CVEN3525
Structural Analysis
Spring 2013
Jan. 31, 2013

LECTURES: T-Th 09:30-10:45 ECCR 1B51
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Office hours: M-W 10:00-12:00; 2:00-3:30 or by appointment.

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Office Hours: W 2:00-4:00 pm room: TBD

TEXTBOOK: Hibbeler R.C., Structural Analysis, Prentice Hall, 8th ed.

WEB PAGE: http://civil.colorado.edu/~saouma/3525

PREREQUISITES: Passing grade (C-) in Mechanics of Materials
CVEN3525 is a prerequisite to CVEN-4545 (Steel Design), CVEN-4555 (Reinforced Concrete Design), CVEN-4525 Matrix Analysis

HOMEWORKS: Group work and submission are strongly encouraged. All homeworks are due on Thursdays at 9:30; Late homeworks are not accepted.

EXAMINATIONS: Feb, 14; Mar. 14; May 6. There will be two quizzes and one final exam. At least one quiz/Final problem will be (nearly) identical to a homework one. Quizzes and final are closed book/notes.

GRADING: Homework (30%), Quizzes (40%), Final (30%). The final grade will depend on the average of the two highest individual point totals (h) for the course. The final letter grade that you get is determined by taking your point total and putting it in one of these

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<th>Letter Grade</th>
<th>A</th>
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COMPUTERS: Some problems in this course may require the use of computers. In most cases, a general purpose spreadsheet program may suffice, however you are encouraged to use numerical analysis packages such as Matlab and MathCAD.

COURSE DESCRIPTION:

Structural analysis is necessary prior to any design. This introductory course will provide the technical foundation to properly understand the analysis of statically determinate (simple) and indeterminate (complex) structures such as cables, trusses, frames, arches. Whereas emphasis will be on 2D structures, you will also be exposed to some 3D cases. Techniques of analysis include flexibility (hand calculation) and stiffness (computer based) methods. You will also be exposed to a widely used commercial program for the analysis of structure, and will be encouraged to program in Matlab and use Mathcad for your assignments. There will be at least one presentation by a Structural Engineer who will discuss the challenges of the profession.
The following ABET course objectives are met by this course:

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to identify, formulate, and solve engineering problems
- an ability to communicate effectively through writing and drawings
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
PREREQUISITE KNOWLEDGE

Static of Particles  
Equilibrium of Rigid Bodies  
Properties of Areas; 1st and 2nd Moments of area  
Properties of Volumes - Center of Gravity  
Analysis of Trusses  
Internal Forces in Beams  
Shear and Bending Moment Diagrams for Beams  
Concept of Stress, Strain  
Axial Loading of Rods  
Torsion of Shafts  
Pure Bending of Beams  
Transverse Loading of Beams  
Transformation of Stress and Strain  
Elementary Design of Beams  
Deflection of Beams by Integration Methods  
Basic Matlab

HOMEWORK

Homework problems are designed to help you better understand and apply the material covered during the lectures. You are encouraged to discuss the problems and work together on the solutions. Homework consists of reading assignments and problem sets.

1. Teamwork is not only accepted but strongly encouraged, provided you list the percentage contribution of each student in order to properly adjust each grade. Not more than two students per group.
2. All work is to be presented on one side of 8 1/2 by 11 inch quadrille paper.
3. All sheets should contain a title consisting of your name, the date, the course title, and the problem being solved.
4. Problems should be presented one problem per sheet or group of sheets with all sheets for each individual problem stapled together when handed in.
5. Each problem should include a complete statement of the problem being considered.
6. All figures should be drawn in a neat manner with a straight edge.
7. All dimensions important to the problem should be shown.
8. No more than 4 significant digits will be accepted.
9. Show all steps in the solution so that there is no question as to how any result was obtained. Do not present scratch work on the problem sheets.
10. Show all final results clearly with units inside a red box.
11. Each homework submitted with MATHCAD will automatically get a 5% bonus
12. Any homework not complying with the above rules, will not be graded (i.e 0). (Remember that the T.A. will try to minimize the time (s)he has to spend on grading).

Mathcad Samples

Mathcad is a computer software that allows you to enter and manipulate text and mathematical equations, perform calculations, analyze and plot data, and format text.

It is extensively used by most companies for internal reports. You are strongly encouraged to adopt it for your homework submissions. There many tutorials you can download.

