DEPARTMENT/PROGRAM: Biomedical Engineering  
COURSE PREFIX/NUMBER: BME 441/541  
PREVIOUS PREFIX/NUMBER: BME 441  
DATE OF LAST ACTION: 1/1/04  
COURSE TITLE: Biomechanics  
ABBREVIATED TITLE: BIOMECHANICS  
SCHEDULING: Fall  
Spring  
Summer  
Every Year  
Alt. Year Odd  
Alt. Year Even  
Other  
COURSE OFFERED BY: DISTANCE EDUCATION ONLY  
ON CAMPUS ONLY  
BOTH ON CAMPUS AND BY DISTANCE EDUCATION  
CREDIT HOURS: 3  
CONTACT HOURS: Lecture/Recitation 2  
Seminar  
Laboratory 3  
Problem 0  
Studio 0  
Independent Study/Research 0  
Internship/Practicum/Field Work 0  
GRADING: ABCDF  S/U  
INSTRUCTOR: Peter L. Mente, assistant professor  
Graduate Faculty Status: Associate  Full  
ANTICIPATED ENROLLMENT: Per semester 20  
Max. Section 20  
Multiple sections: Yes  No  
PREREQUISITE(S): ZO 160 or BIO 183; BME 342, ST 370  
COREQUISITE(S):  
PRE/Corequisite for Restrictive Statement: Credit is not allowed for both BME 441 and BME 541.  
CURRICULA/MINORS: Required: None  
Qualified Elective: BMF  
PROPOSED EFFECTIVE DATE: Spring 05  
APPROVED EFFECTIVE DATE: __________________________  
CATALOG DESCRIPTION (limit to 80 words):  
Students study human body kinematics, force analysis of joints, and the structure and composition of biological materials. Emphasis is placed on the measurement of mechanical properties and the development and understanding of models of biological material.  
RECOMMENDED BY:  
Department Head(s)/Director(s) of Graduate Programs  
Date  
ENDORSED BY:  
Chair(s), College Graduate Studies Committee(2)  
Date  
APPROVED:  
Dean of the Graduate School  
Date  
DOCUMENTATION AS REQUIRED:  
Please number all document pages  
Course Justification  
Proposed Revision(s) with Justification  
Student Learning Objectives  
Enrollment for Last 5 Years  
New Resources Statement  
Consultation with other Departments  
Syllabus (Old and New)  
Explanation of differences in requirements of dual-level courses  
REVISION:  
Content  
Prefix/Number  
Title  
Abbreviated Title  
Credit Hours  
Contact Hours  
Grading Method  
Pre-Corequisites  
Restrictive Statement  
Description  
Scheduling  
TYPE OF PROPOSAL:  
New Course  
Drop Course  
Course Revision  
Dual-Level Course  

Course Justification

BME 541 Biomechanics will serve as an introductory course in the area of biomechanics for incoming graduate students in the biomedical and industrial engineering departments. The new Biomedical Engineering Department with its biofluids and biomechanics track will increase the demand for an introductory biomechanics course for incoming graduate students. Topics to be covered include functional anatomy, static analysis of joint loading, dynamic analysis of motion, tissue material properties, and analysis of joint mechanics. Emphasis is placed on experimental techniques and the collection, analysis, and evaluation of experimental data.

Student Learning Objectives (See attached syllabus)

Consultation With Other Departments

Industrial Engineering

-------- Original Message --------

Subject: Re: new course and request to use your lab for class labs
Date: Thu, 09 Sep 2004 11:20:25 -0400
From: Gary Mirka <mirka@eos.ncsu.edu>
To: Peter Mente <plmente@unity.ncsu.edu>

References: <413CDE20.1000901@unity.ncsu.edu>

Peter (and to whom it may concern),

I fully support your proposal for the development of BME 541 as a grad level version of your BME 441 course. As you know I developed a similar course (IE 543 Musculoskeletal Mechanics) years ago and offered it regularly (every spring semester) for several years. Changes in the composition of our faculty in the area reduced my availability to teach this course, and, in fact, I have not offered it for several years. I think that there would be demand for this course from some of the ergonomics area students. My estimate is that 3-5 students/year would take this course.

Gary

Enrollment for Last 5 Years

The graduate subject matter of this course was most recently taught in the BAE department as BAE 522. That course was last taught formally in 2000. BAE 522 has not been taught since that time and has been dropped. Further updated material was taught in 2002 and 2003 as special topics. With the creation of the BME department, and the reassignment of the faculty member, the material is now formatted as a BME course that is compatible with dual listing with BME 441, and this is the topic of this course action.

<table>
<thead>
<tr>
<th>Year</th>
<th>Taught As:</th>
<th>Graduate Enrollment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>BAE 590 I</td>
<td>4</td>
</tr>
<tr>
<td>2002</td>
<td>BAE 590 I</td>
<td>11</td>
</tr>
<tr>
<td>2001</td>
<td>Not taught</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td>BAE 522</td>
<td>5</td>
</tr>
<tr>
<td>1999</td>
<td>Not taught</td>
<td></td>
</tr>
</tbody>
</table>

Resources

BME 541 will be a dual level course with BME 441, which already exists, no additional resources will be required.

