EM696 “Analysis of Elastic Plates”

Fall 2011
Tuesdays and Thursdays, 4:00 to 5:15 PM
Geology, Math and Computer Science, Room GMCS 305
San Diego State University

Instructor

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Please make sure to include the course name, EM696, in any email correspondence.

Office Hours

Tuesday and Thursday 2:45-3:45 PM
Friday 2pm-4pm (only by appointment)

Textbook

J. N. Reddy, *Theory and Analysis of Elastic Plates and Shells*, CRC press, ISBN 9780849384158; ISBN 10 084938415X

Other useful books

The course will occasionally borrow material from other sources. The following is a list of other suggested references.

Laminated Composite Plates

J. N. Reddy, *Mechanics of Laminated Composite Plates and Shells: Theory and Analysis*, CRC press, ISBN: 9780849315923

Finite Element Method

Nam-Ho Kim, Bhavani V. Sankar, *Introduction to Finite Element Analysis and Design*, Wiley, ISBN 978-0-470-12539-7

Prerequisites

Students are expected to have good understanding of structural analysis, calculus, and partial differential equations. Successful completion of AE 310 (or equivalent) and E 510 (or equivalent) is required.
Prior basic programming skills (MATLAB) are recommended. The students will be asked to use MATLAB when programs need to be written. General knowledge on the finite element method is also recommended. Students will also be asked to model and analyze structures with FEMAP and NASTRAN.

Course objectives

The objective of this course is to teach the fundamentals of structural analysis of elastic plates. The course provides the necessary background on energy principles and variational methods with particular emphasis on the writing of the time-domain equations of motion for elastic multilayered laminated plates.
The course will also introduce tensor analysis and equations of elasticity to provide the students with a solid theoretical background and prepare them for more advanced courses such as composite materials. The theory part will be complemented with practical training in using commercial software such as FEMAP and NASTRAN.

Course Outline

- *Review of Scalars, Vectors, Tensors, and Differential Operators*
  - Vector
  - Second Order Tensor
  - Permutation symbol
  - Scalar and cross products
  - Differential operators
  - Transformation of components of a vector
  - Transformation of components of a tensor
  - Differential operators
  - Gradient and Divergence Theorems

- *Equations of an Elastic Body*
  - Green-Lagrange Strain Tensor
  - Infinitesimal Strain Tensor
  - Second Piola-Kirchhoff Stress Tensor
  - Cauchy Stress Tensor

- *Constitutive Equations*
  - Generalized Hooke's Law
  - Anisotropic Material
  - Monoclinic Material
  - Orthotropic Material
  - Isotropic Material

- *Energy Principles and Variational Methods*
  - Concept of Virtual Displacements
  - Concept of Virtual Forces
  - Virtual Work
  - Complementary Virtual Work
  - Internal Virtual Work
  - Virtual Strain Energy
  - Virtual Complementary Strain Energy
  - Variational Operator
  - Functionals
  - Fundamental Lemma of Variational Calculus
  - Euler-Lagrange Equations
  - Primary and Secondary Variables
  - Principle of Virtual Displacements
  - Hamilton's Principle
  - Principle of Minimum Total Potential Energy

- *Analysis of Elastic Plates*

    - Classical Theory for Laminated Composite Plates
    - First Order Shear Deformation Theories
    - Higher Order Shear Deformation Theories
    - Zig-Zag Theories
    - Layerwise Theories

- *Advanced Topics*

Note: the content of the course ***may change*** depending on student's interests and time constraints

Course Competencies

At the close of EM696 you should be able to...

1. Gain a thorough understanding of Kirchhoff, First Order Shear Deformation, Higher Order, Zig Zag, and Layerwise plate theories.

2. Learn to develop and implement numerical simulations of elastic plates

3. Use the software FEMAP to create FEM models of various plate structures

4. Select an appropriate plate theory for different engineering applications.

5. Describe and summarize the main concepts of the subjects covered in the course with the inclusion of examples.

6. Solve problems similar to the ones discussed in the class and/or assigned in the homeworks.

Grading

In order to acknowledge achievements and monitor progress, the Department needs a realistic and meaningful system for grading performance. The University and the professional community expect the Department to maintain standards that reflect its reputation as one of the foremost programs of its type in the country. According to the University's Graduate Bulletin,

A means outstanding achievement; available for only the highest accomplishment;

B means praiseworthy performance; definitely above average;

C means average; awarded for satisfactory performance.

