CLEMSON UNIVERSITY

Curriculum and Course Change System - Print New Course Form

000077

Course Abbreviation & Number:
X **New Undergraduate Course:** BIO E- 431
.. **New Honors Course:** --
X **New Graduate Course:** BIO E- 6/431

Effective Term: 01/2012
Catalog Title: Medical Imaging
Transcript Title: Medical Imaging
Fixed Credit Course: 3 (3,0)
Variable Credit Course: -(-), (-)

Method of Instruction	Course Modifier	General Education Designation
XA-Lecture Only	..Pass/Fail Only	..English Composition
..B-Lab (w/fee)	XGraded	..Oral Communication
..D-Seminar	..Variable Title	..Mathematics
..E-Independent Study	..Creative Inquiry	..Natural Science w/Lab
..F-Tutorial (w/fee)	..Repeatable	..Math or Science
..G-Studio	maximum credits:	..A&H (Literature)
..H-Field course		..A&H (Non-Literature)
..I-Study Abroad		..Social Science
..L-Lab (no/fee)		..CCA
..N/B-Lecture/Lab(w/fee)		..STS
..N/L-Lecture/Lab(no fee)		

Add cross-listing with the following child course(s):

Catalog Description: Introduction to the history, physics, and basis of medical imaging devices; including X-ray, Computed Tomography, Magnetic Resonance Imaging, and Ultrasound. Students will understand imaging from both an engineering and clinical prospective. Students will have the opportunity to work with real medical-images, to understand the tradeoffs between modalities.

Prerequisite(s): BioE 370 or Equivalent or Consent of Instructor

Projected Enrollment:
Year 1 - 15 Year 2 - 20 Year 3 - 25 Year 4 - 30

Required course for students in:

Statement of need and justification based on assessment results of student learning outcomes: This course supports the Bioelectrical Concentration as a junior/senior tech requirement, it also serves broaden the scope of our graduate course offerings.

Textbook(s): Guy, C., Ffytche, D. Introduction to the Principles of Medical Imaging (Revised Edition).
ISBN: 9781860945021. World Scientific Press (2005)

Learning Objectives: 1. Assess, evaluate, and justify the use and application of medical imaging techniques based on the underlying physical phenomena which these methods employ
1a. Explain, and model behavior of X-ray and CT Imaging based on basic physical principles
1b. Explain MRI using the simple "top" model of spins
1c. Understand the interactions of radiation with tissue, and compare and contrast images based on safety and risk/benefit
2. Explain the outputs of imaging modalities in terms of anatomy and physiology coupled with the physics which the modality employs
3. Design and justify a method for analyzing medical images based on basic image processing techniques

Topical Outline: Introduction (1 Hour)
Review of Advanced Mathematics and MATLAB (5 Hours)
Imaging Basics (3 Hours)
X-ray Imaging (5 Hours)
Computed Tomography (3 Hours)
Nuclear Medicine (5 Hours)
MRI (6 Hours)
Ultrasound (6 Hours)
Image Quality (4 Hours)
Exams (3 Hours)
Practical Application (3 Hours)

Evaluation: Undergraduate:
20% Each of 3 Exams (total 60%)
30% Homework
10% Participation and Quizzes

Graduate:
20% each of 3 exams (Total 60%)
15% Term Project
25% Homework

Add course requirements for honors and/or 600-level courses (if applicable): The graduate student project will require students to explore a real world medical scenarios, through analysis of medical imaging data. Graduate students will be encouraged to pursue a problem of interest in their research domain area. Undergraduate students will be asked to support the graduate students in their efforts, in order to increase exposure to real world images.

Form Originator: ROBODOC,David Kwartowitz **Date Form Created:** 7/12/2011
Form Last Updated by: ROBODOC, David Kwartowitz **Date Form Last Updated:** 9/16/2011
Form Number: 4171

Approval

Ken Mitt | 9/16/11 | Carrie W. Thurber | 11/4/2011

000073

Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
	9/19/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11		
Chair, College Curriculum Committee	Date	Provost	Date
	10/19/11		12/20/11
College Dean	Date	President	Date
			12/20/11
Director, Calhoun Honors College	Date		

SYLLABUS
BIOE 431/631 - MEDICAL IMAGING

Instructor: Prof. David Kwartowitz
Office: 201-2 Rhodes Research Center
Phone: 864.656.5232
e-mail: robodoc@clemson.edu

Class Meeting Times: M W F 10:10 – 11:00am
Class Meeting Location: Rhodes Annex 111

Office Hours: Monday, 1:30 – 2:30p
Thursday, 1:30 – 2:30p
By Appointment

Prerequisites: BioE 370 – Bioinstrumentation and Bioimaging
or Consent of Instructor

1.0 OVERVIEW

Medical Imaging is all around us! Whether it is dental X-Rays, or intra-operative Ultrasound, imaging in one-way or another impacts us all. The application and development of medical imaging systems is an extremely multidisciplinary study, which includes methods in Anatomy and Physiology, Engineering, Physics, and Psychology just to name a few. In this course we will examine both the engineering of imaging systems, as well as the physics behind how they actually work. In addition to this, we will examine some of the clinical applications which medical imaging is used for and look at the tradeoffs between modalities. Finally we will conclude with a unit exploring medical image processing.

This course will focus on using a hands-on approach to imaging from the first day. Methods of simulation and analysis will be stressed, allowing students to experience the images rather than just read about them.

2.0 COURSE MATERIALS

2.1 TEXTBOOK

- Guy, C., Ffytche, D. Introduction to the Principles of Medical Imaging (Revised Edition). ISBN: 9781860945021. World Scientific Press (2005) REQUIRED

- Bankman, I., Handbook of Medical Image Processing and Analysis, Academic Press Series on Biomedical Engineering, Amsterdam, 2009, ISBN: 9780080559148 (Available as a free e-book from the Clemson Library)

2.2 SOFTWARE

- MATLAB (Available free from CCIT)
- MeVisLab (Available free from http://www.mevislab.de)

2.3 OTHER SUPPLIES

- iClicker (Available from the Clemson Apple Store)

3.0 GRADING

3.1 UNDERGRADUATE GRADING CALCULATION

Exam I	20%
Exam II	20%
Exam III	20%
Homework	30%
Participation and Quizzes	10%

3.2 GRADUATE GRADING CALCULATION

Exam I	20%
Exam II	20%
Exam III	20%
Term Project	15%
Homework	25%

3.3 GRADING SCHEMA

A	90 – 100%
B	80 – 89%
C	70 – 79%
D	65 – 69%
F	< 65%

3.4 REQUIREMENTS FOR GRADUATE CREDIT

To receive graduate credit in this course, students must complete a term project including analysis and processing of medical imaging data. Students will be asked to choose a project based on real world medical scenarios. The students will be encouraged to explore within their domain area, in order to bring diversity to the course material. Undergraduate students will be encouraged to help the graduate students with their efforts in order to enrich their experience.

3.5 GRADING DISPUTES

As all grading information is considered time critical, disputes on grades will only be permitted within one week of the return of graded material. Additionally, disputes must be made in writing along with the original copy of the graded material, and an explanation of the dispute. Disputes will be carefully considered and may result in either an increase or decrease in the grade on a given assignment.

4.0 LEARNING OBJECTIVES

- Assess, evaluate, and justify the use and application of medical imaging techniques based on the underlying physical phenomena which these methods employ
    - Explain, and model behavior of X-ray and CT Imaging based on basic physical principles
    - Explain MRI using the simple "top" model of spins
    - Understand the interactions of radiation with tissue, and compare and contrast images based on safety and risk/benefit
- Explain the outputs of imaging modalities in terms of anatomy and physiology coupled with the physics which the modality employs
- Design and justify a method for analyzing medical images based on basic image processing techniques

NOTE: Students may vary in their competency levels on these abilities. You can expect to acquire these abilities only if you honor all course policies, attend classes regularly, complete all assigned work in good faith and on time, and meet all other course expectations of you as a student.

5.0 Due Dates and Assignments

The use of simulations and models will be an important part of the learning experience in this course, and thus assignments will be an important component of this class's process. You will therefore be expected to complete all assignments on time and submit them. Some assignments will be able to be submitted electronically while others will need to be on paper. In the case of a paper assignment, it is due at the beginning of the classroom period in which the assignment is due. In the case of electronic submission, a specific deadline will be set per assignment. This deadline will be absolute, and no assignments will be accepted beyond this deadline.
Extenuating circumstances do occur and thus with prior approval assignments may be accepted late. Requests for approval must be submitted in writing a minimum of 24 hours before the nominal deadline of an assignment. You will be informed promptly as to the status of your request.

6.0 Honor Code and Academic Dishonesty

Academic dishonesty has no place in any academic environment, especially not at a great institution such as Clemson. Seeing as this, cheating or academic dishonesty will not be tolerated, and will be reported to seek disciplinary action per the College of Engineering and Science's Honor Code. A copy of this honor code can be found at: http://www.ces.clemson.edu/ge/Honor%20Code.htm
You are encouraged to collaborate on assignments and projects; however, ultimately, you are responsible for submitting your own work. Make sure you cite all sources, including class members. It will acceptable to give a blanket citation for classmates with whom you worked.
If you have any questions as to how I define academic dishonesty, please contact the instructor.

7.0 Accommodations for Students with Disabilities

Student Disability Services coordinates the provision of reasonable accommodations for students with physical, emotional, or learning disabilities. Accommodations are individualized, flexible, and confidential based on the nature of the disability and the academic environment in compliance with Section 504 of the Rehabilitation Act of 1973 and the Americans with Disabilities Act of 1990. Students are encouraged to consult with the Disability Services staff early in the semester, preferably prior to the first day of class. Current documentation of a specific disability from a

licensed professional is needed. Additional information or appointments are available from Student Disability Services, G-23 Redfern Health Center, 656-6848. Details on policies and procedures are available at www.clemson.edu/asc <http://www.clemson.edu/asc>

8.0 Emergency Procedures

Emergency procedures have been posted in all buildings and on all elevators. Students should review these procedures for their own safety.

9.0 Attendance Policy

This is a senior level class and will thus be moving at a relatively fast rate. Students are expected to attend class and are responsible for all material covered in the class as well as any material covered in the readings. Additionally, you are expected to be on time for class. Entering class once a lecture has begun is distracting to other students, and will not be tolerated.
As you are expected to be in class, you will be allowed one unexcused absence. An unexcused absence will be defined as an absence, which is not either:

a. Previously agreed upon will be excused
b. Accompanied by a doctor's note, doctor's receipt, or prescription dated within 24 hours of class (NB: Blackboard absence reports are not considered valid excuse)

Further 2 or more tardies will be the equivalent of an absence.

PLEASE NOTE: The schedule, policies, procedures, and assignments set out in this syllabus are subject to change in the case of extenuating circumstances, by mutual agreement, and/or to ensure better student learning.

Summary of Topics:

Week	Topic
1	Introduction
1-3	Review of Advanced Mathematics and MATLAB
3-4	Imaging Basics
4-5	X-ray Imaging
6	X-ray Computed Tomography
7-8	Nuclear Medicine
9-11	Magnetic Resonance Imaging
12-13	Ultrasound
14	Image Quality
15	Practical Applications

000084

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print New Course Form**

Course Abbreviation & Number:
X **New Undergraduate Course:** BIO E- 435
.. **New Honors Course:** --
X **New Graduate Course:** BIO E- 635

Effective Term: 01/2012

Catalog Title: Computer Modeling of Multiphysics Problems
Transcript Title: MODEL MULTIPHYS PROB

Fixed Credit Course: 3 (3,0)
Variable Credit Course: - (-), (-)

Method of Instruction	Course Modifier	General Education Designation
X A-Lecture Only	.. Pass/Fail Only	.. English Composition
.. B-Lab (w/fee)	X Graded	.. Oral Communication
.. D-Seminar	.. Variable Title	.. Mathematics
.. E-Independent Study	.. Creative Inquiry	.. Natural Science w/Lab
.. F-Tutorial (w/fee)	.. Repeatable	.. Math or Science
.. G-Studio	maximum credits:	.. A&H (Literature)
.. H-Field course		.. A&H (Non-Literature)
.. I-Study Abroad		.. Social Science
.. L-Lab (no/fee)		.. CCA
.. N/B-Lecture/Lab(w/fee)		.. STS
.. N/L-Lecture/Lab(no fee)		

Add cross-listing with the following child course(s):

Catalog Description: This course will introduce students to a holistic way to deal with complicated engineering problems using a computer modeling approach. For example, a real-world problem governed by combined mechanical, electrical, thermal, electrochemical and mass-transport phenomena will be dealt with in an integrated and multidisciplinary way rather than the conventional piece-wise single-discipline way.

Prerequisite(s): MthSc 208

Projected Enrollment:
Year 1 - 10 Year 2 - 15 Year 3 - 20 Year 4 - 25

Required course for students in: Elective course suitable for partial fulfilment of the 9 credits of BioE Technical Requirement in our curricula

Statement of need and justification based on assessment results of student learning outcomes: This course will provide our students an opportunity to learn computer modeling as a tool for integrating biomedical systems. It offers an advanced engineering component to our existing list of availabl technical requirement courses in response our internal assessment of the curriculum during preparation for ABET accreditation.

Textbook(s):

Learning Objectives: • To implement differential equations along with proper constraints in a computational environment
• To develop basic skills in computer modeling using commercial software COMSOL Multiphysics
• To apply the learned knowledge and skills in the design and analysis of various engineering and bioengineering systems and devices
• To validate and interpret the modeling results from a multidisciplinary aspect
• To critique the conventional piece-wise single-discipline ways of solving engineering problems

Topical Outline: Week 1 Introduction – COMSOL modeling environment
Week 2-3 Review of differential equations
Week 4 Setting up differential equations and constraints in COMSOL
Week 5-6 Basic modeling with COMSOL with case studies
Week 7-9 Advanced modeling with COMSOL with case studies
Week 10 Use of COMSOL in design and analysis of engineering systems
Week 11 Interpretation, assessment and validation of modeling results
Week 12-14 Critical things to consider in dealing with real-world problems
Weeks 15 Final

Evaluation: 435
Quizzes 30%
Homework 30%
Term Project (due before final) 20%
Final Exam 20%

635
Quizzes 20%
Homework 20%
Analytic Assignments* 20%
Term Project (due before final) 20%
Final Exam 20%

A (90% - 100%), B (80% - 89%), C (70% - 79%), D (60% - 69%), F (0% - 59%)

Add course requirements for honors and/or 600-level courses (if applicable): * For graduate credits, students will need to complete two analytic assignments in which they are required to establish differential equations for given physical problems of real-world relevance.

