

# ME 741: ENERGY AND VARIATIONAL METHODS IN APPLIED MECHANICS

Item	Detail(s)
CREDIT HOURS	3 Credit Hours
PREREQUISITES	Graduate Standing or Consent
COURSE DAY/TIME/LOCATION	
INSTRUCTOR	
E-MAIL	
OFFICE LOCATION	
OFFICE HOURS	

## Optional Text

Mechanics of Structures: Variational and Computational Methods," Walter D. Pilkey and Walter Wunderlich, Second Edition, CRC Press, 2003.

## Course Description

Governing equations of mechanics, energy and variational principles, variational methods of approximation, theory of elasticity, material laws, work and energy, beam theory, finite element method, structural systems.

## Course Purpose

1. This course builds on the principles laid in the Mechanics of Materials undergraduate course. The theories of mechanics of elastic bodies will be explained in more details.
2. Energy methods, which presents a tool for deriving the equations of motion of elastic objects, will be emphasized.
3. The course will cover numerical methods to solve these equations also.
4. Students should be familiar with using MATLAB or similar tools.

## Course Objectives

By the end of this course, you should be able to:

1. Students will be able to formulate of the linear problem of elasticity and provide a solution from simple problems
2. Formulate problems using the principles of virtual work and variational principles of elasticity
3. Students will be able to formulate derive the basic principles of the Finite Element Method (FEM/FEA)
4. Develop equations for vibration of simple structures
5. Write computer codes to analyze mechanical systems

## Grading

Grades are based upon student performance on assignments.

Each assessment tool is weighed as follows:

45% Homework

5% Quizzes  
5% Discussion Board Participation  
45% Exams (All Equal Weight)

## Course Policies

### Quizzes

1. After each unit there will be a quiz.
2. Each quiz will have multiple questions.
3. These are concept questions that should take you no time to answer if you have watched the video or read my notes.
4. If you do not answer the questions correctly, it should be a signal that you have not fully understood a concept within the unit. In this case, please go back and review instead of just trying till you get the right answer!!!

### Discussion Module

1. Each module will have its own discussion module
2. Please be sure to post there and respond to at least one post from others in the class.
3. You can respond as much as you like, but one is the minimum.
4. Please note, discussion responses take place in the same thread as the discussion question response.
5. This assignment page is here for grading purposes and no separate submission is needed

### Pre-Class & Post-Class Assignments

1. Several problems will be assigned in each module. Some of these problems may not be in the textbook.
2. The objective of the assignment is to train you to use the principles we covered in class. Please feel free to solve assignment in groups or individually.
3. Most of the problems will require a sketch of the problem along with one or more Free Body Diagrams showing the applied loads along with the external and internal reactions.
4. Show all of your work. Refer to equations in the book if you do not want to repeat them.
5. You will not receive credit for a correct answer if you have not shown the work.
6. Students are encouraged to attempt to solve more problems to increase the depth of their understanding of the material.
7. There will be programming assignments. You can choose whatever language you prefer for programming. I will be showing you examples in MATLAB.
8. Many of the homework assignments will be in the form of proofs and derivations. I suggest using Symbolic Toolbox for derivations and proofs, which can help you produce answer in a relatively shorter time.
9. Assignments should be uploaded into WebCampus. Please use one of the following to convert hand-written assignments into PDF. You can use scanner app such as Genius Scan App, which is free. Please do not upload photos as they may be difficult to read.
10. Please be sure that what you submit is readable. If not, I will return it without grading.
11. Be sure to include your name at the top of the first page
12. Assignments are divided into two types:
13. Students are encouraged to attempt to solve more problems to increase the depth of their understanding of the material.

### Exams

1. You will receive a notice of the exam time at least one week before it.
2. Exams can be within a class period (open book) or take-home.

3. The objective of exams is to test your understanding of material covered so far. Therefore, please do not expect to see one of the assignments problems, slightly masked, in the test. You should not also expect to see something totally new in an exam, as you will not have enough time to consider it.
4. My experience tells me that your chance of passing an exam is greatly enhanced if you solve assignments regularly.