In general, professors in the department award "**A**" grades to acknowledge achievements that go beyond specified course requirements and criteria. By its very nature, this type of performance cannot always be spelled out clearly in advance. "**A**"s are reserved for special efforts that exceed expectations by demonstrating exceptional creativity, boldness, commitment, ingenuity, or elegance.

Grading Factors

Assignment/Activity	% of final grade
Homework. An homework is an assignment that requires several days to be completed. *Collaboration is not allowed.* The homework must be on the desk of the classroom *before the lecture starts* on the due date. *Late homework will be accepted, with penalty of 20%, on the due date only*. Quality of the presentation of the results (clarity, easy to follow etc.) is crucial. Homework completed and *given to the instructor a lecture earlier* than the due date (for example on Tuesday instead of the due date of Thursday) will ***receive up to 10% bonus***.	**40**
Exams 1,2 and final exam (or final project). The students will be asked to describe the main concepts of some subjects covered in the first part of the course and/or to solve some problems similar to the ones analyzed in the class or homework before the mid-term exam date. Quality of the presentation of the results (clarity, easy to follow etc.) is crucial.	**60**
Handwritten notes. The students have the choice to attach a copy (when the homework is completed) of the *at-home improved handwritten* notes of the material covered in the class. If the notes are very detailed and well done the students will ***receive up to 5% bonus***. The best notes will be published on blackboard. The students have also the freedom to select other examples from other books and augment the handwritten notes. If the students do correctly so and the used notation is consistent with the notation adopted in the course, the students will receive an ***additional bonus up to 10%***. These bonuses will be used to increase the grade of the homework.	**BONUS**
TOTAL	**100**

Every assignment or activity will be graded in a scale of 100 points.

Reported Final Grades

A = 90 or higher.

B = 80 or higher (but less than 90).

C = 70 or higher (but less than 80).

D = 60 or higher (but less than 70).

The instructor reserves the right to raise or lower the lower limit of each grade range such that division between letter grades occurs at large gaps in the grade spectrum.

Minor adjustments to avoid grades being decided by a fraction of a point may be adopted.

If you feel a mistake was made in grading any material involving (1) points not added or not recorded properly, (2) points taken-off for an answer that is not 100% correct, or (3) for given partial credit, please talk to the instructor either through e-mail or in person during the office hours.

Participation (classes)

Please do not come late to class sessions as it detracts from the learning experience of everyone involved. You should arrange in advance for a partner to take notes and obtain handouts for any class session you cannot attend.
Class participation will be used in deciding borderline grades.

Participation (seminars)

If a seminar is scheduled, all students must be present. Only University approved excuses for absences will be accepted in the case of seminars. Please note that an essay regarding the seminar may be required and if you miss the seminar (for University approved excuses) then you cannot write the related essay.

Accommodations for Students with Disabilities

Students with disabilities who need support services are encouraged to notify the instructor as soon as possible. This can be done confidentially via email or by phone (see instructor contact information).

Academic honesty

All students admitted to SDSU have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a student at SDSU and to be honest in all work submitted and exams taken in this class and all others

Plagiarism

Plagiarism consists of passing off as yours the work that belongs to someone else. As such, you will be committing plagiarism if you present someone else's work as your own, even with the other person's consent.

Miscellaneous

No electronic devices (for example cell phones, cameras etc.) are allowed in the class. **The students must turn them off**. The use of laptop is allowed in the classrooms for the only purpose of taking notes. *Any other laptop use (e.g. cheking emails or searching the web) must be postponed until the class ends to avoid distractions for the other students*. A violator of this rule will be asked to turn off the computer.

Submitting copy of a homework prepared by somebody else is considered cheating.

Submitting a project which is copied in full or in part from other students' work is considered plagiarism.

Collaboration on a project or homework is not allowed unless specifically allowed by the instructor when the project/homework is assigned.