

## **Fluid Power Circuits and Control**

ABE 5152 Course # 23562

**Class Periods:** T & TH, 4<sup>th</sup> and 5<sup>th</sup> period, at 10:40AM to 12:25PM

**Location:** 214 Rogers Hall

**Academic Term:** Spring 2020

### ***Instructor:***

Tom Burks

Email Address: tburks@ufl.edu

Office Phone Number: 352-294-6728

Office Hours: T or Th, 1:00PM to 2:00PM, 225 Rogers Hall

### ***Teaching Assistant/Peer Mentor/Supervised Teaching Student:***

Please contact through the Canvas website

- Name, email address, office location, office hours

### ***Course Description: 3 Credits***

Engineering analysis, design and experimentation of fluid power circuits, controls and systems. Including the design of hydraulic circuits, fluid power system components, hydraulic actuator analysis, servo and proportional valve performance, and electro-hydraulic control theory and applications.

### ***Course Pre-Requisites / Co-Requisites:***

Senior level undergraduate standing with EGM3400, EGN3353C completed. Graduate Students are encouraged but not required to take EML5311 concurrently. Familiarity with Matlab or other programming experience would also be beneficial.

### ***Course Objectives***

To give students a rigorous background in the theoretical and applied concepts associated with development of fluid power control and systems design. As a result students should be able to develop theoretical control models, as well as build practical fluid power systems. Students will learn to use Automation Studio and Matlab Simscape to model hydraulic circuits and will then use Labvolt Hydraulic trainer to build a functional circuit in hardware.

### ***Materials and Supply Fees***

None

### ***Required Textbooks and Software***

- Fluid Power Circuits and Controls (2<sup>nd</sup> edition)
- Author: John Cundiff
- Publication: CRC Press
- ISBN: 978-1498770019

### ***Recommended Textbooks and Software***

- Title: *Hydraulic Control Systems*
- Author: Noah Manring
- Publication: John Wiley and Sons, Inc.
- ISBN: 0-471-69311-1

### ***Supplemental Materials***

- Title: *Fluid Power Systems: Modeling, Simulation and Control*
- Author: John Watton
- Publication: Prentice Hall
- ISBN: 0-13-323197-6

### ***Supplemental Materials***

- Title: *Fundamentals of Fluid Power Control*
- Author: John Watton,
- Publication: Cambridge University Press
- ISBN: 978-0-521-76250-2

### **Course Meeting, Structure, and Objectives:**

Lecture Period: Tuesday 4<sup>th</sup> and 5<sup>th</sup> period in room 211 Rogers Hall, with labs meeting as announced in other rooms in Rogers Hall.

- 1) This course is a dual listed undergraduate and graduate level course. The two classes will be taught together, but the degree of difficulty of the graduate level class will be more advanced requiring a higher level of mathematics and engineering control concepts.
- 2) There will be approximately one homework and/or lab assignment per week. Late homework will not be accepted without prior approval. You may discuss homework with others, but you may not copy verbatim homework from another student. Cheating on homework will affect all parties involved.
- 3) Some laboratories will require preparation, others are primarily demonstrations. It is mandatory to attend Labs on Thursday. Get advance approval if you can't attend lab. Some labs will require a report by team members, while others will require individual work.
- 4) The student will complete a class design project using Automation Studio or Matlab Simscape, and provide an in class presentation of the project concepts.
- 5) There will be two mid-term exams, one in March and the other at the end of the semester covering course materials.

### ***Attendance Policy, Class Expectations, and Make-Up Policy***

- a) No make-up exams will be given except for valid medical reasons or unless prior arrangements are made.
- b) Laptops and cellphones may be used during class to review slides and take notes, (please no surfing, texting or email during class). Cellphones may not be used during exams, only WIFI disabled tablets or laptops can be used during exam, so that everything must be on your hard drive.
- c) Attendance is expected, unless valid excuse since absence will affect you and lab partner's ability to do some of the projects, so it is necessary to attend.
- d) Students may drop one homework from their lowest score.
- e) Excused absences must be consistent with university policies in the undergraduate catalog (<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>) and require appropriate documentation.