Form Originator: KWEBB,Charles Webb **Date Form Created:** 9/6/2011

000085

Form Last Updated by: , Date Form Last Updated: 9/20/2011
Form Number: 4276

Approval

Kim Wilk	9/17/11	Patricia W. Marinova	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Marnie Lass	9/19/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Doris R. Helms	
Chair, College Curriculum Committee	Date	Provost	Date
K. Tony Hadley	10/19/11		12/20/1
College Dean	Date	President	Date
			12/20/1
Director, Calhoun Honors College	Date		

Department of Bioengineering
BioE 435/635 "Computer Modeling of Multiphysics Problems – A Holistic Approach"
Fall 2011

Instructor: Dr. Guigen Zhang
Professor of Bioengineering
Office: Rhodes 401-4
Phone: 656-4262
e-mail: guigen@clemson.edu
Office Hours: By appointment

DESCRIPTION

This course will introduce students to a holistic way to deal with complicated engineering problems using a computer modeling approach. For example, a real-world problem governed by combined mechanical, electrical, thermal, electrochemical and mass-transport phenomena will be dealt with in an integrated and multidisciplinary way rather than the conventional piece-wise single-discipline way.

This course will be open to undergraduate engineering students (juniors and seniors) and graduate students with a good grasp of partial differential equations and basic knowledge in at least one of the engineering disciplines (e.g., mechanical, electrical, chemical, biomedical, materials, electrochemical, civil, environmental areas).

COURSE LEARNING OBJECTIVES:

- To implement differential equations along with proper constraints in a computational environment
- To develop basic skills in computer modeling using commercial software COMSOL Multiphysics
- To apply the learned knowledge and skills in the design and analysis of various engineering and bioengineering systems and devices
- To validate and interpret the modeling results from a multidisciplinary aspect
- To critique the conventional piece-wise single-discipline ways of solving engineering problems

CLASS POLICIES

1. Attendance to all classes is expected. Students who cannot attend the first class are responsible for contacting the instructor to indicate their intent to remain in that class. If a student does not attend the first class meeting or contact the instructor by the second meeting or the last day to add, whichever comes first, the instructor has the option of dropping the student from the roll.
2. If the instructor does not come to class within the first fifteen minutes, students are authorized to leave.

3. If classes must be missed for extra-curricular activities, illness, or other reasons, the instructor must be informed prior to absence, if possible, or upon return with written documentation from appropriate authorized official. Unexcused absences may detrimentally influence borderline grades. Consistent class attendance is strongly encouraged.
4. There is not a textbook for the course and exams will be composed based on material covered in class and resource material provided through Blackboard. Students are responsible for all material posted on Blackboard unless designated FYI.
5. Assignments must be returned on expected dates. Any assignment returned at a later date without having secured approval will not be graded and will result in a grade of zero (0). Approval may be secured for documented participation in university activities (athletics/student organizations) off-campus, student illness, and family emergencies.
6. Any questions pertaining to grading or requests for re-consideration of grading must be made within **1 week** of when the exam / assignment is returned in class in writing.

REFERENCE MATERIALS AND BOOKS

- COMSOL tutorials and help files
- Equations of Mathematical Physics, Tikhonov AN and Samarskii AA, Dover 1990.
- Partial differential equations of mathematical physics and integral equations, Guenther RB and Lee JW, 1988 Prentice Hall (Dover edition, 1996).

ACADEMIC INTEGRITY (CU official statement on Academic Integrity)

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

The College of Engineering and Science Honor Code is in effect since the fall of 1994. Homeworks, quizzes, and final exam are to be an individual effort unless specified by the instructor. If the honor pledge is not stated and signed at the end of each **Quizzes, Assignments, Homeworks, and Project, *the instructor will not provide a grade***.

Honor Pledge:

1) I have neither given nor received aid for this (examination, homework).

2) We have neither given nor received aid for this team project. The work has been equally divided among team members.

(Provide acknowledgment to contributors - clinicians, graduate students, professors, etc.) (http://www.ces.clemson.edu/info/code.htm)

DISABILITY ACCESS POLICY

In compliance with Section 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990 (ADA), Clemson University recognizes a student with a disability as anyone who has a physical or mental impairment that substantially limits one or more major life activity. Student Disability Services coordinates the provision of reasonable accommodations for students with disabilities. *Students with disabilities needing accommodations should contact the Office of Student Disability Services in G20 Redfern Health Center, 656-6848. Any students requiring additional time for exams / assignments must provide written documentation at the beginning of the semester.*

EMERGENCY PROCEDURES

Emergency procedures have been posted in all buildings and on all elevators. Students should review these procedures for their own safety.

COURSE GRADING SCHEME

435

Quizzes	30%
Homework	30%
Term Project (due before final)	20%
Final Exam	20%

635

Quizzes	20%
Homework	20%
Analytic Assignments*	20%
Term Project (due before final)	20%
Final Exam	20%

A (90% - 100%), B (80% - 89%), C (70% - 79%), D (60% - 69%), F (0% - 59%)

* For graduate credits, students will need to complete two analytic assignments in which they are required to establish differential equations for given physical problems of real-world relevance.

Course Outline

Week 1	Introduction – COMSOL modeling environment
Week 2-3	Review of differential equations
Week 4	Setting up differential equations and constraints in COMSOL
Week 5-6	Basic modeling with COMSOL with case studies
Week 7-9	Advanced modeling with COMSOL with case studies
Week 10	Use of COMSOL in design and analysis of engineering systems
Week 11	Interpretation, assessment and validation of modeling results
Week 12-14	Critical things to consider in dealing with real-world problems
Weeks 15	Final

Note: *Course outline may be subject to minor revisions as needed to allow sufficient time for each topic.*

000089

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print New Course Form**

Course Abbreviation & Number:
X **New Undergraduate Course:** BIO E- 449
.. **New Honors Course:** --
.. **New Graduate Course:** -

Effective Term: 01/2012

Catalog Title: Drug Delivery
Transcript Title: Drug Delivery

Fixed Credit Course: 3 (3,0)
Variable Credit Course: - (-), (-)

Method of Instruction	Course Modifier	General Education Designation
X A-Lecture Only	.. Pass/Fail Only	.. English Composition
.. B-Lab (w/fee)	X Graded	.. Oral Communication
.. D-Seminar	.. Variable Title	.. Mathematics
.. E-Independent Study	.. Creative Inquiry	.. Natural Science w/Lab
.. F-Tutorial (w/fee)	.. Repeatable	.. Math or Science
.. G-Studio	maximum credits:	.. A&H (Literature)
.. H-Field course		.. A&H (Non-Literature)
.. I-Study Abroad		.. Social Science
.. L-Lab (no/fee)		.. CCA
.. N/B-Lecture/Lab(w/fee)		.. STS
.. N/L-Lecture/Lab(no fee)		

Add cross-listing with the following child course(s):

Catalog Description: Fundamental principles of controlled drug delivery including drug release mechanisms, physiological barriers, and various types of delivery routes. Specific emphasis is placed on understanding drug delivery technologies. This course will also describe processes to scale up the fabrication of drug delivery systems.

Prerequisite(s): BioE 302 or consent of instructor

Projected Enrollment:
Year 1 - 20 Year 2 - 25 Year 3 - 30 Year 4 - 35

Required course for students in: Fulfills 3 credits of BioE Technical Requirement

Statement of need and justification based on assessment results of student learning outcomes: This course is part of our effort to broaden the diversity of technical elective courses within our program based on feedback from sen ior exit surveys.

Textbook(s):

Learning Objectives: A) To produce oral and written communication describing the development of drug delivery technologies and scientific news and to assess the impact of the technology.
B) To describe drug delivery concepts
C) To apply diffusion coefficient equations to quantify drug release kinetics
D) To describe manufacturing processes of drug delivery systems
E) To describe drug delivery device testing and regulatory approval process
F) ~~To describe and~~ explain the major classes of drug delivery systems, their strengths and limitations.

Student will be able to

Topical Outline: Intro to drug stability / toxicity (3)
Drug delivery systems (6)
Drug release kinetics (6)
Administration routes (10)
Gene therapy (2)
Hydrogels (2)
Targeting (2)
Manufacturing (6)
Sterilization (3)
Exams (2)
Presentations (2)

Evaluation: • Exam 1 20%
• Exam 2 20%
• Final Exam 20%
• Oral Project Presentation 20%
• Written Project 15%
• Discussion 5%

A - 90-100%
B - 80-89%
C - 70-79%
D - 60-69%
F - <60%

Form Originator: KWEBB,Charles Webb **Date Form Created:** 9/16/2011
Form Last Updated by: , Date Form Last Updated: 10/13/2011
Form Number: 4311

Approval

000090

Ken Wolk	9/17/11	Carina W. Hallows	11/4/11
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Mustace Bass	9/19/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Doris R Helms	12/6/11
Chair, College Curriculum Committee	Date	Provost	Date
	10/19/11		12/21/11
College Dean	Date	President	Date
Director, Calhoun Honors College	Date		

Department of Bioengineering

BioE 449
Introduction to Controlled Drug Delivery Systems
Spring 2011

Tuesday/Thursday 11:00-12:15 PM
109 Rhodes Annex

Instructor: Dr. Frank Alexis
Assistant Professor of Bioengineering
Office: 203 Rhodes Annex
Phone: 656-5003
e-mail: falexis@clemson.edu

Office Hours: Tuesday 12:15-1:15 PM

CLASS POLICIES

1. Consistent class attendance is strongly encouraged. There is not a textbook for the course and exams will be composed based on multiple text books referenced in the syllabus, based on material covered in class, and based on resource material provided through Blackboard. Students are responsible for all material posted on Blackboard unless designated FYI.
2. NO make-up exams/quizzes will be given for any reason. For an **excused** absence on any exam/quiz, the weight for that exam will be applied to the final exam (this is the fairest way to handle absences for everyone concerned, including the absent student). Excused absences include documented participation in university activities (athletics/student organizations), student illness, and family emergencies.
3. Unexcused exam/quiz absence will result in the assignment of a grade of zero (0).
4. Waiting time for instructor: If the instructor does not arrive within 15 minutes of the beginning of class, students may consider the class canceled and leave.
5. Any questions pertaining to grading or requests for re-consideration of grading must be made within **1 week** of when the exam / assignment is returned in class.
6. Academic Integrity (CU official statement on Academic Integrity): **"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a "high seminary of learning." Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."**

The College of Engineering and Science Honor Code is in effect since the fall of 1994. Homeworks, exams, and projects are to be an individual effort unless specified by the instructor. If the honor pledge is not stated and signed at the end of each **Exam, Homework, and Project,** ***the instructor will not provide a grade.***

Honor Pledge:

1) I have neither given nor received aid for this (examination, homework).

2) We have neither given nor received aid for this team project. The work has been equally divided among team members.

(Provide acknowledgment to contributors - clinicians, graduate students, professors, etc.)

(http://www.ces.clemson.edu/info/code.htm)

Disability Access Policy: In compliance with Section 504 of the Rehabilitation Act of 1973, and the Americans with Disabilities Act of 1990 (ADA), Clemson University recognizes a student with a disability as anyone who has a physical or mental impairment that substantially limits one or more major life activity. Student Disability Services coordinates the provision of reasonable accommodations for students with disabilities. *Students with disabilities needing accommodations should contact the Office of Student Disability Services in G20 Redfern Health Center, 656-6848. Any students requiring additional time for exams / assignments must provide written documentation by ~~9/5/06~~.*

DESCRIPTION

Fundamental principles of controlled drug delivery including drug release mechanisms, physiological barriers, and various types of delivery routes. Specific emphasis is placed on understanding drug delivery technologies. This course will also describe processes to scale up the fabrication of drug delivery systems.

Course Learning Objectives:

A) To produce oral and written communication describing the development of drug delivery technologies and scientific news and to assess the impact of the technology.
B) To describe drug delivery concepts
C) To apply diffusion coefficient equations to quantify drug release kinetics
D) To describe manufacturing processes of drug delivery systems
E) To describe drug delivery device testing and regulatory approval process
F) To describe and explain the major classes of drug delivery systems, their strengths and limitations.

Pre-req: BIO302 or consent of instructor

Course Outcomes

Students will be able to find scientific resources, memorize, understand, apply, critically analyze, assess, develop team skills, communicate and describe drug delivery system concepts and technologies through:

Outcomes	Objectives
Knowledge	A,B, C, D, E, F

Comprehension	A, B, C,D, E, F
Application	A, B, D, E, F
Analysis	A, C, F
Synthesis	A, F
Evaluation	A, F
Skills	A, F
Math/Sc. And Eng.	C, D,E
Solve Eng. Problems	C

REQUIRED and SUGGESTED MATERIALS

- Lecture Notes taken in class and posted on Blackboard

Additional textbooks which may be helpful are:
Drug Delivery: Principles and Applications by Binghe Wang, Teruna J. Siahaan, Richard A. Soltero March 2005

Additional readings which may be helpful for Discussion Sessions:
www.nature.com
http://www.biospace.com
http://www.worldpharmanews.com/
http://www.dddmag.com

COURSE MARKING SCHEME

- Exam 1 20%
- Exam 2 20%
- Final Exam 20%
- Oral Project Presentation 20%
- Written Project 15%
- Discussion 5%

Extra credits: Chosen exam questions provided by students (1 point)

A - 90-100%
B - 80-89%
C - 70-79%
D - 60-69%
F - <60%

Note: Exam dates are firm and will not be subject to change.
Note: No exemptions are allowed for the final exam.

Exams: Questions will be based on understanding and memorizing the lecture notes, drug delivery equations; and solving problem abilities. Questions will be from coursework materials available on blackboard and from lectures from each term. Each student will provide 2 questions

that they would like to be asked at the exam and the instructor will select a maximum of nine questions to be part of the exam with a weight of 1 point per question.

Final exam: Questions will be based on understanding and memorizing the lecture notes, drug delivery equations; and solving problem abilities. Questions will be from coursework materials available on blackboard and from lectures from the entire semester.

Written / Oral Project: Students will be divided into teams and will select a drug delivery technology for their project. The project will consist of independent research about a technology including: historical development of the technology, description of the technology; significance of the technology; and a critical evaluation of the technology. See accompanying handout for further details.

