ME 5243 - Advanced Mechanism Design
Fall 2009

First Day Class Information

Arthur G. Erdman & Tom Chase

September 8, 2009

Course Web Site:
http://www.me.umn.edu/courses/me5243/

Lecture room: EE/CSci 3-125

Lecture times: MW 2:30 PM - 3:45 PM

Instructors:

Art Erdman

- **Office:** ME 315
- **Office Hours:**
  - **Thurs:** 8:00-8:50 AM
  - **Fri:** 8:00-8:50 AM
- **Phone:** (612)625-8580
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Tom Chase

- **Office:** ME 305
- **Office Hours:**
  - **Mon:** 4:40-5:30 PM
  - **Wed:** 8:00-8:50 AM
- **Phone:** (612)625-0308
- **E-mail:** trchase@umn.edu

Teaching Assistant:

Anne Fundakowski

- **Office Hours:** ME 1124
- **Phone:** TBA
- **E-mail:** fund0018@umn.edu

Office Hours:

- **Tues:** 12:20-1:10 PM
- **Thurs:** 12:20-1:10 PM

Required Reference:
Sandor, George N., and Erdman, Arthur G., 1984, *Advanced Mechanism Design: Analysis and Synthesis, Volume 2*. Upper Saddle River, NJ: Prentice-Hall, 2001. (Text, available in paperback from Coffman Union Bookstore.)

Background Reference: Erdman, Arthur G., Sandor, George N., and Kota, Sridhar, *Mechanism Design: Analysis and Synthesis, Volume I*, Fourth Edition. Upper Saddle River, NJ: Prentice-Hall, 2001. (ME 3221 textbook.)

Course Outline:

1. Background & Review
   (a) Links, joints, and degrees of freedom
   (b) Linkage analysis
   (c) Linkage synthesis
2. Type synthesis of mechanisms
3. Dimensional synthesis of four bar linkages
   (a) Three precision positions
   (b) Four precision positions
   (c) The LINCAGES-4 package
4. Computer assisted linkage analysis
   (a) ADAMS
   (b) Pro/E Mechanica
5. Solution rectification
6. Multi-loop linkage synthesis
   (a) Triad synthesis
   (b) Synthesizing n-bar linkages
7. Curvature theory
   (a) Centrodes
   (b) Euler-Savary equation
   (c) Cubic of stationary curvature
   (d) Straight line linkages
   (e) Dwell linkages
8. Higher order synthesis
9. Spatial linkages

Course Project: Please see separate handout for requirements and due dates.

Student Shop Access: You are expected to build demonstration prototypes as part of your mechanism design project. While not required, you are encouraged to utilize our fine Student Shop in ME 180 to build your models. The manager, Mr. Peter Zimmermann, is knowledgeable and helpful.

Another option is to use the resources of the Medical Devices Center: *www.mdc.umn.edu.* The MDC supervisor is Mr. Dillon Hodapp, hoda0013@umn.edu.

You must complete some basic safety training this semester in order to use the Student Shop. We will administer this training at the end of one of the lectures early on in the semester.

All standard machine shop safety guidelines apply to the student shop:

- Wear safety glasses with side shields at all times in these labs. If you do not have safety glasses, you can purchase them at the Bookstore or a hardware store.
- If you wear a ring, a watch, a bracelet, or a necklace, remove them and put them in your pocket before turning on a machine tool.
- If you wear a necktie, take it off.
- Secure any loose-fitting clothing before turning on a machine.
- If you have long hair, tie it back before turning on a machine.
- Wear sturdy closed-toe shoes (preferably safety shoes).
- Never engage in horseplay near a machine tool.
- If you have any questions, please ask!

After completing the safety training, please bring some kind of drawing of what you intend to build to Mr. Zimmermann *before* you plan to start construction. (A neat hand sketch will do; a CAD drawing is not required.) Mr. Zimmermann can usually make suggestions on how to build your mechanism faster and easier with materials that are at hand. Therefore, allow yourself some time to make some changes in your plans before beginning fabrication.

Prerequisites: ME 3222 or equivalent, upper division Institute of Technology undergraduate or graduate student.

Grading: (Point allocations)

- Homework: 25%
- Mid-term exam: 20%
- Project: 30%
- Comprehensive final exam: 25%

Re-grades: You may submit a homework assignment, exam or project for re-grading within one week following its return date. Re-grade requests are not accepted after this time limit. The item in question must be re-submitted to one of the instructors with a written explanation of where you feel the original grading was inaccurate. (A phrase or two will suffice.) The item will usually be re-graded in its entirety, and your grade may go down as well as up. Nevertheless, if we made a mistake in grading (and we occasionally do), we encourage you to re-submit your work for correction.

Mid-term exam: Wednesday, October 28. (Administered during the regular lecture time.)

Final exam: Wednesday, December 23, 1:30-3:30 PM (EE/CSci 3-125).
(*Note*: We are looking into whether we can change the final exam to Thursday, December 17, same time, same room, *but this is not guaranteed.* If you have a conflict on December 17, please let us know immediately.)

Homework policy: Homework must be submitted at the *beginning* of the lecture that it is due.

Late homework will be accepted *only* if it is deposited in the mailbox outside of Prof. Chase's ME 305 door no later than 5:30 PM of the day that it is due. Late homework will be penalized 25%.

Programming: You will be expected to do some programming in a high-level language, such as Matlab or C++, as part of your project. You may also have to use high level programming languages to solve some problems on homework assignments.

Incompletes: The grade of "I" is awarded only in the case of exceptional and verifiable severe illness or tragedy. An "I" will not be awarded because you are doing poorly in the class. You must have completed all but a small portion of the course work for an "I" to be considered.

Policy on extra credit: You are not permitted to submit extra work in an attempt to raise your grade.

Conduct and discipline: Please see web page *http://www.umn.edu/oscai* for the University's policies on conduct and discipline. You may work together on your homework and projects, but the work you turn in must be clearly recognizable as your own.

Class attendance: While attendance will not be taken, attendance at all classes is expected. You will be held responsible for all material presented in lecture. The instructor and the teaching assistants will not provide copies of notes for any missed lectures or discussion sections.

Missing an unreasonable number of lectures could constitute grounds for "firing" you from a project team.

Relationship to ME curriculum: This class is a direct extension of the mechanisms portion of the ME 3222 "Design & Manufacturing II" class. We will have to opportunity to explore cutting edge methods for designing linkages to produce motions required to fulfill a plethora of practical tasks. This class is likely to be of interest and value to any mechanical engineering student interested in designing mechanical products.

Closing words: Together we will explore the fascinating world of kinematics. We find this to be an exciting field, as it is both theoretically elegant and highly practical.

The American Society of Mechanical Engineers has a Mechanisms Committee, which is one of the major committees of their Design Engineering Division. They sponsor a Mechanisms Conference every Fall (or late summer). In most years that this course has been offered, at least one design team has submitted their project to ASME as either a student design paper or a journal paper. If you really enjoy the subject matter of this class, we encourage you to become involved in the Mechanisms Committee. (Both Prof. Erdman and Prof. Chase are past chairs of this committee, and we both hosted ASME Mechanisms Conferences in Minneapolis.)

We hope that you become excited about the content of this course! Your suggestions for improving the class are always welcome.