Composite Course Syllabus: ENG EK301, Engineering Mechanics I

INSTRUCTORS

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Prof. Elise Morgan Section A3 E-mail: <u>efmorgan@bu.edu</u> Phone: (617) 353-2791 Office: Rm 221, 110 Cummington Mall Office hrs: M 11:30-1, Th 11:30-1 Prof. Raymond Nagem Section A2 E-mail: nagem@bu.edu Phone: (617) 353-5925 Office: Rm 420, 110 Cummington Mall Office hrs: MW 9:00-11:00

Prof. Frank DiBella Sections A4 E-mail: fdibella@conceptsnrec.com Phone: (617) 610 3005 (cell); 781 937 4718 Office: Rm 245, 110 Cummington Mall for special help sessions scheduled on Saturdays or Sundays Office hrs: Help by phone or direct e-mail

SECTIONS

A1: TR 1:30 – 3:15 pm, LSE B03 A3: TR 1:30 – 3:15 pm, EPC 209 A2: TR 9:00 – 10:45 pm, LSE B03 A4: MW 4:30 – 6:15 pm, SCI 117

GRADUATE STUDENT TEACHERS (GSTs)

A1: YiXin (Vera) Xu (<u>xuyx@bu.edu)</u>	A2: Rui Wu (<u>ruiw@bu.edu)</u>
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UNDERGRADUATE LEARNING ASSISTANTS (LAs)

A1: Kaya Adelzadeh (<u>kaya@bu.edu</u>)

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Course description for bulletin

Fundamental statics of particles, rigid bodies, trusses, frames, and virtual work. Distributed forces, uni-axial stress and strain, shear and bending moment diagrams. Application of vector analysis and introduction to engineering design. Includes design project.

Question-driven Course Synopsis

The big picture goal in EK301 is to understand, with increasing complexity, the manner in which forces are born by and distributed within static structures, when under the influence of one or more applied forces and the structure's own weight. Students will explore this basic goal by first analyzing basic structural elements, and then combining such elements into more complex, multicomponent systems. These systems will be studied in class via small-group and class-wide discussions, as well as individual problem sets, in-class quizzes and exams, and a course design project. Consistent and timely feedback will be provided in each of these scenarios.

Hub Learning Outcomes

Intellectual toolkit: Critical Thinking Intellectual toolkit: Creativity/Innovation

School, Department, and/or Program Outcomes.

EK301 is an Engineering Core course, and is a required course for all undergraduate majors and all Phase I LEAP students in the College of Engineering. Its prerequisite courses are PY211, and its corequisite courses are MA225 and EK125.

Course-Specific Objectives.

As an outcome of completing this course, students will:

i. Become proficient in the modeling and analysis of simple static mechanical systems, (2-D and 3-D particle and rigid body equilibrium, 2-D trusses and frames, virtual work, dry friction), and the effects of simplified loading scenarios (distributed forces, uni-axial stress and strain, internal shear and bending moments), including the use of appropriate diagrams (physical, free body, shear and bending moments). (A, E)

ii. Hub Unit (Creativity/Innovation): Gain experience in carrying out a complex, long term design project (2-D truss), including experimental measurement and statistical analysis of material properties, computer analysis of member forces to determine failure load, consideration of alternative designs to achieve an optimal outcome under cost and physical constraints, construction of a prototype, and testing of the prototype to confirm the theoretical prediction. (A, B, C, D, E, F, G, H, J, K)

iii. Gain experience in working in a team environment in group problems in class and in the design project. (D)

iv. Gain an appreciation for the importance of safety factors and engineering ethics through selected homework problems and in-class exercises and the consideration of the effects of over and under prediction of actual truss performance in the design project. (F)

v. Gain an appreciation of and a facility for producing well-organized and clearly written work to facilitate communications with others and review by supervisors. (G)

vi. Gain exposure to the greater engineering community through receiving announcements in class of Career Development Office and student professional society activities and through presentations in class on relevant contemporary issues via the Engineers in the Real World program and faculty research. (H, I, J)

vii. Hub unit: Critical Thinking. Gain an understanding of the physical laws that govern mechanics, be able to identify logical inconsistencies, and to think critically about the analytical steps required to accurately model such mechanical systems. (A, E)

Instructional Format, Course Pedagogy, and Approach to Learning

Instructors might find the <u>CTL BU Hub Guides</u> helpful for this section; elements of your statement of teaching philosophy may also be applicable.

