Syllabus: ELC 4335, Systems Modeling and Control

Meeting Time: TR 11 – 12:15, Rogers 109

Instructor Contact: Dr. Ian Gravagne, Ian_Gravagne@baylor.edu, 710-7303. Office hours are TR 2 – 4PM. Other visiting hours available by appointment.

Class TA: The class TA is the go-to person for questions about the lab or lab grading. The TA will be announced to the class when TA personnel assignments are available.

Text: *Feedback Control of Dynamic Systems* (8th Ed.); Franklin et al; Pearson. Additional readings will be assigned and provided electronically.

Course Description: ELC 4335 is a required course for the mechanical engineering major. It serves to reinforce the basics of mathematical modeling of dynamical systems, and is also a first course in feedback control theory. Technical topics include (but may not be limited to): methods to derive the describing equations for linear dynamical systems; state-space and frequency domain modeling; PID control theory; stability theory; computational approaches to simulating system dynamics and solving control problems; feedback control design methods. Additional topics include the epistemological limits of mathematical modeling; the existence and ramifications of unknowable information and the corresponding virtue of faith.

Course Objectives: After completion of the course, the student will have demonstrated an ability to:

- Apply the fundamental mathematical tools available for system modeling and feedback control to solve engineering problems;
- Use computing and computational assistance (such as visualization) as an integral part of such solutions;
- Define and identify the virtue of faith; articulate how faith and belief exist concomitantly with mathematical and empirical reason.

Technical Topics:

- Fourier Transform basics, the Fourier Transform as a special case of the Laplace
- Laplace Transforms, inverse transforms and the transfer function (3.1)
- Block diagrams (3.2) [not covering signal flow]
- 2nd order system response and performance specifications (3.3-3.4)
- Steady-state error analysis (4.1-4.2)
- Feedback design, the PID controller and the root locus design method (4.3, 5)
- State space models (7.1-7.4)
- State variable feedback design, controllability and observability (7.5-7.8)
- Couple of lectures on advanced topics if there's time, e.g. digital realizations of controllers.

Labs: There will be four lab exercises throughout the semester to be completed on your own time either solo or in pairs. The TA will be available assist you. All labs must be completed with a passing grade to pass the class.

(continued…)

Grades: Grades will be based on quizzes (extra credit), labs (35%) and examinations (65%).

- Homework practice problems will be assigned but not graded. Collaboration on homework is encouraged but each student should ensure he or she can complete the problems individually.
- One lab write-up may be submitted per two students (with the grade applying to both), or individually.
- There will be at least two in-class assessments, and at least two take-home assessments. These will be announced a minimum of one week in advance. There will also be a final exam.
- In-class quizzes may be assigned periodically. These help the instructor to gauge understanding and are for extra credit. A student scoring the maximum on all quizzes will receive a 1/3 letter grade increase, e.g. from a B to a B+.

Relative to the final numerical grade expressed as a percentage, the nominal grading scale for this course is

A	A-	B+	B	B-	C+	C	C-	D	F
94+	90-93	87-89	83-86	80-82	77-79	73-76	70-72	60-69	59-

This is the most severe possible grading scale; the instructor may choose at his discretion to employ lower numerical grade cutoffs.

Attendance and Class Etiquette: Students are expected to behave in accordance with the rank and maturity of juniors and seniors, which means appearing on time and attending class regularly. Missed class material will not be repeated. If you must be absent, plan to copy notes from a classmate. During class, please keep all computers and cell phones off and stowed unless otherwise instructed. The professor's cell phone will be on in case of university emergency notifications.

Academic Integrity: It is the responsibility of each student to know and adhere to the Baylor University Honor Code (http://www.baylor.edu/honorcode). It is a violation of the course syllabus to view exams or lab deliverables from previous or similar classes. Writing assignments, should they be assigned, may be subjected to the Turn-It-In plagiarism detection tool at the instructor's discretion.

During in-class quizzes and exams, students are required to place cell phones, "smart" watches, computers, calculators or any other electronic device on the floor (or in their backpacks on the floor.) Only pencils and erasers are permitted on the desk. If any electronic device is seen on the desk or in use during a closed-book assessment, your exam may not be graded and an Honor Code violation may be filed.

