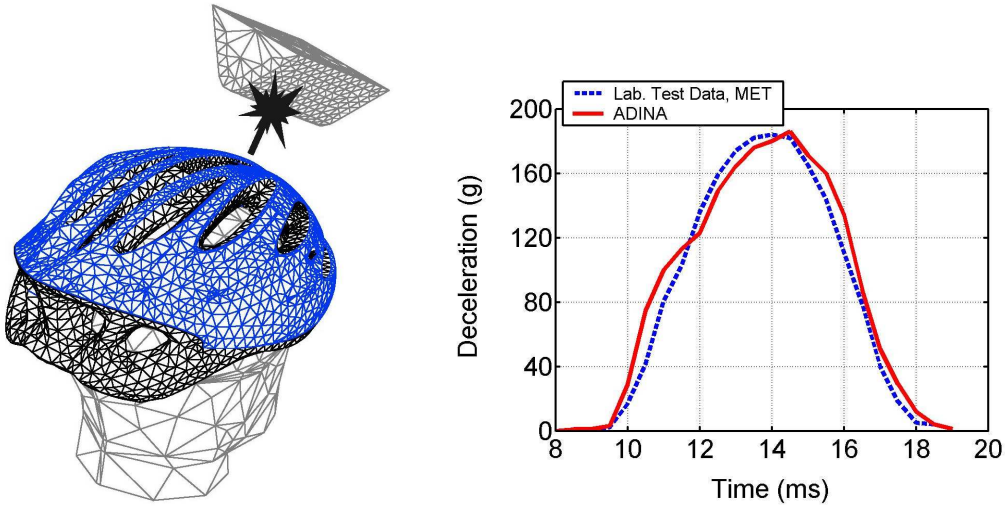
# 2.092/2.093
# Computer Methods in Dynamics
## Fall 2006, TR 11-12:30 (Room 1-390)




**Impact Analysis of Helmet**
Left: Finite Element Model; Right: Test Data and Computed Results

The objective of this course is to teach the student the theory and practical use of modern finite element methods for the solution of linear static and dynamic problems.

**TOPICS**

- The formulation of effective finite element methods for **linear analysis of static and dynamic problems.**
- Finite element modeling of static and dynamic problems.
- Computer numerical solution of equilibrium equations in static and dynamic analysis.
- Study of mode superposition analysis and effective direct integration methods for solution of structural vibration and wave propagation problems.
- Study of efficient techniques for calculation of frequencies, mode shapes, and buckling loads.
- Use of an existing general purpose finite element program for the solution of structural engineering, heat transfer and fluid mechanics problems.

The methods studied in this course are practical procedures that are employed extensively in the mechanical, civil, ocean and aeronautical industries.

## VARIOUS

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|---|---|
| Instructor: | Professor Klaus-Jürgen Bathe<br>Room: 3-356, Tel x3-6645<br>Office hours: by appointment |
| T.A.: | Samar Malek<br>Room: 3-359, Tel x3-0071<br>Email: smalek@mit.edu<br>Office hours: Tuesdays 3-5 pm or by appointment |
| Prerequisites: | Undergraduate statics and mathematics |
| Textbook: | ***Finite Element Procedures***, K.J. Bathe. Prentice Hall, 1996<br>You will find references to special topics in the textbook. |
| Web page: | http://web.mit.edu/2.093/www |
| Request: | While this class is held during what is usually a lunch hour, please refrain from eating (drinking is allowed). Also, please do not use your laptop during the lecture. |
| Grades: | The student's course grade will be based on:<br>o Weekly homework, usually given out Thursday and to be handed in the following Thursday<br>o Term project, due Thursday, November 30, 2006<br>(project proposal due Thursday, October 5, 2006)<br>o Two 1½ hour exams: on Thursday, November 2 and Thursday, December 7, 2006 |

## READING ASSIGNMENTS

The reading assignments will be given in the lectures and will refer to the textbook ***Finite Element Procedures***. We will discuss specific material in chapters 1,4,5,7,8,9,10 and 11.

## COMPUTER ASSIGNMENTS

You will not be required to develop a computer program. However, homework will require that you use the graphical user interface of a finite element program system (ADINA). For this purpose you will obtain a 900-nodes PC version of ADINA which you can freely install. The manuals for the program are also on the CD.

**TERM PROJECT**

Every graduate student taking 2.093 is required to complete a term project; undergraduates taking 2.092 are not required to complete the project. Hence, the only difference between taking 2.093 (graduate students) and 2.092 (undergraduate students) is this requirement regarding the project.

Some suggested projects:

1. Static and dynamic analysis of a specimen with a hole. Testing of various 2-D elements and meshes.

2. Dynamic analysis of a simple model of a high-rise building. Testing of solution schemes.

3. Look through the ADINA Primer to see whether you find a problem of your interest. Rerun and modify the problem.

4. A problem related to your research.

5. Development of a 2-D solid element in the program STAP (see Chapter 12 of the textbook). Testing of the program.

6. Development of the program STAP to perform dynamic structural analysis, or 2-D analysis of heat transfer, field problems, or fluid flow. Testing of the solution schemes.

**Note**: Please choose a (tractable) problem that you can analyze in depth in the very limited time available. The project work is typically started at the beginning of October and involves the following steps:

- Choose a problem and consider a simple mathematical model of the problem (geometry, material data, boundary conditions) such that in the first instance you can compare your analysis results with some analytical results.

- Solve this "simple" mathematical model using ADINA. Obtain an accurate solution.

- Now increase the complexity of the mathematical model and re-solve. Obtain an accurate solution using different finite elements, different meshes etc. Ask "what if" questions and experiment with the finite element method.

- In each case, interpret the calculated response.

Please hand in on October 5, 2006, a short description (a few sentences) of the project you would like to select. This description must be approved for you to proceed.

**IF YOU TAKE THE CLASS**

- Add yourself to the mailing list. At the Athena prompt, type:

  ```
  Athena%blanche 2.093 -a your_username
  ```

- Please pick up the CD of the 900 nodes version of the ADINA program. You can download the programs in the textbook including STAP from www.adina.com, go to Educational.