

### **Learning Objectives**

At the end of the course, the student should be able to design and analyze aerospace engineering components subject to different types of loading. In particular, the objective is to introduce the student to i) the methods of stress, deformation and stability analysis in the design of aerospace engineering components, ii) failure theories, fatigue analysis and thermal stress analysis in the design process, iii) the use of computer tools to solve problems in mechanics. Independent learning, professionalism and applications to real engineering applications and problems will be stressed throughout.

### **Measurable Outcomes**

The achievement of the learning objectives will be measured through the students' ability to:

1. apply mathematical tools to solve mechanics problems,
2. compute the stress, strain and displacement in a beam subject to normal and shear loads,
3. compute the stresses in shafts due to torsion,
4. use the governing equations for 3-D and 2-D solid mechanics,
5. compute the critical load that a component can withstand using different failure criteria including maximum shear stress criteria, von Mises criteria and buckling criteria.
6. design a component for a specified fatigue life,
7. use computational tools to model and analyze structural components,
8. carry out a design project in a team environment and present the results.

### **Prerequisites**

Undergraduate statics, dynamic, calculus, and strength of materials background or permission of the instructor.

### **Lectures**

There will be one lecture of 2 hours and one lecture of one hour a week. Student attendance is necessary to maximize the learning experience.

### **Course Work**

The course work includes homework assignments (both reading and problem solving), tests, quizzes and a design project.

### **Project**

There will be one major structural design project that will be announced in the beginning of the semester. The project will be carried out by teams of 3 students. The teams will be defined by the instructor in the beginning of the semester. The teams will submit an engineering report and give a professional presentation.

### **Homework Assignments**

Homework assignments will be given almost every week. The due date for submission of assignments is at the beginning of class one week after the assignment is given. Late submission of assignments is not accepted. Students are strongly encouraged to discuss homework problems in groups, since this is expected to help the learning process. However, homework assignments

are also used for performance assessment and, therefore, the material that is turned in must represent the student's own understanding of the material.

Homework assignments will consist of three parts: 1) practice problems to be handed in but not graded, 2) graded problems, and for some assignments 3) a design or an application problem.

In addition, one student per lecture will be selected to rewrite and submit lecture notes in English and Turkish with additional notes (glossary of technical terms, related material from the web, additional remarks and questions). This will count as an additional HW grade.

### Quizzes

There will be unannounced/announced quizzes covering either the previous lecture, reading assignment or homework once a week. Some quizzes will be group quizzes where team members work together to solve a given problem.

### Course Web page

Students can have access to the web content through <http://www.ae.metu.edu.tr/~ae361/> website. Homework solutions, announcements and discussions will be posted here. In addition, there will be a forum where students can ask and answer questions.

### Assessment of Student Performance

Student performance will be assessed through homeworks, quizzes and class participation, project and exam grades. The final letter grades will be assigned according to the rules and regulations of the Faculty.

There will be 2 midterm exams and 1 final exam. *An exam might have an oral exam component.* There will be only approved calculators allowed for the exams. A list of approved calculators are:

- o Hewlett Packard – HP 30s
- o Hewlett Packard – HP 33s
- o Hewlett Packard – HP 9s
- o Casio – FX 115 ES, FX 115 MS, and FX 115 MS Plus (Note: FX 115 ES and FX 115 MS models ending with an "-SR" designation are also allowed)
- o Texas Instruments – TI 30XA (or TI 30Xa)
- o Texas Instruments – TI 30X IIS and TI 30X IIB
- o Texas Instruments – TI 36X Solar

### Grading Basis

Quizzes and class participation	10 points
Homework	20 points
Project	20 points
Exam #1 (oral exam)	10 points
Exam #2	20 points
Final Exam	20 points
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Total:	100 points

### Course Outline

Concepts of stress and strain in 3D. Transformations of stress and strain in 3D. Stress-strain and strain-displacement relations in 3D. Generalized Hooke's law. Governing equations of elasticity. Castigliano's theorem. Problems in two dimensional elasticity. Plane-stress and plane-strain applications. Polar coordinates. Torsion of noncircular bars. Axisymmetrically loaded members. Rotating disks, thin and thick cylinder applications. *Failure theories, stability, impact, fatigue and fracture.*

### Bibliography

There is no official textbook for the course. The following reference books will be useful:

