Spring 2024 University of New Mexico
Structural Dynamics & Earthquake Engineering

Course Title CE524–001 (62604)

Credits 3 credits

Instructor

Dr. Fernando Moreu, PE
fmoreu@unm.edu (best way to contact me)
CENT-3056 (third floor Centennial
Engineering Center, Southwest corner),
Office phone (505) 277-1784

Dr. Fernando Moreu is an Associate Professor in the Department of Civil, Construction and Environmental Engineering (CCEE). Dr. Moreu is cross-appointed in the Departments of Electrical and Computer Engineering, Computer Science, and Mechanical Engineering. He has worked for over ten years as a structural engineer involved in the design and construction of over 30 bridges across seven states in the US Midwest. He is the founder and director of the Smart Management of Infrastructure Laboratory (SMILab http://smilab.unm.edu/).

TA Not assigned yet

Class hours Tuesdays and Thursdays 15:30-16:45

Office hours Wednesdays 15:00-17:00 (and by appointment)

Class location We plan to meet at the CEC Media Lab CEC 3001

Course Goals

Develop structural engineers who understand the fundamental dynamic behavior of structural systems, and can apply this understanding to analysis, design, investigation, and assessment. The main materials studied in this course are structural dynamics systems, with introduction to data acquisition and data processing. The context of the course is the understanding of dynamics in the context of structural engineering and vibrations, earthquakes, and related modeling and understanding of dynamic forces, responses, and signals in structural engineering. Matlab and signal processing is a strong component of this course. Those who are interested in structural dynamics but without a strong structural engineering background (other majors or areas of concentration) are encouraged to contact the instructor to discuss the contents of the course and whether this is the right course for their studies/research.

Student Learning outcomes

This course will enable students to:

1. Understand the principles and procedures for analyzing dynamic structural systems common in structural engineering, with an emphasis to buildings and bridges.
2. Comprehend and apply the theoretical and experimental background related to the dynamic behavior and performance of structural systems.
3. Comprehend and apply the theoretical and experimental background related to structural dynamics.
4. Comprehend the fundamental decisions and components involved in the structural design and performance of systems by understanding their fundamental dynamic behavior.
5. Be better prepared to know what is the profession of structural dynamical engineers in private and public positions through guest lecturers, discussions on structural skills, and practice in an applied project.
6. Be inspired by the new technologies for future careers in research, national laboratories, or entrepreneurship in structural dynamics.

Textbook

1. Fundamentals of Structural Dynamics, 2nd Edition, R. Craig and Andrew Kurdila (http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471430447.html)
2. *Other references that will be presented during the semester.*
3. Various supplementary materials will be provided

Other Recommended Text (no need to buy)

1. Vibration: Fundamentals and Practice, 2nd Edition, Clarence W. de Silva ISBN: 0-8493-1987-0 (http://product.half.ebay.com/Vibration_W0QQprZ50930940QQtgZinfo)
2. Dynamics of Structures, 2nd Edition, R. Clough and J. Penzien

Software

MatLab (download from http://it.unm.edu/download/index.html)
UNM created Matlab. We will be using Matlab from the start of the class. Students are highly encourage to become familiar with the basics commands and features for this class and their careers in engineering.

Grading

Up to 3 Midterms:	45 points
Homework:	10 points
Final Exam:	20 points
Semester Project (s):	15 points
Quizzes and Participation:	10 points

Grade Scale

A (>90%), A- (85-90%), B+ (80-85%), B (75-80%), B- (70-75%), C (60-70%), F (<60%)

Course Contents (Approximate)

- Structural Dynamics

PART I: SINGLE-DEGREE-OF-FREEDOM SYSTEMS.

- Mathematical Models of SDOF Systems
- Free Vibration of SDOF Systems
- Response of SDOF Systems to Harmonic Excitation
- Response of SDOF Systems to Non-periodic Excitation
- Response of SDOF Systems to Periodic Excitation; Frequency-Domain Analysis
- Numerical Evaluation of the Dynamic Response of SDOF Systems

PART II: MULTIPLE-DEGREE-OF FREEDOM SYSTEMS-BASIC TOPICS.