### **Lecture Material Covered:**

There will be an approximate 1h and 30m lecture during the Tuesday and 1h during the Thursday meeting time from the primary textbooks. As the semester progresses, the remaining time on Thursday will be spent on Automation Studio or Matlab based experiments or exercises in the class room, PC lab or in Room 214.

### **Typical Course Topics (as time permits)**

- Topic 1: Fluid Power Basics (CH 1 & CH 2: Cundiff)
- Topic 2: Fluid Properties (CH 1: Manring)
- Topic 3: Fluid Mechanics (CH 2: Manring)
- Topic 4: Dynamic Systems and Controls (CH 3: Manring)
- Topic 5: Pressure Control (CH 3: Cundiff)
- Topic 6: Creation and Control of Fluid Flow (CH 4: Cundiff)
- Topic 7: Hydraulic Control Valve Dynamics (CH 4: Manring)
- Topic 8: Hydraulic Pump Dynamics (CH 5: Manring)
- Topic 9: Rotary Actuators and Linear Actuators (Cundiff/Manring)
- Topic 10: Valve Controlled Hydraulic Systems (CH 7: Manring)
- Topic 11: Pump Controlled Hydraulic Systems (CH 8: Manring)
- Topic 12: Hydrostatic Transmissions (CH 6: Cundiff)
- Topic 13: Temperature and Contamination Control (CH 8: Cundiff)
- Topic 14: Auxiliary Components (CH 9: Cundiff)
- Topic 15: Electro-Hydraulic Servo Valves (CH 11: Cundiff, CH 7: Merritt)
- Topic 16: Proportional Valves (CH 12: Cundiff)
- Topic 17: Non-linearities in Control Systems (CH 10: Merritt)
- Topic 18: Modeling Fluid Power Circuits using Automation Studio

### **Laboratory Topics Covered:**

The laboratory time will consist of both instructor lead demonstrations and teaching, and hands on laboratory experiments. In many cases, laboratory experiments will be introduced and started during the in-class laboratory time to be finished later by the student with lab partners. A brief lab report will be submitted by the teams on each lab experiment assignment. There will be approximately 10 lab experiments to be assigned that will require either Automation Studio simulation or in lab circuit construction, or both.

- Topic 1: Basic hydraulic circuits and pressure relief
- Topics 2: Actuators and circuit pressure and flow control
- Topic 3: PLC and Ladder Logic
- Topic 4: Basic electrical controlled hydraulic circuits
- Topic 5: Electrical sequencing of cylinders
- Topic 6: Speed regulation and braking of hydraulic motors.
- Topic 7: Continuous reciprocation with dwell period
- Topic 8: Drilling system and counting actuator cycles
- Topic 9: Multi-pressure Systems
- Topic 10: Rapid transverse-slow feed systems

## **Grading Criteria:**

Homework	25%
Laboratory exercises	20%
Mid-term Exam	20%
Term Design Project and Presentation	15%
Final Exam (non-comprehensive)	20%

## ***Grading Policy***

The following is given as an example only.

<b>Percent</b>	<b>Grade</b>	<b>Grade Points</b>
90.0 - 100.0	A	4.00
87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 - 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 - 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<http://gradcatalog.ufl.edu/content.php?catoid=10&navoid=2020#grades>

## ***Students Requiring Accommodations***

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

## ***Course Evaluation***

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

## ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Commitment to a Safe and Inclusive Learning Environment***

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, [rbielling@eng.ufl.edu](mailto:rbielling@eng.ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

### ***Student Privacy***

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

## **Campus Resources:**

### Health and Wellness

#### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

#### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the [Office of Title IX Compliance](#), located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

#### **Sexual Assault Recovery Services (SARS)**

Student Health Care Center, 392-1161.

**University Police Department** at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

### Academic Resources

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to [Learning-support@ufl.edu](mailto:Learning-support@ufl.edu).  
<https://lss.at.ufl.edu/help.shtml>.

**Career Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring.  
<https://teachingcenter.ufl.edu/>.

**Writing Studio**, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers.  
<https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** [https://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

**On-Line Students Complaints:** <http://www.distance.ufl.edu/student-complaint-process>.