1. Ugural and Fenster, Advanced Strength and Applied Elasticity, 4<sup>th</sup> Ed., Prentice Hall, PTR, 2003.
2. Boresi, A. P. and Schmidt, R. J., **Advanced Mechanics of Materials**, John Wiley and Sons, New York, 2003 (available at [www.knovel.com](http://www.knovel.com) )

3. Bisplinghoff, R. L., Mar, J. W., and Pian, T. H. H., Statics of Deformable Solids, Dover Publications, New York, 1990.
4. Budynas, R. G., Advanced Strength and Applied Stress Analysis, 2<sup>nd</sup> Ed., McGraw-Hill, New York, 1999.
5. Chou, P. C. and Pagano, N. J., Elasticity: Tensor, Dyadic and Engineering Approaches, Dover Publications, New York, 1992.
6. Timoshenko, S. P. and Goodier, J. N., Theory of Elasticity, 3<sup>rd</sup> Ed., McGraw-Hill Book Company, New York, 1987.
7. Juvinal and Marshek, **Fundamentals of Machine Component Design**, 4<sup>th</sup> Ed., John Wiley & Sons, NJ, 2006.
8. Parnes, R., Solid Mechanics in Engineering, John Wiley and Sons, New York, 2001.
9. Budynas and Nisbett, **Shigley's Mechanical Engineering Design**, 8<sup>th</sup> Edition, McGraw-Hill, 2008.
10. Norton, R. L., **Machine Design: An Integrated Approach**, Prentice-Hall, 2004.
11. <http://solidmechanics.org>
12. <http://ocw.mit.edu/OcwWeb/Aeronautics-and-Astronautics/16-01Fall-2005-Spring-2006/MaterialsStructures/index.htm#BelowTable>
13. <http://ocw.mit.edu/OcwWeb/Aeronautics-and-Astronautics/16-20Structural-MechanicsFall2002/CourseHome/index.htm>
14. [www.knovel.com](http://www.knovel.com)

*We grow up thinking that the best answer is in someone else's brain. Much of our education is an elaborate game of "guess what's in the teacher's head?" What the world really needs to know right now is what kind of dreams and ideas are in your head.  
-- Roger von Oech*

## Free Advice

### Discuss the subject with others

**Group study** is strongly encouraged. Interaction with peers and instructors is very beneficial to your learning and digesting the material (and is good for your health too). Make good use of it. Discuss the problems with the TA.



### Ask Questions

It is recommended that you put in at least 2 hours of study for each 1 hour of lecture. It is very useful to read ahead, before the material comes up in the classroom. Feel free to **ask questions**, make comments or just express your opinions during the lecture. Everybody gains from it (including the lecturer).



### Think!

The assigned problem sets present an opportunity for you to think about and apply the material presented in the lectures and in some cases to learn new material. Start them early in the week so that you can think about them and exercise your creative potential. *Note that solving a problem does not only consist of inserting numbers into equations and crunching out new numbers.* **Think!** Strive for 100% on the assignments utilizing all the resources and opportunities available to you.

### Expand your mind

Learning is a process of **expanding your mind**. This is attained by developing new connections between neurons in your brain and strengthening selected neural pathways. Just as in sports, you must have resistance training to strengthen your mind. Be persistent and don't give up when you come to the inevitable hard sections. For some of you that might be at the beginning, for others the resistance might increase with time. Hang in there.



### Don't Copy

**Copying** the solutions to assigned problems from other sources (*students, written notes, and solution manuals*) is not only discouraged, it is forbidden. It is not professional, it does not reflect well on you as a future engineer, and it is detrimental to your character and professional career. It is an activity that shows disrespect for you, for your classmates, for your instructors, and for METU. It also poisons the free learning atmosphere. Instead, communicate your issues to your instructor. If you have questions, ask the instructor or the TAs. The class policy is guided by respect for your friends and classmates: *"No member of this class shall take unfair advantage of any other member in this class."*



### Enjoy!

If you follow the lectures, keep up with the homework problems, and ask questions to your classmates, TAs and the instructor, you will be on your way to mastering the material. Persistence and motivation are the only prerequisites to success. Make it a game to master new skills and knowledge. Be courageous in facing new challenges.  
**Enjoy!**

*Measured objectively, what a man can wrest from Truth by passionate striving is utterly infinitesimal. But the striving frees us from the bonds of the self and makes us comrades of those who are the best and the greatest.*  
*-Albert Einstein*