30.001 STRUCTURES AND MATERIALS

Term 4, Spring 2022

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Goal: The overall goal of the course is to introduce students to statics and the mechanics of deformable solids from both macro and micro perspective. Emphasis will be placed on the application of the equilibrium principles and material behavior to ensure structural integrity in mechanical design. The topics covered in this course provide essential technical basis to the students for the analysis and design of beams and structures.

Text(s):

- R. C. Hibbeler. *Mechanics of Materials.* Ninth Edition, Pearson, 2013.
- Michael F. Ashby and David R. H. Jones. *Engineering Materials 1: An Introduction to Properties, Applications and Design.* Third Edition, Elsevier, 2005.

References:

- James F. Shackelford. *Introduction to Materials Science for Engineers*. Seventh Edition, Pearson Education, 2009.
- Elliot P. Douglas. *Introduction to Materials Science And Engineering: A Guided Inquiry*. First Edition, Pearson, 2013.

Prerequisites: 10.013 Modelling and Analysis, 10.015 Physical World.

Course Description: This course introduces students to statics and the mechanics of rigid bodies. Emphasis will be on the three basic principles of equilibrium, geometric compatibility, and material behavior. The course covers the topics related to the mechanics of materials. Mechanical properties of rigid and deformable bodies; analysis and design of beams and members of structures subjected to tension, compression, torsion, bending and combined stresses. Introduction to mechanical behavior of engineering materials, and the use of materials in mechanical design.

Learning Objectives:

- Use the one-dimensional idealizations of slender members (e.g., rods, simple beams, columns) to calculated stress and deformation states in structures including trusses, beams, and shafts.
- Apply the basic concepts of material properties and the underlying deformation and failure mechanisms to perform materials selection and preliminary sizing of the classes of structures described above.
- Apply the concepts to determine the stress developed in a beam section due to tension, compression, torsion, bending, shear and combined loading.
- Use Mohr's circle to transform stress (strain) components from one orientation to another.
- Assess the applicability of such idealizations of materials and structures and the errors introduced in their use.

Measurable Outcomes: At the end of the course, a student should be able to

- Explain the basic considerations of structural design
- Explain the basic assumptions underlying the idealizations of simple beams, columns, trusses, shafts, and material properties
- Apply basic principles to determining the function and sizing of structural elements and the selection of materials for use in them
- Calculate the stress and strain distributions and deformation of simple structural idealizations, such as those listed in item #2
- Design and internal structural configuration for simple trusses, beams, columns and shafts to meet specified loading and deformation criteria
- Describe the configuration under which the idealizations listed in item #2 cease to be applicable

Pedagogy: This course uses Kolb's experiential learning, which involves numerous active learning and 3D design activity. The 3D project applies concepts learned in class to address interdisciplinary problems within the EPD Pillar Tracks that cuts across SUTD Growth Plan and Sustainability. This is a 12 unit subject, which means that the overall weekly time commitment is, on average, approximately 12 hours. The workload is composed of lectures (3.0 hr), cohort-based learning sessions (2.0 hr.), and individual self-study time (7 hr.) per week. The cohort-based learning will consist of a variety of individual and group activities.

Attendance: Class attendance is ***required***. Your class participation grade will be reduced for each unexcused absence after the first such absence. A roll sheet will be distributed occasionally during cohort sessions to record attendance. If you have a legitimate excuse for missing class, please contact the course instructors before the date you intend to be absent.

Grading:

Component	**Total**
Assignments (Individual + Group)	20%
3D Project	20%
Midterm Exam	25%
Final Exam	25%
Misc. (class participation, class work etc.)	10%
Total	100%

Projects: Grades for the projects will be assigned on a group basis, unless otherwise specified. Peer evaluations of each project will be required. These peer evaluations, in addition to evaluation by the instructors, are used to assess individual participation on the group projects and will influence each individual's grade. No late projects will be accepted.

All assignments must be turned in on time. Assignments will not be accepted/graded after the due date/time. Do not attempt to hand in late assignments, unless you have *prior* approval from the faculty. *Verbatim copying* of any material that you submit for credit is a serious academic offense and will result in penalties and perhaps failing the course.

Course Materials: eDimension will be used for announcements, course handouts, assignment submissions, and other information.

Exams(s):

- Midterm – 02 March (Wed) 2019, 2:30 - 4:30 pm
- Final Exam - 28 April (Thur) 2019, 9:00 - 11:00 am

Formal Reviews: If you feel that part of an assignment (homework, lab report, or exam) was graded in error, you may request a formal review of the work. You have 7 days after your work is returned to submit for a formal review. After the 7-day period, the grade will not be changed. Only formal requests for review will be considered. To obtain a review, you must submit to me a *typed* cover sheet that has your full name, student number, date, and description of the assignment that you want reviewed. You must explain *in* what you feel was incorrect and why you feel like you should have gotten a better score. Staple the questionable assignment to the cover sheet. During a review, the *entire* assignment will be evaluated, not just the issue with which you were concerned. Thus, a formal review may possibly result in a lower overall score.

IMPACT ON SUBSEQUENT COURSES IN CURRICULUM:

This course is a core course in Engineering Product Development Pillar. It provides the foundation and knowledge for a variety of pillar year classes that requires the design and analysis of structural components.

IES ACCREDITATION PROGRAM OUTCOMES ACHIEVED:

This course contributes to the following Program Outcomes and SLOs for EPD

- SLO#1: Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
- SLO#2: Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- SLO#3: Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- SLO#4: Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
- SLO#5: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
- SLO#8: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

- SLO#9: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.
- SLO#10: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- SLO#11: Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- SLO#12: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.