Oral Presentation Grading Rubric

The oral presentations will be evaluated as follows:

Name:_____ Team #:_____ Section: _____

Evaluation Category	Poor (0)	Good (1)	Excellent (2)
Organization (20%)	Disorganized; hard to follow; wandered from topic	Organized and logical sequence, but did not flow well	Well-organized, logical, easy to follow from presentation to hands-on activity
Content (40%)	Inadequate details to support presentation	Few missing details or confusing details for supporting presentation	Adequate and properly presented details to support presentation
	Many terms missing or misused	A few terms missing or misused	Proper use of terminology
Slides &/or Handouts (15%)	Slides or handouts difficult to read and/or confusing; too many or too few slides	Slides or handouts somewhat confusing; too much or too little text	Effective and clear slides and handouts
Conceptual Level & Reasoning (15%)	Missing, incorrect, or inconsistent conclusions	Weak/poorly supported conclusions	Well-stated, well-justified conclusions
	Missing, incorrect, or inconsistent recommendations	Weak/poorly supported recommendations	Well-stated, well-justified recommendations
	Much redundancy; poor flow	Some redundancy and/or tangents	Concise & flows logically
Delivery (10%)	Distracting gestures; did not maintain attention; design did not work well with presentation	Reasonably maintained attention, effective presentation of design	Very effective communication throughout presentation
	Not well rehearsed; poor flow of presentation	Some flow issues with presentation	Well-rehearsed and presentation flowed well
	Never makes eye contact with audience or not audible to audience	Sometimes makes eye contact with audience and is audible	Often makes eye contact with audience and speaker is easily heard.
Total:			

Additional Comments:_____

Written Assignment Grading Rubric

The written reports will be evaluated as follows (% weightings are shown for each category):

Name:_____ Team #:_____ Section: _____

Evaluation Category	Poor (0)	Good (1)	Excellent (2)
Organization (20%)	Disorganized; hard to follow; wandered from topic	Organized and logical sequence, but did not flow well	Well-organized, logical, easy to follow from presentation to hands-on activity
Content (50%)	Inadequate details to support claims	Few missing details or confusing details	Adequate and properly presented details
	Many terms missing or misused	A few terms missing or misused	Proper use of terminology
	Did not address all aspects of required content	Addressed most aspects of required content with some weaknesses	Effectively addressed all required content aspects
Evidence (15%)	No citation of literature	Some missing citation of literature	Proper citation of literature
	Many inaccurate statements	Minor errors in accuracy or conciseness	All statements are accurate and concise
Mechanics (15%)	Numerous (>5) errors in spelling, grammar, syntax	Minor (3-5) errors in spelling, grammar, and syntax	Proper spelling, grammar, and syntax
Total:			

Additional Comments:_____

Course Outline

Date	Term 1	Term 2	Grades
01/13	Why Controlled Drug Delivery is Important?		
01/18	Drug stability, bioavailability, and toxicity		
01/20	Intellectual Properties		**Discussion Courtney**
01/25	Drug Delivery Systems	Select a Technology	**4 Groups**
01/27	Regulations		**2Discussions Kaitlyn nathaly**
02/01	Drug Release Kinetics		
02/03	Drug Release Kinetics		
02/08	Review		**Discussion**
02/10			**Exam 1 Ben**
02/15		Oral Drug Delivery	
02/17		Nasal Drug Delivery	**Discussion Erika**
02/22		Transdermal Drug Delivery	
02/24		Pulmonary Drug Delivery	**Discussion Erik**
03/01		Ocular and Buccal	
03/03		Implant Drug Delivery (bone/stent/microchip)	**Discussion Even**
03/08		Parenteral Drug Delivery	**Discussion**
03/10		Intelligent Drug Delivery	
03/15		Review	
03/17			**Exam 2**
03/22		**Spring Break**	
03/24		**Spring Break**	
03/29		Gene Therapy	**Discussion**
03/31		Hydrogels	
04/05		Targeted Drug Delivery	
04/07		Manufacturing	**Discussion**
04/12		Manufacturing	
04/14		Sterilization	**Discussion**
04/19		Lecture of Choice	**Projects**
04/21			**Present**
04/26			**Present**
04/28		Review	**Discussion**
05/03			**Final Exam**

Written / Oral Project Details

Paper Length: 8-12 pages double spaced.
Presentation Time: 30 minutes
All team members must contribute to both the paper and the presentation (each individual must speak during the oral presentation and each individual must identify within the written document their individual contribution). The sections covering physiology/pathology should be team-researched, written, and presented.

The content of paper / presentation should be essentially identical.

The content must include the following specific requirements: historical development of the technology, description of the technology; significance of the technology; and a critical evaluation of the technology.

Historical Background: Describe the development of the technology on the time scale including inventors, the accomplishment of milestones, failures, success, change of direction, licensing, FDA approval, clinical trials, patents, stage of the technology, funding, etc.

Description of the Technology: Describe the key features of the technology including hypothesis, novelty, claims, space of activity, applications, advantages, formulation, etc.

Significance of the Technology: Describe the pathological problem and its biomedical significance, experimental results in vitro/in vivo/clinical trials, etc.

Critical evaluation of the Technology: Discuss the impact of the technology, experimental results, and possible problems.

References: You are not required to provide a "bibliography" which I define as an exhaustive list of every source of information used. You are required to provide "references" for specific facts that are not accepted as common knowledge.

Only archival literature sources may be referenced, including books, textbooks, journal review articles, primary journal articles, patent documents. On-line sources may be used for your own basic knowledge and as a source of figures. If you include a figure from a website, it should be referenced in the figure caption. **Website/html references may not be included in the reference list** (2 points will be deducted from the final grade per website included in the reference list).
Rationale-1) websites/links are unstable and subject to discontinuation/movement therefore this is not a permanent archival source of information, 2) websites are not peer-reviewed as most scientific journals, therefore there is no quality control on the content.

Reference style is at your discretion-however it should include 1) in-text citation and 2) final reference list including at least authors, title, journal, volume, year, pages.

For example:

Paper text

.....Damaged endothelial cells release thromboxane A2, a soluble signaling molecule that binds to platelets and increases integrin affinity for fibrinogen.[1] .....

End of Document reference list

References

[1] Webb K and T Boland. "Molecular mechanisms of hemostasis." *Circulation Research* **193**: 511-515 (1999).

Discussion

Each student will give a short presentation of 5 minutes followed by 5 minutes of questions from the audience. The presentation will be based on scientific news in the field of drug delivery. Suggested sources of news are provided (but not limited to) in the MATERIALS section above. The student is expected to describe the source of the scientific news, team of scientists, biomedical field, impact of the scientific news, and major results.

000100

Discussion Grading Rubric

The discussion presentation will be evaluated as follows:

Name:_____

Evaluation Category	Poor (0)	Good (1)	Excellent (2)
Organization (20%)	Disorganized; hard to follow; wandered from topic	Organized and logical sequence, but did not flow well	Well-organized, logical, easy to follow from presentation to hands-on activity
Content (40%)	Inadequate details to support presentation	Few missing details or confusing details for supporting presentation	Adequate and properly presented details to support presentation
	Many terms missing or misused	A few terms missing or misused	Proper use of terminology
Slides &/or Handouts (15%)	Slides or handouts difficult to read and/or confusing; too many or too few slides	Slides or handouts somewhat confusing; too much or too little text	Effective and clear slides and handouts
Conceptual Level & Reasoning (5%)	Incorrect response to questions	Weak/poorly response to questions	Well-stated response to questions
	Much redundancy; poor flow	Some redundancy and/or tangents	Concise & flows logically
Delivery (20%)	Distracting gestures; did not maintain attention; design did not work well with presentation	Reasonably maintained attention, effective presentation of design	Very effective communication throughout presentation
	Not well rehearsed; poor flow of presentation	Some flow issues with presentation	Well-rehearsed and presentation flowed well
	Never makes eye contact with audience or not audible to audience	Sometimes makes eye contact with audience and is audible	Often makes eye contact with audience and speaker is easily heard.
Total:			

Additional Comments:_____

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Change/Delete Course Form**

000101

X **Change a Course - Abbrev & Number: BIO E- 471**
Corresponding Lab Course: --
Corresponding Honors course: --
.. **Add Honors course:** --
Corresponding Graduate course: BIO E- -671
.. **Add Graduate course:** --
Course Title: BIOIMAGING

Brief Statement of Change:
Change of course title to more accurately reflect content and clarify distinction with new "Medical Imaging" course

Last Term taught: 1101 Effective Term: 01/2012	.. **Change Abbrev to:** .. **Change Number to:**
X **Change Catalog Title:** from: Biomedical Imaging in Biophotonics to: Biophotonics	X **Change Transcript Title:** from: BIOIMAGING to: Biophotonics

.. **Change of Credit**	From: Fixed Credit: 3 (3,0) Variable Credit: - (-), (-)	To: Fixed Credit: (,) Variable Credit: - (-),(-)

.. **Add cross-listing with the following child course(s):**
.. **Delete cross-listing with the following child course(s):**
.. **Reverse Parent/Child relationship with:**

.. **Change Method of Instruction**		.. **Change Course Modifier**		.. **Change General Education Designation**	
from:	to:	from:	to:	from:	to:
X A-Lecture Only	..	.. Pass/Fail Only	..	.. English Composition	..
.. B-Lab (w/fee)	..	X Graded	..	.. Oral Communication	..
.. D-Seminar	..	.. Variable Title	..	.. Mathematics	..
.. E-Independent Study	..	.. Creative Inquiry	..	.. Natural Science w/Lab	..
.. F-Tutorial (w/fee)	..	.. Repeatable	..	.. Math or Science	..
.. G-Studio	..	maximum credits		.. A&H (Literature)	..
.. H-Field course	..	from:		.. A&H (Non-Literature)	..
.. I-Study Abroad	..	to:		.. Social Science	..
.. L-Lab (no/fee)	..			.. CCA	..
.. N/B-Lecture/Lab(w/fee)	..			.. STS	..
.. N/L-Lecture/Lab(no fee)	..				

.. **Change Catalog Description:**
from:
to:

.. **Change Prerequisite(s):**
from:
to:

Learning Objectives:

Topical Outline:

Evaluation:

Form Originator: KWEBB, Charles Webb **Date Form Created:** 9/6/2011
Form Last Updated by: KWEBB, Charles Webb **Date Form Last Updated:** 9/16/2011
Form Number: 4272

Approval

Kim Mott	9/17/11	Patrice W. Mimbs	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Madhuresh Sz	9/19/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Doris R Helms	
Chair, College Curriculum Committee	Date	Provost	Date
Tammy Webb	10/19/11		12/20/11
College Dean	Date	President	Date
			12/21/11
Director, Calhoun Honors College	Date		

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Major Form**

000103

Change Major Name: Chemical Engineering
Degree: BS
Effective Catalog Year: 2011
.. **Change Major Name to:**
.. **Change Degree to:** (CHE approval required)
X **Change Curriculum Requirements**
(Submit or upload Curriculum map in catalog format. CHE approval required for > 18 hours of changes)
.. **Change General Education Requirements**
(Must also submit a General Education Checklist)
.. **Add, Change or Delete Concentration(s)**
(Submit or upload Curriculum map in catalog format. CHE approval required)
.. **Add, Change or Delete Emphasis Area(s)**
Explanation: The changes proposed here APPLY ONLY TO THE BIOMOLECULAR CONCENTRATION. No course requirements are changed, but three courses are rotated to different semesters to relieve scheduling conflicts that prevent students in the BMOLE Concentration from taking the courses in the semeters now prescribed in the curriculum. The three courses that are moved are:
EXST 411 from fall junior year to fall senior year.
Arts and Humanities/Social Science from fall senior year to spring junior year.
BIOE 302 from spring junior year to fall junior year.
Form Originator: CHGDNG, Charles Gooding **Date Form Created:** 10/2/2011
Form Last Updated by: CHGDNG, Charles Gooding **Date Form Last Updated:** 10/2/2011
Form Number: 4440

Approval

	10/2/11		11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
	10/2/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11		12/20/11
Chair, College Curriculum Committee	Date	Provost	Date
	10/19/11		12/21/11
College Dean	Date	President	Date

CHEMICAL ENGINEERING CURRICULUM
with BIOMOLCULAR ENGINEERING CONCENTRATION

(for students who enter the curriculum during or after the 2011-2012 academic year)

Freshman Year

CES 102	Engineering Disciplines & Skills	2	CH E 130	Chemical Engineering Tools	2
CH 101	General Chemistry	4	CH 102	General Chemistry	4
ENGL 103	English Composition	3	MTHSC 108	Calculus of One Variable II	4
MTHSC 106	Calculus of One Variable I	4	PHYS 122	Physics with Calculus I	3
Arts and Humanities/Social Science[1]		3	Arts and Humanities/Social Science[1]		3
Semester Totals:		*16*			*16*

Sophomore Year

CH E 211	Intro to Chemical Engineering	4	ChE 220	Chemical Engr. Thermodynamics I	3
CH 223	Organic Chemistry	3	ChE 230	Fluids/Heat Transfer	4
MTHSC 206	Calculus of Several Variables	4	CH 224	Organic Chemistry	3
BIOL 110	Principles of Biology (w/Lab)	5	CH 229	Organic Chemistry Lab	1
Arts and Humanities/Social Science[1]		3	BIOCH 305	Biochemistry	3
			BIOSC 434	Biochemistry Lab	2
Semester Totals:		*19*			*16*

Junior Year

CH E 307	Unit Operations Lab. I	3	CH E 321	Chemical Engr. Thermodynamics II	3
CH E 319	Engineering Materials	3	CH E 330	Mass Transfer & Separ. Proc.	4
BIOCH 431	Physical Biochemistry	3	Arts and Humanities/Social Science[1]		3
MTHSC 208	Intro. to Ord. Diff. Equations	4	BMOLE 425	Biomolecular Engineering	3
BIOE 302	Biomaterials	3	PHYS 221	Physics with Calculus II	3
Semester Totals:		*16*			*16*

Senior Year

CH E 407	Unit Operations Lab. II	3	CH E 353	Process Dynamics and Control	3
CH E 431	Chemical Process Design I	3	CH E 433	Process Design II	3
CH E 443	Chem. Engr. Senior Seminar I	1	CH E 444	Chem. Engr. Senior Seminar II	1
CH E 450	Chemical Reaction Engineering	3	Engineering Requirement[2]		3
Engineering Requirement[2]		3	Arts and Humanities/Social Science[1]		6
EX ST 411	Statistical Methods	3			
Semester Totals:		*16*			*16*

Total = 131 hrs.

Notes

[1] See Policy on Social Sciences and Humanities for Engineering Curricula. Six of these credit hours must also satisfy the Cross-Cultural Awareness and Science and Technology in Society Requirements.

[2] Select from CH E 401 or BMOLE 403, BMOLE 423, BMOLE 426, BMOLE 427, BE 428, MICRO 413

Note: No student may exceed two attempts, including a *W*, to complete successfully any CH E course.

000114

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Major Form**

Change Major Name: Environmental Engineering
Degree: BS
Effective Catalog Year: 2012
.. **Change Major Name to:**
.. **Change Degree to:** (CHE approval required)
X **Change Curriculum Requirements**
(Submit or upload Curriculum map in catalog format. CHE approval required for > 18 hours of changes)
.. **Change General Education Requirements**
(Must also submit a General Education Checklist)
.. **Add, Change or Delete Concentration(s)**
(Submit or upload Curriculum map in catalog format. CHE approval required)
.. **Add, Change or Delete Emphasis Area(s)**

Explanation: This curriculum change of the BS Environmental Engineering was approved by the Department of Environmental Engineering and Earth Sciences Curriculum and Assessment Committee on September 22, 2011.
The major change is to drop BE/EE&S 451 from the curriculum and require EE&S 403. The Natural Systems Concentration is to be deleted. The department list of electives was also changed by the addition of courses.
The substitution of EE&S 403 for BE/EE&S 451 was due to a retirement of the instructor and a desire to increase the laboratory skills of our majors so that they are better prepared to solve practical environmental engineering problems.
The deletion of the Natural Systems Concentration is a result of two factors. One is the decrease in the number of faculty due to retirements and administrative changes when Biosystems Engineering was brought into the College of Engineering and Sciences. The other was the relatively small number of students, 2 students out of 42 current majors in our first three semesters, that have selected the Natural Systems Concentration.

