

**Spring 2025 University of New Mexico**  
**Advanced Structural Dynamics**

**Course Title** CE 598 – 008 (79983)

**Credits** 3 credits

**Instructor** Dr. Fernando Moreu, PE  
[fmoreu@unm.edu](mailto:fmoreu@unm.edu) (best way to contact me)  
 CENT-3051 (third floor Centennial  
 Engineering Center),



Dr. Fernando Moreu is an Associate Professor in the Department of Civil, Construction and Environmental Engineering (CCEE). Dr. Moreu is cross-appointed in the Department of Electrical and Computer Engineering, Department of Mechanical Engineering, and Department of Computer Science. He is the founder and director of the Smart Management of Infrastructure Laboratory (SMILab <http://smilab.unm.edu/>). SMILab is housed at the UNM Center for Advanced Research and Computing (CARC)

**TA** Not assigned yet

**Class hours** Tuesdays and Thursdays 15:30-16:45 (to be confirmed)

**Office hours** Mondays 15:00-17:00 at CARC (or by appointment)

**Class location**  
 CEC 3001 (Media Lab)

**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. More specifically: Hardware, Actuators, Shakers, Sensors, Matlab, laboratory, structural dynamics, and signal processing are the main components of this course and students are encouraged to check if this course is the correct one for you. 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. Please contact the instructor if you need more details before registering.

## Student Learning outcomes

This course will enable students to:

1. Understand the principles and procedures for analyzing dynamic structural systems in the laboratory, with an emphasis to buildings and bridges, but also rotatory machines, plates, columns, beams, connections, and other dynamic systems.
2. Comprehend and apply the theoretical and experimental background related to the dynamic behavior and performance of structural systems by designing dynamic experiments.
3. Design, plan, modify, and implement field sensing of structures to collect dynamic properties of importance to owners, managers, and clients.
4. 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.
5. Be inspired by the new technologies for future careers in research, national laboratories, or entrepreneurship in structural dynamics.

### Recommended Text (highly encouraged to buy)

1. Vibration: Fundamentals and Practice, 2nd Edition, Clarence W. de Silva ISBN: 0-8493-1987-0  
(<https://a.co/d/1kRkdDW>)
2. Fundamentals of Structural Dynamics, 2nd Edition, R. Craig and Andrew Kurdila  
(<https://a.co/d/28n4HaA>)

### Other Recommended Text (no need to buy)

1. Dynamics of Structures, 2nd Edition, R. Clough and J. Penzien
2. *Other references that will be presented during the semester.*

### Software

MatLab (download from <http://it.unm.edu/download/index.html>)

Note: MatLab was inveted at UNM

(<https://en.wikipedia.org/wiki/MATLAB>)

### Grading

Up to 2 Midterms:	40 points
Homework:	10 points
Final Exam:	20 points
Semester Project (s):	20 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 Review (first three weeks – Matlab and handwritten mathematical equations)
  - 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
- Sensor Design: Hardware, Software, Deployment, Validation
- Data Acquisition and Analysis
- Digital Signal Processing
- Experimental Modal Analysis Theory and Implementation
- Random Vibration Concepts
- System Identification
- Health Monitoring and Damage Detection
- Pseudo-Dynamic Testing
- Model-based Simulation
- Smart Structures Technology

## Homework

Homework will typically consist mostly of a laboratory experiment and a coded Matlab solution that you will submit in the form of a report like you would do as a dynamics engineer consultant to your client. 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 experiments 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 final plots.

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) 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, the day they are due. If you submit during class or after class, you will lose the points from this homework. I strongly recommend you send your homework on time.

## **Semester Projects**

There will be group projects during the semester that will include laboratory preparation, experiment design, specimen preparation, sensor calibration, sensor deployment, experiment, analysis, and reporting to the class of your experimental methodology. 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. At least one of the projects will involve field testing.

## **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.

During the semester each of you will be asked to lead the presentation of contents both at the laboratory and in the classroom. Students will be given resources available to prepare ahead of time and will present the contents to their fellow classmates with Q&A included as part of the

teaching. I will assist each student beforehand to provide expectations on the content of each presentation.

