

Spring 2020 section 13790 of EML 4312 Control of Mechanical Engineering Systems

Welcome:

Welcome to my section of EML 4312. I'm very happy to teach this course again as it is my favorite among the non-elective courses.

The class meets 7th period (1:55-2:45) on T and 7th & 8th periods (1:55-3:50) on R in TURL 005

Remember that at UF (<https://registrar.ufl.edu/registration/reghowto>) **“If you do not attend at least one of the first two class meetings** or scheduled labs and you do not contact the department offering the course, **you MAY be dropped from the course.”**

History:

Unlike my previous institutions (Marquette, Purdue, Texas A&M) when I joined UF there was no controls class in mechanical engineering. So I started the course that first Fall 1986 semester and I was the only one to teach the course until I took leave for fourteen months in 1993 to work at Caterpillar's Technical Center. Since that time, others have taught the course, but I have taught it many more times than anyone and ask to teach it when possible. I taught it again this Fall semester.

The course has, of course, changed over the years, such as the adding of MATLAB and “modern control”, but now the changes are more evolutionary than radical.

Aerospace Engineers:

Sometimes AeroE's are put off by the name of the course, but don't be. Florida has a Statewide Course Numbering System (SCNS). This is a great thing---it allows students to transfer courses between institutions and helps avoid duplication. But it requires that courses not only be approved by the UF administration, but also in some office in Tallahassee. When I started this course, I was advised to not name it something like “Control Systems” because it would conflict with EEL 4657C Linear Control Systems and other courses. At that time the UF Aerospace Engineering, Mechanics, and Engineering Science (AEMES) department had its own course (I don't remember the number or the name), so we decided on “Control of Mechanical Engineering Systems”. Over the years, if students had bad schedule conflicts we allowed AeroE's to take this course and ME's to take the AeroE course.

Due to many such duplications and a shortage of funds to hire replacements for retiring faculty, UF merged the two departments. Prof. Wei Shyy (now president of Hong Kong University of Science and Technology) from AEMES became chair and I from ME became the associate chair of the new MAE. For some courses (e.g., EGN 3353C Fluid Mechanics, which ironically AeroE's don't take anymore), we kept the AeroE number and for others (e.g., this course) we kept the ME one. I offered to start the paperwork to change EML 4312's name and number, but it was decided that there were more important things to do.

One of the two authors (the other is an EE) of our textbook is the former chair of AeroE at the University of Texas (and now Dean of Engineering at USF). So I am confident he knows what should be in the textbook for you. Although they were for manufacturing work, not controls, I have received awards from the American Helicopter Society and the Aerospace part of SAE. From various interactions, attending events, and reading, I have managed to pick up some, admittedly-limited, aerospace controls knowledge. Controls is very important for aerospace. Many aircraft and rockets have crashed due to controls problems.

This course is one of two prerequisites (the other is EAS 4101 Aerodynamics) for EAS 4400 Stability and Control of Aircraft. The most common instructor of that course (Prof. Lind) has previously taught this course, so he or his colleagues will expect you to know this material and to be able to build on it. This material establishes the basics of controls knowledge and is not heavily aerospace, but you will get that in EAS 4400 and other courses you can take if you want. (Such as EAS 6415 Guidance and Control of Aerospace Vehicles.)

Mechanical Engineers:

This is also a required course for you. Controls crosses many disciplines and is useful in most of the very many industries mechanical engineers work in. Unfortunately, due to that diversity of industries, we cannot slant the course to any particular application field (engine control, CNC, fluid flow control, hydraulics, etc., etc.). The subject has become more-and-more important for ME's with the increased emphasis and importance of such trends as mechatronics, autonomy, internet-of-things, etc.

This course is the prerequisite (along with EML 3301C Mechanics of Materials Laboratory) for EML 4314C Dynamics and Controls System Design Laboratory. Whoever (it rotates) teaches the lecture portion and Shannon Ridgeway (in charge of the laboratory) will expect you to know this material. For example, I am also teaching EML 4314C this Spring and we will start right off with PID control and expect all the ME's to know it.

Textbook:

The first few years I taught this course I ran through five different textbooks looking for the perfect one. I've also tried some others over the years. I believe the one selected (Richard C. Dorf and Robert H. Bishop, 2017, *Modern Control Systems*, 13th ed., Pearson), while not perfect, is the best of the lot. It is also the most-used controls textbook, so I'm not the only one who believes that. You will want a hardcopy of the book as I will not allow computers or other electronic devices (scientific or graphing calculators are OK) in the open-book exams. A small number of the homework problems have traditional units, so be careful if you purchase an international edition with metric units. If delivery of your textbook is delayed, a copy will be available on two-hour course reserve in the Marston Science Library.

You can start reading Chapter 1 and Chapter 2 up to and including Section 2.6. (Note: We will not do 2.7 and some other later sections.) The first class we will start with Laplace transforms from section 2.6, especially using Table 2.3.

Assessments:

Although it is the least-favorite part of my job, it is my duty to provide an assessment of your knowledge of this subject. Your grade for this course will be based upon three exams (each worth 30%) and an undetermined (usually around ten to twelve) number of homeworks in total worth 10% of the grade.

