Spring 2017

Stony Brook University
College of Engineering and Applied Sciences
Department of Biomedical Engineering
BME 260: Statics and Dynamics in Biological Systems
Section: 01
Course Instructor: David A. Rubenstein, PhD
Teaching Assistant: Marc Pomeroy and Elisabeth Steadman
Class Meeting Time: Monday, Wednesday and Friday; 9:00 – 9:53pm
Class Meeting Room: Javits 102
Instructor Office Hours: Monday 10:00 – 11:00am, Wednesday 1:00 – 2:00pm
Instructor Office Location: Bioengineering, Room 101
Instructor Contact Information: david.rubenstein@stonybrook.edu (please put course number in subject of email)
Teaching Assistant Office Hours: Tuesday 1:30 – 3:30pm/Thursday 11:00 – 1:00pm (MP); Tuesday 2:00 – 4:00pm/Thursday 2:00 – 4:00pm (ES)
Teaching Assistant Office Location: Bioengineering, Room 111
Teaching Assistant Contact Information: marc.pomeroy@stonybrook.edu and elisabeth.steadman@stonybrook.edu

COURSE DESCRIPTION

Fundamentals of engineering statics and dynamics in biological systems will be covered using vector methods. Covered topics will include free body diagrams, equilibrium of systems, rectilinear kinetics and kinematics, angular kinetics and kinematics, work, energy and momentum of biological systems. In parallel, the necessary anatomy and physiology of the organ systems including the musculoskeletal system, the nervous system and the cardiovascular system will be covered. This material will lead to a discussion on kinesiology. For more information, please refer to: http://sb.cc.stonybrook.edu/bulletin/current/

Course Pre-requisites
BME 100 and AMS 161 and PHY 125 or 131 or 141

COURSE LEARNING OBJECTIVES

- To provide an introduction to the study of statics and dynamics in biological systems
- Apply mathematical principles to model physiological systems of various complexity
- Describe relevant anatomy and physiology of cells, tissues, organs and organ systems
- Recognize and detail important feedback mechanisms and controls related to biomechanics

ABET LEARNING OUTCOMES

(a) *an ability to apply knowledge of mathematics, science and engineering* – this knowledge will be applied to human physiology in the context of biomechanics
(e) *an ability to identify, formulate and solve engineering problems* – engineering problems associated with biomechanics/kinesiology will be covered

COURSE REQUIREMENTS

Attendance and Make-Up Policy
All students registered for BME 260 are expected to be in class during all class periods. Homework assignments must be handed in at the beginning of class and class notes are the student's responsibility. Office hours are not reviews of the class but are intended as review sessions for specific problems. If you do not attend class and you miss any important announcement(s), it is the student's responsibility to find out what was announced.

Make-up exams will not be given, however, an equivalent project, as deemed by the instructor, may be given in its stead, if a legitimately documented reason can be provided to the appropriate administrative officials for missing the exam. Proof of reason for missing the examination must be provided in a timely fashion and accepted by the administrative officials.

Description and Schedule of Required Readings and Assignments.
Fundamentals of Biomechanics: Equilibrium, Motion and Deformation. 3rd Edition. By: Ozkaya, Springer. ISBN: 978-1461411499.
Fundamentals of Anatomy and Physiology. 10th Edition. By: Martini, Nath and Bartholomew, Pearson. ISBN: 978-0321928610.
Engineering Mechanics: Statics and Dynamics: 14th Edition. By: Hibbler, Pearson. ISBN: 978-0133915426.

Homework is due at the beginning of class on the specified due date. Late homework will not be accepted. All homework assignments should be typed (1 inch margins, 1.5 spaced, times new roman 12) and written in proper English. Equations can be typed fairly easily using an equation editor of your choosing, but if an equation editor is not readily available, please ensure that equations are written neatly and in the proper location within the assignment (e.g. leave a space for them when printing out the document). Make sure to show all calculations as necessary and that any assumptions are listed. Again, it is recommended that equations/calculations are typed to make the grading more reliable, however, neat hand-written assignments will be accepted. We will not accept "scratch-work."

Additionally, a standard BME portfolio is expected to be turned in by each student by the end of the class. A portfolio information document can be found on Blackboard. **As the class progresses**, it is expected that the student will keep his/her portfolio up-to-date, with graded assignments, notes and anything else that the student deems is necessary within the portfolio. Complete portfolios (Lastname_Firstname.pdf) are due to the instructor (upload to Blackboard) by 05/05/2017 at 12:00 pm (noon). More details regarding the portfolio can be found on the portfolio information document on Blackboard.