Books and Other Course Materials

Required: R.C. Hibbeler, <u>Engineering Mechanics: Statics</u>, 14^{th} ed., Pearson Prentice Hall $(12^{th} - 13^{th} \text{ editions fine as well})$

Additional references:

Meriam, Kraige, & Bolton, <u>Engineering Mechanics Statics</u>, 8th ed., Wiley, 2015 Bedford, Fowler, & Liechti, <u>Statics and Mechanics of Materials</u>, Pearson Prentice Hall

Website/Digital Materials

The course website is on BlackBoard (<u>learn.bu.edu</u>). Electronic materials will be posted periodically throughout the semester, so check the website often for updates. These will include the course syllabus, homework solutions, and document for the truss project. Keep in mind that all sections will have the same homework and project assignments, but the quizzes and exams will be unique for each section.

Assignments and Grading Criteria

Assignments:

Your progress and evaluation for the course material will consist of weekly problem sets, weekly in-class quizzes, two in-class exams, a design project, and a final exam. The two lowest **quiz** grades will be dropped. The breakdown for the grade weighting is:

Homework7.5%Weekly quizzes17.5%Design project15%Each exam20%

Due to the importance of the design project, failure to participate in the project will result in a failing grade for the course. Nominally, the mean of the overall score in a section will set the dividing line between a B and a B-.

Grading Criteria:

One of the best methods to learn the material is to read the text *before* the material is presented in class, attend and pay attention in class, and work through the assigned problem sets. The course is structured to give you ample feedback regarding your understanding of the material through the problem sets and quizzes. By working through the problem sets, you will prepare yourself for the in-class quiz, which in turn will prepare you for the inclass exams. Assistance will be provided in the Discussion Section, so please seek out help if you need it!

Another helpful practice is to alternate teaching the problems to your classmates, which will force you to think about how to tackle and solve a problem. It is common for engineers to work in groups, so keeping in mind the Ethics Code, we encourage you to form groups to work out (but not copy) the problem sets. The quizzes and exams are solo efforts,

however, so it is in your best interest to make sure you understand the problem set and not rely too heavily on your classmates or the GST & LA.

A perfect homework solution (this applies to quizzes and exams as well) should be:

- (a) legible and well organized, with labeled Free Body Diagrams
- (b) demonstrate a thought process and worked-out steps
- (c) correct!

Each problem will be graded on a 10/7/0 scale. A high score of 10 indicates that you worked through the entire problem and came to a correct or mostly correct solution. A score of 7 indicates that you made a valiant effort and a 0 will be given for a minimal attempt or lack thereof. Partial credit will be given for all forms of evaluation, so steps (a) and (b) are in your best interest! If you are short on time (particularly for the quizzes and exams), please at least attempt to set up and show your steps for how to solve the problem. Please keep the following rules in mind when writing up your solution:

- (a) Your name, section number, and problem set number must appear at the top of every sheet.
- (b) Do not submit work that has ragged edges.
- (c) Start each problem on a new page.
- (d) Indicate the final solution by drawing a solid box around it.

Problem sets will be based on lecture material, and generally will be due at the beginning of the Wednesday/Thursday lecture. Since solutions to the problem sets will be posted following the final Thursday lecture, **late problem sets are not permitted** and will receive a zero.

