

**UNIVERSITY OF PORTLAND**  
**Donald P. Shiley School of Engineering**  
**ME 304 – Finite Element Analysis**  
**Fall Semester, 2019**

**"Find the gift God gave you. Sharpen, hone, and train it. And, then go use it. Go!"**

-Donald P. Shiley '51

**Course Description:** Course builds on the concepts learned in strength of materials and introduces finite element analysis (FEA). Topics include elasticity, 3-dimensional Hooke's law, and failure theories. FEA is introduced mathematically beginning with springs, trusses, and beams. A commercial FEA software package is used to model plane stress and three-dimensional geometry. Individual projects are used to introduce three-dimensional analysis.

Number of Credits: 3

Class Schedule: Section A: 11:25-12:30 MWF, Section B: 12:30-1:25 MWF

Course Instructor: Kenneth E. Lulay, Ph.D., P.E.  
Shiley Hall 236. Ph: 943-7432. e-mail: [lulay@up.edu](mailto:lulay@up.edu)  
Web pages: <http://faculty.up.edu/lulay/>

Office Hours: Available any time if I'm in my office. I'll try to be in my office:

Monday	9:30-10:10
Tuesday	11:20-12:00
Wednesday	1:45-3:00
Thursday	1:00-3:00
Friday	1:35-2:00

Graduate Assistant Tutoring: 5 nights per week (Sunday-Thursday), 6PM-8PM, SH124

Prerequisites: Prerequisites: EGR322 with C- or better

Supplies required: Circle templates, colored pencils (8 colors, minimum), engineering paper, straight edge.

Supplies recommended: 3-ring notebook, pocket stapler, three-hole punch

Textbooks: Lee, Huei-Huang, *Finite Element Simulations with ANSYS Workbench 19*, SDC Publication, 2018.

Lulay, Ken, *The Stress Imagination Workbook*, University of Portland Printshop, Fall 2019.

**Course Purpose:** This course is the middle of three required courses in mechanical engineering with a strong focus on stress analysis (the other courses being Strength of Materials and Machine Design). Stress analysis is a critical aspect in mechanical engineering in that it provides the engineer a way of estimating the expected life and performance of a loaded part. This course is intended to help you:

- Develop as a human being. We are all a work-in-progress.
- Develop ability to solve large relatively complex problems by breaking them into smaller pieces.

- Develop “trouble-shooting” problem solving skills.
- Develop the ability to have confidence in your engineering decisions (and non-engineering ones as well).
- Develop a strong sense of what stress and strain are and prepare you to use that knowledge in engineering applications.

**Student Outcomes,** Students shall be able to demonstrate:

- an understanding of the mathematical foundations of finite element analysis
- an ability to solve 1-dimensional finite element problems using Excel
- an understanding that stress and strain are fully three-dimensional phenomena with interactions between different coordinate directions
- ability to create and apply 3D Mohr’s Circle and Hooke’s Law
- an understanding of the principles of stress and strain, plane stress and strain, and properly apply static failure theories.
- ability to analyze the stresses and strains using commercial FEA software
- ability to interpret FEA results and to identify potential “pitfalls” of interpretation
- ability to validate your own engineering conclusions

**Schedule:**

Topic	Week	Topic	Week
Quantitative skills	1	Beams	8
Matrix algebra basics	2	Elasticity and Static failure theories	9
Intro to the finite element method	3	2D FEA	11
Axial loaded members	4	3D FEA	11
Trusses - transformations	5	Pitfalls and Interpretation	12
Visualizing stress in uniaxial members	7	Project work	12-14

**Method of Determining Final Grade:**

- Aspirational Ethics/Professional Responsibility 5%
- FEA Homework 10%
- Stress Imagination Workbook 10%
- Projects (2 projects) 10%
- Quizzes 15%
- Midterms (2 midterms) 30%
- Final 20%

At the completion of the course, the total scores from the above distributions will be combined into a letter grade according to the following scale:

Above 90%	A range (A- to A)
80% to 90%	B range (B- to B+)
70% to 80%	C range (C- to C+)
60% to 70%	D range (D- to D+)
Less than 60%	F

**Aspirational ethics and professional responsibility**

Assignments (aka “reflections”) will be given near-weekly regarding “aspirational ethics and professional responsibility.” Grading will be based on completion of the assignments.

### **Stress Imagination Workbook**

The objective of the *Stress Imagination Workbook* is to give you practice solving an engineering problems using unique methods so that you may gain a much deeper understanding of stress than equations alone provide. Its primary purpose is for educational development and your own personal assessment of your understanding; not for instructor assessment. Assignments will be given near-weekly.