Form Originator: TJVRC, Thomas Overcamp **Date Form Created:** 9/23/2011
Form Last Updated by: , **Date Form Last Updated:** 9/26/2011
Form Number: 4390

Approval			
Thomas J Overcamp	28 Sept 2011	Patricia W. Medaris	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Tarik Kovacevic	9/28/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Dario A. Gallina	12/20/11
Chair, College Curriculum Committee	Date	Provost	Date
R. Mayne Hadley	10/19/11		12/21/11
College Dean	Date	President	Date

DEPARTMENT OF ENVIRONMENTAL ENGINEERING AND EARTH SCIENCES

BACHELOR OF SCIENCE IN ENVIRONMENTAL ENGINEERING

FRESHMAN YEAR

First Semester	Second Semester
2 CES 102 Engineering Disciplines & Skills	2 ENGR 130 Engineering Fundamentals[2]
4 CH 101 General Chemistry	4 CH 102 General Chemistry
4 MTHSC 106 Calculus I	4 MTHSC 108 Calculus II
3 ENGL 103 Composition I	3 PHYS 122 Physics I
3 Humanities/Social Science Requirement[1]	3 HIST 124[3]
16	16

SOPHOMORE YEAR

First Semester	Second Semester
3 EES 201 Environ Engineering Fund I	4 EES 202 Environ Engineering Fund II
3 BIOL 103 General Biology[4]	4 CH 201 Organic Chemistry[5]
1 BIOL 105 General Biology Lab[4]	4 MTHSC 208 Calculus Diff Eq
4 MTHSC 206 Calculus III	2 EG 210 Engineering Graphics[6]
3 PHYS 221 Physics II	2 CE 208 Dynamics
3 CE 201 Statics	
17	16

JUNIOR YEAR

First Semester	Second Semester
3 EES 402 Water & Wastewater Treatment	3 EES 485 Hazardous Waste Management
1 EES 403 Water & Wastewater Trmt Lab	3 EES 484 Municipal Solid Waste Mgmt
2 Engineering Economics Requirement[7]	3 ME 310 Thermodynamics & Heat Transfer
4 MICRO 305 General Microbiology[8]	4 CE 341 Intro to Fluid Mechanics
3 Statistics Requirement[9]	4 Earth Sciences Requirement[10]
3 Humanities/Social Science Requirement[1]	
16	17

SENIOR YEAR

First Semester	Second Semester
3 EES 486 Pollution Prevention	3 EES 475 Env Eng Capstone Design
3 EES 430 Air Pollution Engineering	6 Engineering or Science Requirement[11]
3 EES 480 Environmental Risk Assessment	6 Humanities/Social Science Requirement[1]
1 EES 450 Env Eng Senior Seminar	
5 Engineering or Science Requirement[11]	
15	15

TOTAL HOURS = 128

[1] See the Policy on Humanities and Social Sciences for Engineering Curricula. Students are encouraged (but not required) to take PHIL 345 (Environmental Ethics) to fulfill the non-literature humanities requirement.
[2] ENGR 141 is an acceptable substitute.
[3] HIST 124 satisfies 3 credit hours of the social science requirement and the Science and Technology in Society requirement for the Humanities and Social Sciences for Engineering Curricula. If a student is not able to enroll in the second semester of the freshman year, this course may be taken at another time.
[4] May substitute BIOL 110 for BIOL 103 and BIOL 105; BIOL 110 is 5 hours.
[5] May substitute CH 223 + CH 227.
[6] EG 208 or EG 209 is an acceptable substitute.
[7] The following courses are acceptable: CE 352 or IE 384.
[8] May substitute BIOSCI 210, which is 3 hours; must make up the 1 hour in any manner.
[9] The following courses are acceptable: EX ST 301 for 3 credit hours; MTHSC 302 for 3 credit hours; or GEOL 211 for 4 credit hours.
[10] The following courses are acceptable: GEOL 101 + GEOL 103 or CSENV 202.
[11] The following courses are acceptable. Any combination of engineering or science courses is permitted, or any mix of the two that totals 11 credit hours from a department-approved list.

Addendum for Information Only
Department Approved List of Electives

Engineering Options

BE 322	Sm Watershed Hydrology & Sedimentology	3
BE 422	Hydrologic Modeling Sm Watersheds	3
BE 440	Renewable Energy Resource Engineering	3
BE 464	Non-Point Source Mgt. in Eng. Ecosys.	3
CE 206	Structural Mechanics	4
CE 255	Geomatics	3
CE 321	Geotechnical Engineering	4
CE 342	Applied Hydraulics and Hydrology	3
CE 447	Stormwater Management	3
CE 482	Groundwater and Contaminant Transport	3
ECE 307	Basic Electrical Engineering	2
ECE 309	Electrical Engineering Laboratory	1
EES 410	Environmental Radiation Protection I	3
EES 411	Ionizing Radiation	3
CHE 321	Chemical Engineering Thermodynamics II	3
CHE 401	Transport Phenomena	3
CHE 450	Chemical Reaction Engineering	3
EE&S 802†	Environmental Engineering Principles	

†This intended for students seeking graduate education in environmental engineering. The student must satisfy the enrollment restrictions of the Graduate School.

Science Options

BIOCH 305	Essentials of Biochemistry	3
BIOCH 306	Essentials of Biochemistry Lab	1
BIOSC 410	Limnology	3
BIOSC 443	Freshwater Ecology	3
BIOSC 444	Freshwater Ecology Laboratory	2
CH 331	Physical Chemistry I	3
CH 332	Physical Chemistry II	3
CH 411	Instrumental Analysis	3
CH 412	Instrumental Analysis Lab	2
CH 413	Chemistry of Aqueous Systems	3
CSENV 485	Soil Chemistry	3
ENTOX 400	Wildlife Toxicology	3
ENTOX 421	Chemical Sources and Fate in Env Systems	4
ENTOX 430	Toxicology	3
GEOL 300	Environmental Geology	3
GEOL 318	Introduction to Geochemistry	3
GEOL 408	Geohydrology	3
GEOL 421	GIS Applications in Geology	3

MICRO 410	Soil Microbiology	3
EE&S 843‡	Environmental Chemistry	3
EE&S 851‡	Biological Principles of Environmental Engineering	3

‡This intended for students seeking graduate education in environmental engineering. The student must satisfy the enrollment restrictions of the Graduate School.

Proposed Changes to the Curriculum for the B.S. Degree in Environmental Engineering

I. Deletion of the Concentration

The major change to the degree program will be to delete the Natural Systems Concentration. The reasons include:

1) Low demand (only two students out of 42 thus far) combined with an inadequate number of faculty to teach the required courses; and

2) Establishing a more clear distinction between the Environmental Engineering degree and the Biosystems Engineering degree. We have found that the Concentration has created too much confusion among students regarding the differences between the two degrees, since the Concentration emphasizes areas that overlap. Now that both degrees are housed in the Department of Environmental Engineering and Earth Sciences, it is essential that a clear distinction be established between them.

Commensurate with deletion of the Natural Systems Concentration, the second paragraph in the Undergraduate Announcements that describes the degree should be *changed from:*

> The curriculum for the Bachelor of Science degree in Environmental Engineering consists of 128-130 credit hours and the Natural Systems Concentration also consists of 128-130 credit hours. The first two years of the program are common for all students enrolled in the degree. In the junior and senior years, students may select a core curriculum that emphasizes areas traditionally associated with environmental engineering, such as water and wastewater management, solid and hazardous waste management, air pollution control, pollution prevention and risk assessment. Alternatively, students entering their junior year may choose the Natural Systems Concentration, which places a greater emphasis on environmental processes in natural environments. All students participate in two professional seminar courses and complete a capstone design project.

To:

> The curriculum for the Bachelor of Science degree in Environmental Engineering consists of 128-130 credit hours. Students participate in a professional seminar course and complete a capstone design project.

II. Changes to the Map

Changes that involve moving courses to different semesters and/or years, addition of one course, and deletion of one course are outlined below:

Change	Reason
Moved CE 341 from the first semester junior year to the second semester junior year.	To balance the laboratory load. Since we added a lab to this semester (EE&S 403) and the students also take microbiology lab, we didn't want to have three labs in one semester.
Moved EE&S 430 from the first semester junior year to the first semester senior year.	To balance the course load.
Replaced "Humanities/Social Science Requirement" in the second semester freshman year with "HIST 124." The corresponding footnote was also reworded.	HIST 124 was originally specified in the footnote, where it was getting overlooked by the General Engineering advisors. Moving it to this slot avoids that problem. Our concern is with students who are unable to get a seat; we will monitor this to determine if it becomes a problem.
Moved EE&S 402 from the second semester junior year to the first semester junior year.	This course is essential for the capstone design. In the event students can't fit it in during their junior year, they can still take it their senior year and apply it to the capstone course the next semester.
Added EE&S 403 to the first semester junior year, as the lab component to EE&S 402.	We wanted students to have another lab within environmental engineering; previously, the only one was as a part of EE&S 202.
Moved the engineering economics requirement from the second semester junior year to the first semester junior year.	To balance the course load.
Moved the arts and humanities requirement from the second semester junior year to the second semester senior year.	To balance the course load.
Moved EE&S 485 from the second semester senior year to the second semester junior year.	This is a potentially important course for capstone design, so we wanted the students to take it earlier.
Deleted BE (EE&S) 451 in the second semester senior year.	This made room for EE&S 403. Also, we believe we can accomplish the objectives of the senior seminar in a single semester course (EE&S 450).
Added ENGR 141 as an acceptable substitute for ENGR 130.	To avoid the need to process a course substitution form.
Deleted BE 415 from the list of *Engineering Options*.	This course has a prerequisite that is not in the curriculum.
Moved the arts and humanities requirement from the first semester senior year to the second semester senior year.	To balance the course load.

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print New Course Form**

000121

Course Abbreviation & Number:
X **New Undergraduate Course:** PH SC- 117
.. **New Honors Course:** --
.. **New Graduate Course:** -

Effective Term: 01/2012
Catalog Title: Introduction to chemistry and earth science for elementary education majors
Transcript Title: INTRO CHEM & EARTH
Fixed Credit Course: 4 (3,3)
Variable Credit Course: -(-), (-)

Method of Instruction	Course Modifier	General Education Designation
..A-Lecture Only	..Pass/Fail Only	English
..B-Lab (w/fee)	XGraded	..Composition
..D-Seminar	..Variable Title	Oral
E-Independent	..Creative Inquiry	..Communication
..Study	..Repeatable	..Mathematics
..F-Tutorial (w/fee)	maximum credits:	Natural Science
..G-Studio		Xw/Lab
..H-Field course		..Math or Science
..I-Study Abroad		..A&H (Literature)
..L-Lab (no/fee)		A&H (Non-
N/B-Lecture/Lab		..Literature)
X(w/fee)		..Social Science
N/L-Lecture/Lab(no		..CCA
..fee)		..STS

Add cross-listing with the following child course(s):

Catalog Description: This course integrates topics in chemistry, earth science and environmental science. It emphasizes the interconnections among the various science disciplines and the practical application to experiments and activities appropriate for the elementary classroom. Credit toward a degree will be given for only one of PHSC 117 or 107.

Prerequisite(s): Elementary Education Majors or consent of instructor.

Projected Enrollment:
Year 1 - 90 Year 2 - 90 Year 3 - 90 Year 4 - 90

Required course for students in: Elementary Education Program

Statement of need and justification based on assessment results of student learning outcomes: This course fulfills a science content requirement for students in the elementary education program. In order for the Elementary Education program to meet their accreditation requirements (i.e. ACEI SPA requirements), their students need to show evidence that they "know, understand, and use fundamental concepts of physical, life, and earth/space sciences" (ACEI SPA Standard 2.2 Science). This course provides content that will help them address that need.

Textbook(s): Hill, J. W., McCreary, T.W., & Kolb, D. K. (2010). Chemistry for Changing Times (12th edition). Upper Saddle River, NJ: Pearson Education Inc.

Learning Objectives: • Construct ideas and connections between concepts to make sense of the ideas rather than simply memorizing isolated facts.
• Gain an appreciation for and understanding of the way science and scientists work.
• Develop an understanding of the interconnectedness of different science disciplines.
• Work cooperatively with others in small group settings to accomplish a common goal.
• Provide an adequate foundation in science content that will enable future teachers to teach science in elementary school.

Topical Outline: Week Lecture Topic
1 Measurements, and classification of matter.
2 Atoms (consult Ch.2)
3 Atomic Structure (consult Ch.3)
4 Introduction to chemical bonds (Consult Ch.4)
5 Minerals
6 Mole concept/ Chemical equations (Consult Ch.5)
7 Tuesday: Exam1, Thursday: Introduction to acids and bases. (Consult Ch.7)
8 Composition of earth (Consult Ch.12)

9 Chemistry of earth (Consult Ch.12)

10 Chemistry of the Atmosphere. (Consult Ch. 13)

11 Energy and fuel; global climate change (Consult Ch. 15)
12 Tues. :Exam 2, Thu.: the water cycle (Consult Ch. 14)
13 The water cycle and contaminations (Consult Ch. 14)
14 Earth's dwindling resources (Consult Ch.12)

Laboratories

Week Laboratories
1 Read and understand safety rules, formulate cooperative groups, introduction to lab work.
2 How is the mass of a liquid related to its volume?
3 Chemical changes

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4 Is mass conserved during chemical reaction?; Why are some reactions faster than others?
5 Minerals Identification
6 Visit to the Geology museum
7 How do we define operationally different classes of compounds?
8 No Labs
9 Minerals project presentation
10 Rock Identification
11 Acid Rain
12 Water Flow
13 No Labs
14 Big theme project presentation

Evaluation: Lab Reports 20%
Weekly homework assignments 5%
Class participation 5%
Two Exams (2@15%) 30%
Final Exam 20%
Minerals Project 10%
Big theme project 10%

TOTAL 100%

Learning Activities associated with General Education competencies (if applicable): Natural Science: Students will demonstrate scientific literacy by explaining and applying scientific principles when writing lab reports and projects.
Critical Thinking: Big theme project, requires students to critically demonstrate a phenomena, and explain it while making connections among the various science disciplines.

Form Originator: MNAMMOU,Minory Nammouz **Date Form Created:** 9/19/2011
Form Last Updated by: , **Date Form Last Updated:** 10/12/2011
Form Number: 4335

Approval

Thomas J. Williams	14 Oct 2011	Patricia W. Marshall	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Tanja Kostic	10/14/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Doris R. McLaurin	
Chair, College Curriculum Committee	Date	Provost	Date
R. Terry Harper	10/19/11		12/20/11
College Dean	Date	President	Date
			12/21/11
Director, Calhoun Honors College	Date		

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PHSC 117 INTRODUCTION TO CHEMISTRY AND EARTH SCIENCE FOR ELEMENTARY EDUCATION MAJORS	**Course Syllabus**

INSTRUCTOR:

Dr. Minory Nammouz
Office: 332A Brackett Hall
E-mail: mnammou@clemson.edu
Phone: 864-656-5014

COURSE DESCRIPTION

This course integrates topics in chemistry, earth science and environmental science. It emphasizes the interconnections among the various science disciplines and the practical application to experiments and activities appropriate for the elementary classroom. Credit toward a degree will be given for only one of PHSC 117 or 107.

