun, moon, planets, stars
Aristotle: mechanics and astronomy
The first measurements of diameter and distance in the solar system
Greek Science after Aristotle
Greek Mathematics
The Ptolemaic Synthesis

II. The Unification of Heaven and Earth: One Set of Physical Laws

Tycho: the new star of 1572 and the immutability of the heavens
Galileo: observation of spots on the sun and mountains on moon: the end of heavenly perfection
Galileo's mechanics: the concept of inertia
Galileo's mechanics: the law of falling bodies

III. The Copernican Revolution

Copernicus and the heliocentric universe
Tycho and the newfound importance of observation
The Tychonic system: a mixture of old and new
Kepler: the Platonic solids and reading the mind of God
Kepler: the war on Mars and the laws of planetary motion
Galileo: the spyglass and the news from the starry messenger
The Two World Systems: Copernican and Ptolemaic

IV. The Newtonian Synthesis
Newton: the laws of mechanics
Newton: the apple and the moon, Universal Gravitation
Newton's Principia
The theory underlying Kepler's laws of Planetary Motion
Newtonian mechanics and the discovery of Neptune

V. The Nature of Energy
Force, energy, and work
The conservation of mechanical energy
Heat: transport and conservation
James Joule and the mechanical equivalent of heat
The first law of thermodynamics: conservation of energy
The second law of thermodynamics: the conversion of heat into work
The third law of thermodynamics: entropy and the heat death of the universe

VI. The Theory Atoms and the Foundations of Modern Chemistry
The theory of atoms
Alchemy, chemistry, and the hunt for the elements
Boyle, Charles, and the ideal gas law
The kinetic theory of gases
The discovery of the electron and J.J. Thomson's plum pudding model
Mendeleev and the periodic table

VII. The Nature of Light
The nature of light, wave or particle? Newton vs. Hooke and Huygen
The behavior of light: reflection, refraction, and dispersion
Optical instruments reveal new worlds: the microscope and the telescope
Thomas Young, two slit interference, and the triumph of the wave model
The speed of light: Aristotle, Galileo, Roemer, Fizeau, Michelson

VIII. The Unification of Electricity and Magnetism
The early study of magnetism: Magnus to Gilbert
Electric charge: Greeks, Franklin, Coulomb
The invention of the battery: Volta
Electric current: Ampere and the forces between current carrying wires
Faraday's law of electro-magnetic induction and the lines of force
The unification of electricity and magnetism by Maxwell
The electromagnetic theory of light
The search for the aether: Michelson-Morley

IX. The Ultimate Collapse of Classical Physics
The end of physics: the triumphs of classical physics
Problems for classical physics at the end of the nineteenth century:
    the basis for the atomic spectra,

cavity radiation and the ultraviolet catastrophe,
photo-electric effect and the failure of red light,
the discovery of the nucleus and the radiative collapse of the classical atom
A brief overview of modern physics: relativity and quantum mechanics
The uncertainty principle and the end of determinism
The relation between classical and modern physics: the equivalence principle

Examinations: All sections will require three midterm exams and a comprehensive final. The examinations will consist of both multiple choice questions and essay questions. The multiple choice questions will be drawn from the lectures and the required reading. The essays will explore themes brought up repeatedly throughout the course over several lectures and in the reading assignments. Essays will be graded for content, organization, and mechanics. The final exam will be comprehensive.

Representative Texts: _The Sleepwalkers, A History of Man's Changing Vision of the Universe_, Arthur Koestler, Arkana

Five Equations that Changed the World, The Power and Poetry of Mathematics, Michael Guillen, Hyperion

Sidereus Nuncius, Galileo Galilei, translation Albert van Helden, University of Chicago Press

Physical Science 131 Course Reader with selections from:
Physics, Aristotle
On the Revolutions of the Heavenly Spheres, Nicolaus Copernicus
The Secret of the Universe, Johannes Kepler
The New Astronomy, Johannes Kepler
The Harmony of the Worlds, Johannes Kepler
Dialogues Concerning the Two Chief World Systems, Galileo Galilei
Dialogues Concerning Two New Sciences, Galileo Galilei
Principia, Isaac Newton
Experiments and Observations of Electricity, Benjamin Franklin
The Forces of Matter, Michael Faraday
A Dynamical Theory of the Electromagnetic Field, James Clerk Maxwell

Lecture Sections: All sections of this course will either meet three times weekly for fifty minutes or two times weekly for one hour and fifteen minutes. The class sessions will be used for lectures, discussions and examinations.

