Western University- Faculty of Engineering
Department of Civil and Environmental Engineering

CEE3344A - DYNAMICS OF STRUCTURES – COURSE OUTLINE – Fall 2016

Students are introduced to concepts of structural dynamics and the response of civil engineering structures to time-varying loads, including those due to wind and earthquakes. This requires the extension of structural theory to include the effects of the mass and damping and to evaluate the action of various deterministic and random dynamic loads. The importance of dynamic loads in the design of dynamically sensitive civil engineering structures, such as tall buildings, towers and chimneys and long span bridges is examined and their treatment in the National Building Code of Canada is reviewed. Topics include:

- Equation of motion of single-degree-of-freedom systems;
- Free and forced vibrations;
- Response spectra;
- Numerical evaluation of dynamic response;
- Generalised single-degree-of-freedom systems;
- Rayleigh's method;

Prerequisites:

CEE 2221A/B

Note: It is the **student's responsibility** to ensure that all Prerequisite and/or Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also **student's responsibility** to ensure that they have not taken any course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Corequisites:

CEE 3340A/B

Antirequisites:

CEE4490

Contact Hours:

2 lecture hours per week; 2 tutorial hours per week; (recommended additional personal study 3 hours). Attendance at the tutorial session is **mandatory**.

Instructors:

Fall Term

Haitham Aboshosha, SEB 3117; e-mail: haboshos@uwo.ca; *Administrative Support*: SEB 3005
Amal Elawady, SEB 3117; e-mail: aelawady@uwo.ca; *Administrative Support*: SEB 3005
Office hours: Friday 11-12 am at SEB 3117.

Textbook:

The course notes were previously prepared by Dr. Ayman El Ansary.
Prepared class notes should be brought to each class, and may be purchased at the UWO bookstore (purchase required).

Chopra, A.K., Dynamics of Structures, Theory and Applications to Earthquake Engineering, Prentice Hall, (3rd edition) 2006. (purchase required).

Other References:

Tedesco, J.W., McDougal, W. G., and Ross, C.A. "*Structural Dynamics*", Addison-Wesley

Humar, J. L. "*Dynamics of structures*", Balkema, 2005.

Clough, Penzien, *"Dynamics of Structures"*, McGraw-Hill, 1993

M. Paz, *"Structural Dynamics"*, Van Nostrand Reinhold Co., 1985.

Hurty, Rubinstein, *"Dynamics of Structures"*, Prentice-Hall, 1964

Biggs, *"Introduction to Structural Dynamics"*, McGraw-Hill, 1964

Units:

SI units will be used in lectures and examinations

Specific Learning Objectives:

1. Equation of motion of single-degree-of-freedom systems. At the end of this section, the student should be able to:
   a) Understand the concept of damping, mass stiffness and motion, and their relation
   b) Idealize the motion and derive mathematical description of motion

2. Free and forced vibrations of single-degree-of-freedom. At the end of this section, the student should able to apply knowledge of mathematics, science and engineering to:
   a) Solve the differential equation of motion, and describe free vibration
   b) Find natural frequency, and resonant response
   c) Differentiate between the responses of undamped and damped vibration
   d) Calculate response to harmonic and periodic excitation, transmissibility
   e) Understand human response to vibrations
   f) Calculate response to arbitrary, step and pulse excitations using Duhamel's integral

3. Numerical evaluation of dynamic response. At the end of this section, the student should recognize the need of using numerical methods in dynamics of structures. The student should able to compute the dynamic response by implementing the following in spreadsheet
   a) Method based on interpolation of excitation
   b) Central difference method
   c) Newmark's method, Wilson's method

4. Response spectra.
   a) Understand the response spectrum concept
   b) Identify the relations between deformation, pseudo-velocity and pseudo-acceleration spectra
   c) Recognize the difference between design and response spectra
   d) Design simple structures using response spectra

5. Generalized single-degree-of-freedom systems and Rayleigh's method
   a) Understand the representation of motion in generalized coordinate
   b) Idealize and draw the shape function
   c) Derive and solve equation of motion for continuous beam subject to lateral force, and support motion
   d) Derive and solve equation of motion lumped mass system
   e) Calculate frequencies using Rayleigh's method

Evaluation:

The final course mark will be determined as follows:

Weekly problems, assignments	30%
Quiz	20%
Final Examination	50%
Total	100%

Note:

Students must pass the final examination to pass this course. Students who do not satisfy this requirement will be assigned the aggregated mark as determined above, or 48%, whichever is less.