Syllabus Attached.

Explanation of differences in requirements of dual-level courses (See attached syllabus)
SYLLABUS: BME 441/541 – Biomechanics

INSTRUCTOR
Dr. Peter L. Mente, Assistant Professor, Department of Biomedical Engineering
Office: 120 DS Weaver Labs
Phone: 515-6757
E-mail: plmente@unity.ncsu.edu

OFFICE HOURS
To be determined (TBD)

CLASS HOURS
TBD
Room: TBD

LAB HOURS
TBD
Room: TBD

REQUIRED TEXTBOOK
Basic Orthopaedic Biomechanics by Van C. Mow (Editor), Wilson C. Hayes (Editor) (1995).
Approximate cost $110.
Appropriate journal articles will be used to supplement the text.

COURSE PREREQUISITES
Students should have completed the following courses before taking BME 441/541:
ZO 160 or BIO 183: Introductory Biology
BME 342: Experimental & Analytical Methods in Biomedical Engineering Analysis
ST 370: Statistics

COURSE RESTRICTION
Credit is not allowed for both BME 441 and BME 541.

COURSE DESCRIPTION
Students study human body kinematics, force analysis of joints, and the structure and composition of biological materials. Emphasis is placed on the measurement of mechanical properties and the development and understanding of models of biological material mechanical behavior.

STUDENT LEARNING OBJECTIVES
At the conclusion of this course, the student will be able to:
1. Identify the basic molecular constituents of biological tissues and be able to explain how these molecules contribute to the structure and mechanical properties of the various tissues in the body.
2. Calculate the loading on the various components of the musculoskeletal system.
3. Describe the various body systems involved in human motion and explain the key muscular and skeletal actions in human movement.
4. Explain the techniques used to measure the kinematics and kinetics of motion and analyze the resulting data.
5. Explain the different theories used to model the material properties of biological tissues and choose an appropriate model for a given material.
6. Discuss how a tissue's material properties and make-up influence its performance.
7. Analyze the stresses and strains in a structural tissue.
8. Evaluate journal articles in the field of biomechanics.
9. Design an experiment to test a hypothesis on a topic in biomechanics.
10. Evaluate and critique a proposed experimental design.
11. Collect, analyze, and evaluate experimental data.
12. Write up and present experimental results in a form appropriate to the field of biomechanics.

DIFFERENCES IN REQUIREMENTS FOR BME 441 AND BME 541
A major portion of the course grade (25%) is based on the semester long lab project that students devise and carry out. On these projects undergraduates enrolled in BME 441 will be allowed to work in pairs while graduate students enrolled in BME 541 will have to work individually. Projects must be approved in advance by the instructor and the required level of sophistication in experimental design and analysis will be greater for graduate students than for undergraduate students.

POLICIES AND PROCEDURES
1. All students must have access to the Eos computing system. The instructor will communicate extensively with the class through email. The instructor will use email addresses for each student as on file with registration and records. It is highly recommend that students make their unity email accounts their “official” university accounts. To change the account listed by registration and records students may call 5-2572 and request a change. It is the student’s responsibility to make sure the university has the correct e-mail address and that the account is working and can accept e-mail. If you have problems with a university email account you should contact ITECS help desk 200 Page Hall (5-2458, eoshelp@ncsu.edu)

2. Absences and late or missed assignments can be excused for circumstances defined in NCSU’s attendance policy (http://www.ncsu.edu/policies/academic_affairs/pols_regs/REG205.00.4.php). Any arrangements for making up missed work must be made with the instructor in advance for non-emergency absences and immediately upon your return to class for emergency absences. In all cases, the instructor should be contacted prior to an absence if possible.

3. HONESTY AND INTEGRITY: Students are expected to adhere to the guidelines for academic integrity outlined in the NCSU Code of Student Conduct: (http://www.ncsu.edu/policies/student_services/student_discipline/POL11.35.1.php). Cheating and plagiarism will result in loss of credit for the entire test or assignment in question. Each student should solve the homework problems independently of other students. All assignments are assumed to represent the individual student’s own work; any group assignments where collaboration is allowed will be clearly identified. Discussions of problems and strategies to be used in solving homework problems are fine, when allowed (i.e. not on test problems), but shared solutions are not. Any material derived from others should be clearly identified by citation, quotation, or other explicit means. The instructor’s understanding and expectation are that by handing in a test or assignment the student is acknowledging that the honor pledge has been adhered to and that the student has neither given nor received unauthorized aid. Violations on any part of an assignment will result in a zero for the entire grade for the portfolio, homework, or test of which the problem is a part.

4. Reasonable accommodations will be made for any student with a verifiable disability. In order to take advantage of available accommodations, students must register with Disability Services at 1900 Student Health Center, Campus Box 7509, 5-7653. For more information see Disability Services for Students (www.ncsu.edu/provost/offices/affirm_action/dss/). For additional information on NC State's policy on working with students with disabilities, please see the Handbook for Teaching and Advising.