Quizzes (~15 mins) will be *based* on the homework problems, and will be given on the lecture *following* the homework due date (typically on the next Monday/Tuesday). Each quiz will be graded on a 10-point scale. Your problem sets will likely not be graded and returned to you before the quiz, so please study the posted solutions to the problem sets in order to prepare for the quiz. The two lowest scores will be dropped, but if you miss a quiz **without prior arrangement**, you will be given a zero.

Resources/Support

Office hours: Each instructor will post their office hours by the beginning of the semester. EK301 instruction consists of your biweekly lecture section and an *open-door* discussion section. Your course registration asked you to sign up for a specific discussion section, but attendance is purely voluntary and you are not required to attend the section that you registered for; you can attend any discussion section. The discussion section is held in room 202 (110 Cummington Mall) and is run by the Graduate Student Teachers (GSTs) and Learning Assistants (LAs). The GST/LAs will be present to answer any questions you may have on the lecture material, as well as to provide basic homework assistance. Note that their job is not to do the homework for you! We recommend that you first try the homework on your own, and then visit the discussion section to get help from the GST or LA if you get stuck or have specific questions.

The hours are: Mon 6:30–9:15 pm, Tues 4:30–9 pm, Weds 4:30–9 pm

Accommodations for Students with Documented Disabilities: If you are a student with a disability or believe you might have a disability that requires accommodations, please contact the Office for Disability Services (ODS) at (617) 353-3658 to coordinate any reasonable accommodation requests. ODS is located at 19 Deerfield Street on the second floor.

Community of Learning: Class and University Policies

Class Policy: We expect that if you are registered for EK301, you should attend class. Most of the course material can be found in a textbook, but not everything, and you will be tested on what is covered in class, not what is simply covered in the textbook. Tuition at B.U. is expensive, so make the most of your time and money by taking advantage of all the resources you are paying for! We also expect that you will do your best to pay attention during lecture. You will have a busy schedule with many academic (and social) demands, so we know from experience that paying attention 100% of the time can be a difficult task. However, we do ask that you not distract your peers if your attention starts to wander. Please ignore all forms of non-approved (!) electronic communication temptation (texting, email, web surfing, etc) and turn off your cell phone during class.

While class attendance is highly encouraged, and successful students often report that attending class is one of the best ways to learn the material, the course faculty treat you as responsible adults with the ability to manage your priorities and therefore do not take attendance as a general rule. Most sections will experience a guest lecture from a BU Engineering alumnus, per invitation by the Dean's Office and its the Engineers in the Real World program. The course instructors are aware of and in agreement with Boston University's <u>Policy on Religious Observance</u>, whereby absences for any religious beliefs are understood and missed assignments on such occasions will be given a chance to be made up. Students are must notify their instructor in advance for such occasions.

Assignment Completion & Late Work.

Homeworks: Since solutions to the problem sets will be posted following the final Thursday lecture, **late problem sets are not permitted** and will receive a zero. *Quizzes:* We do not typically grant makeup quizzes, but in recognition of unforeseen events that could cause a quiz to be missed, we drop the two lowest quizzes. Makeup exams will be given only in extreme circumstances. It is your responsibility to let your instructor know as far in advance as possible of an unavoidable conflict or medical emergency.

Academic Conduct Statement

Cheating on homework, quizzes, exams, project reports, or any form of assignment, may be a form of plagiarism and is an infringement of every code of engineering ethics. Plagiarism is a serious academic offense and should not be taken lightly. Understanding your ethical responsibilities is an integral part of becoming a professional. A copy of the Code of Ethics of engineers, promulgated by the Accreditation Board for Engineering and Technology (ABET) and the National Society of Professional Engineers, can be found on the main course web site. Please recall that when you enrolled at Boston University, you agreed to an Academic Honesty Pledge. The Academic Conduct Code details your responsibilities as well as the results of code violations, and is posted at:

https://www.bu.edu/academics/policies/academic-conduct-code/

TECHNOLOGY and ACTIVE LEARNING in EK301

EK301 transitioned to a new lecture format starting in the Spring 2012 semester. Our hope is that this new format will better help you learn the material. Periodically throughout each lecture, you will work in 4-person groups on example problems.

