

CIVE 842: Structural Dynamics

Fall Semester 2018

University of Nebraska-Lincoln

MW 4:30 PM – 5:45 PM

Scott Engineering Center 111/Peter Kiewit Institute 160

Prerequisites: CIVE 341 (Introduction to Structural Engineering) or similar.
CIVE 443 (Structural Analysis) or similar is recommended.

Prerequisite Knowledge: This course extensively builds on previous knowledge from other courses. This includes the following topics with corresponding UNL Lincoln campus equivalents:

1. Rigid Body Dynamics (MECH 373)
2. Calculus II/Calculus III (MATH 107 and MATH 208)
3. Differential Equations (MATH 221)
4. Linear Algebra (MATH 314)
5. Matrix Structural Analysis (CIVE 443)
6. Computer Programming via MATLAB (CSCE 155N)

Note that some of these courses are not official prerequisites.

Description: Dynamic behavior of civil engineering structures. Free and forced vibrations of single and multiple degree-of-freedom systems. Response of continuous beam and frames. Elastic-plastic behavior and introduction to nonlinear analysis. Analysis and design considerations for buildings and bridges subjected to seismic loadings. Application of computer-aided numerical procedures.

Course Objectives:

1. **Derive** the equation(s) of motion and **explain** the relevant variables that govern the response of single and multiple degree-of-freedom systems.
2. **Identify** and **describe** the fundamental dynamic parameters of a system and their influence on the dynamic response.
3. **Select** the most appropriate method and **solve** equation(s) of motion for a single or multiple degree-of-freedom system subject to free, harmonic, periodic, or random (earthquake) vibrations.
4. **Identify** and qualitatively **describe** the impact of assumptions and limitations of various solution methods for the dynamic response of structures.
5. **Describe** the construction of response and design spectra for earthquakes; and, qualitatively **describe** the impact of relevant parameters on their shapes.

CIVE Graduate Program Fit:

1. Although not required, this course is one of the basic core computational/analysis courses for graduate students within the Structural Engineering track.
2. This course is listed as a relevant elective for graduate students in the Geotechnical and Materials Engineering track.

3. This course is a prerequisite for (with tentative offerings):
 CIVE 948: Blast-Resistant Structural Design (Fa. 18)
 CIVE 945: Structural Analysis and Design for Dynamic Loads (Sp. 20)

Textbook: **Chopra, Anil K.** (2016). *Dynamics of Structures*. 5th Edition, Prentice Hall, Stamford, CT. 992p. ISBN-13: 978-0134555126.

Optional Reference: Clough, Ray W. and Penzien, Joseph. (2003). *Dynamics of Structures*. 3rd Edition, Computers & Structures Inc., Berkeley, CA. 730p.

Background References: Hildebrand, Francis B. (1992). *Methods of Applied Mathematics*. 2nd Edition, Dover Publications, Englewood Cliffs, NJ. 362p.

Palm, William J. (2010). *Introduction to MATLAB for Engineers*. 3rd Edition, McGraw-Hill, New York, NY. 576p.

Instructor: **Richard L. Wood** (rwood@unl.edu)
 362K Whittier Research Facility, office: (402) 472-1916

Office Hours: Monday 5:45 pm – 6:45 pm (Whittier 362K or PKI 206F)
 Wednesday 11:30 AM – 1:00 PM (Whittier 362K)
other times are available by appointment

Digital office hours are available upon request for any students to alleviate scheduling and location conflicts. Please request this via email with a minimum of 12 hours of notice. A zoom meeting invitation will be sent upon request. Office hours are offered on a first-come, first serve basis.

Email Policy: In each email, use **“CIVE 842”** as part of the subject line. This will ensure that your email is filtered appropriately and responded in a timely manner.

Course Documents: **Canvas at UNL** (<http://canvas.unl.edu>) will be used to **distribute course material** (notes, assignments, reference documents, etc.). It is essential for students to have access to download the appropriate material and verify your e-mail address on the site.

Grading:	1. Homework (approx. one per week, drop of lowest assignment)	25%
	2. Midterm #1 (announced minimally 1 week ahead)	20%
	3. Midterm #2 (announced minimally 1 week ahead)	20%
	4. Final Exam	30%
	5. Attendance, Conduct, Participation, and Quizzes	5%

At the conclusion of the semester, the **final grades** may be curved if the class average is less than 70% and/or the highest grade is less than 100%. Throughout the semester, the **mean and the standard deviation will be provided to estimate performance on each assignment**. Any student is encouraged to

inquire directly with the instructor at any time if they have a question on their performance.

Grading Scale: In this course, the following grade scale will be adopted.