COURSE LEARNING OUTCOMES

- Construct ideas and connections between concepts to make sense of the ideas rather than simply memorizing isolated facts.
- Gain an appreciation for and understanding of the way science and scientists work.
- Develop an understanding of the interconnectedness of different science disciplines.
- Work cooperatively with others in small group settings to accomplish a common goal.
- Provide an adequate foundation in science content that will enable future teachers to teach science in elementary school.

TEXTBOOKS AND OTHER MATERIALS:

- Hill, J. W., McCreary, T.W., & Kolb, D. K. (2010). *Chemistry for Changing Times (12th edition)*. Upper Saddle River, NJ: Pearson Education Inc.
- Experiments and other supplemental readings will be handed out in class and/or on Blackboard.
- Laboratory notebook (Laboratory book with carbonless copies that enables you to turn in the copy of your data pages at the end of lab).
- Safety goggles (must be worn at all times during lab)
- Scientific calculator

GRADING POLICY:

Your course grade will be determined based upon the total number of points you earn this semester. Each area of evaluative assessment will contribute as follows.

Lab Reports	20%
Weekly homework assignments	5%
Class participation (attendance + class activities)	5%
Two Exams (2@15%)	30%
Final Exam	20%
Minerals Project	10%
Big theme project	10%
TOTAL	100%

Grades are assigned based upon your final percentage of points earned:

90-100%: A 80-89.9%: B 70-79.9%: C 60-69.9%: D 59.9% and below: F

TIME STUDENTS WAIT FOR PROFESSOR ARRIVAL:

Students may leave after 20 minutes if the professor or a guest lecturer does not arrive in that time.

ATTENDANCE POLICY:

- Students are expected to arrive on time for class.
- If a student accumulates more than three unexcused absences prior to the final day to withdraw from the course, you may be dropped from class for non-attendance.
- Excused absences include documented illness, official university functions, court attendance, religious observances, military duty, and funeral attendance. Written documentation is required for the absence to be excused. The MyCLE absence notification system is NOT an official absence excuse.

ACADEMIC INTEGRITY STATEMENT:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

All work submitted for a grade must be your own, unless group work is assigned. All text included in assignments that was written by someone other than the student must be correctly quoted and cited.

Topical Outline

Week	Lecture Topic	Questions to be considered *(Cited from the NRC science Framework)	Laboratories
1	Measurements, and classification of matter.	" PS1: How can one explain the structure, properties, and interactions of matter? PS1.A: *How do particles combine to form the variety of substances one observes?"*	Read and understand safety rules, formulate cooperative groups, introduction to lab work.
2	Atoms (consult Ch.2)		How is the mass of a liquid related to its volume?
3	Atomic Structure (consult Ch.3)		Chemical changes
4	Introduction to chemical bonds (Consult Ch.4)		Is mass conserved during chemical reaction?; Why are some reactions faster than others?
5	Minerals	"PS1.B: Chemical Reactions: *How do substances combine or change (react) to make new substances? How does one characterize and explain these reactions and make predictions about them?"* ***Note: Understanding of chemical reactions and properties of elements are essential to the understanding of the later topics in earth science.***	Minerals Identification
6	Mole concept/ Chemical equations (Consult Ch.5)		Visit to the Geology museum
7	Tuesday: Exam1, Thursday: Introduction to acids and bases. (Consult Ch.7)		How do we define operationally different classes of compounds?
8	Composition of earth (Consult Ch.12)	"PS1.C: Nuclear Processes: *What forces hold nuclei together and mediate nuclear*	No Labs

		processes" Relation to Earth science: "ESS1. C: The History of Planet Earth: *How do people reconstruct and date events in Earth's planetary history?"* "ESS2. B: Earth Materials and Systems*: How do major earth systems interact?"*	
9	Chemistry of earth (Consult Ch.12)	"ESS3.A: Natural Recourses. How do humans depend on Earth's resources?"	Minerals project presentation
10	Chemistry of the Atmosphere. (Consult Ch. 13)	"ESS2. D: Weather and Climate. What regulates Weather and Climate?"	Rock Identification
11	Energy and fuel; global climate change (Consult Ch. 15)	"ESS3.D: Global Climate Change. How do people model and predict the effects of human activities on Earth's climate?"	Acid Rain
12	Tues. :Exam 2, Thu.: the water cycle (Consult Ch. 14)		Water Flow
13	The water cycle and contaminations (Consult Ch. 14)	"ESS2.C: The Roles of Water in Earth's Surface Processes"	No Labs
14	Earth's dwindling resources (Consult Ch.12)	"ESS3.B: Natural Hazards. How do Natural Hazards affect individuals and societies?" "ESS3.C: Human impacts on Earth systems. How do humans change the planet?"	Big theme project presentation
	Final Exam		

*National Research Council. (2011). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

Lab Reports:

Much of the work that you will do in this laboratory course will be done in cooperative groups; therefore lab reports will follow a specific format. Experiments and directions for recording and reporting results will be handed out and discussed during first lab meeting.

Homework:

Weekly homework will be assigned; you are responsible for turning all homework assignments no later than the assigned due date.

Exams:

The course will include two exams and a final.

Projects: (*the following is a brief description of the projects, detailed instructions will be provided later during the semester*)

MINERALS

The structure and properties of solid materials depend on chemical bonds and intermolecular interactions. Whether they are covalent, ionic, or a mixture of bonding types, bonds determine if something is hard or soft, easily broken down by acids and bases, and capable of being shaped into interesting forms. In this collaborative project your group will be asked to look up information about a mineral and to use on-line resources for imaging of solid structures to develop a power point presentation about a mineral from a list that will be provided.

BIG THEME PROJECT

This project, which is done individually, allows you to make this course a place where you take a question or problem of interest to you and explore it in more detail. The project will culminate in a poster you present at the last lab period of the semester and in a five-page paper that you write about the project. You will be expected to do some of your own literature research to support your project. The project topic has to be approved by the professor.

CLEMSON UNIVERSITY

Curriculum and Course Change System - Print New Course Form

000128

Course Abbreviation & Number:
X **New Undergraduate Course:** PH SC- 118
.. **New Honors Course:** --
.. **New Graduate Course:** -

Effective Term: 01/2012
Catalog Title: Introduction to Physics, Astronomy, and Earth Science for Elementary Education Majors
Transcript Title: INTRO PHYS & ASTRO

Fixed Credit Course: 4 (3,3)
Variable Credit Course: -(-), (-)

Method of Instruction	Course Modifier	General Education Designation
..A-Lecture Only	..Pass/Fail Only	English
..B-Lab (w/fee)	XGraded	..Composition
..D-Seminar	..Variable Title	Oral
E-Independent	..Creative Inquiry	..Communication
..Study	..Repeatable	..Mathematics
..F-Tutorial (w/fee)	maximum credits:	Natural Science
..G-Studio		Xw/Lab
..H-Field course		..Math or Science
..I-Study Abroad		..A&H (Literature)
..L-Lab (no/fee)		A&H (Non-
N/B-Lecture/Lab		..Literature)
X(w/fee)		..Social Science
N/L-Lecture/Lab(no		..CCA
..fee)		..STS

Add cross-listing with the following child course(s):

Catalog Description: This course integrates topics in physics, astronomy, and earth science. It emphasizes the interconnections among the various science disciplines and the practical application to experiments and activities appropriate for the elementary classroom. Credit toward a degree will be given for only one of PHSC 118 or 108.

Prerequisite(s): PHSC 117 or consent of instructor

Projected Enrollment:
Year 1 - 90 Year 2 - 90 Year 3 - 90 Year 4 - 90

Required course for students in: Elementary Education Program

Statement of need and justification based on assessment results of student learning outcomes: This course fulfills a science content requirement for students in the elementary education program. In order for the Elementary Education program to meet their accreditation requirements (i.e. ACEI SPA requirements), their students need to show evidence that they "know, understand, and use fundamental concepts of physical, life, and earth/space sciences" (ACEI SPA Standard 2.2 Science). This course provides content that will help them address that need.

Textbook(s): Physical Science by Bill W. Tillery

Learning Objectives: • Construct ideas and connections between concepts to make sense of the ideas rather than simply memorizing isolated facts.
• Gain an appreciation for and understanding of the way science and scientists work.
• Develop an understanding of the interconnectedness of different science disciplines.
• Develop explanations for observations about everyday natural phenomena.
• Work cooperatively with others in small group settings to accomplish a common goal.
• Provide an adequate foundation in science content that will enable future teachers to teach science in elementary school.

Topical Outline: Week Lecture Topic
1 Force, mass
2 Gravity and Kepler's laws of planetary motion
3 Causes of the seasons
4 Electricity and magnetism (in context of electric motors, lightning, and earth's magnetic field)
5 Electrical currents
6 flow of water in streams
7 Heat and energy in relation to climate and earth interior heat.
8 Waves (in context of water waves, sound waves, and seismic waves)
9 Waves, Cont.
10 Physics of light
11 Spectroscopy (the composition of suns and stars)
12 The scale of the earth and universe
13 History of earth and nuclear processes
14 Nuclear Processes, Cont.: fusion, fission and radioactive decays

Laboratories
Week Lab Topic
1 Introduction to labs
2 Force Lab I
3 Force Lab II
4 Electricity Lab I
5 Electricity Lab II
6 Project I Presentation
7 Stream processes and landscapes
8 Forms of energy
9 Sound lab

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10 Reflection and Refraction of light
11 Color addition and color vision
12 Project II presentation
13 Dating of rocks, fossils and geologic events
14 No Labs

Evaluation: Lab Reports 20%
Weekly homework assignments 5%
Class participation (attendance + class activities) 5%
Two Exams (2@15%) 30%
Final Exam 20%
Projects 20%

TOTAL 100%
Grades are assigned based upon your final percentage of points earned:
90-100%: A 80-89.9%: B 70-79.9%: C 60-69.9%: D 59.9% and below: F

Learning Activities associated with General Education competencies (if applicable): Natural Science:
Students will demonstrate scientific literacy by explaining and applying scientific principles in their lab report and projects assignments.
Critical Thinking:
Students are required to critically demonstrate and explain phenomena by making connections among the various science disciplines.

Form Originator: MNAMMOU,Minory Nammouz **Date Form Created:** 9/21/2011
Form Last Updated by: , Date Form Last Updated: 10/12/2011
Form Number: 4365

Approval

Thomas J. Queenan 14 Oct 2011		Patricia W. Marrow	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Tanja Karanfil	10/14/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Anne O. Nelson	
Chair, College Curriculum Committee	Date	Provost	Date
K. Todd Holloway	10/19/11	Doug O. Smith	12/20/11
College Dean	Date	President	Date
			12/21/11
Director, Calhoun Honors College	Date		

PHSC 118 INTRODUCTION TO PHYSICS ASTRONOMY AND EARTH SCIENCE FOR ELEMENTARY EDUCATION MAJORS	**Course Syllabus**

INSTRUCTOR:
Dr. Minory Nammouz
Office: 332A Brackett Hall
E-mail: mnammou@clemson.edu
Phone: 864-656-5014

COURSE DESCRIPTION

This course integrates topics in physics, astronomy, and earth science. It emphasizes the interconnections among the various science disciplines and the practical application to experiments and activities appropriate for the elementary classroom. Credit toward degree will be given for only one of PHSC 118 or 108. *Preq*: PHSC 117 or consent of instructor.

COURSE LEARNING OUTCOMES

- Construct ideas and connections between concepts to make sense of the ideas rather than simply memorizing isolated facts.
- Gain an appreciation for and understanding of the way science and scientists work.
- Develop an understanding of the interconnectedness of different science disciplines.
- Develop explanations for observations about everyday natural phenomena.
- Work cooperatively with others in small group settings to accomplish a common goal.
- Provide an adequate foundation in science content that will enable future teachers to teach science in elementary school.

TEXTBOOKS AND OTHER MATERIALS:

- Tillery, B. (2011). *Physical Science (9th edition)*. McGraw. Hill Co.
- Experiments and other supplemental readings will be handed out in class and/or on Blackboard.
- Laboratory notebook (spiral bound book with carbonless copies that enables you to turn in the copy of your data pages at the end of lab).
- Safety goggles (must be worn at all times during lab)
- Scientific calculator

GRADING POLICY:

Your course grade will be determined based upon the total number of points you earn this semester. Each area of evaluative assessment will contribute as follows.

Lab Reports	20%
Weekly homework assignments	5%
Class participation (attendance + class activities)	5%
Two Exams (2@15%)	30%
Final Exam	20%
Projects	20%
TOTAL	100%

Grades are assigned based upon your final percentage of points earned:

90-100%: A 80-89.9%: B 70-79.9%: C 60-69.9%: D 59.9% and below: F

TIME STUDENTS WAIT FOR PROFESSOR ARRIVAL:

Students may leave after 20 minutes if the professor or a guest lecturer does not arrive in that time.

ATTENDANCE POLICY:

- Attendance is required. Students are expected to arrive on time for class.
- If a student accumulates more than three unexcused absences prior to the final day to withdraw from the course, you may be dropped from class for non-attendance.
- Excused absences include documented illness, official university functions, court attendance, religious observances, military duty, and funeral attendance. Written documentation is required for the absence to be excused. The MyCLE absence notification system is NOT an official absence excuse.

ACADEMIC INTEGRITY STATEMENT:

"As members of the Clemson University community, we have inherited Thomas Green Clemson's vision of this institution as a 'high seminary of learning.' Fundamental to this vision is a mutual commitment to truthfulness, honor, and responsibility, without which we cannot earn the trust and respect of others. Furthermore, we recognize that academic dishonesty detracts from the value of a Clemson degree. Therefore, we shall not tolerate lying, cheating, or stealing in any form."

All work submitted for a grade must be your own, unless group work is assigned. All text included in assignments that was written by someone other than the student must be correctly quoted and cited.

Topical Outline

Week	Lecture Topic	Lab Topic
1	Force, mass	Introduction to labs
2	Gravity and Kepler's laws of planetary motion	Force Lab I
3	Causes of the seasons	Force Lab II
4	Electricity and magnetism (in context of electric motors, lightning, and earth's magnetic field)	Electricity Lab I
5	Electrical currents	Electricity Lab II
6	flow of water in streams	Project I Presentation
7	Heat and energy in relation to climate and earth interior heat.	Stream processes and landscapes
8	Waves (in context of water waves, sound waves, and seismic waves)	Forms of energy
9	Waves, Cont.	Sound lab
10	Physics of light	Reflection and Refraction of light

11	Spectroscopy (the composition of suns and stars)	Color addition and color vision
12	The scale of the earth and universe	Project II presentation
13	History of earth and nuclear processes	Dating of rocks, fossils and geologic events
14	Nuclear Processes, Cont.: fusion, fission and radioactive decays	
	Final Exam	

ASSESSMENTS

Lab Reports:

Much of the work that you will do in this laboratory course will be done in cooperative groups; therefore lab reports will follow a specific format. Experiments and directions for recording and reporting results will be handed out and discussed during first lab meeting.