### **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, companies, and important projects and 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 2025 semester. Students are expected to complete a *minimum* of seven and half 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

Regarding: Engineering Accreditation Commission Accreditation Board for Engineering and Technology (ABET)

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

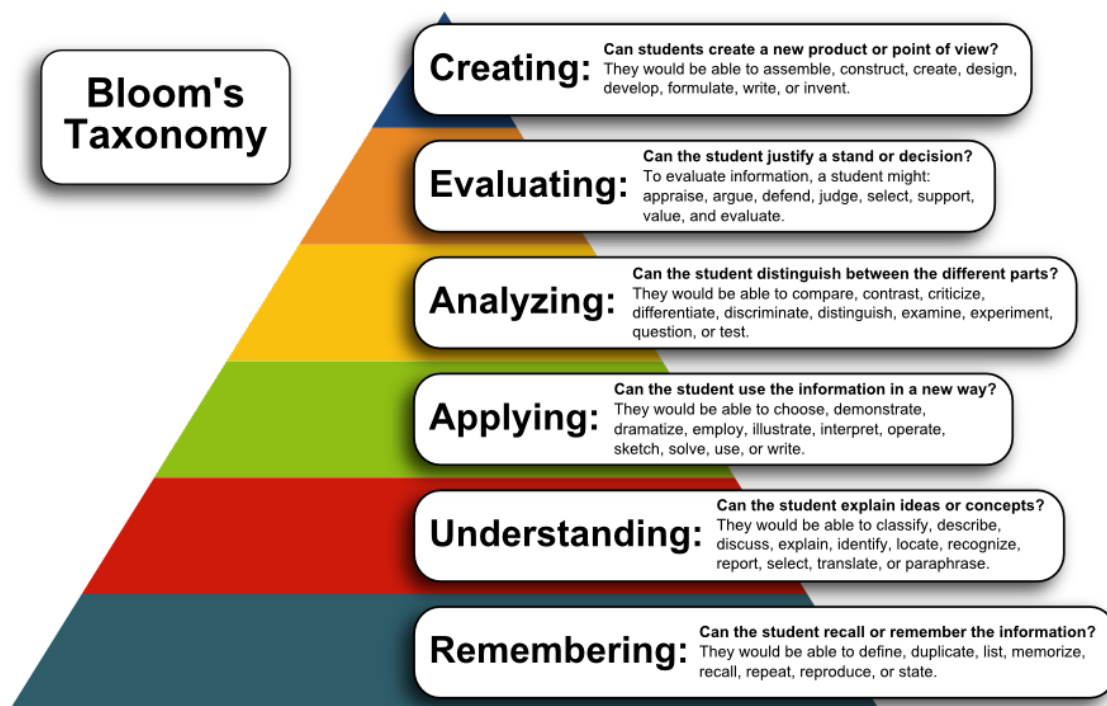
- (a) An ability to apply knowledge of mathematics, science, and engineering
- (c) An ability to design a system, component, or process to meet desired needs
- (e) An ability to identify, formulate, and solve engineering problems
- (k) An ability to use the techniques, skills, and modern engineering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

### Educational Psychology - Bloom's Taxonomy (Bloom 1956, revised by Anderson 2001)



(Figure from Baruch College)

**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 sources 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 the Pathfinder.

**Accommodation Statement** Accessibility Services (Mesa Vista Hall 2021, 277-3506) provides academic support to students who have disabilities. If you think you need alternative accessible formats for undertaking and completing coursework, you should contact this service right away to ensure your needs are met promptly. If you need local assistance in contacting Accessibility Services, see the Bachelor and Graduate Programs office.

**Title IX Statement:** Title IX prohibitions on sex discrimination include various forms of sexual misconduct, such as sexual assault, rape, sexual harassment, domestic and dating violence, and stalking. Current UNM policy designates instructors as required reporters, which means that if I am notified (outside of classroom activities) about any Title IX violations, I must report this information to the Title IX coordinator. If you or someone you know has been harassed or assaulted and would like to receive support and academic advocacy, there are numerous confidential routes available to you. For example, you can contact the Women's Resource Center, the LGBTQ Resource Center, Student Health and Counseling (SHAC), or LoboRESPECT. LoboRESPECT can be contacted on their 24-hour crisis line, (505) 277-2911, and online at [loborespect@unm.edu](mailto:loborespect@unm.edu). You can receive non-confidential support and learn more about Title IX through the Title IX Coordinator at (505) 277-5251 and <http://oeo.unm.edu/title-ix/>. Reports to law enforcement can be made to UNM Police Department at (505) 277-2241.

**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/>.

**Support in Receiving Help and in Doing What is Right:** I encourage students to be familiar with services and policies that can help them navigate UNM successfully. Many services exist to help you succeed academically, and to find your place at UNM, see [students.unm.edu](http://students.unm.edu) or ask me for information about the right resource center or person to contact. UNM has important policies to preserve and protect the academic community, especially 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>). Please ask for help in understanding and avoiding plagiarism or academic dishonesty, which can both have very serious disciplinary consequences.

**Land Acknowledgement:** (see <https://diverse.unm.edu> on appropriate use) 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.