Your instructor may opt to have your group work on an iPad tablet or some other means to document your work. A large part of the analysis in EK301 comes from successful diagnosis of the forces that act on a structure, so correctly drawing the relevant free body diagram(s) (FBD) is a vital but difficult first step. Use of the iPad during lecture will consist of you and your group writing down the steps you took to tackle the problem and wirelessly submitting the work, all within a 15-minute time period. The faculty and GSTs will circulate around the room to provide assistance if necessary, so don't hesitate to ask for help! At the end of the exercise the lecturer will review the work and highlight correct steps and common mistakes. The goal is to provide you with immediate feedback on your comprehension of the material (particularly on the graphical analysis), rather than have you wait several weeks for your graded assignments to be returned. Your files will additionally be available for download after lecture.

You will NOT be graded on the quality or correctness of your work, but don't be surprised if your group's work gets presented to the class during the feedback portion. Your names will not be publicized, but feel free to take credit if your steps were correct. However, since the feedback portion is as important as your work effort, you should show all the steps you followed to the solution, even if you're not sure if they're correct. Just try to be as systematic and orderly as possible so we can make sense of your work.

Groups

You will be assigned groups to work in throughout the semester. The purpose of the assignments is to generate a working conversation on how to tackle the problem, and working with someone who you don't necessarily know is a great way to learn. In order to cover the material in a timely fashion and to allow the faculty space to circulate through the lecture hall, please put your bags and coats in the back of the lecture hall when you enter, and sit in your group-designated seats during the entirety of the lecture. If you find you don't particularly enjoy your group, please try to make the best of things and take heart that the groups will be switched up twice throughout the semester. If you find you are experiencing serious problems with one or more group members, please discuss the matter with the faculty and we will try to resolve the situation. We will administer peer feedback surveys midway and at the end of each group setting, so you'll have a chance to let us know how things are going. You are free to choose your own group from within your section for the design project.

Please designate a member of your group to be in charge of drawing out your work. This person should not be solely responsible for the work! We ask that you rotate this role within your group as the lectures proceed.

iPad policy

In order to provide feedback on your analysis, you will work out the example problem on an iPad tablet based on your group discussion. The iPad is an ideal tool to enable the faculty to provide penalty-free feedback on your understanding of the concepts. One tablet and stylus will be provided for each group during lecture and will be distributed and collected at the beginning and end of each lecture. The iPad is an ideal tool for getting distracted from the course! As such, we expect a high level of responsibility for your use of these devices. They should be used only to work out the problem, and not, for example, be used to play Angry Birds or catch up on Facebook (internet access, iTunes, and app installation have been disabled to remove all temptations!).

EK301 Spring 2019 Semester Tues/Thurs Schedule and Syllabus]			
L#	Date	Reading	Agenda	Quiz # on	HW	HW on
1	1/22	C2:1-7	Introduction, vector review			
2	1/24	C3:1-4	Multiple forces, static equilibrium			
3	1/29	C3:1-4	Internal tensions	Q0 (Ethics)		
4	1/31	C2:8-9	Dot product, projections		#1 due	L1,2
5	2/5	C4:1-4	Moments; Cross product	Q1 (HW 1)		
6	2/7	C4:5-8	Moment projections; couples; equivalent systems		#2 due	L3,4
7	2/12	C5:1-3	2-D static equilibrium; Project introduction	Q2 (HW 2)		
8	2/14	C5:1-3	Supports, reaction forces		#3 due	L5,6
9	2/21	C5:1-3	Reaction forces	Q3 (HW 3)		
10	2/26	C5:4,7	Static indeterminancy; 2-3 force members		#4 due	L7,8
11	2/28	C5:5	3-D supports and static equilibrium	Q4 (HW 4)		
12	3/5	C5:5, C6:1-3	Truss analysis: Method of joints		#5 due	L9, 10
13	3/7	Thru HW 4	EXAM 1 (covers through HW 4 material)			
14	3/19	C6:4	Truss analysis: Method of sections	Q5 (HW 5)		
15	3/21	C6:6	Frames 1		#6 due	L11, 12, 14
16	3/26	C6:6	Frames 2			
17	3/28	C6:6	Frames 3/Frames module	Q6 (HW 6)		
18	4/2	C8:1-3	Dry Friction (structures, wedges)		#7 due	L15, 16
19	4/4	C9:1-2	Distributed forces: centroids	Q7 (HW 7)		
20	4/9	Thru HW 7	EXAM 2 (covers through HW 7)			
21	4/11	C4:9, C9:4	Centroids & COM continued; distributed forces		#8 due	L17, 18
22	4/16	C7:1-3	Shear/bending	Q8 (HW 8)		
23	4/18	C7:1-3	Shear/bending moment eqns & diagrams		#9 due	L19, 21
24	4/23	C11:1-3	Virtual work	Q9 (HW 9)		
25	4/25	C11:1-3	Virtual work		#10 due	L22, 23
26	5/30	C11:1-3	Virtual work	Q10 (HW 10)		
27	5/2	Class Notes	Uni-axial stress/strain		#11 due	L24-26