Furthermore, it is a violation of the course syllabus, and may be a violation of Federal copyright law, to copy, record, photograph or reproduce in any way the lectures and materials in this course without the written consent of the instructor.

Accommodations: Any student who needs academic accommodations related to a documented disability should inform the instructor immediately at the beginning of the semester. You are required to obtain appropriate documentation, and information regarding accommodations, from the Office of Access and

Learning Accommodation (OALA), 1st floor East Wing of Sid Richardson. Alternative exam testing requests must be requested at least one week prior to the exam.

Title IX: Baylor University does not discriminate on the basis of sex or gender in any of its education or employment programs and activities, and it does not tolerate discrimination or harassment on the basis of sex or gender. If you or someone you know would like help related to an experience involving sexual or gender-based harassment, sexual assault, sexual exploitation, stalking, intimate partner violence, or retaliation for reporting one of these types of prohibited conduct, please contact the Title IX Office at (254) 710-8454 or report online at www.baylor.edu/titleix.

The Title IX office understands the sensitive nature of these situations and can provide information about available on- and off-campus resources, such as counseling and psychological services, medical treatment, academic support, university housing, and other forms of assistance that may be available. Staff members at the office can also explain your rights and procedural options if you contact the Title IX Office. You will not be required to share your experience. If you or someone you know feels unsafe or may be in imminent danger, please call the Baylor Police Department at (254) 710-2222 or Waco Police Department (911).

CAC Workshop Reflections

BIG PICTURE: Define, examine, establish faith as a viable kind of "knowing", along with mathematical/algorithmic and empirical reasoning. (The two principal tools of engineers.)

PEDAGOGY:

- First Day: 5-minute video suggesting that mathematics is a kind of faith (we assent to the truth of its foundations and existence even though these are not provable within mathematics itself).
- Add reflection question to quizzes: This week, I believed that _____. My faith was well-founded because _____. Repeat throughout semester.
- Beginning of class: excerpts from readings or scripture related to faith. Personal sharing of reflection question (to help students see how to think about and answer it in the future). Opening prayer.

CONTENT:

- Three "major" readings throughout semester assigned with HW. (Probably one or both chapters on Faith in Mere Christianity [ch 11 on why faith is a virtue])
- A lecture devoted to Incompleteness Theorems, Unknowable Information. (Reflection: If we are to know the unknowable, what kind of Oracle could reveal it? Why would that Oracle *want* to reveal anything to us? Is the Oracle itself knowable? How do we know if He/It is trustworthy?)
- Discussion of readings? Have had marginal success with this in past… Possible short essay near end of course? Not sure yet…

ASSIGNMENT:

Throughout the course, you have been prompted to reflect on how you see and experience faith in your life. We have seen that there are truth propositions beyond human limits of understanding, and argued that faith is (in one sense) a defensible acquiescence to those propositions – propositions that are related to the foundations of mathematics and science, religions, and many other matters. Lastly, we have discussed the possible existence of an oracle that can reveal hidden truth propositions to us, and how we might test the trustworthiness of such an oracle.

In lieu of a take-home exam for your final, your assignment is to read the attached "appendix" from the book Miracles, in which C.S. Lewis presents a model of how prayer might work. Then write a short reflection paper that addresses the following questions:

1.) What assumptions does Lewis make about his model? (In other words, what ideas does Lewis assume must be true *a priori* in order for the model to work or "make sense"?)
2.) Do you think this model can be scientifically tested? If so, how would design the experiment and what would you hypothesize for an outcome? If not, explain why not.

[Add boilerplate stuff about word length, spacing, font, TurnItIn, etc…]

ASSESSMENT:

General philosophy about asking engineers for papers of this nature: go easy, be generous. Participation matters! (And… I can't afford to spend hours grading this at the end of a semester.)

X%: Formatting of the paper. (Did you read my instructions?!)

Y%: Grammar, sentence structure, writing. (Problem areas for ESL students.)

Z%: Sliding scale based on the following, roughly corresponding to Blooms Taxonomy:
Were the questions answered? Do the answers demonstrate factual understanding of the Lewis model? Are any reasonable assumptions identified and articulated? Does student defend these assumptions as "true" or else question them? Is a reasonable experiment proposed? A hypothesis? If not, can the student justify why the experiment would fail? Does the student connect (synthesize) the Lewis model with the ideas around faith discussed/learned throughout the class?