GINA CODY SCHOOL OF ENGINEERING AND COMPUTER SCIENCE

ELEC 481/ENGR 6131
Linear Systems
Department of Electrical and Computer Engineering
Fall 2025

Course Instructor:
Dr. K. Khorasani
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Office: EV 12-113

Office Hours:
Thursday: 1:00-2:30 pm

Tutorials: N/A

Labs: Please see your class schedule for details
Lab Demonstrators:
ELEC 481 /2- EEEI – S. Asgari (asgari.shadi@yahoo.com)
ELEC 481 /2- EEEJ – H. Kazemi (hamedkazemi85@gmail.com)
ELEC 481 /2- EEEK – M. Kazemi (m.g.kazemi@gmail.com)

Course Calendar Description:
Review of matrix algebra. State-space description of dynamic systems: linearity, causality, time-invariance, linearization. Solution of state-space equations. Transfer function representation. Discrete-time models. Controllability and observability. Canonical forms and minimal-order realizations. Stability. Stabilizability and pole placement. Linear quadratic optimal control. Observer design.

This course deals with the fundamental principles of linear systems. With the advancement of technology, engineers have become interested in designing systems that are not merely workable but also the best possible. Consequently, it is important to study the limitations of a system; otherwise one might unknowingly try to design an impossible system. Thus, a thorough investigation of all the properties of a system is essential. In fact, many design procedures have evolved from such investigations. This course is devoted to this study and the design procedures developed thereof.

Prerequisites: AERO 371 or ELEC 372 or MECH 371.

Specific Knowledge and Skills Needed for this Course:
Students taking this course are expected to have sufficient knowledge of the following topics. Should you have difficulties in any of these topics, you are strongly encouraged to review them before the DNE deadline.

Linear and matrix algebra, Classical control systems and design approaches, Basic Matlab programming familiarity.

Course materials
Required Textbook:

- *Required textbook(s):* W. Brogan, Modern Control Theory, 3rd Edition
- *Suggested Textbook:* R. Decarlo, Linear Systems and B. C. Kuo, Automatic Control Systems
- *Instructor's lecture notes: will be posted in Moodle course management site*

• *Software Use:* Matlab

Grading Scheme

GRADING POLICY

Evaluation Tool	**Weight**
2 Midterm Exams	**30%**
Final *	**45%**
Project + Lab: Attendance is mandatory	**25%**
Assignment	**0%**
Total	**100%**

Tentative Course Schedule

TENTATIVE COURSE OUTLINE

Topics	**Week**
Introduction to Systems (Ch. 1 and Ch. 2)	1-2
Mathematical Description of Systems (Ch. 3 and Ch. 4 (review of matrix algebra))	3
State Variable Analysis of Linear Systems (Ch. 9)	4-5
State Transition Matrix and the Fundamental Matrix (Ch. 9)	6-7
Canonical Representations and Realization Theory (Chs. 7,8,11, and 12)	8-9
State Feedback and State Estimator (Ch. 13)	10-11
Closed Loop Pole-Zero Assignment (notes)	12

Lab Details

The following provide a list of relevant information regarding the ELEC 481 lab:

1. Lab Room: H805-3
2. Four setups:
   - ECP Inverted Pendulum (Model 505)
   - Industrial Plant Emulator(Model 220)
   - Torsional Apparatus (Model 205)
   - Magnetic Levitation Apparatus (Model 730)

You can check ECP websites <http://www.ecpsystems.com/index.htm> for more information.

3. System Information:
   - Operating system: Windows 10 64bit
   - Accounts: Group account only, no individual account supported.
     UserID: elec481, Password: elec481

4. Seats: the room can occupy 4 groups, e.g. about 8 seats.

For more lab information, you can find
athttp://users.encs.concordia.ca/~realtime/elec481/index.html

Please remain in the sections that you have registered.

The lab is bi-week based, totally six times and the total lab hours are 15 hours. The lab will start in the week of Sept 22th.

For the Graduate Students there is NO Lab, but instead the students will work in Teams of TWO in a Project where all the details will be described and uploaded to Moodle.

Engineering Tools
N/A

Details on assessment tools:
N/A

Other information

TERM PROJECT
There are four setups/systems that you can choose to develop your project target application on, specifically:

•ECP Inverted Pendulum (Model 505)
• Industrial Plant Emulator (Model 220)
• Torsional Apparatus (Model 205)
• Magnetic Levitation Apparatus (Model 730)

You can check the ECP websites <http://www.ecpsystems.com/index.htm> for more information.

Both Undergraduate and Graduate students will work in a **team of three and two, respectively**. I will randomly assign you into teams. This information will be communicated to you ASAP. Once the teams are formed you will decide on which target application your project will be based on. As soon as you determine this you need to communicate and inform me of this decision.

The approval will be based on first-come first-served! For each setup there is a **maximum number of 3 teams** that can be assigned to. Once that limit for a given setup is reached I will inform the class so that NO other teams subsequently can select that given setup and has to identify and select another setup. Therefore, the sooner you make this decision, the higher the likelihood that you can choose the setup that is closest to your plans.

For the selected target application, you need to perform a number of tasks. All the teams are expected to complete the same list of tasks. This list will be distributed to you in Moodle. The project requires a written report from each team. Your report should provide sufficient details regarding the design procedure, validation, verification, and evaluation through simulations and analysis. All the details corresponding to these may be included in an Appendix to ensure the readability of the report. The main body of the report should address only your main observations, results, and discussions. Only ONE report is to be handed in for each group. The *deadline* for submission of the report is the date of the **Final Exam**.

Graduate Attributes:
N/A

Course Learning Outcomes (CLOs):

By the end of this semester, students are expected to master the following engineering concepts.

(a) An ability to design and conduct experiments, as well as to analyze and interpret data. Students would be able to design controllers to achieve certain specific goals. (b) An ability to learn by self-study, to integrate knowledge into one's overall education, and to engage in life-long learning. Every technical professional must be able to learn independently. For example, some instruction would be given on how one can pick out and summarize the important points in a chapter in a textbook. Then students are responsible for certain material on an exam, without that material being lectured on. (c) An ability to function in a team. (d) An ability to communicate effectively. It is expected that the students will prepare an acceptable written project report. (e) An ability to design a system, component, or process to meet desired needs. This includes instruction on the design processes appropriate for the systems under investigation.

Health and Safety Guidelines

All health and safety rules specific to this course can be found in the lab manual. General health and safety instructions and available health and safety trainings can be found at:
Safety Programs - Concordia University (https://www.concordia.ca/campus-life/safety/general-safety.html)

On Campus Resources

Please visit Student services at Concordia University for the services available Gina Cody School students.