HOMEWORK
Assignments will be due at the beginning of the class period on the due date. Lab reports should follow the guidelines passed out in class. Late assignments will not be accepted without prior approval. Grades will be lowered 30% for homework turned in late (even with approval) without a valid medical or emergency excuse. Homework should be well organized and solutions presented in a clear and logical manner. Place a box around the final answer and any important intermediate values. Keep solutions in order, use only one side of a page and begin each new problem on a new sheet of paper. Neatness counts, be professional.

A major lab project testing a hypothesis developed by the student from an area of biomechanics must be completed and presented to the class in order to pass this course.

If there are any scoring problems or questions on labs or homework, turn the assignment in question back in to the instructor, within one week, with a written explanation of what you believe was marked or scored incorrectly.
EXAMS

There will be three tests, one of which will be given during the scheduled final exam time. The final exam will be comprehensive though it will concentrate on material covered after the second in class test. For tests, students will be responsible for the instructional objectives and material covered in lecture, reading assignments (which may not be covered in class), homework, and anything distributed in class. Test grades will not be curved.

No make-ups will be given for exams missed without prior approval or a valid medical or emergency excuse. If a student misses the final without a valid excuse, a zero will be averaged into her/his grade.

If there are any scoring problems or questions about grading, turn the test back in to the instructor, within one week, with a written explanation of what you believe was marked or scored incorrectly.

GRADING

The final grade will be computed as follows for those who complete the lab project.

Two in class tests 15% each
Final Exam 20%
Homework 10%
Lab Assignments 15%
Lab Project 25%

Those who do not complete the lab project will receive the grade of F in the course.

Grading Scale
The following grades are guaranteed for the stated weighted averages:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>97-100</td>
</tr>
<tr>
<td>A</td>
<td>93-96</td>
</tr>
<tr>
<td>A-</td>
<td>90-92</td>
</tr>
<tr>
<td>B+</td>
<td>87-89</td>
</tr>
<tr>
<td>B</td>
<td>83-86</td>
</tr>
<tr>
<td>B-</td>
<td>80-82</td>
</tr>
<tr>
<td>C+</td>
<td>77-79</td>
</tr>
<tr>
<td>C</td>
<td>73-76</td>
</tr>
<tr>
<td>C-</td>
<td>70-72</td>
</tr>
<tr>
<td>D+</td>
<td>67-69</td>
</tr>
<tr>
<td>D</td>
<td>63-66</td>
</tr>
<tr>
<td>D-</td>
<td>60-62</td>
</tr>
<tr>
<td>F</td>
<td>59 or less</td>
</tr>
</tbody>
</table>

Grades may be moved to the next higher level depending upon the student's participation in class.

LABORATORY SAFETY

Several laboratory exercises will require that students use potentially hazardous equipment. Students must read the lab safety manual before using any equipment and adhere to all safety requirements. Closed-toe shoes and appropriate protective safety equipment (eye goggles, gloves etc.) should be worn at all times. The lab instructor will review general lab safety practices and precautions for biohazards during the first lab period.

TOPICS AND SCHEDULE

<table>
<thead>
<tr>
<th>Week</th>
<th>Class Topic</th>
<th>Lab Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Functional Anatomy</td>
<td>Biohazards and Lab Safety</td>
</tr>
<tr>
<td>2</td>
<td>Functional Anatomy</td>
<td>Joint Anatomy Lab</td>
</tr>
<tr>
<td>3</td>
<td>Static Analysis, Calculating Forces in a Joint</td>
<td>Forces During a Squat Exercise (TK)</td>
</tr>
<tr>
<td>4</td>
<td>Anthropomorphic Measurements</td>
<td>Anthropomorphics</td>
</tr>
<tr>
<td>5</td>
<td>Muscles and Movement</td>
<td>EXAM 1</td>
</tr>
<tr>
<td>6</td>
<td>Basic Dynamics</td>
<td>EMG</td>
</tr>
<tr>
<td>7</td>
<td>Measuring Motion and Forces</td>
<td>Gait Analysis</td>
</tr>
<tr>
<td>8</td>
<td>Gait Analysis</td>
<td>Material Property Testing of Bone</td>
</tr>
<tr>
<td>9</td>
<td>Stress/Strain</td>
<td>Material Property Testing of Bone-Cont.</td>
</tr>
<tr>
<td>10</td>
<td>Elastic/Viscoelastic Properties</td>
<td>EXAM 2</td>
</tr>
<tr>
<td>11</td>
<td>Material Properties of Biological Materials</td>
<td>Material Property Testing of Ligaments</td>
</tr>
<tr>
<td>12</td>
<td>Material Properties of Biological Materials</td>
<td>Material Property Testing of Cartilage</td>
</tr>
<tr>
<td>13</td>
<td>Material Properties of Biological Materials</td>
<td>Lab Project</td>
</tr>
<tr>
<td>14</td>
<td>Biomatериалы/Biocompatibility/Rejection, Stress and Tissue Adaptation, Mechanical Factors in Healing</td>
<td>Lab Project Presentations</td>
</tr>
<tr>
<td></td>
<td>FINAL EXAM</td>
<td></td>
</tr>
</tbody>
</table>