## Topics to be Covered

Module 1: Equations for Linear Problems of Elasticity-I  
Module 2: Equations for Linear Problems of Elasticity-II  
Module 3: Linear Problems of Elasticity, Special Cases  
Module 4: Classical Structural Mechanics –I  
Module 5: Classical Structural Mechanics –II  
Module 6: Virtual Work – I  
Module 7: Virtual Work –II  
Module 8: Approximate Methods in Elasticity – I  
Module 9: Approximate Methods in Elasticity – II  
Module 10: Approximate Methods in Elasticity – III  
Module 11: Finite Element Method I, Fundamental and Bars under Axial Loading  
Module 12: Finite Element Method II, Beams in Bending  
Module 13: Finite Element Method III, Trusses  
Module 14: Finite Element Method IV, Frames  
Module 15: Finite Element Method V, Plane Stress  
Module 16: Dynamic Response

## UNIVERSITY POLICIES

### Public Health Directives

Face coverings are mandatory for all faculty and students in the classroom. Students must follow all active UNLV public health directives while enrolled in this class. [UNLV public health directives](https://www.unlv.edu/coronavirus/health-requirements) are found at <https://www.unlv.edu/coronavirus/health-requirements>. Students who do not comply with these directives may be asked to leave the classroom. Refusal to follow the guidelines may result in further disciplinary action according to the [UNLV Student Conduct Code](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), [https://www.unlv.edu/sites/default/files/page\\_files/27/StudentConduct-Code.pdf](https://www.unlv.edu/sites/default/files/page_files/27/StudentConduct-Code.pdf), including being administratively withdrawn from the course.

### Academic Misconduct

Academic integrity is a legitimate concern for every member of the University community. We all share in upholding the fundamental values of honesty, trust, respect, fairness, responsibility, and professionalism. By choosing to join the UNLV community, students accept the expectations of the Student Academic Misconduct Policy, and are encouraged to always take the ethical path whenever faced with choices. Students enrolling at UNLV assume the obligation to conduct themselves in a manner compatible with UNLV's educational mission. An example of academic misconduct is plagiarism. Plagiarism is using the words or ideas of another person, from the Internet or any other source without proper citation of the source(s). See the [Student Conduct Code](#).

## **Auditing Classes**

Auditing a course allows a student to continue attending the lectures and/or laboratories and discussion sessions associated with the course, but the student will not earn a grade for any component of the course. Students who audit a course receive the same educational experience as students taking the course for a grade, but will be excused from exams, assessments, and other evaluative measures that serve the primary purpose of assigning a grade.

## **Classroom Conduct**

Students have a responsibility to conduct themselves in class and in the libraries in ways that do not interfere with the rights of other students to learn, or of instructors to teach. Use of devices such as pagers and cellular phones, or potentially disruptive activities are only permitted with the prior explicit consent of the instructor. Students are specifically prohibited to record classes without instructor authorization, including online/remote classes (either audio only, or video and audio). The instructor may rescind permission at any time during the class. If a student does not comply with established requirements or obstructs the functioning of the class, the instructor may initiate an administrative withdrawal of the student from the course.

Since the COVID-19 pandemic forced most instruction to be delivered remotely starting on March 2020, numerous students have asked instructors to record their synchronous classes, so that they can access them at their convenience. Instructors who agree to record their classes (audio only, or video and audio) should inform students in advance. Recorded lectures may not be broadly released to anyone, but made available exclusively to those students enrolled in the class during the particular academic term. Recorded lectures must be stored securely, and are subject to the Nevada System of Higher Education's Records Retention Policy, meaning that the recordings can only be deleted 120 days after the end of class (i.e., after grades are posted). Once this requirement is met, the recordings should be deleted. Class recordings are protected from disclosure, as they are deemed part of an educational record under the Family Educational Rights and Privacy Act (FERPA).

