# Boston University ENG EK 301: Engineering Mechanics I
# SYLLABUS FOR FALL 2019

**NOTE:** You are expected to read through this document and be familiar with the policies and dates described within; print out, sign, and pass in the signature page with your first homework assignment. Some dates may be subject to change; changes will be announced in class, via email, and on the website. Check this document prior to emailing your instructors for logistical information.

## INSTRUCTORS


Prof. Michael Albro
Section A3
E-mail: albro@bu.edu
Phone: (617) 353-9953
Office: Rm 307, 110 Cummington Mall
Office hrs: Mon 4:30-6 pm

Prof. Caleb Farny
Section A2
E-mail: farny@bu.edu
Phone: (617) 353-8664
Office: Rm 207, 110 Cummington Mall
Office hrs: Tues 10:30-12:30, Wed 9-11, or by appt

Prof. Raymond Nagem
Sections A1, A4
E-mail: nagem@bu.edu
Phone: (617) 353-5925
Office: Rm 420, 110 Cummington Mall
Office hrs: MW 9-11 am

Prof. Katherine Zhang
Sections A5, A6
E-mail: yanhang@bu.edu
Phone: (617) 353-4406
Office: Rm 219, 110 Cummington Mall
Office hrs: MW 9:45-10:45am, or by appt


## SECTIONS, GRADUATE STUDENT TEACHERS, LEARNING ASSISTANTS

A1 (Nagem): Tues/Thurs 9-10:45 am, LSE B03. GST: Xuedong Zhu (xdzhu@bu.edu)
LA: Federico Coppo (fcoppo@bu.edu)
A2 (Farny): Tues/Thurs 1:30-3:15 pm, PHO 203. GST: Yilin Zhu (ylzhu96@bu.edu)
LAs: Priyan Pathirana (priyanp@bu.edu), Thayanie Sandrakumar (thayanie@bu.edu)
A3 (Albro): Mon/Weds 2:30-4:15 pm, EPC 209. GST: Yuying Tan (tyuying@bu.edu)
LAs: Sierra Carter (smcarter@bu.edu), Wenhao Yang (ywh@bu.edu)
A4 (Nagem): Tues/Thurs 3:30-5:15 pm, EPC 209. GST: Chuqiao Huyan (cqhuyan@bu.edu)
LAs: Prudence Aquiatan (pdna@bu.edu), Huiru Huang (huiruh@bu.edu)
A5 (Zhang): Mon/Weds 12:20-2:05 pm, PHO 210. GST: Alexei Sondergeld (asonderg@bu.edu), LAs: Dominic Asciutto (dominicj@bu.edu), Drue Davis (drued@bu.edu)
A6 (Zhang): Mon/Weds 2:30-4:15 pm, PHO 210. GST: Eric Bressler (emb1@bu.edu)

### Course description

Fundamental statics of particles, rigid bodies, trusses, frames, and virtual work. Distributed forces, 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 Foundation Phase 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).

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)

**Books and Other Course Materials**
**Required:** R.C. Hibbeler, Engineering Mechanics: Statics, 14th ed., Pearson Prentice Hall (12th – 13th editions fine as well)
**Additional references:**
Meriam, Kraige, & Bolton, Engineering Mechanics Statics, 8th ed., Wiley, 2015
Bedford, Fowler, & Liechti, Statics and Mechanics of Materials, Pearson Prentice Hall

**Website/Digital Materials**
The course website is on BlackBoard (learn.bu.edu). 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:

| | |
|---|---|
| Homework | 7.5% |
| Weekly quizzes | 17.5% |
| Design project | 15% |
| Each exam | 20% |

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:
**PROBLEM SETS AND QUIZZES**
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 in-class 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 10/7/3/0 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, 3 points designates a few correct steps, 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.

**PROJECT**

A chief activity of an Engineer is to apply their skills to design and build, not just study. The goal of an engineering education is to develop the ability to apply your course work to recognize, define, and solve real problems in creative but practical ways. There are many aspects of engineering practice that are as important as writing and solving equations. In EK301 we will introduce you to some of these aspects through an exciting design contest.

The contest will involve designing, building, and testing a truss made from soda straws and straight pins. The truss will have to bridge a pre-specified distance and support a minimum load. You will have to experimentally determine certain physical properties of the soda straws, and use your measurements to analyze and optimize your design to support as much weight as possible. The project will culminate in a contest in which your truss will be loaded until it collapses. Your grade will depend, in part, on how close the results of your failure analysis come to the actual failure results during testing. Further details will be presented later in the semester.