Course Writing Requirement:

Short Papers: All students in all sections will submit a series of five, 500 word, typewritten papers (double spaced, 12 point font) based on the lectures, discussions, and reading assignments. Papers will be due every two weeks for the first ten weeks of the semester. Some of the papers will include a measurement project which will require that students devise a technique to solve a given problem and then prepare a written report detailing their methodology and results. Possible projects include the measurement of the diameter of the sun and moon, the acceleration due to gravity, the mass of earth, the wavelength of light, and so on. A paper based on a science question interview, designed to explore commonly held perceptions, may also be included. Papers may include graphs, diagrams, and images. Papers will be graded for content, organization, and mechanics.

Research Paper

All students will also submit a 1500 word research paper according to the following schedule. All papers must cite at least six references. Papers will be graded for content, organization, and mechanics.

Schedule for Research Paper
Week 3: Choose a topic from suggested topic list or submit your own idea for a topic
Week 5: Submit a list of 3 possible sources for your paper
Week 7: Submit an outline of your paper and a six source bibliography
Week 15: Submit final version to the instructor for grading

Reading Assignments

Daily reading assignments will be made which will consist of required reading from the texts and class handouts.

Physical Science 131 Course Grading Policy

All sections of this course will use the following weighting system for determination of final course grades. Exam scores will not be "curved" and no extra credit work will be allowed. No exam scores will be dropped.

Grading Weights	
Midterm Exams (3 @11.66% each)	35%
5 short papers (500 words)	20%
1500-Word Paper	20%
Class participation	5%
Final Exam	20%
Total	100%

Course letter grades for Physical Science 131 will be assigned on the following basis in all sections:

Grades	
100-85.0	A
84.9-75.0	B
74.9-60.0	C
59.9-50.0	D
below 49.9	F

September 11, 1998
Department of Physics

Attachment #3: Typical syllabus

Proposed Course: Physical Science 131
Concepts of Classical Physics from Babylon to Maxwell

PHYSICAL SCIENCE 131 SYLLABUS
Concepts of Classical Physics from Babylon to Maxwell

INSTRUCTOR: Dr. Steven J. White

LECTURE: 10:10-11:00 a.m. M, W, & F @ 161 McLane Hall

OFFICE: 246 Science, 278-2040 (voice mail)

OFFICE HOURS: M, T, W, Th 4:10-5:00 P.M., F 1:00-2:00 P.M.

E-MAIL: stevenwh@csufresno.edu

COURSE WEBSITE: http://maxwell.phys.csufresno.edu:8001/~white/PS131.html

REQUIRED TEXTS:
The Sleepwalkers, A History of Man's Changing Vision of the Universe, Arthur Koestler, Arkana

Five Equations that Changed the World, The Power and Poetry of Mathematics, Michael Guillen, Hyperion

Sidereus Nuncius, Galileo Galilei, translation Albert van Helden, University of Chicago Press

Physical Science 131 Course Reader with selections from:
Physics, Aristotle
On the Revolutions of the Heavenly Spheres, Nicolaus Copernicus
The Secret of the Universe, Johannes Kepler
The New Astronomy, Johannes Kepler
The Harmony of the Worlds, Johannes Kepler
Dialogues Concerning the Two Chief World Systems, Galileo Galilei
Dialogues Concerning Two New Sciences, Galileo Galilei
Principia, Isaac Newton
Experiments and Observations of Electricity, Benjamin Franklin
The Forces of Matter, Michael Faraday

A Dynamical Theory of the Electromagnetic Field, James Clerk Maxwell

Catalog Description: Concepts, theories, and laws of classical physics. Mathematics, astronomy, mechanics, light, electricity, magnetism, thermodynamics, chemistry, the atom. Satisfies general education upper division science requirement Integration Area B. Prerequisite: General Education Quantitative Reasoning and Area B Breadth Requirements. (3 lecture hours)

Prerequisite: General Education Quantitative Reasoning and Area B Breadth Requirements

Objectives: This course will chart the conceptual development of classical physics from the early astronomy and mathematics of the Babylonians to the unification of electricity and magnetism by James Maxwell in the mid-nineteenth century. The development of classical physics is one of the greatest intellectual achievements in human history. It is expected that the course will improve your understanding of these accomplishments, the methods, and the impact that scientific thought has made on society. The course will examine the science of the ancient Greeks, the heliocentric theory of Copernicus, and the contributions of Galileo, Kepler, and Newton. Other topics will include the theory of atoms and the foundations of chemistry, the conservation of energy, the relationship between mechanical work and heat, entropy, electricity, magnetism, and the nature of light.