Homework:

Weekly homework will be assigned; you are responsible for turning all homework assignments no later than the assigned due date.

Exams:

The course will include two exams and a final.

Projects:

Topical Project

Students will be asked to work in groups to search an assigned topic in detail by referring to a variety of references and present their findings.

Big theme project

This project, which is done individually, allows you to make this course a place where you take a question or problem of interest to you and explore it in more detail. The project will culminate in a poster you present at the last lab period of the semester and in a five-page paper that you write about the project. You will be expected to do some of your own literature research to support your project. The project topic has to be approved by the professor.

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print New Course Form**

Course Abbreviation & Number:
X **New Undergraduate Course:** GEOL- 125
.. **New Honors Course:** --
.. **New Graduate Course:** -

Effective Term: 01/2012

Catalog Title: Sustainable Resource Use
Transcript Title: Sust. Resource Use

Fixed Credit Course: 3 (3,0)
Variable Credit Course: 0-0 (0-0), (0-0)

Method of Instruction	Course Modifier	General Education Designation
X A-Lecture Only	.. Pass/Fail Only	.. English Composition
.. B-Lab (w/fee)	X Graded	.. Oral Communication
.. D-Seminar	.. Variable Title	.. Mathematics
.. E-Independent Study	.. Creative Inquiry	.. Natural Science w/Lab
.. F-Tutorial (w/fee)	.. Repeatable	X Math or Science
.. G-Studio	maximum credits:	.. A&H (Literature)
.. H-Field course		.. A&H (Non-Literature)
.. I-Study Abroad		.. Social Science
.. L-Lab (no/fee)		.. CCA
.. N/B-Lecture/Lab(w/fee)		X STS
.. N/L-Lecture/Lab(no fee)		

Add cross-listing with the following child course(s): ENSP 125

Catalog Description: This course explores the challenges our society faces in making the transition to renewable resource use in a way that is truly sustainable environmentally, economically and socially. The conflicting demands of each system will be examined and used to critically examine possible solutions using a systems based approach.

Prerequisite(s): None

Projected Enrollment:
Year 1 - 30 Year 2 - 30 Year 3 - 35 Year 4 - 40

Required course for students in:

Statement of need and justification based on assessment results of student learning outcomes: Many students lack a basic understanding of the challenges in applying the concepts of sustainability to their personal life and intended professional endeavors. This course will give them a foundation at looking at this issue in a holistic way and addressing problems using a system based approach.

Textbook(s): An Introduction to Sustainable Resource Use, Callum Hill, 2011; with selected readings from An Introduction to Sustainable Development, Peter P. Rogers, Kazi F. Jalal, and John A. Boyd; The End of Growth: Adapting to Our New Economic Reality, Richard Heinberg; World on the Edge, How to Prevent Environmental and Economic Collapse, Lester Brown, and others

Learning Objectives: Develop a holistic understanding of how natural, economic, and social systems interact to foster or prevent sustainability.
Understand the tradeoffs and limitations involved in seeking solutions to the challenges of sustainability using an approach that relies primarily on scientific and technologically breakthroughs.
The ability to think critically about the diversity of ethical issues raised by human interactions with the environment.
The ability to creatively and effectively apply the principles of sustainability to his or her own field of study.
Ability to cope with complexity by examining complex problems, and especially by hearing diverse perspectives on those problems and proposed solutions.

Topical Outline: Week 1 Nature of Science and Sustainability
Week 2 Challenges to Sustainability
Week 3 Thermodynamics, Energy, and Resource Flows
Week 4 Basic System Analysis
Week 5 Ethics and Economic Systems
Week 6 Equity and Worldwide Resource Flow
Week 7 Biodiversity and Sustainability
Week 8 Sustainable Land Uses
Week 9 Sustainability of Raising Animals as Food
Week 10 Sustainable Mining Practices
Week 11 Sustainable Use of Water Resources
Week 12 Sustainable Use of Energy
Week 13 Sustainable Use of Energy
Week 14 Sustainability and Global Climate Change

Evaluation: Assignments 20%
Essays 20%
Two Hour Tests 40%
Final Exam 20%

Learning Activities associated with General Education competencies (if applicable): Ethical Judgment - Using case studies, students will examine how technological advances and market driven systems have created a host of ethical dilemmas. They will need to propose solutions that are both economically and morally sustainable.

Natural Science - Through reading assignments and case studies, students will develop an understanding of the relationship between biological (biodiversity and ecosystem function), geological, and environmental principles that will be used to propose workable solutions to problems of sustainability. The laws of nature (such as thermodynamics) that will dictate the workability of energy based solutions are the same laws that govern the flow of energy and waste in biological systems.
Science, Technology and Society - Through the writing of essays and examining video documentaries, students will gain an understanding of the interplay between society and it's complex relationship with science and technology - particularly as it applies to the limits of S&T in solving societal problems relating to sustainable practices and solving ethical issues.

Form Originator: BRAMES,Scott Brame **Date Form Created:** 9/18/2011
Form Last Updated by: , Date Form Last Updated: 9/28/2011
Form Number: 4315

Approval

Thomas J. Overcamp	28 Sept 2011	Patrice W. Mimms	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Taylor Karanfil	9/28/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11		
Chair, College Curriculum Committee	Date	Provost	Date
R. Mark Roberts	10/19/11	Dennis R. Hall	12/20/11
College Dean	Date	President	Date
			12/21/11
Director, Calhoun Honors College	Date		
Approvals related to cross-listing require the following signatures:			
[Child Course] Chair, Department Curriculum Committee	Date	[Child Course] Chair, College Curriculum Committee	Date
Taylor Karanfil	9/28/11		
[Child Course] Department Chair	Date	[Child Course] College Dean	Date

ENSP 125/Geol 125, Sect. 400 (online)
Sustainable Resource Use

Instructor: Scott Brame brames@clemson.edu
332 Brackett 864-656-7167

Textbook: An Introduction to Sustainable Resource Use, Callum Hill, 2011

Grading:

Assignments	20%
Essays	20%
Hour Test 1	20%
Hour Test 2	20%
Final	20%

Grading scale:

A: 91-100
B: 81-90
C: 71-80
D: 61-70
F: below 61

Online Participation policy: Being that this is an online class it is expected and demanded that you are engaged on a daily basis in this class. In particular, you will want to keep up with the assigned readings as regular quizzes will be assigned on that reading. You are encouraged to use the discussion board to communicate with your fellow classmates.

Valuable information and resources for distance education students are available at http://www.clemson.edu/ccit/support_services/it_support/distance_education/index.html

Assignments: These are composed of both online quizzes and specific case studies for which you need to propose a reasonable solution. The timed quizzes designed to ensure you are completing the assigned reading and to reinforce important concepts. Please see the document on BB under Assignments >Quizzes called "Online Class Quiz and Test Guideline and Policy" for guidance on this issue.

Essays: Short Essays (400-500 words) will be assigned for specific readings and/or specific topics. The goal is to develop your organizational and analytical skills as it applies to expressing your thoughts through writing.

Hour Tests: Taken online using BB. You are given a window of time (usually 24 hours) and a time period (usually 1.5 hours) to complete them.

Powerpoints: For almost every reading there is a powerpoint to accompany the reading that gives you an idea of what the instructor thinks is important.

Course Goals: Develop a holistic understanding of how natural, economic, and social systems interact to foster or prevent sustainability. Understand the tradeoffs and limitations involved in seeking solutions to the challenges of sustainability using an approach that relies primarily on scientific and technologically breakthroughs. Develop the ability to think critically about the diversity of ethical issues raised by human interactions with the environment. Understand how to creatively and effectively apply the principles of sustainability to your own field of study. Learn how to cope with complexity by examining complex problems, and especially by hearing diverse perspectives on those problems and proposed solutions.

Reading Assignments and Schedule

Week 1	Nature of Science and Sustainability
Week 2	Challenges to Sustainability
Week 3	Thermodynamics, Energy, and Resource Flows
Week 4	Basic System Analysis
Week 5	Ethics and Economic Systems
Week 6	Equity and Worldwide Resource Flow
Week 7	Biodiversity and Sustainability
Week 8	Sustainable Land Uses
Week 9	Sustainability of Raising Animals as Food
Week 10	Sustainable Mining Practices
Week 11	Sustainable Use of Water Resources
Week 12	Sustainable Use of Energy
Week 13	Sustainable Use of Energy
Week 14	Sustainability and Global Climate Change

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Change/Delete Course Form** 000133

X **Change a Course - Abbrev & Number: GEOL- 409**
Corresponding Lab Course: GEOL-L-409
Corresponding Honors course: --
X **Add Honors course:** GEOL-H-409
Corresponding Graduate course: --
X **Add Graduate course:** GEOL- -609
Course Title: SUBSURFACE METHODS

Brief Statement of Change:
- add 409H and 609 sections; - change of course name; - update details of course content, catalog description, and prerequisites

Last Term taught: 1001 Effective Term: 01/2012	.. **Change Abbrev to:** .. **Change Number to:**
X **Change Catalog Title:** from: Subsurface Methods to: Environmental and Exploration Geophysics	X **Change Transcript Title:** from: SUBSURFACE METHODS to: Env & Exp Geophysics

.. **Change of Credit**	From: Fixed Credit: 4 (3,3) Variable Credit: - (-), (-)	To: Fixed Credit: (,) Variable Credit: - (-),(-)

.. **Add cross-listing with the following child course(s):**
.. **Delete cross-listing with the following child course(s):**
.. **Reverse Parent/Child relationship with:**

.. **Change Method of Instruction**		.. **Change Course Modifier**		.. **Change General Education Designation**	
from:	to:	from:	to:	from:	to:
.. A-Lecture Only	..	.. Pass/Fail Only	..	.. English Composition	..
.. B-Lab (w/fee)	..	X Graded	..	.. Oral Communication	..
.. D-Seminar	..	.. Variable Title	..	.. Mathematics	..
.. E-Independent Study	..	.. Creative Inquiry	..	.. Natural Science w/Lab	..
.. F-Tutorial (w/fee)	..	.. Repeatable	..	.. Math or Science	..
.. G-Studio	..	maximum credits		.. A&H (Literature)	..
.. H-Field course	..	from:		.. A&H (Non-Literature)	..
.. I-Study Abroad	..	to:		.. Social Science	..
.. L-Lab (no/fee)	..			.. CCA	..
X N/B-Lecture/Lab(w/fee)	..			.. STS	..
.. N/L-Lecture/Lab(no fee)	..				

X **Change Catalog Description:**
from: Develop an understanding of the principles and methods used to acquire, analyze, and interpret subsurface geological data. Emphasis on borehole measurements, seismic, gravimetric, magnetic, and electrical methods, and on their applications to hydrogeology, remediation, and oil and gas exploration.
to: Students develop an understanding of the principles and methods used to acquire, analyze, and interpret geophysical data. Emphasis on seismic/radar, gravimetric, and electromagnetic methods. Applications to hydrogeology, environmental engineering and science, soil science, contaminant transport and remediation, near surface geology, geotechnical problems, oil and gas exploration, and carbon sequestration.

X **Change Prerequisite(s):**
from: GEOL 313
to: GEOL 313 or consent of instructor

Learning Objectives: To provide students with a basic knowledge of the methods used to interpret the nature and distribution of rocks in the subsurface, and how these interpretations can be used in the exploration and management of earth resources. To meet these objectives, the course will provide students with a fundamental knowledge of:
(1) The principles upon which each of the methods is based;
(2) The mechanics of acquiring data for each method;
(3) The manner in which the data for each method are interpreted;
(4) The applications and limitations of each method.

Topical Outline: 1. Nature of rocks in the subsurface (2 weeks)
2. Wave based imaging (radar and seismic) (4 weeks)
3. Tomography & Geophysical Inverse Problems (1 week)
4. Potential fields (gravity) (1 week)
5. Principles and applications of electrical resistivity imaging (2 weeks)
6. Principles and applications of self potential measurements (1 week)
7. Principles and applications of induced polarization measurements (1 week)
8. Principles and applications of magnetic measurements (1 week)
9. Principles and applications of electromagnetic induction measurements (1 week)

Lab schedule:
1. rock physics
2. Matlab

3. waves
4. reflection surveying
5. Dix equation & diffraction
6. refraction
7. field work (GPR)
8. tomography
9. gravity
10. resistivity
11. field work (resistivity)
12. project (lab/field)
13. field work (EMI + project)
14. project (lab/field)

Evaluation: GEOL409
midterm exam - 15%
final exam - 20%
homework - 50%
project presentation - 15%

GEOL409H
midterm exam - 15%
final exam - 20%
homework - 40%
project presentation - 15%
project paper - 10%

GEOL609
midterm exam - 15%
final exam - 20%
homework - 30%
project proposal - 10%
project presentation - 5%
project paper - 20%

Duplication (if applicable): N/A

Add course requirements for honors and/or 600-level courses (if applicable): Additional work on assignments is required for honors and 600-level students. Additional work includes: mathematical derivations, computer programming, reviews of journal articles. Graduate students lead the group field projects in the course. Both GEOL409H and GEOL609 students are responsible for preparing a final written project report (GEOL409 students are only required to make a presentation).

Form Originator: SMOYSEY, Stephen Moysey **Date Form Created:** 3/23/2011
Form Last Updated by: , **Date Form Last Updated:** 9/23/2011
Form Number: 3989

Approval

Thomas J. Boudreau	28 Sept 2011	Carrie N. Mclaren	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Carla Koons	9/28/11		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Chris R. Helms	
Chair, College Curriculum Committee	Date	Provost	Date
R. Terry Weed	10/19/11		12/20/11
College Dean	Date	President	Date
			12/21/11
Director, Calhoun Honors College	Date		

SYLLABUS
GEOL409(H)/609: Environmental and Exploration Geophysics

Contact Information

Instructor:	Dr. Stephen Moysey
Office:	Brackett 338 (Ph. 656-5019)
Office Hours:	T-11:00-12:00, TH – 2:00-3:00, or by appointment
E-mail:	smoysey@clemson.edu
Blackboard:	Will be used to post announcements, discussions, and files required for the course.

Course & Lab Information

Class Time:	T/TH – 12:30-1:45
Class Location:	322 Brackett Hall
Lab Time:	T – 2:00-5:00
Lab Location:	Brackett 333 (Computer Lab) and Brackett 323 (go to the lab first)
Attendance:	The lecture and lab are integrated ad both are required parts of this course.

Attendance is mandatory for all lecture, lab and field activities. Note that off-campus fieldwork will be required for the lab and students should come dressed and prepared to endure the rugged conditions associated with working outdoors. On field work days come prepared to go directly to the site. If the instructor is no present at the start of the class period, students are expected to review the last classes content for at least 15 minutes prior to adjourning.