### **FEA Homework**

Some concepts will be difficult to understand sufficiently well to succeed as an engineer. Homework will often be challenging – this is good although not always enjoyable. This is how people learn. The homework assigned in this course is meant to be the *minimum* sufficient to help you judge your own depth of knowledge. Many topics will require you working additional problems before **you can honestly be convinced that you do understand the material deeply**. Its primary purpose is for educational development and your own personal assessment of your undertraining; not for instructor assessment

FEA homework will be assigned near-weekly and is required to learn the material. Assignments will be due at the beginning of class on the date indicated. Late work is accepted up to one week late (through the beginning of class the following week), with a 50% penalty. Except in the case of a free pass (see below), the 50% penalty is applied to ALL late work.

### **Homework in general**

***All homework is assumed to be the individual work of the student submitting the assignment.***

Copying from another student, the solution manual, or other sources is not acceptable and will result in a score of zero for all students involved. Additionally, I am required to report all instances of academic dishonesty to the Dean for appropriate follow up by the university. Please refer to the section on Group and Individual Work below for further information.

You are **highly encouraged to avoid using calculators** to do simple arithmetic on homework as you will not be permitted to use calculators on quizzes and exams.

Not all assigned homework problems will be graded.

**FREE PASS:** You receive one free pass for a late FEA homework assignment. No assignments are accepted over one week late. However, you may turn in **one** FEA homework assignment up to one week late that will receive no late penalty. To have your free pass applied to a late assignment, write FREE PASS clearly at the top of the assignment when you turn it in. You have only **ONE** free pass to use, and it is your decision on when to apply it. If you do not write FREE PASS on the assignment before turning it in, a free pass will not be applied, and a free pass will not be retroactively applied. The purpose of the free pass is to accommodate unexpected life events such as illness, oversleeping, emotional distress, etc. However, you have **one** to use and may use it at any time, for any reason you choose.

I cannot accept piecemeal assignments, so you will be graded on only the first portion you turn in. Late work may not be graded in a timely fashion. Please make a copy if you will need your homework to study for an exam.

You are required to use the **Homework Format** posted online. The purpose of this is to help you develop important engineering documentation and problem solving skills that you will need in your

career. All FEA homework shall be submitted on engineering paper, one side only (except for computer printouts). Engineering paper is available from the bookstore or can be purchased online. It is a required item and thus qualifies for financial reimbursement like a textbook. Your work must be completed in pencil. Your assignment must be stapled (I recommend purchase of a pocket stapler).

**Homework that does not comply to the Homework Format may be penalized or even not accepted.**

### **Projects**

There will be two projects, each worth 5% of the course grade. To receive credit, the project must be of professional quality – anything less than that will not be accepted. For each project:

Full credit (100%) – convincingly communicate the soundness of your engineering work on the first submission (*you may meet with me prior to submission to discuss your work, but I will not review the document in detail*).

Partial credit (75%) - convincingly communicate the soundness of your engineering work on second submission after meeting with instructor and resubmitting with all recommending improvements.

No credit (0%) – does not convincingly communicate the soundness of your engineering work.

**Quizzes:** will be given periodically to test your understanding of the material presented in class or covered on homework. Missed quizzes cannot be made up for any reason. Your lowest quiz score will be dropped. **No calculators** or any other electronic device will be allowed on quizzes. All electronic devices (cell phones, calculators, etc.) must be kept in a back pack, pocket, or left with the instructor for the duration of the quiz.

### **Midterm Exams**

You must complete your exam in pencil only. Straight edges are highly encouraged (ID card works well). **No calculators** or any other electronic device will be allowed on exams. All electronic devices (cell phones, calculators, etc.) must be kept in a back pack, pocket, or left with the instructor for the duration of the exam.

There may be multiple versions of each exam. If you miss an exam for a valid emergency (medical emergency, death in the family), please let me know, BEFORE the regularly scheduled exam start time (email or phone). At my discretion, in the case of a valid emergency, missed exams may be made up within one week of the regularly scheduled exam. The instructor must be notified of valid non-emergency exam absences at least ONE WEEK prior to the scheduled exam date to receive a make-up exam. All missed exams must be made up within one week of the regularly scheduled exam, and will consist of an alternate exam which is generally more difficult than the regular exam. If you are uncertain about your circumstances meeting the above requirements, come talk to me.

Unclear methodology on exams, regardless of the answer may result in a significantly reduced grade, depending upon instructor's judgment. Engineering work must always be clear.

If you wish to dispute an exam grade, you must submit a written explanation describing your dispute. This is due within one week after the exam is returned.

### **Group and Individual Work:**

**Individual Work:** When you submit your work with your name on it, you are attesting that the work you are submitting is your own. To take credit for work that is not your own is a serious breach of all professional codes of ethics. As a practicing engineer, this could have very serious repercussions including losing the ability to continue to practice as an engineer! Students are encouraged to form

study groups and discuss assignment parameters and “sticky points” of assignments. However, the actual work must be completed by the individual student who’s submitting the work for credit.