PSci 131 Homepage: Materials for this course are available via the internet at the course website address listed above. At the website you will find an online syllabus, class announcements, and homework assignments. In addition, you will find links to many other sites on the web dealing with the conceptual development of classical physics. New material and links will be added on a regular basis, so check the site often.

Preparation: You must complete the General Education Quantitative Reasoning and Area B Breadth Requirements before taking Physical Science 131. This course will utilize intermediate algebra and basic geometry. We will also utilize scientific notation and unit conversion factors.

Attendance: Please make an effort to attend every class meeting. Many of the exam questions will come from the lecture and class discussion topics, so it will be to your advantage to attend and participate in the class. If you miss a lecture then get the notes from a friend.

Reading Assignments: Reading assignments will also be made on a daily basis. It is strongly suggested that you complete the reading assignment before class time so that you will be prepared to discuss the material.

Course Writing Requirement

Short Papers: You will submit a series of five, 500 word typewritten papers (double spaced, 12 point font) based on the lectures, discussions, and reading assignments. The papers will be due every two weeks for the first ten weeks of the semester. One of the papers will include a measurement project which requires that you and your partner devise a technique to solve a given problem and then prepare a written report detailing their methodology and results. Each person will need to prepare their own paper. Papers may include graphs, diagrams, and images.

Research Paper: All students will submit a 1500 word research paper according to the following guidelines and schedule. All papers will require at least six references. Papers may include graphs, diagrams, and images.

Physical Science 131 is an upper division science course, and for that reason, your term paper must have significant science content. If you wish, you can choose a scientist and, along with a biography, present his or her contribution to science in the historical context. However, it must be clear that you understand the scientific concepts. It would also be appropriate to discuss the impact of a certain scientific discovery on society, but this would be in addition to a clear presentation of the essential scientific concepts. In any case, your paper must have significant scientific content.

Schedule for Research Paper:
Week 3: Choose a topic from suggested topic list or submit your own idea for a topic
Week 5: Submit a list of 3 possible sources for your paper
Week 7: Submit an outline of your paper and a six source bibliography
Week 15: Submit final version to the instructor for grading

Examinations: There will be three midterm exams during the semester and a comprehensive final exam. The material for these exams will come from the lectures and the assigned reading. The exams will include multiple choice questions and essay questions. All of the examinations will be closed book and as such you may not use any notes or books during the exam. Make-up exams will not be given without an excused absence. If you are absolutely unable to take an exam you must notify me before the exam. An excused absence will be granted only in cases of illness or family emergency. You must provide written evidence to obtain an excused absence.

Cheating and plagiarism: University policy defines "cheating" as "the practice of fraudulent and deceptive acts for the purpose of improving a grade or obtaining course credit. Typically, such acts occur in relation to examinations. It is the intent of this definition that the term "cheating" not be limited to examination situations only but that it include any and all actions by a student which are intended to gain an unearned academic advantage by fraudulent and deceptive means." University policy defines "**plagiarism**" as "a specific form of cheating which consists of the misuse of the published and/or unpublished works of another by representing the material so used as one's own work." Cheating or plagiarism will not be tolerated in this course. Depending upon the seriousness of the action, the student may be penalized by an "F" on the assignment to an "F" in the course and the filing of a Cheating/Plagiarism Report to be placed in the student's permanent academic record.

Students with disabilities: If you have a disability, be sure to identify yourself to the University and the instructor so that reasonable accommodation for learning and evaluation within the course can be made. Please contact Services to Students with Disabilities, Library Room 1049, 278-2811.

Course Grading Policy: The following weighting system will be used for determination of your final course grade. Exam scores will not be "curved" and no extra credit work will be allowed. No exam scores will be dropped.

