THEORY OF PLATES AND SHELLS
CIV_ENV 410-0-1
Spring 2023

Class Hours:	Tue/Thu 8:00am – 9:20 pm
Room Location:	Tech LG52
Prerequisites:	Theory of Elasticity, Continuum Mechanics
Instructor:	Madura Pathirage Office: Tech A136 Phone: (847) 440-6506 E-mail: madura-pathirage@northwestern.edu
Instructor Office Hours:	By appointment via e-mail
Grader:	Hyunjin Lee hyunjinlee2021@u.northwestern.edu
Grader Office Hours:	By appointment via e-mail
Suggested Reading:	-Ventsel, Eduard, Theodor Krauthammer. "Thin plates and shells: theory, analysis, and applications.", 2002. -Reddy, Junuthula Narasimha. “Theory and analysis of elastic plates and shells.”, 2006.
Course Materials:	-SAP2000 Structural Analysis software. Student version at csiamerica.com **-**ABAQUS Student version at https://academy.3ds.com/en/software/abaqus-student-edition **-**Any finite element solver. For instance CAST3M at http://www-cast3m.cea.fr/
Course Webpage:	canvas.northwestern.edu
Description:	This course focuses on the mechanics and analysis of thin plates and shells. Topics covered include, but not limited to, 1) Derivation of governing equations for plates, cylindrical shells and spherical shells; 2) Approximated theories; 3) Analytical and numerical methods for the solutions of elastic problems. 4) Civil engineering applications.
Course Objectives:	The objective of this course is to introduce graduate and senior undergraduate students to advanced topics in structural mechanics and, more specifically, to the mechanics of plates and shells. Students will build on the knowledge gained through all mechanics related courses of the undergraduate curriculum (mechanics of materials, theory of elasticity, concrete design, etc.).
Course Outcomes:	Upon successful completion of the course, students will have an advanced understanding of the behavior of plates and shells as well as knowledge of specific modeling theories that can be used for the analysis of this type of structures. More specifically, they will be able to: 1. Derive the governing equations for plates.

2. Derive the governing equations for cylindrical shells.
3. Derive the governing equations for spherical shells.
4. Compute the solution of the governing equations for particular cases of practical interest.
5. Analyze complex plate/shell structural systems analytically and numerically.

Grading Policy: Grades between 0 and 100 are assigned based upon the level of mastery of the subject by the student.

Homework: Bi-weekly homework assignments. Neatness and presentation will be evaluated.

Final Grade: 0.40 (homework) + 0.30 (midterm exam) + 0.30 (final exam)

Academic Integrity: Student-teacher relationships are built on trust. Acts, which violate this trust, undermine the educational process. In this class, assignments that are turned in must represent the student's own work. Submission of any assignment that is in violation of this policy will result in zero points granted for that specific assignment.

Disability: Any student requesting accommodations related to a disability or other condition is required to register with AccessibleNU (accessiblenu@northwestern.edu) and provide the instructor with an accommodation notification from AccessibleNU.

TENTATIVE CLASS SCHEDULE

#	Date	Day	Week	Topic
1	03-30	Thu	1	Introduction. Fundamental assumptions for circular thin plates.
2	04-04	Tue	2	Governing equation for thin circular plates.
3	04-06	Thu		Analytical solutions. Flexibility method. Reinforced concrete plates.
4	04-11	Tue	3	Theory of general bending of thin plates.
5	04-13	Thu		Theory of general bending of thin plates.
6	04-18	Tue	4	Analytical solutions. Cylindrical bending. Double Fourier series.
7	04-20	Thu		Theory of circular cylindrical shells. Membrane and flexural behaviors.
8	04-25	Tue	5	Governing equation for circular cylindrical shells and general solution.
9	04-27	Thu		Analytical solutions of circular cylindrical shells.
10	05-02	Tue	6	Analytical solutions and flexibility method.
	05-04	Thu		**MIDTERM EXAM**
11	05-09	Tue	7	Ring beams.
12	05-11	Thu		Flexibility method for cylindrical shell and ring beam joint analysis.
13	05-16	Tue	8	Theory of spherical shells. Membrane behavior and examples.
14	05-18	Thu		Membrane behavior and examples. Flexural behavior.
15	05-23	Tue	9	Geckler's approximation. Analysis of a water tank. Flexibility method.
16	05-25	Thu		Strain energy methods. Ritz method and example.
17	05-30	Tue	10	Introduction to FE formulation for the general bending of thin plates.
18	06-01	Thu		Introduction to FE formulation for the general bending of thin plates.
	06-07	Wed	11	**FINAL EXAM 9AM-11AM**