Required Textbook: *Introduction to Applied Geophysics* (2006, *H.R. Burger, A.F. Sheehan and C.H Jones,* Norton) - make sure to get the cd with the book if you buy it online instead of at the bookstore.
Other Recommended Books:
An Introduction to Applied and Environmental Geophysics (2011, J.M. Reynolds, Wiley)
Applied Geophysics (1990, W.M. Telford, L.P. Geldart, and R.E. Sheriff, Cambridge University Press)

Grades: Grades for GEOL409/409H/609 will be assessed using the grading scheme below. Students are advised that enrollment in GEOL409H and GEOL609 will include additional content beyond that required for students in GEOL409, including but not limited to problems of increased difficulty, mathematical derivations, and computer programming. GEOL409H students will be required to complete additional questions on homework assignments and prepare a paper reporting the results of their final project. In addition to extra homework and exam problems, GEOL 609 students are required to lead an undergraduate team in completing a group field project and will be responsible for producing a formal project proposal, overseeing the undergraduate project presentation and producing a detailed written report summarizing the project results.

	GEOL 409	**GEOL 409H**	**GEOL 609**
Mid-term Exam	15%	15%	15%
Final Exam	20%	20%	20%
Homework	50%	40%	30%
Project Proposal	N/A	N/A	10%
Project Presentation	15%	15%	5%
Project Paper	N/A	10%	20%
Total	***100%***	***100%***	***100%***

Course letter grades will be assigned as follows based on your overall percentage grade for the course:
A = 90-100%, B=75-90%, C = 60-75%, D = 45-60%, F <45%

Late Policy: A penalty will be given to any assignment turned in late (5% per day) and no assignment turned in 1 week after the due date will be graded without written prior consent on the instructor.

Exam Policy: Exams must be completed within the specified exam period. Exceptions will only be made if arrangements are made prior to the exam day and in accordance with University regulations.

Course Description

Students will investigate subsurface methods (primarily passive and active measurements of geophysical signals) to infer the structure of the earth and for monitoring subsurface processes. The course will combine an understanding of fundamental principles with a practical knowledge of field surveys.

Course Content

Topical overview

1. Nature of rocks in the subsurface (2 weeks)
2. Wave based imaging (radar and seismic) (4 weeks)
3. Tomography & Geophysical Inverse Problems (1 week)
4. Potential fields (gravity) (1 week)
5. Principles and applications of electrical resistivity imaging (2 weeks)
6. Principles and applications of self potential measurements (1 week)
7. Principles and applications of induced polarization measurements (1 week)
8. Principles and applications of magnetic measurements (1 week)
9. Principles and applications of electromagnetic induction measurements (1 week)

Lab schedule

1. rock physics
2. Matlab
3. waves
4. reflection surveying
5. Dix equation & diffraction
6. refraction
7. field work (GPR)
8. tomography
9. gravity
10. resistivity
11. field work (resistivity)
12. project
13. field work (EMI + project)
14. project

000142

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Change/Delete Course Form**

X **Change a Course - Abbrev & Number: PHYS- 122**
Corresponding Lab Course: --
Corresponding Honors course: PHYS-H-122
.. **Add Honors course: --**
Corresponding Graduate course: --
.. **Add Graduate course: --**
Course Title: PHYSICS WITH CAL I

Brief Statement of Change:
We are changing the mathematics co-requisite from MTHSC 106 to MTHSC 106 or MTHSC 107. This makes it clearer to students that a co-requisite of MTHSC 104 alone is not sufficient preparation for success in PHYS 122. MTHSC 104+107 = MTHSC 106, however, so students taking (but not having already completed) MTHSC 107 should be ready to take the PHYS 122 course.

Last Term taught: 1108 Effective Term: 08/2012	.. **Change Abbrev to:** .. **Change Number to:**	
.. **Change Catalog Title:** from: to:	.. **Change Transcript Title:** from: PHYSICS WITH CAL I to:	
.. **Change of Credit**	From: Fixed Credit: 3 (3,) Variable Credit: - (-), (-)	To: Fixed Credit: (,) Variable Credit: - (-),(-)

.. **Add cross-listing with the following child course(s):**
.. **Delete cross-listing with the following child course(s):**
.. **Reverse Parent/Child relationship with:**

.. **Change Method of Instruction**		.. **Change Course Modifier**		.. **Change General Education Designation**	
from:	to:	from:	to:	from:	to:
X A-Lecture Only	..	.. Pass/Fail Only	..	.. English Composition	..
.. B-Lab (w/fee)	..	X Graded	..	.. Oral Communication	..
.. D-Seminar	..	.. Variable Title	..	.. Mathematics	..
.. E-Independent Study	..	.. Creative Inquiry	..	.. Natural Science w/Lab	..
.. F-Tutorial (w/fee)	..	.. Repeatable	..	.. Math or Science	..
.. G-Studio	..	maximum credits		.. A&H (Literature)	..
.. H-Field course	..	from:		.. A&H (Non-Literature)	..
.. I-Study Abroad	..	to:		.. Social Science	..
.. L-Lab (no/fee)	..			.. CCA	..
.. N/B-Lecture/Lab(w/fee)	..			.. STS	..
.. N/L-Lecture/Lab(no fee)	..				

.. **Change Catalog Description:**
from:
to:

X **Change Prerequisite(s):**
from: Co-req: MTHSC 106
to: Co-req: MTHSC 106 or 107 or equivalent

Learning Objectives:
Topical Outline:
Evaluation:

Form Originator: JKING2, Jeremy King **Date Form Created:** 9/8/2011
Form Last Updated by: , Date Form Last Updated: 9/23/2011
Form Number: 4289

Approval

Jeremy B King	9/27/2011	Patricia H. Marcum	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Mark D Zion	9/27/2011		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11		
Chair, College Curriculum Committee	Date	Provost	Date
T. Danny Hooley College Dean	10/19/11	Doris R Helms	12/20/11

College Dean	Date	President	Date 12/21/11
Director, Calhoun Honors College	Date		

000144

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Change/Delete Course Form**

X **Change a Course - Abbrev & Number: PHYS- 207**
Corresponding Lab Course: --
Corresponding Honors course: --
.. **Add Honors course:** --
Corresponding Graduate course: --
.. **Add Graduate course:** --
Course Title: GENERAL PHYSICS I

Brief Statement of Change:
We are changing the Co-req from MTHSC 105 to MTHSC 102 or 104 or 105 since taking MTHSC 102 or 104 would also be an acceptable state of preparation for PHYS 207.

Last Term taught: 1108	.. **Change Abbrev to:**
Effective Term: 01/2012	.. **Change Number to:**
.. **Change Catalog Title:**	.. **Change Transcript Title:**
from:	from: GENERAL PHYSICS I
to:	to:

.. **Change of Credit**	From: Fixed Credit: 3 (3,0) Variable Credit: - (-), (-)	To: Fixed Credit: (,) Variable Credit: - (-),(-)

.. **Add cross-listing with the following child course(s):**
.. **Delete cross-listing with the following child course(s):**
.. **Reverse Parent/Child relationship with:**

.. **Change Method of Instruction**		.. **Change Course Modifier**		.. **Change General Education Designation**	
from:	to:	from:	to:	from:	to:
X A-Lecture Only	..	.. Pass/Fail Only	..	.. English Composition	..
.. B-Lab (w/fee)	..	X Graded	..	.. Oral Communication	..
.. D-Seminar	..	.. Variable Title	..	.. Mathematics	..
.. E-Independent Study	..	.. Creative Inquiry	..	.. Natural Science w/Lab	..
.. F-Tutorial (w/fee)	..	.. Repeatable	..	.. Math or Science	..
.. G-Studio	..	maximum credits		.. A&H (Literature)	..
.. H-Field course	..	from:		.. A&H (Non-Literature)	..
.. I-Study Abroad	..	to:		.. Social Science	..
.. L-Lab (no/fee)	..			.. CCA	..
.. N/B-Lecture/Lab(w/fee)	..			.. STS	..
.. N/L-Lecture/Lab(no fee)	..				

.. **Change Catalog Description:**
from:
to:

X **Change Prerequisite(s):**
from: Co-requisite: MTHSC 105 or equivalent
to: Co-requisite: MTHSC 102 or 104 or 105 or equivalent

Learning Objectives:

Topical Outline:

Evaluation:

Form Originator: JKING2, Jeremy King **Date Form Created:** 9/8/2011
Form Last Updated by: , **Date Form Last Updated:** 9/23/2011
Form Number: 4291

Approval

Jeremy R. King	9/27/2011	Carrie W. Anderson	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
Mahbub Gani	9/27/2011		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
	10/14/11	Doris R. Helms	12/20/2011
Chair, College Curriculum Committee	Date	Provost	Date
R. Terry Worley	10/19/11		12/21/2011
College Dean	Date	President	Date

Director, Calhoun Honors College ..... Date .....

CLEMSON UNIVERSITY **Curriculum and Course Change System - Print Change/Delete Course Form**

X **Change a Course - Abbrev & Number: PHYS- 221**
Corresponding Lab Course: --
Corresponding Honors course: PHYS-H-221
.. **Add Honors course:** --
Corresponding Graduate course: --
.. **Add Graduate course:** --
Course Title: PHYSICS WITH CAL II

Brief Statement of Change:
Because students utilize integral calculus in PHYS 221, we are adding a co-req of MTHSC 108 to ensure they have exposure to the tools they need to be successful in their second semester physics coursework.

Last Term taught: 1108 Effective Term: 01/2012	.. **Change Abbrev to:** .. **Change Number to:**
.. **Change Catalog Title:** from: to:	.. **Change Transcript Title:** from: PHYSICS WITH CAL II to:

.. **Change of Credit**	From: Fixed Credit: 3 (3,) Variable Credit: - (-), (-)	To: Fixed Credit: (,) Variable Credit: - (-),(-)

.. **Add cross-listing with the following child course(s):**
.. **Delete cross-listing with the following child course(s):**
.. **Reverse Parent/Child relationship with:**

.. **Change Method of Instruction**		.. **Change Course Modifier**		.. **Change General Education Designation**	
from:	to:	from:	to:	from:	to:
X A-Lecture Only	..	.. Pass/Fail Only	..	.. English Composition	..
.. B-Lab (w/fee)	..	X Graded	..	.. Oral Communication	..
.. D-Seminar	..	.. Variable Title	..	.. Mathematics	..
.. E-Independent Study	..	.. Creative Inquiry	..	.. Natural Science w/Lab	..
.. F-Tutorial (w/fee)	..	.. Repeatable	..	.. Math or Science	..
.. G-Studio	..	maximum credits		.. A&H (Literature)	..
.. H-Field course	..	from:		.. A&H (Non-Literature)	..
.. I-Study Abroad	..	to:		.. Social Science	..
.. L-Lab (no/fee)	..			.. CCA	..
.. N/B-Lecture/Lab(w/fee)	..			.. STS	..
.. N/L-Lecture/Lab(no fee)	..				

.. **Change Catalog Description:**
from:
to:

X **Change Prerequisite(s):**
from: Pre-req: PHYS 122
to: Pre-req: PHYS 122; Co-req: MTHSC 108, or equivalent MTHSC 111

Learning Objectives:
Topical Outline:
Evaluation:

Form Originator: JKING2, Jeremy King **Date Form Created:** 9/8/2011
Form Last Updated by: , **Date Form Last Updated:** 9/23/2011
Form Number: 4290

Approval

[signature]	9/27/2011	[signature]	11/4/2011
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculum Committee	Date
[signature]	9/27/2011		
Department Chair	Date	Chair, Graduate Curriculum Committee	Date
[signature]	10/14/11	[signature]	12/20/2011
Chair, College Curriculum Committee	Date	Provost	Date
[signature]	10/19/11	[signature]	12/21/2011
College Dean	Date	President	Date

Director, Calhoun Honors College	Date		

000148

CLEMSON UNIVERSITY **Curriculum and Course Change System - General Education Checklist**

Major Name: Mechanical Engineering

Specific General Education Requirements

Requirement	Select from Gen Ed List	Select from Restricted Gen Ed List	Specific Course(s)	No Change
		Specify restrictions - e.g. PHIL courses only	Specify courses or cluster* of courses if appropriate	
English Composition			ENGL 103	
Oral Communication*	..	..	..	X
Academic & Professional Development			..	X
Mathematics	..	..	..	X
Natural Science with lab	..	..	..	X
Math or Natural Science	..	..	..	X
Arts & Humanities (Literature)	..	X XX	..	..
Arts & Humanities (Non-Literature)	..	X XXX	..	..
Social Sciences	..	X XXX	..	..
Cross-Cultural Awareness	..	X XXX	..	..
Science and Tech. in Society	..	X XXX	..	..

*Departments may specify a cluster of courses to meet the Oral communication competency but must include a plan for implementation and assessment in the following textbox: *Departments may specify a cluster of courses to meet the Oral communication competency but must include a plan for implementation and assessment in the following textbox: In our ABET defined Program Objectives and outcome Criteria, we have the following defined outcome: "Mechanical Engineering graduates will be able to communicate through verbal and written means that are complete, succinct, clear, and convincing to make effective oral/visual technical presentations to peers and management; to prepare technical summaries and written reports that describe and document engineering studies". This objective (for oral communication) is achieved through continual emphasis, practice, instruction, and critique in the Senior Design Sequence (ME 401 and ME 402). Two criterion are used for assessment. Failure in any one of these criterion will result in a review of the program implementation. Criterion 1: 80% of faculty juries will indicate that students communicated effectively (capstone design jury surveys; departmental assessment committee is responsible). Criterion 3: 80% of respondents will agree or strongly agree that Clemson graduates communicate effectively (Employer Survey; departmental assessment committee is responsible).

We recognize the importance of oral communication in the engineering workplace. Engineering projects typically require teams of professionals, sometimes including members from outside engineering. We recognize that oral communication includes both speaking and careful, critical, respectful listening. Clear, complete but concise oral communication is a necessity in such team settings. Communication with management and peers outside the team require different approaches. We have established a series of required courses in which oral communication skills are developed at levels including personal (small team), group (team and 1st-level management), and public (peers, client, upper management). This oral communication competency is discussed in greater detail in the distributed communication section below.

Distributed Competencies

The faculties of each degree program will decide the most appropriate ways to integrate learning experiences in each of the areas below. Quantification in terms of credit hours is avoided in favor of the presumption that faculties will want to place a serious effort in each area and distribute this effort to a significant degree throughout their curricula.