Grading Weights	
Midterm Exams (3 @11.66% each)	35%
5 short papers (500 words)	20%
1500-Word Paper	20%
Class participation	5%
Final Exam	20%
Total	100%

Course letter grades will be assigned on the following basis:

Grades	
100-85.0	A
84.9-75.0	B
74.9-60.0	C
59.9-50.0	D
below 49.9	F

Physical Science 131
Course Topics & Schedule

Week #1
Mathematics and astronomy in Babylon
Early Greek Science: Thales to Plato

Week #2
Observation of the motions of the heavenly bodies: sun, moon, planets, stars
Aristotle: mechanics and astronomy
The first measurements of diameter and distance in the solar system

Week #3
Greek Science after Aristotle
Greek Mathematics
The Ptolemaic Synthesis

Week #4 **Midterm Exam #1**
Copernicus and the heliocentric universe
Tycho: the new star, observations, and the Tychonic system
Kepler: the platonic solids and the mind of God
Kepler: the war on Mars and the laws of planetary motion
Galileo: the spyglass and the news from the starry messenger

Week #5
The Two World Systems: Copernican and Ptolemaic
Galileo's mechanics: the concept of inertia
Galileo's mechanics: the law of falling bodies

Week #6
Newton: the laws of mechanics
Newton: the apple and the moon, Universal Gravitation
The theory underlying Kepler's laws of Planetary Motion
Newton's Principia

Week #7
The nature of light, wave or particle? Newton vs. Hooke and Huygen
Thomas Young, two slit interference, and the triumph of the wave model
The early study of magnetism: Magnus to Gilbert

Week #8 **Midterm Exam #2**
Electric charge: Greeks, Franklin, Coulomb
The invention of the battery: Volta
Electric current: Ampere and the forces between current carrying wires
Faraday's law of electro-magnetic induction and the lines of force

Week #9
Force, energy and work
The conservation of mechanical energy
Heat: transport and conservation

Week #10
James Joule and the mechanical equivalent of heat
The first law of thermodynamics: conservation of energy
The second law of thermodynamics: the conversion of heat into work

Week #11
The third law of thermodynamics: entropy and the heat death of the universe
The atom and the kinetic theory of gases

Week #12 <u>Midterm Exam #3</u>
Brief summary of electricity and magnetism: experiment and theory
The unification of electricity and magnetism by Maxwell
The electromagnetic theory of light

Week #13
The search for the ether: Michelson-Morley
The speed of light: Aristotle, Galileo, Roemer, Fizeau, Michelson
The discovery of the electron and J.J. Thomson's plum pudding model

Week #14
The end of physics: the triumphs of classical physics
Problems for classical physics at the end of the nineteenth century:
- the basis for the atomic spectra,
- cavity radiation and the ultraviolet catastrophe,
- photo-electric effect and the failure of red light,
- the discovery of the nucleus and the radiative collapse of the classical atom

Week #15
A brief overview of modern physics: relativity and quantum mechanics
The uncertainty principle and the end of determinism
The relation between classical and modern physics: the equivalence principle

<u>Comprehensive Two-Hour Final Examination</u>

G. E. Specifications for Area B	Common Content Topics	Sample Readings	% Time
1. "Provide instruction in the fundamental principles and methods of the science being studied, and the development and testing of hypotheses."	**Fundamental principles of:** astronomy mechanics light electricity magnetism thermodynamics atomic theory foundations of chemistry **Methods of science:** Newton's explanation of the tides the discovery of the Neptune the measurement of the speed of light **Development & testing of scientific hypotheses:** the Copernican system the concept of inertia the single-fluid model of electric charge the wave theory of light atomic theory the search for the aether	Newton, pgs. 9-20 Guillen, pgs.119-164 Guillen, pgs.119-164 Guillen, pgs.165-214 Feynman pgs. 1-9 Newton, pgs. 351-355 Koestler, pgs.121-226	20 %
2. "Must involve understanding and active exploration of the fundamental principles which govern the materials of the physical universe as well as the distribution of those materials and the processes applicable to them, together with an understanding of and ability to employ the experimental and mathematical methods used in science."	**Fundamental principles that "govern the materials of the physical universe":** the laws of motion the conservation of matter the conservation of momentum the conservation of electric charge the electric force the magnetic force gravity **"processes applicable to" the materials of the physical universe:** the laws of thermodynamics the origin of electromagnetic radiation. **"understanding of and ability to employ the experimental and mathematical methods used in science"** measurement of the diameter of earth measurement of the wavelength of light the behavior of falling bodies the mass of sun	Newton, pgs. 9-20 Guillen, pgs. 9-63 Guillen, pgs.165-214	15 %

