ABEN/ME 479/679 - Fluid Power Systems
Fall 2015, 3 Credits, T,R 3:30-4:45,

Instructor: Dr. Tom Bon
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Pre-reqs: ME 352 or CE 309 or ABEN 263 (or equivalent courses)

Course Web Page: NDSU Blackboard system

Office Hrs: 10:00 – 10:50 a.m. M, T, W, Th, & F
Also by appt. or drop in and see if I am available.

Course Rationale

Fluid power is being used in widely different areas such as transportation, machine tools, ship control, agricultural equipment, space technology, aircraft, mining and many more. In recent years, the academic world has tried to keep up with the increasing demand for specialists in hydraulic and pneumatic systems by offering new courses, or even a fluid power option. However, properly trained people are still at a premium in this area, and many fluid power manufacturers have undertaken educating their own and their customers’ staff members to meet this professional expertise need.

Student Outcomes
At the conclusion of this course, students should be able to:

• understand the terminology, functional role, applications and industry practices related to fluid power systems (abet a, and e);

• create mathematical models to describe the operation, and analyze the performance of various fluid power systems using appropriate statics, dynamics, fluid mechanics, thermodynamics and heat transfer equations (abet a and k);

• design a fluid power system starting from its required function. (abet c);

• use computer software to design, simulate, and analyze various fluid power systems (abet k);

• have hands-on experience with real hydraulics. Build basic hydraulic systems, operate them, and collect experimental data (abet b); and.

• effectively communicate their results in problems, labs, and projects (abet g).

Course Outline and Prerequisites
This course will introduce engineering undergraduate and graduate students to fluid power generation, transmission and control aspects. Pipes, compressors, pumps, motors and control valves will be analyzed in detail. In addition, complex components, such as servo actuators and electro-hydraulic servo valves will be discussed.
Software packages will be available in the computer rooms to design, simulate and animate various fluid power systems. The students will be able to build schematics by simply dragging and dropping components from a library onto the diagram. Once circuits are completed, the software will generate animations showing the operation of moving components and fluid flow. There will be four computer laboratories during the semester. Due to the large enrollment and limited number of licenses available, students will work in teams of two or three on a computer. A team report will be due one week after each laboratory. Plans may include using limited exercises incorporating Matlab/Simulink into the course as well.

A hydraulic trainer setup will be used in the ABEN lab area to demonstrate basic hydraulic operation, validate computer-designed circuits and give students hands-on experience. Students will be able to build circuits with pumps, filters, flow and pressure-control valves, actuators and gages by mounting quick-connect pressure lines between these components.

A design project will be assigned shortly before the middle of the semester. Teams of three to four students will be assigned to work on the project. A team report will be due two weeks before finals week. One class period will be reserved for various issues related to the project in the second part of the semester. In the mean time, students are encouraged to contact the instructors with regard to the project after class or during office hours. There will be additional deliverables in the project assigned to the students enrolled in ABEN/ME 679.

Enrolled students must have at least third-year standing in an engineering curriculum. Statics, dynamics and fluid mechanics (ME 352, or CE 309, or ABEN 263) is the prerequisite. A course in control theory or instrumentation is helpful, but not required.

Grading Policies
Three midterm tests will be given, each test covering approximately 25% of the material. The final exam will be comprehensive, but will emphasize the final part of the material. The following weighting will used to calculate the final score:

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<tr>
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<th>ABEN-ME 479</th>
<th>ABEN-ME 679</th>
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<tbody>
<tr>
<td>Tests (3) &amp; quizzes</td>
<td>45%</td>
<td>40%</td>
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<tr>
<td>Final exam</td>
<td>25%</td>
<td>20%</td>
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<tr>
<td>Lab reports</td>
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<td>Project</td>
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<td>HW</td>
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<td>Additional items</td>
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Final grades will assigned according to the following scale:

- A: 90% or better
- B: 80% “
- C: 70% “
- D: 60% “
- F: less than 60%

Assignments are due at 5:00 p.m. on the due date. For homework assignments, I may collect the entire assignment or only problems selected at random from the assignment.
ACADEMIC HONESTY:

Students with disabilities needing special consideration are requested to alert me at the first class.