## **Copyright**

The University requires all members of the University Community to familiarize themselves with, and to follow copyright and fair use requirements. You are individually and solely responsible for violations of copyright and fair use laws. The University will neither protect nor defend you, nor assume any responsibility for employee or student violations of fair use laws. Violations of copyright laws could subject you to federal and state civil penalties and criminal liability, as well as disciplinary action under University policies. Additional [copyright policy information](https://www.unlv.edu/provost/copyright) is available at <https://www.unlv.edu/provost/copyright>.

## **Disability Resource Center (DRC)**

The [UNLV Disability Resource Center](https://www.unlv.edu/drc) (Student Services Complex, SSC-A, Room 143, <https://www.unlv.edu/drc>, telephone 702-895-0866) provides resources for students with disabilities. Students who believe that they may need academic accommodations due to a permanent disability, temporary or permanent medical need, or academic support due to pregnancy are encouraged to contact the DRC as early as possible in the academic term. A Disabilities Specialist will discuss what options may be available to you. Students who are already registered with the DRC should request their accommodations online each semester, and make an appointment to discuss their accommodations with their instructors.

## Final Examinations

The University requires that final exams given at the end of a course occur on the date and at the time specified in the Final Exam schedule. The Final Exam schedule is typically available at the start of the semester, and the classroom locations are available approximately one month before the end of the semester. See the [Final Exam Schedule](#).

## Identity Verification in Online Courses

All UNLV students must use their Campus-issued ACE ID and password to log in to WebCampus-Canvas.

UNLV students enrolled in online or hybrid courses are expected to read and adhere to the [Student Academic Misconduct Policy](https://www.unlv.edu/studentconduct/misconduct/policy), <https://www.unlv.edu/studentconduct/misconduct/policy>, which states that “acting or attempting to act as a substitute for another, or using or attempting to use a substitute, in any academic evaluation or assignment” is a form of academic misconduct. Intentionally sharing ACE login credentials with another person may be considered an attempt to use a substitute, and could result in investigation and sanctions, as outlined in the Student Academic Misconduct Policy.

UNLV students enrolled in online courses are also expected to read and adhere to the [Acceptable Use of Computing and Information Technology Resources Policy](https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy), <https://www.it.unlv.edu/policies/acceptable-use-computing-and-information-technology-resources-policy>, which prohibits sharing university accounts with other persons without authorization.

To the greatest extent possible, all graded assignments and assessments in UNLV online courses should be hosted in WebCampus-Canvas or another UNLV-managed platform that requires ACE login credentials for access.

## Incomplete Grades

The grade of “I” (Incomplete) may be granted when a student has satisfactorily completed three-fourths of course work for that semester/session, but cannot complete the last part of the course for reason(s) beyond the student’s control and acceptable to the instructor, and the instructor believes that the student can finish the course without repeating it. For undergraduate courses, the incomplete work must be made up before the end of the following regular semester. Graduate students receiving “I” grades in 500-, 600-, or 700-level courses have up to one calendar year to complete the work, at the discretion of the instructor. If course requirements are not completed within the period indicated, a grade of “F” will be recorded, and the student’s GPA will be adjusted accordingly. Students who are fulfilling an Incomplete grade do not register for the course, but make individual arrangements with the instructor who assigned the “I” grade.

## Library Resources

Librarians are available to consult with students on research needs, including developing research topics, finding information, and evaluating sources. To make an appointment with a subject expert for this class, please visit the [Libraries’ Research Consultation](https://guides.library.unlv.edu/appointments/librarian) website, <https://guides.library.unlv.edu/appointments/librarian>. You can also [ask the library staff](https://ask.library.unlv.edu/) questions via chat and text message at <https://ask.library.unlv.edu/>.

## Missed Classwork

Any student missing class, quizzes, examinations, or any other class or laboratory work because of observance of religious holidays will be given an opportunity during that semester to make up the missed work. The make-up opportunity will apply to the religious holiday absence only. It is the responsibility of the student to notify the instructor within the first 14 calendar days of the course for Fall and Spring

courses (except for modular courses), or within the first 7 calendar days of the course for Summer and modular courses, of their intention to participate in religious holidays which do not fall on state holidays or periods of class recess. For additional information, please visit the Missed Classwork policy, under Registration Policies, on the [Academic Policies](#).