I believe it is unfair to students who have part-time jobs, family responsibilities, etc., to have night exams. So the two during-semester exams will be during normal class time on Thursdays. The date of the exams will be announced at least a week in advance.

The final exam (partially new material, partially cumulative) will be given at the Registrar-assigned time: Thursday **30 April** 12:30-2:30. It will **NOT** be offered early. Schedule your Summer break plans accordingly.

You will be allowed to bring the textbook, notes, and anything else on paper to the exams. You will probably want to bring a calculator and ruler also. Please note, the open-book/open-notes allowance is to backstop you in case you draw a blank on something or need a table or figure. You should be able to do 95% of the exams without consulting anything. If you spend your precious exam time reading your textbook or notes, you may get to repeat this course next semester.

Of the courses I teach, this is a more difficult one than average. It is NOT straight memorization or plug-and-chug, but rather also includes required understanding of some abstract concepts. You do not want to fall behind as concepts build upon each other. Generally, students find the middle part of the semester to be a little easier than the beginning and the end. But students and their perceptions of this course vary widely.

Expectations of Students:

You are adults and can make your own decisions (skipping class, not doing reading, not doing homework, etc.), but you have to bear the consequences. You are responsible for all announcements (homework assignments, reading suggestions, etc.) made in any class whether you are there or not. You are responsible for any messages sent to your Gatorlink (@ufl.edu) email. Homework will be due at the START of classes.

Class is to be a learning environment. You are to respect your classmates and not do anything which disturbs them. If I make a mistake or something is not right or something needs to be explained better, please bring it to my attention. The assigned classroom has some seats with poor visibility. If your eyesight is like mine, please sit front-and-center.

One of my fellow classmates when I was a student had extremely poor eyesight. I ran into him years later and he (with accommodations) has had an excellent, productive engineering career. If you require some sort of accommodation to do well in this course, please get the official letter from the Disability Resources Center at the start of the semester so I can fulfil your needs properly. (For example, don't bring me a letter just before an exam.)

I expect absolute integrity from you. As someone who hears a lot of Honor Court cases (one year I tied with Dr. Abbitt for the most by a faculty member within all UF) and was the only engineering faculty member on the Academic Integrity Task Force, I would be a hypocrite if I did not report honor code violations. The typical penalty for a first-time cheater on an exam is an un-droppable “E” for this course. The typical penalty for a first-time cheater on a homework is a reduction in the final course grade.

Schedule:

Although I have taught this many times, I find each cohort of students is different. Hence, the pace at which the material is covered varies. For example, some groups are good at Laplace transforms or linear algebra (and unfortunately some are not) depending upon their backgrounds. Or sometimes I have to circle back to a topic if exam performance on that topic is dismal. So there is no fixed schedule. However, the dates of the first two exams will be announced at least a week in advance. Since you are expected to know all this material for the follow-on courses, the final exam will be cumulative in part.

Other Section:

Prof. Matthew Hale is teaching section 13791 of this course. It meet MWF 6th period in FLG 230. Both of us are experienced in teaching this course. Although his office is just across the hall from mine, we will each teach the course our own way. If you or your friends think you might want to be in my section, you must come from the beginning. Students who skip the first two classes and think they can “add” later without disadvantage usually are disappointed. Also, what he covers, or allows or requires, may be greatly different from what I do. The end goal is the same, we may just approach it in different ways.

Controls:

Unlike subjects such as “Aerodynamics” or “Vibrations”, students often have a mistaken impression of what will be in controls. For example, we will not teach you how to wire up the on-off switch for an electric motor.

We will deal with systems in which the output is dynamic--it changes with time. Hence the two fundamental prerequisites for this course are MAP 2302 Elementary Differential Equations and EGM 3401 Engineering Mechanics – Dynamics. You need to have satisfactorily completed those courses before taking this course.

First we learn to write the equations of all sorts of simple systems using both Laplace transforms and linear algebra (matrices). For example, mechanical translational, mechanical rotational, electrical, hydraulic, pneumatic, liquid level, heat transfer, and combination systems. We model those systems with linear differential equations in time. So then we can understand how the systems will behave in response to different inputs. (For example, how long will it take for your Thanksgiving turkey to be done, or your camera flash to charge, or for the space shuttle’s engines to gimbal.) Being able to calculate stability and accuracy is maybe even more important.

Then we learn how to make the systems perform better. For example, how to tune the algorithm in a robot's controller so it responds fast and accurately without going past the desired final position.

I have visited, and continue to visit, many companies. For example, last month I visited leading companies in Germany and France. From what I see, I think having a basic understanding of controls will only continue to grow in importance for engineers.

Contact:

You can contact me at schuejk@ufl.edu if you have any questions. (Although I will be on international travel next week.) Do NOT use Canvas to contact me if you want a quick response.

They are still finalizing the TA's for this course. We will announce them, their locations, and their hours in one of the first classes.

Have a good break. I'm looking forward to a productive semester in the Spring.

Sincerely,
John K. Schueller, P.E.
Professor of Mechanical and Aerospace Engineering
University of Florida