Authorized aid on individual work includes:

- *discussing the interpretation of the assignment statement;*
- *sharing ideas or approaches for completing the assignment/solving the problem; and,*
- *explaining concepts involved in the assignment/problem.*

*The following are examples of practices that are **not allowed**:*

- *Watching another student complete a problem, then copying/repeating the work, or using solutions obtained from on-line, previous students, or other such “resource.”*
- *More than one student working on one homework assignment for all or part of an assignment, then copying and submitting the problems as individual work*
- *Submitting the work of another as your own*

*Remember, “you play as you practice”...there are no solutions manual for real engineering problems!*

**Group Work:** *Some assignments and projects may be assigned as group work – this will be clearly indicated as such. When all or part of an assignment is assigned as group work, that assignment, or portion of the assignment, to be completed by a group will be specified. Whenever group work is submitted, names of **all contributors** must appear on the submitted assignment. Credit will not be awarded to students whose names do not appear. It will also be assumed that no additional students contributed to the submitted work.*

### **General Class Policies**

I encourage students to work together on all homework assignments (see section on *Group and Individual Work* above). However, you must not offer anyone assistance during an examination. Please be aware that I have zero tolerance for cheating. If I detect any evidence of this during an exam or while grading, appropriate action will be taken.

**Website:** Assignments will be posted on the course website, and solutions will be posted after the assignment is due. <http://faculty.up.edu/lulay/ME304>

**Communication:** A consistent message we here from employers is that they seek individuals with good communication skills. Listening and staying informed is a critical element of effective communication. Therefore, students are responsible for regularly checking and acting upon messages sent to their University e-mail. Each student is also expected to follow the standard homework format at all times. And also, being present and listening (attending and paying attention in class) is part of communication.

**Solutions:** Homework is assigned to help you learn – therefore, don’t just “do the work”, **understand** it. Attending class and simply doing homework is usually insufficient to understand the material and to do well on exams. Real/deep learning will mainly occur by “getting your hands dirty” (doing the work). After each assignment has been submitted the solutions will be posted on the course web page. Students are **HIGHLY** encouraged to review all problems and to understand the correct methodology.

**Professional Responsibility:** I do consider all students to be **practicing professionals right now**, and therefore, expect professional behavior: always do your best, complete and **understand 100% of the assigned work**, do your own work and work on teams appropriately, show respect to peers and the instructor, arrive on time (before class begins) and be ready to participate as soon as class begins.

I do understand that cell phones are ubiquitous in the professional world, but not at all times and not in all circumstances. Electronic devices are distracting to me, so please, out of professional courtesy, no non-approved class related use of cell phones or similar devices in class. Besides, you are paying big bucks per hour to be in class, so please make the most of your investment by focusing on class work during class time. That should leave sufficient time outside of class for you to decide to use your cell phone...or not.

**Ask Questions!** It is your responsibility to ask questions when you are confused, need further explanations, or simply want to grow beyond the class expectations. The instructor's responsibility is NOT to answer the question for you, but rather to help guide you to answer it for yourself. So please do not get frustrated when I do not answer your question as directly as you may have hoped.

### **University Policies and Resources**

**School of Engineering's Lab/Shop Access and Safety Policy** No one is allowed to work in the shops or labs without appropriate training from the shop technician and without instructor permission.

**University of Portland's Code of Academic Integrity** Academic integrity is openness and honesty in all scholarly endeavors. The University of Portland is a scholarly community dedicated to the discovery, investigation, and dissemination of truth, and to the development of the whole person. Membership in this community is a privilege, requiring each person to practice academic integrity at its highest level, while expecting and promoting the same in others. Breaches of academic integrity will not be tolerated and will be addressed by the community with all due gravity.

**Assessment Disclosure Statement:** Student work products for this course may be used by the University for educational quality assurance purposes.

**Accessibility Statement:** The University of Portland endeavors to make its courses and services fully accessible to all students. Students are encouraged to discuss with their instructors what might be most helpful in enabling them to meet the learning goals of the course. Students who experience a disability are also encouraged to use the services of the Office for Accessible Education Services (AES), located in the Shepard Academic Resource Center (503-943-8985). If you have an AES Accommodation Plan, you should make an appointment to meet with your faculty member to discuss how to implement your plan in this class. Requests for alternate location for exams and/or extended exam time should, where possible, be made two weeks in advance of an exam, and must be made at least one week in advance of an exam. Also, you should meet with your faculty member to discuss emergency medical information or how best to ensure your safe evacuation from the building in case of fire or other emergency.

