CIE 324: Structural Engineering II
(SECTION B)
Spring 2016

COURSE DESCRIPTION:

This is a second of a two-course sequence on structural analysis required of all civil engineering students. The course concentrates on the calculation of deflections and the analysis of statically indeterminate structures. Various methods will be presented to compute displacements, with the use of virtual work emphasized. For analysis of statically indeterminate structures, the force method of analysis (also called flexibility method) will be emphasized. Displacement-based methods will also be introduced including slope deflection method and moment distribution. Structures examined in this course will be modeled as planar trusses, beams and/or frame structures. Students will use a general purpose structural analysis program to analyze more complicated structures.

COURSE STAFF:

Instructor: Siamak Epackachi
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TA: Youyou Zhang
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Office hours: T/TH 11:30 – 1:30 pm

CLASS SCHEDULE:

Lecture: M/W/F 2:00-2:50 NSC 218
Recitation: F 8:00-8:50 NSC 216

REFERENCES:

Fundamentals of Structural Analysis by Leet, Uang and Gilbert, McGraw-Hill, ISBN-13: 978-0073401096, ISBN-10: 0073401099.

GRADING:

Assignments	20%
Final project	5%
Midterms	40%
Final	35%

- Attendance at all lectures and recitations, and active participation is expected. The instructor regularly brings up questions and discussions during lecture time. Students are encouraged to volunteer in answering questions and participate in discussions.

- *Sustained effort starting today*: Come to class and recitations regularly. Pay attention in class without distractions through smartphones etc. Bring a scientific calculator and follow along with calculations in class.

- For the assignments, although students may consult with classmates, it is expected that solutions that are submitted, reflect the individual work of students. At least one question

from the assignments will appear on the mid-term and final exams, modified only for dimensions and values of loading.

- Every week, problem(s) will be assigned during the recitation. You must attempt to solve the problem(s). During recitation, the instructor will show in detail how to solve the problem(s), and help you reach the correct answer. The problem(s) will be collected at the end of recitation for extra credit. You will get 5 bonus points towards your HW grade for solving problems during each recitations. Attendance is not mandatory but it is strongly recommended as it will help you succeed in the course.

- A significant part of engineering is written communication of laboratory work and analysis/design proposals. Heavy emphasis will be placed on clarity, organization and readability of your work. (a) All assignments must be submitted with no more than one problem per page. (b) Write your name, course and homework number on a cover sheet. (c) Staple pages together. (d) A clear and well-labeled **drawing** or **free body diagram** as appropriate *must* be presented with every problem. (e) Always use **units** everywhere in your work – a number without units makes no sense in engineering. (f) Show each step of the problem and clearly explain the logic being used. (g) Clearly box all final answers.

COURSE OBJECTIVES:

When you graduate as a Civil Engineer, you will be responsible for designing buildings, roads and railroads, bridges, retaining walls, water carrying pipes and many other structures that make up the backbone of our society. To do this, you must be able to calculate the forces acting on these structures and the stresses and deformations that develop in them as a result, so that you can design them for strength and serviceability. In EAS207 – Statics, you learnt to calculate internal forces in statically *determinate* structures; in EAS209 – Mechanics of Materials, you learnt about stresses and how to calculate deflections of beams; and in CIE 323 – Structure I, you began the study of deflections of structures. In this course, you will learn how to calculate deflections not just of components such as beams, but of complete structures. You will also learn to analyze statically *indeterminate* structures. Students who take this course will be expected to achieve the following objectives:

i. To develop a strong intuition of structural behavior, i.e., being able to answer questions like "What is the predominant mode of behavior of a structure?", "what are the principal load paths in a structure?" etc., that is essential for conceptual design of structures.
ii. To obtain a thorough understanding of the analytical principles of structural mechanics. Such principles form the basis of computer methods such as the Finite Element Method. After taking this course, therefore, you will be able to take such classes as CIE423 on Matrix Structural Analysis, and CIE426 on the Finite Element Method.

COURSE LEARNING OUTCOMES:

When you complete this course, you will be able to:

Course learning outcomes	SO	Assessment tools
a. Compute deflections of structures using the Principle of Virtual Work	a, e	HW, exams
b. Draw influence lines and use them to calculate the response of bridges to moving loads	a, e	HW, exams
c. Analyze qualitatively, the response of statically indeterminate structures	a, e	HW, exams
d. Distinguish between the Force Method and the Displacement Method of indeterminate structural analysis	a, e	HW, exams
e. Compute internal forces in statically indeterminate structures by the Force Method and by the Displacement Method	a, e	HW, exams
f. Apply Matrix Structural Analysis to simple one-dimensional structures	a, e	HW, exams
g. Navigate and use a general purpose structural analysis program	a, e	HW
h. Present calculations in an organized and readable form.	g	HW, exams

(a) *Apply knowledge of mathematics, science and engineering*: CIE324 is an engineering problem solving course that builds upon students' background in mathematics and physics to form a linkage between abstract concepts and physical problems common in engineering practice.