Quiz and Examination:

One 1-hour quizzes (closed book) will be held during the year in the tutorial period. A three-hour final examination will be held during the examination periods. The schedule of quiz is to be determined. Only approved calculators may be used.

The quiz and the final examination will be **CLOSED BOOK**: approved handheld programmable calculators are allowed, but **NO** other external sources of information, including books, notes or crib sheets, are permitted.

Assignments:

Solution to Part A of each weekly assignment must be turned in by the end of the tutorial period. Each student must turn in solution to Part B of each weekly assignment at **4.00 pm Tuesday in LOCKER 69**, second floor, Spencer Engineering Building. **Late assignment will receive a grade of zero**. Extensions are to be negotiated with the course instructors, not the teaching assistants.

Use of English:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work

with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Cheating:

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.
For more information on scholastic offenses, please see:
http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

Attendance:

Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Conduct:

Students are expected to arrive at lecture on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

Sickness and Other Problems:

Students should immediately consult with the instructor of Department have any problem that could affect their performance in the course. Where appropriate, the problems should be documented (see attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Notice:

Students are responsible for regularly checking their e-mail and notices posted outside the Civil and Environmental Engineering Department Office.

Consultation:

Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Course Breakdown: Total = 76.4 Au's, Engineering Science = 38.2 AU's; Engineering Design = 25.2 AU's; Science = 13.0 AU's.

The attached document "INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED" is part of this course outline.

Western University
Faculty of Engineering
2016-2017

INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic accommodation will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services office if you are in first year) that there are compelling medical or compassionate grounds that can be documented before academic accommodation will be considered. Different regulations apply to term tests, final examinations and late assignments. Read the instructions carefully. (see the 2016 Western Academic Calendar).

A. *GENERAL REGULATIONS & PROCEDURES*

1. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

2. Bring your request for academic accommodation to the attention of the Chair of the department (or the Undergraduate Services office if you are in first year) prior to the scheduled time of the test or final examination or due date of the assignment. If you are unable to contact the relevant person, leave a message with the appropriate department (or Undergraduate Services office, if you are in first year). The addresses, telephone and fax numbers are given at the end of these instructions. Documentation must be provided as soon as possible.

3. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or exam reweighted on a retroactive basis is not permitted.

B. *TERM TESTS*

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).

2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).

3. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

C. *FINAL EXAMINATIONS*

1. If you are unable to write a final examination, contact the Undergraduate Services Office PRIOR TO THE SCHEDULED EXAMINATION TIME to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).

2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.

3. In order to receive permission to write a special examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. **It is the student's responsibility to check the date, time and location of the special examination.**

D. *LATE ASSIGNMENTS*

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
   ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

SHORT ABSENCES

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or the counsellors in the Undergraduate Services Office if you are in first year.

DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

ACADEMIC CONCERNS

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2016 Western Academic Calendar available at www.westerncalendar.uwo.ca.

Absences Due to Illness - page 117
Academic Accommodations for Students with Disabilities - page 118
Academic Accommodations for Religious Holidays - page 119
Incomplete Standing - page 104
Scheduling of Term Assignments – page 97
Scholastic Offences - page 113
Special Examinations - page 132

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

***Drop Deadlines*:**		
	First term half course (i.e. “A” or “F”):	November 5, 2016
	Full courses and full-year half courses (i.e. “E”, “Y” or no suffix):	November 30, 2016
	Second term half or second term full course (i.e. “B” or “G”):	March 7, 2017

Undergraduate Services Office:	SEB	2097	telephone: (519) 661-2130	fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering:	TEB	477	telephone: (519) 661-2131	fax: (519) 661-3498
Dept. of Civil and Environmental Engineering:	SEB	3005	telephone: (519) 661-2139	fax: (519) 661-3779
Dept. of Electrical and Computer Engineering, Software Engineering Mechatronics Engineering	TEB	279	telephone: (519) 661-3758	fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering:	SEB	3002	telephone: (519) 661-4122	fax: (519) 661-3020