- Mathematical Models of MDOF Systems
- Vibration Properties of MDOF Systems
- Dynamic Response of MDOF Systems—Mode-Superposition Method

- Data Acquisition and Analysis
- Digital Signal Processing
- Experimental Modal Analysis Theory and Implementation
- Introduction to Structural Health Monitoring and Smart Structures Technology

Homework

Homework will typically consist mostly of hard copy solutions for problems related to the concepts of the class. You can solve equations by hand or with a word processor. All the hard copy homework should be scanned as one single PDF file and uploaded to LEARN. The homework PDF document should be named following the format "YourLastName_HomeworkNumber," for example, "Moreu_01". No late homework will be accepted except with a documented excuse.

Homework will typically consist mostly of coded Matlab solutions about structural dynamic problems related to the concepts of the class. You are expected to submit a hardcopy solution on addition to a digital copy with your entire code and files, so the results can be checked using Matlab. All the files need to be submitted so I can run them in my computer and see the plots without any change on the code, as you would do working with a company and client and sharing your code. The code should be your own, and clear to be read. You are expected to comment your code using the % symbol in your .m file as you will do with a company or client

sharing your code.

No late homework will be accepted except with a documented excuse. You are encouraged to work together to understand concepts and develop approaches for problem solving throughout the course. However, each student must submit their own/individual work (unless noted otherwise for the laboratory homework which will be done in pairs of two). Evidence of inappropriate collaboration (i.e., submitting identical assignments, code that others coded for you) will result in no credit for that homework. Academic dishonesty includes, but is not limited to, dishonesty in quizzes, tests, or assignments; claiming credit for work not done or done by others; hindering the academic work of other students; misrepresenting academic or professional qualifications within or without the University; and nondisclosure or misrepresentation in filling out applications or other University records.

The homework is due before class, 15:30 pm, the day they are due, unless indicated otherwise. If you submit during class or after class, you will lose points on your homework. I strongly recommend you send your homework ahead of time to perform well in your grade.

Semester Projects

There will be group projects during the semester that will include design, analysis, and reporting to the class of the final design about structural dynamics. The group projects expect a high level of detail in the design as well as a high quality of reporting to the rest of the classmates and external judges. There will be two or three semester projects throughout the semester.

Quizzes and Participation

It is imperative to contribute to the class action and there will be quizzes and other activities (seminars, lectures, videos) to enhance your engagement with the instructor. Quizzes may take place during classes and may or may not be announced throughout the semester. They may or may not include collaborative problems.

Class Etiquette

In this class, you are expected to attend professionally and interact professionally within the activities in the class. Some students taking this class are working in research, reports, clients, companies, and important projects and chose to attend to benefit from this class. Everyone attending the class is expected to participate in a learning and professionally environment in the lecture, as well as office hours. In

general, you will benefit the most if you participate in the active Q&As, contribute to the discussion sessions, and ask questions.

This being said, I am an approachable person, flexible, and I strongly believe in having an open conversation with the students registered in my class. Feel free to contribute with your ideas and be active and engaging in my class. Also contact me directly with anything you believe I can help with. I enjoy the professional relationship between students and professors and I hope I can assist your career and your learning in this class.

Expected Work in This Class

This is a three-credit-hour course. Class meets for two 1 hour - 15 minutes sessions of direct instruction for fifteen weeks during the Spring 2024 semester. Students are expected to complete a *minimum* of six hours of out-of-class work (or homework, study, assignment completion, and class preparation) each week. Plan accordingly to dedicate this effort in this class and meet me if you think you need additional help from me.

Course Outcomes

With Reference to:
Engineering Accreditation Commission Accreditation Board for Engineering and Technology (ABET)

The following ABET-specified outcomes are required from this course:

(a) An ability to apply knowledge of mathematics, science, and engineering
(c) An ability to design a system, component, or process to meet desired needs
(e) An ability to identify, formulate, and solve engineering problems
(k) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The following UNM Civil Engineering-specified outcomes are required from this course:

A. Graduates will achieve an appropriate level of **technical competence** in:
   2. Using modern tools for engineering analysis, including computers and sophisticated laboratory equipment.
   3. Approaching and solving engineering problems in a structured manner.
   4. Synthesizing knowledge from various sources to produce creative, cost-effective designs for civil engineering facilities.

B. Graduates will be prepared for the **engineering profession** through:
   8. An ability to communicate effectively, both in written and oral forms, as well as an ability to listen.