Following are samples of Mathcad solutions
Solution:
Since there are no axial forces, there are two unknowns and two equations of equilibrium. We have two equations of equilibrium ($\sum F_y$ and $\sum M$), we judiciously start with the second one, as it would directly give us the reaction at B. Considering an infinitesimal element of length $dx$, weight $dW$, an moment $dM$:

$$\sum M^A = \int_{x=0}^{x=L} w_0 \left( \frac{x}{L} \right)^2 dx \times x - R_B \cdot L = 0$$

$$R_B = \frac{1}{L} \cdot w_0 \left( \frac{L^4}{4 \cdot L^2} \right) = \frac{1}{4} w_0 \cdot L$$

With $R_B$ determined, we solve for $R_A$ from

$$\sum F_y = 0$$

$$R_A + \frac{1}{4} w_0 \cdot L - \int_{x=0}^{x=L} w_0 \left( \frac{x}{L} \right)^2 dx = 0$$

$$R_A = \frac{w_0 \cdot L^3}{6} - \frac{1}{4} w_0 \cdot L = \frac{1}{12} w_0 \cdot L$$

5.4 Three Span Beam
Determine the reactions of the following three span beam
Solution:

We have 4 unknowns ($R_x$, $R_y$, $R_z$, and $R_n$), three equations of equilibrium and one equation of condition ($\sum M_y = 0$), thus the structure is statically determinate. Though there are many approaches to solve for these four unknowns (all of them correct), a few are simpler to pursue. In this case, it is easiest to "break" the structure into substructures and examine the free body diagram of each one of them separately.

1. Isolating ab:
   \[ \sum M_z = 0 \quad 9\text{ft}R_{ay} - 40\text{kip}\cdot5\text{ft} = 0 \quad R_{ay} = \frac{40\text{kip}\cdot5\text{ft}}{9\text{ft}} = 22.2\text{kip} \]
   \[ \sum M_x = 0 \quad 40\text{kip}\cdot4\text{ft} - 8\cdot9\text{ft} = 0 \quad S_x = \frac{40\text{kip}\cdot4\text{ft}}{9\text{ft}} = 17.8\text{kip} \]
   \[ \sum F_x = 0 \quad R_{ax} = 30\text{kip} \]

2. Isolating bd:
   \[ \sum M_z = 0 \quad -S\cdot18\text{ft} - 40\text{kip}\cdot15\text{ft} + 4\frac{\text{kip}}{\text{ft}}\cdot12\text{ft}\cdot6\text{ft} - 30\text{kip}\cdot2\text{ft} + R_{cy}\cdot12\text{ft} = 0 \]
   \[ R_{cy} = \frac{S\cdot18\text{ft} + 40\text{kip}\cdot15\text{ft} + 4\frac{\text{kip}}{\text{ft}}\cdot12\text{ft}\cdot6\text{ft} + 30\text{kip}\cdot2\text{ft}}{12\text{ft}} = 105.7\text{kip} \]
   \[ \sum M_x = 0 \quad -S\cdot6\text{ft} - 40\text{kip}\cdot3\text{ft} + 4\frac{\text{kip}}{\text{ft}}\cdot12\text{ft}\cdot6\text{ft} + 30\text{kip}\cdot10\text{ft} - R_{dy}\cdot12\text{ft} = 0 \]
   \[ R_{dy} = \frac{-S\cdot6\text{ft} - 40\text{kip}\cdot3\text{ft} + 4\frac{\text{kip}}{\text{ft}}\cdot12\text{ft}\cdot6\text{ft} + 30\text{kip}\cdot10\text{ft}}{12\text{ft}} = 30.1\text{kip} \]
E-MAILS:

University policy (http://www.colorado.edu/policies/email.html) states: E-mail is an official means for communication within CU-Boulder. Therefore, the University has the right to send communications to students via e-mail and the right to expect that those communications will be received and read in a timely fashion. Henceforth you will often be contacted by e-mail for: assignments, clarifications, quiz announcement and other course related matters. You will be contacted exclusively through your official CU issued e-mail address.

DISABILITIES:

If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu.

If you have a temporary medical condition or injury, see Temporary Injuries under Quick Links at Disability Services website (http://disabilityservices.colorado.edu/) and discuss your needs with your professor.

RELIGION:

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, {{insert your procedures here}}

See full details at http://www.colorado.edu/policies/fac_relig.html

CLASSROOM BEHAVIOR

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran’s status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies at http://www.colorado.edu/policies/classbehavior.html and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

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HONOR CODE:

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the
academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://honorcode.colorado.edu