ME 4232: Fluid Power Control Lab.

Department of Mechanical Engineering
University of Minnesota

http://www.me.umn.edu/courses/me4232

Instructor: Prof. Perry Y. Li,
MechE 309
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Pre-requisite: Thorough understanding of materials in ME 3281 or equivalent
This course can be used to satisfy senior laboratory requirement.

Texts:
http://www.me.umn.edu/~wkdurfee/projects/ccefp/fp-chapter/
3. A systems dynamics text with chapters on introduction to control systems such as:
   2. Close and Frederick, "Modeling and Analysis of Dynamic Systems",

Other texts:
• "Industrial Hydraulic Technology", 2nd Ed. Parker Hannafin Training Module
• Merritt, "Hydraulic control systems", Wiley, 1967
The Parker book explains how things work without much analysis (similar to the Eaton text but not as colorful!). Merritt is an excellent (although old and expensive) book on modeling of hydraulics components and systems that is still being heavily used by researchers. Sullivan is written more in a regular text book style and discusses components, circuits and analysis.

Teaching Assistants:
Everett Wenzel E-mail: wenz0081@umn.edu TuTh 9:00-11:00am, TuTh 11:15am-1:10pm
Sangyoon Lee E-mail: sylee@umn.edu MW 2:30-4:25pm
Mohsen Saadat E-mail: saad0021@umn.edu MW 10:10-12:05pm, MW 12:20-2:15pm,

Format:
• One 110 minutes lecture (Friday) per week (occasional industry speakers)
• Two 2 hour lab sessions

Office hours: (MechE 309)
• Monday 11:00-12:00 (can be extended to 1:00pm) (tentative)
• After lectures, walk in, or my appointment (call/email)
• Email questions welcome
Course objectives:

Fluid power plays an important role in many sectors of the economy. It is used in aerospace, machine tools, off-road vehicles, material testing systems etc. This course has three objectives:

- Introduce fluid power components, circuits, and systems
- Provide hands-on experience in designing, analyzing and implementing control systems for real and physical systems;
- Provide first hand experience in modeling, control and other dynamical systems concepts introduced in Systems Dynamics and Control (ME3281).

Throughout the course, students will be encouraged to derive and use mathematical models to make predictions and to answer queries.

Expected outcomes:

1. Familiarity with common hydraulic components, their use, symbols, and mathematical models
2. Ability to formulate and analyze simple mathematical models of hydraulic circuits
3. Ability to identify single input single output (SISO) dynamical systems
4. Ability to design, analyze and implement simple control systems
5. Appreciation of advantages and disadvantages of various types of controllers
6. Ability to relate control systems analysis with actual performance
7. Intuitive and mathematical appreciation of dynamical system concepts (e.g. stability, instability, resonance)
8. Appreciation of un-modeled real world effects
10. Comfortable with commercial hydraulic catalogs

Laboratory and computing assignments

1. Construction of simple fluid power system circuits and making measurements on them (roughly first half of the semester)
2. Controller design and implementation for an electro-hydraulic actuator (roughly second half of the semester)
3. Computer modeling of hydraulic components and circuits

Course conduct:

1. Observe safety precautions at all times
2. During the lab sessions, your first objective is to learn about the system, component, or controller that you are working on. Data taking is for reporting purposes, so plan your experiments accordingly.
3. Lab reports should be type written, succinct, but self-contained. Page limits are sometimes imposed. They should contain your observations (use well labeled graphs!) as well as explanations, and if appropriate, mathematical analysis.
4. The exercises on the lab sheets are base line exercises. You are encouraged to formulate additional questions and to test them using the lab setup. How much you learn depends on how willing you are to ask and answer additional questions.
Course outline (Major Topics):

1. Fluid Power Components and Circuits 7 weeks
2. Control of Fluid Power Systems 7 weeks

*See course webpage for a more detailed schedule.

Course Structure:

This course will consist of one two-hour lecture per week and two two-hour lab sessions per week. Lab exercises will be the primary learning tool in this course. During lab sessions, your first objective is to learn about the system, component, or controller you are working on. The exercises described in the lab handouts are baseline exercises. You are encouraged to formulate additional questions to test using the lab setup. How much you learn depends on how willing you are to ask and answer additional questions. Lectures will primarily supply background information needed to understand the lab activities and will occasionally include guest lectures by fluid power experts.

Because a great deal of the value you will gain from this course will revolve around lab and classroom activities, active attendance during all meeting sections is expected. The class participation component of your grade reflects your attendance and participation in all activities.

Lab Reports:

All lab reports must follow the Mechanical Engineering Lab Report Guidelines, available at: [http://me.umn.edu/education/undergraduate/writing.shtml](http://me.umn.edu/education/undergraduate/writing.shtml). Most labs include a pre-lab activity that must be completed prior your lab session and initialed by your lab TA at the start of lab. Lab reports, with attached prelab assignments are due at the start of your lab section one week after completing the lab, unless otherwise directed. Any late lab reports will receive a 20% grade reduction per week late (or portion thereof).

Final Exam:

The cumulative final exam will be held **10:30 p.m.–12:30 p.m., Monday, December 21**. If you are unable to take the final exam at the scheduled time, please see the instructor to arrange for an alternative time. Except for emergency situations, any arrangement must be made 1 week prior to the exam.

Re-grades:

Any grade disputes must be made within 1 week of returning the assignment. The material to be regraded must be submitted to the instructor with an attached written explanation of the grading Inaccuracies.

Grade Computation:

Grade point ranges will be determined at the end of the term. In general, 90-100 is an “A”, 80-90 is a “B”, and 70-80 is a “C.” The weighting of evaluation criterion is as follows:

<table>
<thead>
<tr>
<th>Evaluation Criterion</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Lab assignments (reports)</td>
<td>60%</td>
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<tr>
<td>Active Participation</td>
<td>10%</td>
</tr>
<tr>
<td>Final exam</td>
<td>30%</td>
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</tbody>
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Course Policies:
1. **Accommodations for Students with Disabilities**: Students with special needs must talk to the instructor as soon as possible; all conversations will be kept confidential. As per University policy, reasonable accommodations will be made on an individual student basis.
2. **Student Conduct**: The classroom environment is very important to promoting learning. Disruptive behavior that might interfere with the learning process of other students will not be tolerated.
3. **Sexual Harassment**: Sexual harassment is prohibited as defined by the University policy which can be found at: [http://www1.umn.edu/usenate/policies/sexualharassmentcp.html](http://www1.umn.edu/usenate/policies/sexualharassmentcp.html)
4. **Academic Dishonesty**: All submitted work must be your own. Any form of academic dishonesty will be treated very seriously. If you have any concerns about the authenticity of your work, or when group work is appropriate, please contact the professor. For further information about the University policy on academic dishonesty, refer to [http://www.umn.edu/regents/policies/academic/StudentConduct.pdf](http://www.umn.edu/regents/policies/academic/StudentConduct.pdf)