C. Graduates will have an **educated view of the world**, including:
   11. An understanding of the role and limitations of technology in addressing society's problems.

Accommodation Statement UNM is committed to providing equitable access to learning opportunities for students with documented disabilities. As your instructor, it is my objective to facilitate an inclusive classroom setting, in which students have full access and opportunity to participate. To engage in a confidential conversation about the process for requesting reasonable accommodations for this class and/or program, please contact Accessibility Resource Center at arcsrvs@unm.edu or by phone at 505-277-3506.
Support: Contact me at (505) 277-1784 or in office/check-in hours and contact Accessibility Resource Center (https://arc.unm.edu/) at arcsrvs@unm.edu or (505) 277-3506.

Academic Integrity The University of New Mexico believes that academic honesty is a foundation principle for personal and academic development. All University policies regarding academic honesty apply to this course. Academic dishonesty includes, but is not limited to, cheating or copying, plagiarism (claiming credit for the words or works of another from any type of source such as print, Internet or electronic database, or failing to cite the source), fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without informing the instructor, or tampering with the academic work of other students. The University's full statement on academic honesty and the consequences for failure to comply is available in the college catalog and in the Pathfinder.

Title IX Statement: Our classroom and our university should always be spaces of mutual respect, kindness, and support, without fear of discrimination, harassment, or violence. Should you ever need assistance or have concerns about incidents that violate this principle, please access the resources available to you on campus. Please note that, because UNM faculty, TAs, and GAs are considered "responsible employees" any disclosure of gender discrimination (including sexual harassment, sexual misconduct, and sexual violence) made to a faculty member, TA, or GA must be reported by that faculty member, TA, or GA to the university's Title IX coordinator. For more information on the campus policy regarding sexual misconduct and reporting, please see: https://policy.unm.edu/university-policies/2000/2740.html.

Support: LoboRESPECT Advocacy Center, the Women's Resource Center, and the LGBTQ Resource Center all offer confidential services.

Land Acknowledgement: Founded in 1889, the University of New Mexico sits on the traditional homelands of the Pueblo of Sandia. The original peoples of New Mexico Pueblo, Navajo, and Apache since time immemorial, have deep connections to the land and have made significant contributions to the broader community statewide. We honor the land itself and those who remain stewards of this land throughout the generations and also acknowledge our committed relationship to Indigenous peoples. We gratefully recognize our history.

Citizenship and/or Immigration Status: All students are welcome in this class regardless of citizenship, residency, or immigration status. Your professor will respect your privacy if you choose to disclose your status. As for all students in the class, family emergency-related absences are normally excused with reasonable notice to the professor, as noted in the attendance guidelines above. UNM as an institution has made a core commitment to the success of all our students, including members of our undocumented community. The Administration's welcome is found on our website: http://undocumented.unm.edu/.

Responsible Learning and Academic Honesty: We all have shared responsibility for ensuring that learning occurs safely, honestly, and equitably. Submitting material as your own work that has

been generated on a website, in a publication, by an artificial intelligence algorithm (AI), by another person, or by breaking the rules of an assignment constitutes academic dishonesty. It is a student code of conduct violation that can lead to a disciplinary procedure. *Please ask me for help in finding the resources you need to be successful in this course. I can help you use study resources responsibly and effectively.* Off-campus paper writing services, problem-checkers and services, websites, and AIs can produce incorrect or misleading results. Learning the course material depends on completing and submitting your own work. UNM preserves and protects the integrity of the academic community through multiple policies including policies on student grievances (Faculty Handbook D175 and D176), academic dishonesty (FH D100), and respectful campus (FH CO9). These are in the *Student Pathfinder* (https://pathfinder.unm.edu) and the *Faculty Handbook* (https://handbook.unm.edu).

Support: Many students have found that time management workshops or work with peer tutors can help them meet their goals. These and are other resources are available through Student Learning Support at the Center for Teaching and Learning.

Respectful Conduct Expectations: I am committed to building with you a positive classroom environment in which everyone can learn. I reserve the right to intervene and enforce standards of respectful behavior when classroom conduct is inconsistent with University expectations [and/or classroom community agreements]. Interventions and enforcement may include, but are not limited to, required meetings to discuss classroom expectations, written notification of expectations, and/or removal from a class meeting. Removal from a class meeting will result in an unexcused absence. Five or more unexcused absences may result in permanent removal and a drop from the course (see attendance policy). The University of New Mexico ensures freedom of academic inquiry, free expression and open debate, and a respectful campus through adherence to the following policies: D75: Classroom Conduct, Student Code of Conduct, University Policy 2240 – Respectful Campus, University Policy 2210 – Campus Violence.