**Mental Health Statement:** As a college student, you may sometimes experience problems with your mental health that interfere with academic experiences and negatively impact daily life. If you or someone you know experiences mental health challenges at UP, please contact the University of Portland Health and Counseling Center in Orrico Hall (down the hill from Franz Hall and Mehling Hall) at [www.up.edu/healthcenter](http://www.up.edu/healthcenter) or at 503-943-7134. Their services are free and confidential, and if necessary they can provide same day appointments. In addition, after-hours phone counseling is available if you call 503-943-7134 and press 3 outside of business hours. Also know that the University of Portland Public Safety Department (503-943-4444) has personnel trained to respond sensitively to mental health emergencies at all hours. Remember that getting help is a smart and courageous thing to do – for yourself, for those you care about, and for those who care about you.

**Non-Violence Statement:** The University of Portland is committed to fostering a community free from all forms of violence in which all members feel safe and respected. Violence of any kind, and in particular acts of power-based personal violence, are inconsistent with our mission. Together, we take a

stand against violence. Join us in learning more about campus and community resources, UP's prevention strategy, and reporting options on the [Green Dot website, www.up.edu/greendot](http://www.up.edu/greendot) or the [Title IX website, www.up.edu/titleix](http://www.up.edu/titleix).

**Ethics of Information:** The University of Portland is a community dedicated to the investigation and discovery of processes for thinking ethically and encouraging the development of ethical reasoning in the formation of the whole person. Using information ethically, as an element in open and honest scholarly endeavors, involves moral reasoning to determine the right way to access, create, distribute, and employ information including: considerations of intellectual property rights, fair use, information bias, censorship, and privacy. More information can be found in the Clark Library's guide to the [Ethical Use of Information](http://libguides.up.edu/ethicaluse) at [libguides.up.edu/ethicaluse](http://libguides.up.edu/ethicaluse).

**The Learning Commons:** Trained peer tutors and writing assistants in the Learning Commons, located in Buckley Center 163, work with you to facilitate your active learning and mastery of skills and knowledge. For questions about the Learning Commons, please send all correspondence to Jeffrey White, Administrator, at [white@up.edu](mailto:white@up.edu). The Learning Commons is a program of the Shepard Academic Resource Center (SARC.)

**Math Resource Center:** Appointment-based tutoring is available through our online scheduler at [www.bit.ly/up\\_mrc](http://www.bit.ly/up_mrc). Walk-in tutoring Sundays through Thursdays evenings. For MTH 141, request appointments at [math141@up.edu](mailto:math141@up.edu). The course-specific schedule can be found at [www.up.edu/learningcommons](http://www.up.edu/learningcommons), or the reception desk in BC 163.

**Writing Assistance:** Brainstorming ideas for your paper, create an outline, work on citations, or review a draft with a Writing Assistant. Visit [www.up.edu/learningcommons](http://www.up.edu/learningcommons) to access our Writing Center schedule.

**The Language Studio:** Contact the language assistance hotlines to schedule a time to meet throughout the semester at [chinesetutor@up.edu](mailto:chinesetutor@up.edu), [frenchtutor@up.edu](mailto:frenchtutor@up.edu), [germantutor@up.edu](mailto:germantutor@up.edu), or [spanishtutor@up.edu](mailto:spanishtutor@up.edu).

**Natural Sciences Center:** Send your tutoring requests to [biotutor@up.edu](mailto:biotutor@up.edu), [chemtutor@up.edu](mailto:chemtutor@up.edu), or [physicstutor@up.edu](mailto:physicstutor@up.edu).

**Speech & Presentation Lab:** Improve your presentations by requesting an appointment at [speech@up.edu](mailto:speech@up.edu).

**Group Work Lab:** Make an appointment for your group project at [groupwork@up.edu](mailto:groupwork@up.edu).

**Nursing Tutoring:** Tutoring is available for pathophysiology, BIO205, anatomy and physiology, and other nursing courses on a walk-in or appointment basis. Up-to-date schedule information is at [www.up.edu/learningcommons/nursing](http://www.up.edu/learningcommons/nursing).

**Economics and Business Tutoring:** For support in economics, OTM, finance, accounting, and business law courses, send requests for appointments to your discipline's tutor email hotline: [econtutor@up.edu](mailto:econtutor@up.edu), [otmtutor@up.edu](mailto:otmtutor@up.edu), [financetutor@up.edu](mailto:financetutor@up.edu), [accountingtutor@up.edu](mailto:accountingtutor@up.edu), or [bizlaw@up.edu](mailto:bizlaw@up.edu).

**Learning Assistance Counselor:** Learning assistance counseling is also available in BC 163. The counselor teaches learning strategies and skills that enable students to become more successful in their studies and future professions. The counselor provides strategies to assist students with reading and comprehension, note-taking and study, time management, test-taking, and learning and remembering. Appointments can be made in the on-line scheduler available to all students in Moodle or during posted drop-in hours.