(e) *An ability to identify, formulate and solve engineering problems*: The problems demonstrated in class and in homework assignments encourage students to idealize real-world problems so that they may apply their engineering knowledge and judgment to develop meaningful solutions. These exercises are designed to develop students' confidence, so that they will be able to make the next transition, from problem-solving to design.

(g) *Communicate effectively*: Because engineers frequently communicate via engineering calculations, a premium is placed on the quality, order, neatness and correctness of all solution of problems performed as part of CIE324. Students are continually reminded that the quality of their engineering calculations is a statement of their regard of their profession.

Relationship of CIE324 to Student Outcomes (Course Assessment Matrix):

a	b	c	d	e	f	g	h	i	J	k
3				3		1				

ACCOMODATIONS:

If you require classroom or testing accommodations due to a disability, please contact Accessibility Resources, located at 25 Capen Hall. AR can be reached by phone at (716) 645-2608 or by email at stu-accessibility@buffalo.edu. Please inform me as soon as possible about your needs so that we can coordinate your accommodations.

SYLLABUS/SCHEDULE:

Class No.	Date	Topic	HW Due
1	1/25	Introduction and course outline	
2	1/27	Review (CIE 323)	
3	1/29	Review (Bending moment diagram)	
4	2/1	Chapter 10: Virtual Work – overview	HW1
5	2/3	Chapter 10: Virtual Work – trusses	
6	2/5	Chapter 10: Virtual Work – beams	
7	2/8	Chapter 10: Virtual Work – frames + Bernoulli	HW2
8	2/11	Introduction to indeterminate structures	
9	2/13	Chapter 11: Flexibility Method – overview	
10	2/15	Chapter 11: Flexibility Method – frames	HW3
11	2/17	Chapter 11: Flexibility Method – multiple degrees of indeterminacy	
12	2/19	Chapter 11: Flexibility Method – support settlement, temperature change and fabrication error	
13	2/22	Chapter 12: Slope-Deflection Method – overview	HW4
14	2/24	Chapter 12: Slope-Deflection Method – Equations	
15	2/26	Chapter 12: Slope-Deflection Method – continuous beams	
16	2/29	Review	
17	3/2	**No class, Midterm (chapters 10 and 11) 5:00 pm – 7:00 pm**	
18	3/4	Chapter 12: Slope-Deflection Method – frames without sideways	
19	3/7	Chapter 12: Slope-Deflection Method – frames with sideways	HW5
20	3/9	Chapter 13: Moment Distribution – overview	
21	3/11	Chapter 13: Moment Distribution – beams	
-	3/14	**Recess**	
-	3/16	**Recess**	
-	3/18	**Recess**	
22	3/21	Chapter 13: Moment Distribution – more examples	HW6
23	3/23	Chapter 13: Moment Distribution – frames without sideways	
24	3/25	Chapter 13: Moment Distribution – frames with sideways	
25	3/28	Chapter 14: Influence Lines – review	HW7
26	3/30	Chapter 14: Influence Lines – indeterminate structures	
27	4/1	Chapter 14: Influence Lines – using moment distribution	
28	4/4	Review	
29	4/6	**No class, midterm (Chapters 12 and 13) 5:00 pm – 7:00 pm**	
30	4/8	Chapter 14: Influence Lines – using Muller-Breslau Principle	

31	4/11	Chapter 14: Influence Lines – live load patterns	HW8
32	4/13	Chapter 16: General Stiffness method	
33	4/15	Chapter 17: Matrix analysis of trusses – matrices	
34	4/18	Chapter 17: Matrix analysis of trusses – individual member	HW9
35	4/20	Chapter 17: Matrix analysis of trusses – inclined truss bar	
36	4/22	Chapter 18: Matrix Analysis of beams and frames – flexural member (tentative)	
37	4/25	Chapter 18: Matrix Analysis of beams and frames (tentative)	HW10
38	4/27	Chapter 18: Matrix Analysis of beams and frames (tentative)	
39	4/29	Analysis of structures using SAP2000	
40	5/2	Analysis of structures using SAP2000	HW11
41	5/4	**Final Review**	
42	5/6	**Final Review**	
Final exam on 5/9/2016 (Chapters 10 and 18) 3:30 pm – 6:30 pm at NSC 218			Final Project