**EXAMS**

There will be two in-class exams given during the semester, administered in class on October 9/10$^{th}$ and November 12/13$^{th}$. **DO NOT MAKE TRAVEL PLANS FOR THESE DATES.**
The final exam will be given during the final exam period. Since the Registrar will set the date later during the semester, **DO NOT MAKE TRAVEL PLANS BEFORE THE END OF THE EXAM PERIOD**.
Make-up 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.

If you qualify for extended time on exams, per evaluation from the Office of Disability Services, it is your responsibility to present your documentation to your instructor at **least** a week before the first exam. If you expect to receive extended time based off previous semesters, please let your instructor know at the beginning of the semester, even if you haven't received your documentation yet. We cannot accommodate last-minute requests (less than a week prior to the first exam) for extended time.

**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-doo*r 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 3:30–9 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 Offfice and its the Engineers in the Real World program. The course instructors are aware of and in agreement with Boston University's Policy on Religious Observance, 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 strongly encouraged to notify their instructor in advance, particularly if an accommodation must be made, 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. To allow for unforeseen circumstances when you're unable to submit a homework assignment, we will drop the lowest homework grade.

*Quizzes:* We do not grant makeup quizzes, but in recognition of unforeseen events that could cause a quiz to be missed, we drop the two lowest quizzes.

*Exams:* 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/*

**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 document your work electronically. 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. You and your group will document the steps you took to tackle the problem and the faculty and GSTs will circulate around the room to provide assistance if necessary. Don't hesitate to ask for help! At the end of the exercise your instructor 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.

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*
Your instructor may assign in-class groups for you to work with 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. 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.

| EK301 Fall 2019 Semester Mon/Weds Schedule and Syllabus | | | | | |
|---|---|---|---|---|---|
| **L #** | **Date** | **Text** | **Agenda** | **Quiz # (on)** | **HW** |
| 1 | 9/4 | Ch 2:1-7 | Introduction, vector review | | |
| 2 | 9/9 | Ch 3:1-4 | Multiple forces, static equilibrium | Q1 (Ethics) | |
| 3 | 9/11 | Ch 3:1-4 | Internal tensions | | #1 due |
| 4 | 9/16 | Ch 2:8-9 | Dot product, projections | Q2 (HW 1) | |
| 5 | 9/18 | Ch 4:1-4 | Moments; Cross product | | #2 due |
| 6 | 9/23 | Ch 4:5-8 | Moment projections; couples; equivalent systems | Q3 (HW 2) | |
| 7 | 9/25 | Ch 5:1-3 | 2-D static equilibrium; Project introduction | | #3 due |
| 8 | 9/30 | Ch 5:1-3 | Supports, reaction forces | Q4 (HW 3) | |
| 9 | 10/2 | Ch 5:1-3 | Reaction forces | | #4 due |
| 10 | 10/7 | Ch 5:4,7 | Static indeterminancy; 2-3 force members | | |
| 11 | 10/9 | Thru HW 4 | **EXAM 1** *(covers through HW 4 material)* | | |
| 12 | 10/15 | Ch 5:5 | 3-D supports and static equilibrium | | |
| 13 | 10/16 | Ch 6:1-3 | Truss analysis: Method of joints | | #5 due |
| 14 | 10/21 | Ch 6:4 | Truss analysis: Method of sections | Q5 (HW 5) | |
| 15 | 10/23 | Ch 6:6 | Frames 1 | | #6 due |
| 16 | 10/28 | Ch 6:6 | Frames 2 | Q6 (HW 6) | |
| 17 | 10/30 | Ch 6:6 | Frames 3/Frames module | | #7 due |
| 18 | 11/4 | Ch 8:1-3 | Dry Friction (structures, wedges) | Q7 (HW 7) | |
| 19 | 11/6 | Ch 8:3,<br>Ch 9:1-2 | Friction, Distributed forces: centroids | | #8 due |
| 20 | 11/11 | 9:4 | Centroids & COM continued; distributed forces | | |
| 21 | 11/13 | Thru HW 8 | **EXAM 2** *(covers through HW 8)* | | |
| 22 | 11/18 | Ch 7:1-3 | Shear/bending | Q8 (HW 8) | |
| 23 | 11/20 | Ch 7:1-3 | Shear/bending moment eqns & diagrams | | #9 due |
| 24 | 11/25 | Ch 7:1-3 | Shear/bending moment eqns & diagrams | | |
| 25 | 12/2 | Ch 11:1-3 | Virtual work | Q9 (HW 10) | |
| 26 | 12/4 | Ch 11:1-3 | Virtual work | | #10 due |
| 27 | 12/9 | Ch 11:1-3 | Virtual work | Q10 (HW 10) | |
| 28 | 12/11 | | Special topics | | #11 due |