G. E. Specifications for Area B	Common Content Topics	Sample Readings	% Time
3. "Must engage students in understanding the fundamental principles and laws of Physical Science, exploring the analytical and quantitative methods of inquiry, and clearly demonstrating the use of the scientific method. Students should exit these courses with clear insight into what science is, its methods, and its limits of inquiry."	**Principles and laws of physical science:** given under Specification #2 **"Use of the scientific method"** Galileo's telescope observations Galileo's uniformly accelerated bodies Tycho's new star and the eternal heavens Kepler's description of planetary motion Newton's observations: the apple and the moon Thomas Young and two-slit interference James Joule and the mechanical equivalent of heat Faraday's discovery of induced emf	 Galileo, pgs. 1-113 Galileo, pgs. 160-187 Koestler, pgs. 290-294 Koestler, pgs. 317-348 Guillen, pgs.9-63 Guillen, pgs. 119-164	15%
4. "The university requires that its general education instruction in Physical Science utilize and emphasize the physical principles and math necessary for complete understanding of the analytical techniques utilized in scientific inquiry."	This course is devoted to the development of the physical principles which pertain to matter and energy. These principles are listed under specification #2. The physical laws will be expressed in mathematical form as equations. Calculations will be made using the methods of arithmetic, geometry and algebra. These calculations will be carried out during lecture and by students in preparation for and as part of their writing assignments. **Examples of "analytical techniques utilized in scientific inquiry":** measurements of size in the solar system Kepler's laws of planetary motion Newton's invention of the calculus Maxwell and the speed of light		10%
5a. "Explore the content and methodology of the Physical Sciences, including the necessity of math in much of its methodology."	**Content of the Physical Sciences...** This is covered under Specifications 1 & 2 **Methodology of the Physical Sciences...** Simple observations and early astronomy Galileo's observations and the Copernican theory Tycho's observations and the Tychonic system Kepler's empirical laws of planetary motion Galileo's experiments and the concept of inertia Newton's synthesis: a unified framework Franklin's experiments and the single fluid model James Joule and the mechanical equivalent of heat Fizeau and the measurement of the speed of light Maxwell's unification of electricity & Magnetism Michelson and Morley's search for the aether	 Koestler, pgs.19-86 Galileo, pgs. 1-113 Koestler, pgs.286-304 Koestler, pgs.317-348 Koestler, pgs.504-517	10%
5b. "Teach students how to critically evaluate information presented as scientific (i.e., expose students to the different types of empirical inquiry)."	**Critical examination of scientific proposals:** Aristotle's Physics the Ptolemaic system the Tychonic model of the universe Kepler's construction of the universe Galileo's theory of the tides The one and two fluid models of electricity Thomson's plum pudding model of the atom	 Koestler, pgs.87-116 Koestler, pgs.66-83 Koestler, pgs.286-304 Koestler, pgs.249-269 Koestler, pgs.471-473	5%

G. E. Specifications for Area B	Common Content Topics	Sample Readings	% Time
5c. "By using tools of science, encourage students to enter into major scientific debates that affect our democratic society, economic systems, and our quality of life, e.g., nuclear power, genetic engineering, the purity of our drinking water, environmental issues, and science education. Students should learn how to develop informed judgments, and therefore be able to influence societal views about science technology."	**Provide an assessment of popular scientific knowledge...** The course will include a writing assignment in which students gather information by conducting interviews of their peers. The interview topics will deal with broad issues raised within the course. Possible interview topics include: What is the evidence for the existence of atoms? What would happen if you were to release a feather while standing on the surface of the moon? Is it possible for an object in motion to remain in motion even if no force acts upon the object? How do we know for certain that the earth orbits the sun? What is the nature of light?		5 %
5d. "Examine the structure and implications of major scientific disputes in their historical context."	**"explore major scientific disputes in their historical context"** the immutability of the heavens the physics of Aristotle and the new mechanics the Ptolemaic and Copernican Systems the nature of light the existence of atoms	Koestler, pgs.87-116 Copernicus, pgs. 3-36	10 %
5e. "Include discussion of ethical issues."	**"discussion of ethical issues":** the persecution of Bruno, the trial of Galileo, Newton's behavior in the dispute over calculus	Koestler, pgs.471-503	5 %
5f. "Strive to develop a lasting curiosity and sense of wonder in the universe by actively engaging students in the scientific process."	During this course students will come to realize that they hold many incorrect beliefs about nature which were first formulated as physical law by Aristotle. We will confront these ideas and discover that they do not, in fact, describe reality. The simplicity and wide ranging applicability of the physical laws that are subsequently developed in this course will lead students to see the universe and its components as a unified system. This realization, a universe which is understandable, even to a non-scientist, will spark a life-long sense of curiosity to learn more about the workings of nature.		5 %