All work in this course must be completed in a manner consistent with NDSU University Senate Policy, Section 355: Code of Academic Responsibility and Conduct available at http://www.ndsu.nodak.edu/policy/335.htm and the Honor System of the College of Engineering and Architecture (CEA) available at http://www.ndsu.nodak.edu/ndsu/cea/. You are expected to read and abide by both policies, which are incorporated herein by reference. A signature sheet indicating your agreement to abide by the CEA Honor Pledge will be distributed in class. The CEA Honor Code states the following about violations: 'If, from the evidence presented, the [Honor] Commission determines that a violation has taken place, it will recommend disciplinary action. Disciplinary action may include, but is not limited to, failure or a grade reduction in the course; failure or grade reduction on the examination, quiz, paper or project in question; or a recommendation for suspension or expulsion.'

Tentative Schedule

Introduction to fluid power:
- Comparison between fluid power, electrical and mechanical systems
- Basic symbols
- System Basics
- Fluids for power transmission: properties, additives, aeration, cavitation, contamination, filtration
- Pneumatic and hydraulic concepts. Principles and equations
- Introduction of Automation Studio and the hydraulic test stand
- Air preparation

Test 1

Fluid power generation:
- Pneumatic and hydraulic concepts. Principles and equations
- Introduction of Automation Studio and the hydraulic test stand
- Air preparation Air compressors, receiver tanks
- Pumps
  - Hydrostatic vs. hydrodynamic. Characteristics
  - Types: pros and cons, efficiency, power, applications
  - Pump selection
- Accumulators
- Automation Studio II
- Automation Studio and Hydraulic Test Stand

Test 2
- Cylinders: classification, calculation, video
- Motors
- Piping, hoses and connectors including friction loss calculations
- Valves
  o Directional control valves
  o Flow Control valves
  o Pressure control valves
  o Pilot control valves
- Systems Analysis

Test 3

- Electrohydraulics
- Automation Studio and Matlab/Simulink
- Systems
  o Servo systems
  o Electro hydraulics

Final test

Final Exam is Thursday, December 17, 2014, from 10:30 a.m. to 12:30 p.m.

Problem Format:

If using ASME engineering paper:

Fill out information including Name, Course, Homework no. and problem no on Problem line, and date due.

ON the sheet, Given: including a sketch for the problem, Find: listing the objectives, and the Soln. Include assumptions, show formulas, calculation line and box or underline answers and place ANSW by the answer.

For regular engineering paper or ordinary paper.

Top line: Date due, course, and Name

Follow the procedure for Given, Find, and Sol’n. as mentioned for the ASME paper. For the ME paper, fill out the sections provided at the top of each sheet. Every sheet is a problem set should have the basic information at the top of each sheet.
Some information concerning ABET:

ABET is the Accreditation Board for Engineering and Technology. ABET is a specialized accreditation agency meaning it certifies specific programs at a college or university as compared institutional accreditation agencies that examine an entire college or university. Each accredited department must be reviewed by a site visit at least once every six years. The method of accreditation has changed with the ABET 2000 initiative. Every department has a set of evaluation criteria it has developed and submits to ABET. These criteria form the evaluation basis for the department by the ABET reviewers.

Program Educational Objective 1. Within a few years of graduation, graduates are expected to have established themselves as practicing engineers with the ability to address new and existing engineering challenges in agricultural and closely related biological industries. This objective addresses the following student outcomes:

ABET-a Apply knowledge of mathematics, science and engineering
ABET-b Design and conduct experiments, as well as to analyze and interpret data
ABET-c Design a system, component, or process to meet desired needs
ABET-e Identify, formulate, and solve engineering problems
ABET-k Use techniques, skills, and modern engineering tools necessary for engineering practice
ABEN-l Ability to apply engineering skills to agricultural, environmental & biosystems

Program Educational Objective 2. Within a few years of graduation, graduates are expected to have established themselves as practicing engineers who have interpersonal and collaborative skills and the capacity for productive and advancing careers in leadership roles. This objective addresses the following student outcomes:

ABET-d An ability to function on multi-disciplinary teams
ABET-f An understanding of professional and ethical responsibility
ABET-g An ability to communicate effectively
ABET-h The broad education necessary to understand the impact of engineering solutions in the global and societal context
ABET-i Recognition of the need for and an ability to engage in lifelong learning
ABET-j Knowledge of contemporary issues