Cooperation is allowed on homework/projects but students **cannot** hand in the same assignment. The majority of the work must be from the individual. Any instance of copying from a solution manual, colleague's assignment, etc. will be handled according to the CEAS policy on academic integrity violations. If help is needed, please come to office hours before the date the assignment is due to ensure that you can complete the assignment in a timely manner. **For more information see the homework assignment information document on Blackboard. Note that the intention of homework is to illustrate your understanding of the material.**

Graded assignments will include homework assignments, quizzes and examinations that test the basic and applied understanding of statics and dynamics of biological systems. Examinations will be a mixture of short answer and quantitative problem solving. More information about the examinations will be provided approximately one week prior to the exam. More information about the specific homework assignments will be provided with each assignment.

Academic Integrity
The instructor, the Biomedical Engineering Department, the College of Engineering and Applied Sciences and Stony Brook University all take academic integrity very seriously. As such, all suspected cases of academic integrity violations will be reported directly to the College of Engineering Committee on Academic Standing and Appeals (CASA). For this class, a potential common academic integrity violation will be copying others work. This includes copying figures, equations, comments, findings, etc. directly and indirectly (e.g. paraphrasing) from any resource (primary sources, secondary sources, Wikipedia, google …). IF IT IS NOT YOUR WORK, YOU CANNOT SUBMIT IT AS YOUR OWN; THIS IS A VIOLATION OF THE ACADEMIC INTEGRITY POLICY. At this level of education, ignorance of what constitutes plagiarism and/or ignorance of what are acceptable practices on homework are NOT acceptable excuses for committing an academic integrity violation. Additionally, cheating, copying or otherwise trying to circumvent the intention of class assignments and the learning environment in general, constitute an academic integrity violation. You will be reported to CASA if your work is suspect. The instructor reserves the right to submit any (or all) assignments to plagiarism detectors. If you have any questions regarding academic integrity concepts or what constitutes a violation, it is the responsibility of the student to get them resolved prior to the deadline of the assignment (e.g. email the professor, attend office hours, etc.). More information on Stony Brook University integrity policies can be found on the following website (and others that you can link to): http://sb.cc.stonybrook.edu/bulletin/current/policiesandregulations/policies_expectations/responsibilities_integrity.php.
It is suggested that you familiarize yourself with these policies and the penalties associated with committing integrity violations.

Exams
Midterm/Final exams and unannounced/announced quizzes will be closed book exams.

Unannounced quizzes may be given at any time during the term. There is no make-up for missed quizzes. Quizzes have the same weight as one homework assignment and can cover any topic of the professor's choosing.

Midterm Examination – 03/24/2017 (in class) **Final Examination – 05/10/2017 (8:30-11:00pm, location TBN)**

Calculator Policy
Very simple; use the calculator that you feel most comfortable with. It can be a programmable calculator but you cannot have a program on the calculator that is associated with this course. Also, if your calculator can communicate with the internet or other calculators, these features must be disabled during exams. Any student found to violate this policy will receive a grade of zero on the exam on which they violated this policy and will be reported to the appropriate SBU academic integrity boards.

Grading Comments/"No-Calculator" Solutions
The correct answer to an engineering problem is **just** as important as the approach taken. If you do not get the correct answer, you **will not** get full credit. I take the approach that the overall approach/flow of the solution is worth approximately 70-80% of the total grade and the final solution is worth approximately 20-30% of the total grade. This means that if your calculator breaks during an exam, you can still receive a good portion of the credit for that problem. You can set-up the first calculation and state that the answer to that calculation is β, then use β in the next calculation to get γ, and so on. If the entire problem is set-up correctly but there are no calculations, you will receive 70-80% of the total points.

Class Schedule Comment
In general, Monday class periods are reserved for physiology discussions, Wednesday class periods are reserved for statics/dynamics principles and Friday is reserved for example problem solutions. I believe that it is better to "separate" the discussion on physiology and engineering principles, so that the complicated issues that are discussed in this course are not confounded by mixing what is discussed. Hopefully, the students will appreciate that, in general, the physiological principles that we are discussing on Monday can be described by the engineering principles that are discussed on Wednesday. Note that when problems are completed in-class, it is **more** important that you listen and understand why choices were made during the problem solution than just blindly copying down every step. Most (if not all) of the math you can replicate at home, if you understand the principles behind why we are doing the math.