Upper Bound (%)	Lower Bound (%)	Letter Grade Conversion
100.00	98.50	A+
98.49	93.00	A
92.99	90.00	A-
89.99	87.00	B+
86.99	83.00	B
82.99	80.00	B-
79.99	77.00	C+
76.99	73.00	C
72.99	70.00	C-
69.99	67.00	D+
66.99	63.00	D
62.99	60.00	D-
59.99	<i>below</i>	F

**Non-Letter
Grade Policies:**

For pass/no pass enrollments, “pass” is defined as a grade equal to or greater than a C. A score of C- or lower equates to a “no pass.” Additionally for pass/no pass enrollments, homework submissions are encouraged, but not explicitly required.

For audit enrollments, students with excessive absences will not be credited an “audit” grade on their transcripts. Excessive unexcused absence count is defined as greater than five classes.

Notes:

1. **Optional laboratory exercises** utilizing a small-scale shake table will be held in Whittier Research Center at mutually agreed upon times throughout the semester (outside of or during normal lecture time). These laboratory exercises are intended to complement theoretical lectures with visual demonstrations. Video link is possible; however, video latency will reduce its effectiveness.
2. All homework assignments are due at the **start of class** on the due date assigned, unless otherwise noted. Late work will only be accepted within two days of the due date, in the absence of **prior approval** for extraneous circumstances. Late work will be deducted 25% per calendar day. Note homework not turned at the start of class or at the announced submission time will be indicated as late and will be deducted 25%.
3. Turnitin will be the **anti-plagiarism software** used within the Canvas platform. Submitting a Turnitin-enabled assignment is almost identical to submitting a regular Canvas assignment. When a paper is submitted through

Turnitin, it is compared against three vast databases. An "Originality Report" is generated which will show which elements of a student's paper matches content from Turnitin's databases. The three primary sources are 1) current and archived web, 2) student papers, and 3) content partnerships.

4. As indicated on the schedule, there will be **two midterm exams and one final exam**. The subject matter for each exam will be announced in class at least one week before.
5. If a student **misses an exam**, the instructor must be notified as soon as possible. For compelling (and documented) reasons, the instructor reserves the right to provide a make-up exam, change the weight of other exams, or assign a term project in determining the course grade.
6. **All exams will be closed-book and closed-notes**. One single-sided 8.5 x 11 inches sheet of notes or an "equation sheet" are permitted for each exam. Equation sheets from previous exams (unedited) will be permitted in subsequent exams. No examples or complete sentences are permitted. If you are typing your equation sheet, be mindful of the variables, subscripts, etc. The equation sheet must be of your own effort (no sharing). No electronic devices of any kind, other than a calculator, will be permitted for an exam or quiz. Bags must be placed on the floor adjacent to your chair and not on the table.
7. Disputes regarding grades must be performed within **two days of returning the exams**. For exam or grades disputes, a **written document** must be turned into the instructor by the deadline.
8. Any **unclaimed exams** will be discarded two weeks after they have been returned to the class.
9. The instructor may choose to use **unannounced quizzes** at the start or end of class. These quizzes are implemented such that students stay current with the class material. Quizzes are typically closed book and notes.
10. Attendance, participation, class attention, and quizzes will be assessed/taken throughout the duration of the course. **Unexcused absences** and late arrivals will result in reduced points allocated for "*Attendance, Conduct, Participation, Quizzes*".
11. Select assignments may require the use of **MATLAB**. MATLAB is provided to the UNL community free of charge for on-campus or VPN use. For details on procuring a license, visit: <http://procurement.unl.edu/matlab-licenses>. Assignments done in MATLAB must adhere to the same format as described below and all developed files should have appropriate comments (% syntax).
12. **Active learning strategies** will be used in class that allow students to participate in class polls, quizzes, and discussions. This will be done as a classroom experiment and will invoke the use of color coded flashcards initially. All students will be given a single flashcard, if lost it is the student's responsibility to replace it.
13. **Class evaluations** will be performed online at both Lincoln and Omaha campuses. To encourage participation of the evaluations for continuous class improvement, an extra credit score of 0.5% will be applied to the final grade

for completion of the class evaluation. Details on the documentation for online submission will be provided towards the end of the semester.

**Homework/
Assignment
Format:**

Homework preparation and submission guidelines are established to create professional quality detail. Points will be deducted if the format is not followed.

1. Each assignment is to be solved neatly on **engineering graph paper or plain white computer paper**. (Note legal pad or other lined paper is not accepted).
2. Each problem must have a **problem statement, problem sketch, diagrams, solution steps, equations used** (with variables and then substituted values), and a **final answer**. The final answer must be **boxed** and include appropriate **units** and **sign conventions**.
3. Start each problem on a **new blank page**.
4. Use of a **straight edge** is compulsory for sketches, figures, and tables.
5. **All your work must be shown**. The solution steps are just as important as the final answer and any solution which does not contain the previous steps will receive deduction in points.
6. If a paper submission is required, multiple pages should be **stapled** or bound.
7. Electronic homework submission guidelines are listed below. Note no paper copies will be accepted, unless otherwise explicitly stated.