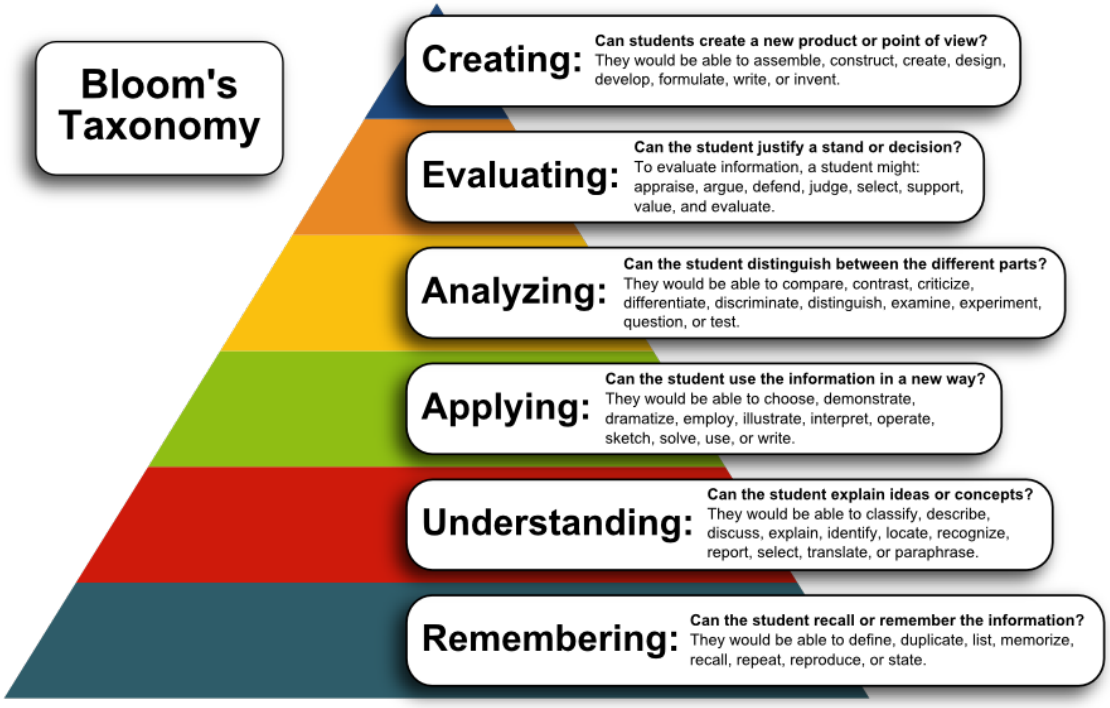
Connecting to Campus and Finding Support: UNM has many resources and centers to help you thrive, including opportunities to get involved, mental health resources, academic support such as tutoring, resource centers for people like you, free food at Lobo Food Pantry, and jobs on campus. Your advisor, staff at the resource centers and Dean of Students, and I can help you find the right opportunities for you.

Wellness: If you do need to stay home due to illness or are experiencing a wellness challenge, please take advantage of the resources below. You can communicate with me at fmoreu@unm.edu; I can work with you to provide alternatives for course participation and completion. Let me, an advisor, or another UNM staff member know that you need support so that we can connect you to the right resources. UNM is a mask friendly, but not a mask required, community. If you are experiencing COVID-19 symptoms, please do not come to class.

Support: Student Health and Counseling (SHAC) at (505) 277-3136. If you are having active respiratory symptoms (e.g., fever, cough, sore throat, etc.) AND need testing for COVID-19; OR If you recently tested positive and may need oral treatment, call SHAC.
TimelyCare: Free 24/7 virtual care services (medical, emotional support, health coaching, self-care, basic needs support. Go to http://timelycare.com/unm.
LoboRESPECT Advocacy Center (505) 277-2911 can offer help with contacting faculty and managing challenges that impact your UNM experience.

Educational Psychology - Bloom's Taxonomy

(Bloom 1956, revised by Anderson 2001)



(Figure from Baruch College)