Homework Format
Assignments are due at the beginning of the class period on the specified due date (the due dates can be found on the homework information sheet and with the homework assignments on Blackboard). The homework assignment sheet (posted on Blackboard) lists the specific homework due dates. Late homework will **NOT** be accepted (e.g. if the professor has started lecture, any homework not turned in, will be considered late). Each homework problem set must be stapled and marked with BME 260, your name and due date. It is **required** that the students in preparation of assignments employ a prescribed format which consists of the following steps:

1. **KNOWN:** After carefully reading the problem, state briefly and concisely what is known about the problem. Do not repeat the problem statement.

2. **FIND:** State briefly and concisely what must be found.
3. **SCHEMATIC AND GIVEN DATA:** Draw a schematic of the physical system to be considered, carefully identifying geometric parameters. Appropriately label all knowns and unknowns with arrows on the schematic. Label the diagram with relevant information from the problem statement, including coordinate directions. Nearly all problems require a schematic.
4. **ASSUMPTIONS:** List all simplifying assumptions that you feel to be pertinent to the problem.
5. **ANALYSIS:** Begin your analysis of the problem. Develop the analysis from *stated* fundamental principles, definitions, postulates, or assumptions, or from specifically named basic equations. Develop the analysis as completely as possible before substituting numerical values. Perform the calculations needed to obtain the desired results. It is often good to explain briefly in words, your proposed method of solution. Frequent reference to the schematic will be extremely helpful in organizing and explaining your approach.
6. **COMMENTS:** Where appropriate, discuss the results. Such a discussion may include a summary of key conclusions, a critique of the original assumptions, and an inference of trends obtained by performing *what-if* and *parameter sensitivity* calculations. Take the point of view that the problem isn't worth doing unless you can draw some conclusions or make some recommendations. It may be appropriate to extend the analysis to make your own contribution. Do not complain about the problem difficulty.

Choice of Problems

Many of the in-text problems are worked out, thus I do not see a point in "re-working" these problems within the class. I feel it is much more important to complete problems that you do not have access to. Therefore, it is important that students pay attention when problems are worked in-class, so that you have access to the material and can practice these problems on your own time. If you miss a problem solution, it is your responsibility to obtain the information, from other students, not from the professor or from the TA. The problems that are worked out in the text should be reviewed by the student on their own time. One of the best ways to be successful in this course is to work and rework as many problems as possible. Note that it is more important to listen to how problems are approached instead of trying to copy each and every step that the professor takes. Much of the math, you can do yourselves.

GRADING

Homework/Projects/Quizzes: 35% (the lowest one (1) HW assignment will be dropped; e.g. only 10 HW count; the project and any quizzes cannot be dropped)
Midterm: 25%
Portfolio: 5%
Cumulative Final: 35%

Final Grading Scale

$[95-100]=A$ $[89-95)=A-$ $[86-89)=B+$ $[82-86)=B$ $[79-82)=B-$ $[76-79)=C+$ $[72-76)=C$ $[69-72)=C-$ $[65-69)=D+$ $[60-65)=D$

After an assignment has been handed back, you have one week to challenge the grade (exception is the final – only grade calculations errors will be considered). You can challenge the homework only after a 24 hour grace period.

MEETING SCHEDULE – COURSE TOPICS (SUBJECT TO CHANGE)

Lecture Number	Class Date	Topic Covered in Class
	01/23/2017	**Class Introduction**
1	01/25/2017	Introduction to Statics and Dynamics
2	01/27/2017	Introduction to Force, Moment and Torque Vectors
3	01/30/2017	Muscle Tissue – Function, Organization and Characteristics of Skeletal Muscle
4	02/01/2017	Statics – Systems in Equilibrium
5	02/03/2017	Coplanar Force System – In Class Examples
6	02/06/2017	Nerve Tissue – Function, Action Potential and the Neuromuscular Junction
7	02/08/2017	Statics – Friction, Center of Gravity and Simply Supported Structures
8	02/10/2017	Simply Supported Structures and Friction – In Class Examples
9	02/13/2017	Muscle and Nerve Interactions – Excitation-Contraction Coupling
10	02/15/2017	Introduction to Dynamics – Linear Kinematics: Uniaxial Motion, Displacement, Velocity, Acceleration
11	02/17/2017	Uniaxial Kinematics of a Particle – In Class Examples
12	02/20/2017	Osseous Tissue, Bone Structure and the Axial and Appendicular Skeleton
13	02/22/2017	Dynamics – Linear Kinematics: Biaxial Motion, Normal-Tangential, Cylindrical, Dependent and Relative Motion
14	02/24/2017	Biaxial Kinematics of a Particle – In Class Examples
15	02/27/2017	Joints and Lubrication of Joints
16	03/01/2017	Dynamics – Planar Kinematics of a Rigid Body: Translation, Rotation and Absolute Motion Analysis
17	03/03/2017	Planar Kinematics of a Rigid Body – In Class Examples
18	03/06/2017	Introduction to Kinesiology
19	03/08/2017	Dynamics – Relative Motion Analysis, Instantaneous Center
20	03/10/2017	Planar Kinematics of a Rigid Body Relative Motion – In Class Examples
03/13/2017 – 03/17/2017 – Spring Break		