Ethical Judgement Integration Plan - Address competencies, implementation, and assessment: Implemented through ME 200, ME 201, ME 400, ME 402, and the ME labs ME 333, ME 444. Furthermore, the faculty emphasizes the importance of and expectations for academic integrity in every ME class as a natural part of developing professional integrity in our students. More specifically, students discuss and develop their academic code of ethics after review of professional codes of ethics and academic honor codes. Students discuss basic issues such as what ethics is and is not, why it is important in our personal and professional lives, and what constitutes academic integrity.
In ME 201 students learn the basics of statics and dynamics and the importance these subjects play in our lives as consumers
and as engineers. At least one case study is introduced to make students aware of ethical dilemmas that engineers might face as
they practice engineering involved with this technical area. Discussion and critical thinking related to the case study are required.
Students relate case study issues to the personal framework they are developing to help them deal with ethical and professional
questions. Similar discussions take place throughout the curriculum.
In the junior and senior labs (ME 333 and 444) experimental data are developed, gathered, analyzed, and reported. The ethical
issues associated with these activities are discussed and expectations made clear to the students. Safety requirements,
including safety training and professional responsibilities associated with safe practice is required. Students are exposed to issues
associated with reporting unsafe working conditions and the ethical responsibilities of such.
The course ME 402 is the capstone design course in our curriculum. Students develop design solutions to an industry sponsored
project. Ensuring that the ethical issues involved with such projects have been addressed in a responsible way will be a part of
the design solution.
Finally, in the Senior Seminar course ME 400, ethical issues related to professional practice are discussed in a more general
sense, including guest led discussions from professionals such as from the Rutland Institute for Ethics. This discussion and
associated writing seek to solidify the ethical judgment that the students has developed over four years.
Our program objective and outcome criteria are defined for ABET. The Objective is defined as "Mechanical Engineering graduates
will be able to conduct their engineering work in a professional manner, cognizant of related ethical and contemporary issues, and
to continually improve their capabilities through life-long learning". It is the responsibility of the departmental assessment
committee to evaluate the three criteria. If a failure in any of the criteria is found, the department will review the related courses
and address immediately. Criterion 1: Average of Clemson student scores will be at or above the national average on questions related to ethics on the FE exam. Criterion 2: 80% of the respondents will agree or strongly agree that they are well prepared to function ethically, within societal context, and expectant of life-long learning (Exit Interviews in ME 400).

Communication Integration Plan - Address competencies, implementation, and assessment: We recognize the importance of communication, written, oral, and graphic, in the engineering workplace. Engineering projects typically require teams of professionals, sometimes including members from outside engineering. We recognize that communication includes both

formal documentation of work product completed and informal communication with peers and other collaborators. Clear, complete, and concise communication is a necessity in such professional settings. Communication with management and peers outside the team requires different approaches.
We require all students to take ENGL 314, a technical writing class, to ensure formal instruction in written communication from a
technical perspective. ME 222/333/444 (Mechanical Engineering Labs): Written lab reports are required at all levels of the
mechanical engineering lab sequence. These lab reports are collaborative efforts that focus on presenting the problem at hand,
the acquired and interpreted information, and the protocol under which this information was collected.
ME 401 (Mechanical Engineering Design): In this course, we prepare students for success in their final capstone design course.
Oral presentations and written communication are prepared and critiqued on a continual basis. Students submit weekly
documents on their work individually in addition to weekly executive summaries and intermediate design reports. Design reviews of
their project are critiqued by faculty and by guests.
ME 402 (Internship in Engineering Design): In this course, students address industry sponsored design projects and are compelled
to communicate with the client through written documentation and oral presentation. This includes executive summaries, budget
extension requests, approval of requirements documents, intermediate design reports, experimentation reports, prototyping
reports, concept reports, analysis and simulation reports, and others. The feedback to the students is provided through the
faculty advisory committee and external industry sponsors.
In our ABET defined Program Objectives and Outcome Criteria, we have the following defined outcome: "Mechanical Engineering
graduates will be able to communicate through verbal and written means that are complete, succinct, clear, and convincing to
make effective oral/visual technical presentations to peers and management; to prepare technical summaries and written reports
that describe and document engineering studies". This objective (for oral communication) is achieved through continual emphasis,
practice, instruction, and critique in the Senior Design Sequence (ME 401 and ME 402). Three criterion are used for assessment.
Failure in any one of these criterion will result in a review of the program implementation. Criterion 1: 80% of faculty juries will
indicate that students communicated effectively (capstone design jury surveys; departmental assessment committee is
responsible). Criterion 2: 80% of respondents will agree or strongly agree that the laboratory course sequence improved their
written communication skills (Laboratory Course Sequence Survey; departmental assessment committee is responsible). Criterion
3: 80% of respondents will agree or strongly agree that Clemson graduates communicate effectively (Employer Survey;
departmental assessment committee is responsible).

Critical Thinking Integration Plan - Address competencies, implementation, and assessment: This general education competency is perhaps the one most thoroughly integrated throughout our curriculum. By their very nature, engineering education and practice are based on reasoning, critical thinking, and problem solving. Foundational technical skills, knowledge, and understanding are developed primarily through building analytical, numerical, and physical models and then applying these models to solve problems. The problem solving mode requires reasoning in the formulation stages when various paths could be selected on which to create the

models. The actual solution stage normally involves application of mathematical or computational skills. The final stage in which results are interpreted, validated, and communicated requires critical thinking. The design process is a form of problem solving but in a more open-ended framework and rests more firmly on critical thinking skills. Here again, communication of the final design product requires critical thinking. Therefore, since our curriculum is centered around engineering problem solving and design, it can be said that it is centered around this broad general education competency and the overwhelming majority of our required courses focus on this competency. These courses are listed below with a very brief connection made to this competency.
CH 101, PHYS 122, 124, 221, Science Requirement – These courses of basic science are primarily focused on problem solving and
associated required reasoning and critical thinking processes. Both mathematical and experimental problem solving modes are
used.
MTHSC 106, 108, 206, 208, Numerical Analysis Requirement, Statistics Requirement – These courses in mathematics address
problem solving and associated required reasoning and critical thinking processes. Both mathematical and computational problem
solving modes are involved.
ENGR 141, EG 208, ECE 307 & 309 – These courses expose students to problem solving with computational support (ENGR 141),
with graphical support (EG 208), and from an electronics point of view (ECE 307, ECE 309).
ME 201, 202, 203, 302, 303, 304, 305, 306, 308, 312, 401, 402, 403, and three technical electives. These courses are the bulk
of our technical courses, as would be expected of an engineering program. They all involved problem solving along with reasoning
and critical thinking as the fundamentals and more advanced topics in both the structures and motion and the thermal and fluid
sciences stems of our curriculum are developed.
ME 222, 333, 444 – This laboratory sequence further develops this competency area through hands-on activities associated with
discovery of engineering fundamentals, measurement, instrumentation, data collection and processing, and reporting. Clearly all
these lab courses contribute to this general education area.
We are assessing the critical thinking competency through our second ABET defined objective and outcomes assessment
program. The responsibility of assessment is assigned to the departmental assessment committee and any deficiencies in the two
related criteria will trigger a review by the department of the related courses. The objective is "Mechanical Engineering graduates
will be able to: identify, formulate, and solve engineering problems through application of fundamental principles and techniques
from mathematics, science, and engineering with primary attention being focused on applications in thermal sciences, fluid
systems, structures, and mechanical systems". The outcomes are assessed as follows. Criterion 1: Students will pass at a rate
equal to or greater than the national average (assessed on the Fundamental of Engineering Exam). Criterion 2: Faculty juries will
indicate that 80% of students groups performed at or above expectations relative to this objective and the associated outcomes
(Capstone Design Jury Surveys).

Form Originator: LELAND, Linda Cocke **Date Form Created:** 3/8/2011
Form Last Updated by: LELAND, Linda Cocke **Date Form Last Updated:** 10/3/2011 **Form Number:** 3918

000152

Approval

		11/4/11
Chair, Department Curriculum Committee	Date	Chair, Undergraduate Curriculun
	10/3/11	
Department Chair	Date	Chair, Graduate Curriculum Com
	10/14/11	12/20/1
Chair, College Curriculum Committee	Date	Provost
		12/21
College Dean	Date	President

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CLEMSON UNIVERSITY **Curriculum and Course Change System - General Education Checklist**

Major Name: Chemical Engineering Biomolecular Concentration

Specific General Education Requirements

Requirement	Select from Gen Ed List	Select from Restricted Gen Ed List	Specific Course(s)	No Change
		Specify restrictions - e.g. PHIL courses only	Specify courses or cluster* of courses if appropriate	
English Composition			ENGL 103	
Oral Communication*	..	..	X ChE 307, 407, 433, 444	..
Academic & Professional Development			X ChE 443, 444	..
Mathematics	..	..	X MTHSC 106	..
Natural Science with lab	..	..	X Ch 101	..
Math or Natural Science	..	..	X MTHSC 108	..
Arts & Humanities (Literature)	X	..	..	..
Arts & Humanities (Non-Literature)	X	..	..	..
Social Sciences	X	..	..	..
Cross-Cultural Awareness	X	..	..	..
Science and Tech. in Society	X	..	..	..

*Departments may specify a cluster of courses to meet the Oral communication competency but must include a plan for implementation and assessment in the following textbox: Oral communication skills are developed in a four-course sequence, beginning with ChE 307. Basic instruction is provided on preparation and oral presentation of laboratory plans and analysis of experiment results. Each student makes and receives constructive feedback and a grade on two such presentations. In ChE 407 student ability is developed further through additional instruction and practice with respect to laboratory work. In ChE 433 the context changes to oral presentations on chemical process design projects. Each student must take an active role in two progress reports and a final presentation. Critique and instruction are provided after each progress report. The final project presentation is evaluated by a panel of professional practitioners as well as the course instructor. In ChE 444 student teams prepare and present a 40-minute talk on a current topic relevant to professional practice.

Evaluation of student performance on these activities is documented each year in our annual assessment report. If more than 20% of senior oral presentations are judged by the faculty or external design jury to be less than competent at the level expected of new BS graduates, the Undergraduate Committee must convene to investigate reasons for the deficiency in oral communication and recommend action to the faculty.

Distributed Competencies

The faculties of each degree program will decide the most appropriate ways to integrate learning experiences in each of the areas below. Quantification in terms of credit hours is avoided in favor of the presumption that faculties will want to place a serious effort in each area and distribute this effort to a significant degree throughout their curricula.

Ethical Judgement Integration Plan - Address competencies, implementation, and assessment: The Accreditation Board of Engineering and Technology (ABET) mandates that

graduates of accredited programs must understand their professional and ethical responsibilities. Chemical Engineering students are introduced to ethical responsibilities in the freshman courses, CES 102 and ChE 130. In all subsequent chemical engineering courses, ethical responsibilities of professional practice are discussed as appropriate to the technical topic. Assignments on ethics are not usually required in these courses, but the consistent message is that appropriate ethical conduct is a part of the profession. At the junior and senior level in ChE 307, 407, 431, and 433, ethical responsibilities become more concrete in the context of instruction and assignments related to health and safety in chemical process operations and environmental protection outside the plant boundaries. Each lab experiment plan prepared by the students must include a discussion of proper safety precautions. Safety and environmental protection are major categories of evaluation in the capstone design project. In addition, ChE 444 always includes one or more student oral presentations on aspects of business ethics in the practice of chemical engineering.

Evaluation of student performance on these issues is documented each year in our annual assessment report. If the average score of Clemson's senior level chemical engineering students is more than one standard deviation below the national average score on the ethics portion of the Fundamentals of Engineering Exam, the Undergraduate Committee must convene to investigate reasons for the deficiency in ethical judgment and recommend action to the faculty. [Note: We do not have access to scores of individual students on the FE exam. We receive information only on the number of students who passed (at Clemson and nationally) and the average score of students on each topic (at Clemson and nationally).]

Communication Integration Plan - Address competencies, implementation, and assessment: The ability to communicate effectively is another ABET-mandated Student Outcome that we must assess and evaluate annually to maintain program accreditation. Oral and written communications are developed together in the four-course sequence already described above. Though earlier courses frequently include oral presentations and narrative written assignments, formal instruction begins in ChE 307. Instruction is provided on written preparation or laboratory plans and reports of experiment results. Some of these assignments must be converted into and oral format. In ChE 307 each student makes and receives constructive feedback and a grade on six written reports and two oral presentations. Much of this work is done in team format, but individual work is broken out so that the skills of each student can be developed and evaluated. In ChE 407 communication skills are developed further through additional instruction and practice with respect to laboratory work. Normally five written reports and one oral presentation are required. In ChE 433 the context changes to chemical process design projects. Each student must take an active role in two progress reports and a final presentation. One interim and one final written report are required. These are not short assignments. The written reports are typically 50 pages each. Critique and instruction are provided after each interim or progress report. The final project report and presentation are evaluated by a panel of professional practitioners as well as the course instructor. In ChE 444 student teams prepare and present a 40-minute talk on a current topic relevant to professional practice.

Evaluation of student performance on these activities is documented each year in our annual assessment report. If more than 20% of senior oral presentations or written reports are judged by the faculty or external design jury to be less than competent at the level expected of new BS graduates, the Undergraduate Committee must convene to investigate reasons for the deficiency in communication skills and recommend action to the faculty.

Critical Thinking Integration Plan - Address competencies, implementation, and assessment: Five ABET-mandated Student Outcomes address critical thinking directly. These are the requirements that BS graduates must demonstrate:

- The ability to apply knowledge of math, engineering, and science,
- The ability to design and conduct experiments, and to analyze and interpret data,
- The ability to design a system, component, or process to meet needs within realistic

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constraints,
- The ability to identify, formulate, and solve engineering problems,
- The ability to apply engineering tools, skills, and techniques.

The undergraduate program in chemical engineering at Clemson is a blend of classroom instruction, laboratory practice, and project work designed to insure that all students develop these critical thinking skills, which are required to function successfully as an engineer. The courses that address critical thinking in greatest depth are:

- ChE 307 Unit Operations Lab I
- ChE 407 Unit Operations Lab II
- ChE 433 Process Design II

In the lab courses students are given specific objectives, but only general instructions. They must develop their own detailed lab plans to accomplish the objectives; they must write their own procedures; they must figure out how to reduce their experimental data to a form that addresses the objectives; and they must analyze their results, compare them to prior knowledge on the subject, and write a cogent report. This entire sequence is repeated at least seven times over the breadth of the two courses. The reports generated from each experiment are evaluated by the faculty teaching the course, and detailed critiques are returned to the students.

In the capstone design course (ChE 433) students are again given specific objectives but not detailed instructions. Each semester-long project is open-ended. Students must conduct an independent literature search to assess the current state of knowledge on their subject and use what they find to develop a solution to their assigned problem. Project reports are evaluated by the course instructor and by a team of external engineering practitioners.

Evaluation of student performance on these critical thinking activities is documented each year in our annual assessment report. The Undergraduate Committee must convene to investigate reasons for the deficiency in critical thinking skills and recommend action to the faculty if either of the following occurs:
- The percentage of Clemson's senior level chemical engineering students score who pass the Fundamentals of Engineering Exam is lower than the national average two years in a row,
- More than 20% of senior teams are judged by the faculty or external design jury to be less than competent at the level expected of new BS graduates in any area other than teamwork or communication skills.

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Form Number: 4442

Approval

Gooding	10/2/11	Carissa W. Thurmond 11/4/11
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Department Chair	Date	Chair, Graduate Curriculum Com
	10/14/11	Doris R. Helms 12/20/1
Chair, College Curriculum Committee	Date	Provost 12/21
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College Dean	Date	President