| IMPORTANT SEMESTER DATES | |
|---|---|
| TBD | **Straw testing** |
| 10/7 | **Last day to drop without a 'W'** |
| TBD | **Straw testing report due** |
| 11/8 | **Last day to withdraw (with a 'W')** |
| TBD | **Preliminary design report due** |
| 12/6 | **Final design report due** |
| 12/7 | **Truss testing** |

| EK301 Fall 2019 Semester Tues/Thurs Schedule and Syllabus | | | | | |
|---|---|---|---|---|---|
| **L #** | **Date** | **Text** | **Agenda** | **Quiz # on…** | **HW** |
| 1 | 9/3 | Ch 2:1-7 | Introduction, vector review | | |
| 2 | 9/5 | Ch 3:1-4 | Multiple forces, static equilibrium | | |
| 3 | 9/10 | Ch 3:1-4 | Internal tensions | Q1 (Ethics) | |
| 4 | 9/12 | Ch 2:8-9 | Dot product, projections | | #1 due |
| 5 | 9/17 | Ch 4:1-4 | Moments; Cross product | Q2 (HW 1) | |
| 6 | 9/19 | Ch 4:5-8 | Moment projections; couples; equivalent systems | | #2 due |
| 7 | 9/24 | Ch 5:1-3 | 2-D static equilibrium; Project introduction | Q3 (HW 2) | |
| 8 | 9/26 | Ch 5:1-3 | Supports, reaction forces | | #3 due |
| 9 | 10/1 | Ch 5:1-3 | Reaction forces | Q4 (HW 3) | |
| 10 | 10/3 | Ch 5:4,7 | Static indeterminancy; 2-3 force members | | #4 due |
| 11 | 10/8 | Ch 5:5 | 3-D supports and static equilibrium | | |
| 12 | 10/10 | Thru HW 4 | **EXAM 1** *(covers through HW 4 material)* | | |
| 13 | 10/17 | Ch 6:1-3 | Truss analysis: Method of joints | | #5 due |
| 14 | 10/22 | Ch 6:4 | Truss analysis: Method of sections | Q5 (HW 5) | |
| 15 | 10/24 | Ch 6:6 | Frames 1 | | #6 due |
| 16 | 10/29 | Ch 6:6 | Frames 2 | Q6 (HW 6) | |
| 17 | 10/31 | Ch 6:6 | Frames 3/Frames module | | #7 due |
| 18 | 11/5 | Ch 8:1-3 | Dry Friction (structures, wedges) | Q7 (HW 7) | |
| 19 | 11/7 | Ch 8:3,<br>Ch 9:1-2 | Friction, Distributed forces: centroids | | #8 due |
| 20 | 11/12 | Thru HW 8 | **EXAM 2** *(covers through HW 8)* | | |
| 21 | 11/14 | Ch 4:9, Ch 9:4 | Centroids & COM continued; distributed forces | | |
| 22 | 11/19 | Ch 7:1-3 | Shear/bending | Q8 (HW 8) | |
| 23 | 11/21 | Ch 7:1-3 | Shear/bending moment eqns & diagrams | | #9 due |
| 24 | 11/26 | Ch 7:1-3 | Shear/bending moment eqns & diagrams | Q9 (HW 9) | |
| 25 | 12/3 | Ch 11:1-3 | Virtual work | | #10 due |
| 26 | 12/5 | Ch 11:1-3 | Virtual work | Q10 (HW 10) | |
| 27 | 12/10 | Ch 11:1-3 | Virtual work | | #11 due |

| IMPORTANT SEMESTER DATES | |
|---|---|
| TBD | **Straw testing** |
| 10/7 | **Last day to drop without a 'W'** |
| TBD | **Straw testing report due** |
| 11/8 | **Last day to withdraw (with a 'W')** |
| TBD | **Preliminary design report due** |
| 12/6 | **Final design report due** |
| 12/7 | **Truss testing** |

Submit with HW 1:

I've read through the course syllabus and the semester dates.

Name: _____

Signature: _____