

## Mech 403 Computer Aided Design, Rice University, Fall 2011, J.E. Akin (revised 8/24/11)

This class is mainly a self-pace course with a few formal lectures and associated quizzes. The SolidWorks (SW) system will be our main resource. It was selected because of its shorter 'learning curve' and wide range of tools to support mechanical design. SW has at least a million users worldwide. The simulation (analysis) capabilities within SW were previously marketed under the name CosmosWorks (CW). You can find reference materials under that name at several web sites. The class website has several Help and Demo files, see [www.clear.rice.edu/mech403](http://www.clear.rice.edu/mech403)

The main task in this course is to complete a group project. The group project, beginning at midterm, will be the main variable part of the course grade (30%). It will require the construction of solid parts and an assembly and some type (stress, thermal, vibration, etc.) of finite element analysis (FEA) of the assembly, along with a written report and oral presentation. The group project report is graded on writing style and the communication value of the technical images (from SnagIt) and less on the actual results presented. Groups will have the option of accepting the group grade received on the draft report, or revising the draft during the last class for a final report grade. If you do not suggest an acceptable project you will be assigned the default project. Samples of prior reports will be provided.

This course requires several tutorials to be completed for SW solid model building and simulation capabilities; SnagIt for screen captures for report writing; TK Solver as an introduction to non-procedural 'case solvers'. See the link [www.clear.rice.edu/mech403/403\\_Tutorial\\_Schedule\\_2011.pdf](http://www.clear.rice.edu/mech403/403_Tutorial_Schedule_2011.pdf). The widely employed (but difficult to learn) Ansys 11 finite element analysis and computational fluid dynamics tools will also be introduced through a demonstration.

To review thinking of solids, as commonly represented in three orthographic views (front, top and side), there is a sketching assignment described at [www.clear.rice.edu/mech403/mech403\\_sketching\\_2011.pdf](http://www.clear.rice.edu/mech403/mech403_sketching_2011.pdf). Other examples of section views are at [www.clear.rice.edu/mech403/403\\_Section\\_Sketches.pdf](http://www.clear.rice.edu/mech403/403_Section_Sketches.pdf) and examples of auxiliary views are at [www.clear.rice.edu/mech403/403\\_Auxiliary\\_View\\_Sketching.pdf](http://www.clear.rice.edu/mech403/403_Auxiliary_View_Sketching.pdf). You are required to construct a specific solid part and prepare drawings, with dimensions, for that part (see that assignment at [www.clear.rice.edu/mech403/403\\_Solid\\_Part\\_2011.pdf](http://www.clear.rice.edu/mech403/403_Solid_Part_2011.pdf)).

Grading will be as follows: Hand sketch 5%, FEA quiz\* 10%, Solid model with dimensioned drawings hardcopy 20%, Group project report and presentation 30%, Required tutorials 35%.

<i>Class</i>	<i>Day</i>	<i>Date</i>	<i>Topic</i>	<i>Assignment</i>
1	Tue	8/23	Organization, CAD	Examine SW Help and Simulation Help
2	Thur	8/25	SW, Solids Demo	Standard view sketches, Begin SW solids tutorials
3	Tue	8/30	SW, Analysis Demo	Continue SW solids tutorials
4	Thur	9/1	Dimension Standards	Continue SW solids tutorials
5	Tue	9/6	SW tutorials	Continue SW solids tutorials
6	Thur	9/8	SW tutorials	Begin 3D body construction
7	Tue	9/13	SW tutorials	Finish 3D body construction, start drawings
8	Thur	9/15	SW, Thermal concepts*	Text Chap. 13, Submit 3D body drawings
9	Tue	9/20	SW, Stress concepts*	Text Chap. 3, Begin SW analysis tutorials
10	Thur	9/22	SW, Meshing	Revise 3D drawing/dimensions
11	Tue	9/27	SW, Vibration concepts*	Text Chap. 11, Continue all tutorials
12	Thur	9/29	SW tutorials	All tutorials, Select group members

13	Tue	10/4	SW Optimization	Continue tutorials
14	Thur	10/6	Select group project	State initial members of your group
-----		10/11	Midterm Recess	
15	Thur	10/13	TK Solver / Case solvers	Complete Tutorials, Report group members
16	Tue	10/18	Group Project	Build parts
17	Thur	10/20	Group Project	Build parts, attempt to mesh parts
18	Tue	10/25	Group Project	Build parts, analyze parts
19	Thur	10/27	Group Project	Submit 1st draft of part(s) drawing/dimensions
20	Tue	11/1	Group Project	Build assembly
21	Thur	11/3	Group Project	Build assembly, attempt to mesh assembly
22	Tue	11/8	Group Project	Analysis of project assembly
23	Thur	11/10	Group Project	Analysis of project assembly
24	Tue	11/15	Group Project	Outline project presentation PowerPoint
25	Thur	11/17	Group Project	Complete project report
26	Tue	11/22	Complete presentation PPT	Draft design report hardcopy due
-----		11/25	Thanksgiving Break	(Drafts returned at next class for revision)
27	Tue	11/29	Group presentations	Attend presentations and critique them
28	Thur	12/1	Group presentations	Final design report hardcopy due

\* Denotes lectures with an associated take-home quiz that will be posted after the third one.

### 3-D Printing

Rice does have a 3-D printer that can make physical copies (scaled up or down) of any valid solid built in SolidWorks (and output as a \*.stl file). The Rice printer uses a polymer material. Commercial printers can use casting sand, wax, polymer, gold, steel, etc. to build parts. However, they are expensive. Printed 3D samples of models previously built on SW will be passed around the class.

### Finite element analysis reference material (by J.E. Akin)

We use the simulation software as a black box tool, with only very limited lectures on the theory behind it. It is very risky to use such tools without an understanding of its basic theoretical foundation and limitations. The *recommended* text gives some basic theory and example applications for stress analysis, heat transfer, etc. The text, Finite Analysis Concepts via SolidWorks, J.E. Akin, World Scientific Publishers, 2010, contains a detailed index. Courses on detailed finite element theory are available.

### SolidWorks solid modeling reference materials (see bookshelf in ME241):

W. Silva, "SolidWorks Workbook", CDP Inc., 2004

W. Silva, "Introduction to SolidWorks", CDP Inc., 2003.

W. Silva, "SolidWorks Assemblies", CDP Inc., 2004.

SDRC, CosmosWorks Designer, 2006

SDRC, CosmosWorks Professional, 2006

J.R. Steffen, Analysis of Machine Elements using CosmosWorks Professional, SDC Pub., 2006

P.M. Kurowski, Engineering Analysis with CosmosWorks, SDC Pub., 2004

The above items, various texts and other software manuals provide additional material and examples that may not be covered in required tutorials. **The reference materials are not to be removed from the room without written permission.**