IMPORTANT SEMESTER DATES	
2/11-2/15	Straw testing
2/26	Last day to drop without a 'W'
3/22	Straw testing report due
4/5	Last day to withdraw (with a 'W')
4/5	Preliminary design report due
4/26	Final design report due
4/27	Truss testing

EK301 Spring 2019 Semester Mon/Weds Schedule and Syllabus						
L#	Date	Reading	Agenda	Quiz # on	HW	HW on
1	1/23	C2:1-7	Introduction, vector review			
2	1/28	C3:1-4	Multiple forces, static equilibrium			
3	1/30	C3:1-4	Internal tensions	Q1 (Ethics)		
4	2/4	C2:8-9	Dot product, projections*		#1 due	L1,2
5	2/6	C4:1-4	Moments; Cross product	Q2 (HW 1)		
6	2/11	C4:5-8	Moment projections; couples; equivalent systems		#2 due	L3,4
7	2/13	C5:1-3	2-D static equilibrium; Project introduction	Q3 (HW 2)		
8	2/19	C5:1-3	Supports, reaction forces		#3 due	L5,6
9	2/20	C5:1-3	Reaction forces	Q4 (HW 3)		
10	2/25	C5:4,7	Static indeterminancy; 2-3 force members		#4 due	L7,8
11	2/27	C5:5	3-D supports and static equilibrium	Q5 (HW 4)		
12	3/4	C5:5, C6:1-3	Truss analysis: Method of joints		#5 due	L9, 10
13	3/6	Thru HW 4	EXAM 1 (covers through HW 4 material)			
14	3/18	C6:4	Truss analysis: Method of sections	Q6 (HW 5)		
15	3/20	C6:6	Frames 1		#6 due	L11, 13, 14
16	3/25	C6:6	Frames 2	Q7 (HW 6)		
17	3/27	C6:6	Frames 3/Frames module		#7 due	L15, 16
18	4/1	C8:1-3	Dry Friction (structures, wedges)	Q8 (HW 7)		
19	4/3	C9:1-2	Distributed forces: centroids		#8 due	L17, 18
20	4/8	C4:9, C9:4	Centroids & COM continued; distributed forces			
21	4/10	Thru HW 7	EXAM 2 (covers through HW 7)			
22	4/17	C7:1-3	Shear/bending		#9 due	L19, 21
23	4/22	C7:1-3	Shear/bending moment eqns & diagrams			
24	4/24	C11:1-3	Virtual work	Q9 (HW 9)		
25	4/29	C11:1-3	Virtual work		#10 due	L22, 23
26	5/1	C11:1-3	Virtual work/Uni-Axial stress/strain	Q10 (HW 10)		
27	5/2	Class Notes	Uni-axial stress/strain		#11 due	L24-26

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