21	03/20/2017	The Extracellular Matrix of Animal Connective Tissue
	03/22/2017	Review – Physiology/Mechanics
	03/24/2017	**Midterm Exam** (Covers Material Through Lecture 17)
22	03/27/2017	Mechanisms of Cell Communications with External Signals
23	03/29/2017	Dynamics – Linear Kinetics of a Particle: Force and Acceleration
24	03/31/2017	Linear Kinetics of a Particle – In Class Examples
25	04/03/2017	Cardiovascular System: Blood and Heart Anatomy
26	04/05/2017	Dynamics – Planar Kinetics of a Rigid Body: Force and Acceleration
27	04/07/2017	Linear Kinetics of a Particle and Moment of Inertia – In Class Examples
28	04/10/2017	Cardiovascular System: Cardiac Cycle and Blood Vessels
29	04/12/2017	Dynamics – Planar Kinetics of a Rigid Body: Force and Acceleration, Equations of Motion
30	04/14/2017	Planar Kinetics of a Rigid Body – In Class Examples
31	04/17/2017	The Gastrointestinal System
32	04/19/2017	Dynamics – Kinetics of a Particle: Work and Energy
33	04/21/2017	Conservation of Energy, Power and Efficiency – In Class Examples
34	04/24/2017	Dynamics – Kinetics of a Rigid Body: Work and Energy
35	04/26/2017	Conservation of Energy of a Rigid Body – In Class Examples
36	04/28/2017	Dynamics – Kinetics of a Particle: Impulse and Momentum
37	05/01/2017	Dynamics – Kinetics of a Rigid Body: Impulse and Momentum
38	05/03/2017	Impulse-Momentum of a Particle and Rigid Body – In Class Examples
	05/05/2017	Review – Physiology/Mechanics

CLASS PROTOCOL

It is expected that all students will respect the learning environment of their colleagues and make sure that all cell phones (and other mobile devices that can "ring") are turned off during class periods. Checking social media, email, completing other assignments that are not related to this class should wait until after the class period ends. Any electronic device that rings, beeps, chirps or otherwise interrupts the class will be handed over to the professor for the remainder of the class. Students should not enter the class late as this may provide a distraction to other students. Students who continually enter the classroom late, for unexcused reasons, may have their final grade penalized.

CLASS RESOURCES

Library: This is a great resource for outside reading material on physiology and engineering matters. It is the student's responsibility to use this resource as they deem necessary to succeed in the class. Website http://www.library.stonybrook.edu/

Blackboard: This will be used extensively in class, for posting assignments, lecture material and other class business. Please make sure to check blackboard as needed. Main login: https://blackboard.stonybrook.edu/webapps/login/

Writing Center: Can help with any writing, for this class or others.
See: http://www.stonybrook.edu/commcms/writrhet/writing_center/writing.html, for more information.

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ELECTRONIC COMMUNICATION STATEMENT

Email and especially email sent via Blackboard (http://blackboard.stonybrook.edu) is one of the ways the faculty officially communicates with you for this course. It is your responsibility to make sure that you read your email in your official University email account. For most students that is Google Apps for Education (http://www.stonybrook.edu/mycloud), but you may verify your official Electronic Post Office (EPO) address at http://it.stonybrook.edu/help/kb/checking-or-changing-your-mail-forwarding-address-in-the-epo. If you choose to forward your official University email to another off-campus account, faculty are not responsible for any undeliverable messages to your alternative personal accounts. You can set up Google Mail forwarding using these DoIT-provided instructions found at http://it.stonybrook.edu/help/kb/setting-up-mail-forwarding-in-google-mail. If you need technical assistance, please contact Client Support at (631) 632-9800 or supportteam@stonybrook.edu.

DISABILITY SUPPORT SERVICES (DSS) STATEMENT

If you have a physical, psychological, medical or learning disability that may impact your course work, please contact DSS, ECC Building, room 128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and DSS. For procedures and information go to the following website: ttp://www.stonybrook.edu/ehs/fire/disabilities

ACADEMIC INTEGRITY STATEMENT

Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare and Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

CRITICAL INCIDENT MANAGEMENT:

Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.