In accordance with the policy approved by the Faculty Senate regarding missed class time and assignments, students who represent UNLV in any official extracurricular activity will also have the opportunity to make up assignments, provided that the student provides official written notification to the instructor no less than one week prior to the missed class(es).

The spirit and intent of the policy for missed classwork is to offer fair and equitable assessment opportunities to all students, including those representing the University in extracurricular activities. Instructors should consider, for example, that in courses which offer a “Drop one” option for the lowest assignment, quiz, or exam, assigning the student a grade of zero for an excused absence for extracurricular activity is both contrary to the intent of the Faculty Senate’s policy, and an infringement on the student’s right to complete all work for the course.

This policy will not apply in the event that completing the assignment or administering the examination at an alternate time would impose an undue hardship on the instructor or the University that could be reasonably avoided. There should be a good faith effort by both the instructor and the student to agree to a reasonable resolution. When disagreements regarding this policy arise, decisions can be appealed to the Department Chair/School Director, College/School Dean, and/or the Faculty Senate Academic Standards Committee.

For purposes of definition, extracurricular activities may include, but are not limited to: academic recruitment activities, competitive intercollegiate athletics, fine arts activities, liberal arts competitions, science and engineering competitions, and any other event or activity sanctioned by a College/School Dean, and/or by the Executive Vice President and Provost.

## **Rebelmail**

Rebelmail is UNLV’s official email system for students and by University policy, instructors and staff should only send emails to students’ Rebelmail accounts. Rebelmail is one of the primary ways in which students receive official University communications, information about deadlines, major Campus events, and announcements. All UNLV students receive a Rebelmail account after they have been admitted to the University. Emailing within WebCampus-Canvas is also acceptable.

## **Tutoring and Coaching**

The Academic Success Center (ASC) provides tutoring, academic success coaching, and other academic assistance for all UNLV undergraduate students. For information regarding tutoring subjects, tutoring times, and other ASC programs and services, please visit the [ASC website](https://www.unlv.edu/asc), <https://www.unlv.edu/asc>, or call 702-895-3177. The ASC building is located across from the Student Services Complex (SSC). Academic success coaching is located on the second floor of SSC A, Room 254. Drop-in tutoring is located on the second floor of the Lied Library, and on the second floor of the College of Engineering building (TBE A 207).

## **UNLV Writing Center**

One-on-one or small group assistance with writing is available free of charge to UNLV students at the [Writing Center](https://writingcenter.unlv.edu/), <https://writingcenter.unlv.edu/>, located in the Central Desert Complex, Building 3, Room 301 (CDC 3–301). Walk-in consultations are sometimes available, but students with appointments

receive priority assistance. Students may make appointments in person or by calling the Center, telephone 702-895-3908. Students are requested to bring to their appointments their Rebel ID Card, a copy of the instructions for their assignment, and two copies of any writing they have completed on their assignment.

## **Diversity Statement**

As an institution of higher learning, UNLV represents a rich diversity of human beings among its faculty, staff, and students, and is committed to aspiring to maintain a Campus environment that values that diversity. Accordingly, the University supports understanding and appreciation of all members of its community, regardless of race, sex, age, color, national origin, ethnicity, creed, religion, disability, sexual orientation, gender, gender identity, marital status, pregnancy, genetic information, veteran status, or political affiliation. Please see [University Statements and Compliance](https://www.unlv.edu/about/statements-compliance), <https://www.unlv.edu/about/statements-compliance>.

A successful learning experience requires mutual respect and trust between the students and the instructor. Accordingly, the instructor asks that students be willing to listen to one another's points of view, acknowledging that there may be disagreements, keep discussion and comments on topic, and use first person, positive language when expressing their perspectives.