**Electronic
Homework
Submission:**

All homework assignments will be **submitted electronically through the Canvas platform**. Only electronic submission of the assignments will be accepted, unless otherwise disclosed on the assignment. Your file upload must be a single or collated pdf file. Note multiple files will not be considered for credit.

Note your scan should be professionally presentable, in color, and all your work must be shown as outlined. **Verify and double check your pdf file before submission**. It is your responsibility to guarantee the quality and contents of the pdf. Note no paper copies will be collected nor accepted.

Points will be deducted if your homework does not follow this criterion in format and submission. Scanners are free for students to use at the university library system as well as at any PrintIT (Wepa) Kiosk (for more information on these services, please refer to: <http://libraries.unl.edu/photocopy> and <https://its.unl.edu/services/wepa>). If you have questions, please do not hesitate to contact the instructor.

**Paperless
Class
Format:**

No handouts other than any documents handed out on the first day will be provided to the students. This includes lecture notes, examples, and homework problem statements. Students are permitted to use digital devices for notetaking (i.e. tablets), but this is not required. It is the students' responsibility to ensure adequate material is available for class time.

Exceptions to this policy is exams and quizzes. These will be conducted in a traditional paper format.

Class Announcements: Daily class announcements will be projected at the start of the course. This is to update students on the class time schedule, provide reminders for assessments, and clarifications. Daily announcements, as shown at the start of class, will not be routinely posted to the Canvas site.

For short notice announcements, emails will be sent to the students through the digital platform. It is the students' responsibility to ensure that their email address is valid and checked in a timely manner.

Academic Dishonesty: You are encouraged to work together on your assignments, but copying will not be tolerated. For all computer generated work, be sure you work on separate computer terminals and do not turn identical assignments. Scores will be minimally reduced for all suspected parties. Any student who commits this or other acts of misconduct may be subject to further disciplinary action by the University. The regulations in the "Code of Conduct" concerning **academic honesty will be strictly enforced** in this class.

Student Code of Conduct: Students are expected to be familiar with the Student Code of Conduct. A link is available here: <https://studentconduct.unl.edu/student-code-conduct>. If you have any questions or concerns – inquire with the instructor before submission.

Acts of Academic Dishonesty: Students violating the Code of Conduct will be imposed a sanction, depending on the severity of the offense. Example sanctions may include:

- 1) Reduced grade on assignment, paper, quiz, or exam
- 2) Zero on assignment, paper, quiz, or exam
- 3) Grade of F on transcript for the course
- 4) Other

If a sanction is imposed, an electronic “Academic Integrity Report Form” must be submitted to the Office of Student Conduct and Community Standards and the Department Chair(s). Note this required by the UNL Office of the Executive Vice Chancellor. A link to this form is available here:
https://studentconduct.unl.edu/forms/Academic%20Integrity%20Report%20Form_Fillable.pdf

Accommodations for Students with Disabilities Policy: Students with disabilities are encouraged to contact me (the instructor or teaching assistant) for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide individualized accommodations to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 232 Canfield Administration, (402) 472-3787 voice or TTY.

Tentative Course Outline:

	Topic	Reference
1.	Introduction to Dynamic Loads	External Material
2.	Equation of Motion	Chapter 1
3.	SDOF Introduction	Chapter 1
4.	SDOF Undamped Free Vibration	Chapter 2
5.	SDOF Damped Free Vibration	Chapter 2
6.	SDOF Dynamic Response	Chapter 2
7.	SDOF Harmonic Response – Undamped	Chapter 3
8.	SDOF Harmonic Response – Damped	Chapter 3
9.	SDOF Frequencies and System Identification (Lab)	Chapter 2-3
10.	SDOF Harmonic Base Excitation	Chapter 3
11.	SDOF Periodic Loads	Chapter 3
12.	SDOF Arbitrary and Impulsive Loads	Chapter 4
13.	SDOF Numerical Evaluation	Chapter 5
14.	SDOF Earthquake Response Spectrum	Chapter 6
15.	SDOF Seismic Design Spectrum	Chapter 6
16.	SDOF Earthquake Response (Lab)	Chapter 6
17.	Multiple Degree-of-Freedom (MDOF) Introduction	Chapter 9
18.	MDOF Natural Modes	Chapter 10
19.	MDOF Undamped Systems	Chapter 10
20.	MDOF Damped Systems	Chapter 12