

California State University, Chico
Mechanical and Mechatronic Engineering - Advanced Manufacturing and Applied Robotics
Fall 2021 MECA 482 Control System Design

Class time and location:

MECA 482-01	(7534) – Mo We Fr 12:00PM – 12:50 PM	Online
MECA 482-02	(7537) – Mo We Fr 1:00 PM – 1:50 PM	Online

Instructor: H. Sinan Bank, hsbank@mail.csuchico.edu, 530-898-4619

Office: Zoom

Office Hrs.: Mo We Fr 2:00 pm– 4:00 pm

Prerequisites: EECE 211, MATH 260. Recommended: MECA 380, MECH 320; either CSCI 111 or MECH 208

Course Usage of Blackboard Learn:

The course syllabus and other material will be posted on Blackboard Learn. You are responsible for regularly checking the on-line resources, which is accessed through the Chico State Portal.

We will also use a course webpage to show off some of the details for the class publicly.

Course Objectives:

1. To elicit the dynamic performance of the system,
2. To design controllers which satisfies specifications and requirements of
 - Stability,
 - Input tracking,
 - Robustness in the presence of disturbance,
 - Frequency Response*,
3. Understand and implement the system identification aspects with a given system's input,

Coverage includes the following topics:

- Classical control theory for Single-Input-Single-Output (SISO) systems
- Introduction to matrices and their use in modern control system theory
- Addition, subtraction, multiplication, and inversion of matrices
- Derivation of models of components and systems in the time domain
- Derivation of state space formulations for the models
- Numerical methods for solving the system of state equations
- Derivation of the Laplace transform solutions of state equations
- Derivation of state transition matrix and its application in solving state equations
- Converting from State Space to a Transfer Function
- Deriving conditions for stability in state-space
- Block diagrams
- Analysis
- Controllers
- Implementation of these topics with a simulation-based rendering solution (CoppeliaSim)
- Learning-based control system design (Reinforcement Learning) *

[*] Subject to our pace to finish the earlier chapters,

Textbook

Nise, “Control Systems Engineering”, Wiley, 2015 7th Ed. (E-book is acceptable).

Other suggested books/ references for students self-learning efforts and the instructor would incorporate some questions from there. Please see more information at the corresponding Blackboard’s Section.

Introduction to Feedback Control, Beard, R.W., 2020 (Free)

Feedback Systems: An Introduction for Scientist and Engineers, Karl J. Astrom, Richard M. Murray

Automatic Control Systems, by Farid Golnaraghi, Benjamin Kuo, Tenth Edition, McGraw-Hill, 2017

System Dynamics and Control, by K. Ogata, 4th Edition, Pearson Education, 2013

Modeling and Analysis of Dynamic Systems, by C.M.Close, D.K. Frederick, John Wiley, 2003, 3rd Edition

Feedback Control of Dynamic System, 4th Edition, by Charles L. Phillips, Troy Nagle, Aranya Chakraborty

Scherz, Paul, and Simon Monk. Practical electronics for inventors. McGraw-Hill Education, 2013. (eBook is acceptable)

Mechatronics with Experiments, Sabri Cetinkunt, 2015

Software:

- MathWorks MATLAB Suite with additional required toolboxes as pointed in the Black Board,
- A document scanner (e.g, Tap Scanner, [Adobe Scanner](#), Cam Scanner) to scan your assignments appropriately,

- CoppeliaSim (V-REP) for physics-based simulation of labs and some of the examples,

The instructor is NOT responsible the installation of the software. There are appropriate details already provided on Blackboard. However, the instructor will NOT assist any installation of any software and any delays of the assignments will be subject to the penalties.

Please see suggested computer setup by the department.

Hardware (Tentative):

We will have in class labs for you to realize the theoretical knowledge into something tangible. In control theory, using simple systems to test the theoretical application is a generic approach.

Exams:

There will be take home exams. Each successive exam may include prior course material. Note:

1. These subject to change with a fair notification.
2. Late homework will be accepted with additional penalties.

Assignments and Grading Policies

2 Exams*	20%
5 HWs	20%
3 Labs	-
Participation**	10%
Group Project	20%
Final Exam	30%

*There will be online exams. Each successive exam may include prior course material.

** Participation credit is based on your intellectual contribution to the class. **Your attendance to the class is NOT affecting the participation credit.**

Participation Credit

The participation credit relates to the following pointers:

- The constructive (+ point) or non-constructive (- points) behavior in the class to improve the learning outcome of everyone,
- The addressed relevant questions during the class,
- Your answers to the questions during the class session,
- The outcome of in-class quizzes,
- Outstanding final project delivery which positively affects the future semesters of the class, as many points as you check in the list above, you will guarantee higher points.

Generic Rubric

Report Rubric

	Expert			Proficient			Apprentice			Novice		
	A+	A	A-	B+	B	B-	C+	C	C-	D+	D	D-
Technical Content (Equations, Numerical Usage, and Illustrations)	<ul style="list-style-type: none"> • All equations are clear, accurate, and labeled. All variables are defined and units specified. Discussion regarding the equation development and use has been stated. • All figures, graphs, charts, and drawings are accurate, consistent with the text, and of good quality. They enhance understanding of the text. • All items are labeled in accordance with engineering standards and are referred to in the text. 			<ul style="list-style-type: none"> • Most equations are accurate and clear. Most variables are defined and units specified. With some minor exceptions, adequate discussion regarding the equation development and usage has been stated. • For the most part, illustrations are accurate, consistent with the text, and of good quality. • All items are generally labeled in accordance with engineering standards and are referred to in the text. 			<ul style="list-style-type: none"> • Most equations are accurate. Too many variables are not defined. Discussion regarding the development and usage of the equation is unclear. • In some cases, illustrations are not conveying information clearly. • While items are labeled, references to these items are missing. 			<ul style="list-style-type: none"> • There may be inaccuracies within the equation. Little or no attempt is made to make it easy for the reader to understand the use of an equation or its derivation. • Figures, graphs, charts, and drawings are of poor quality, have numerous inaccuracies and mislabeling, or may be missing. • There is no corresponding explanatory text for included items. 		
Visual Format and Organization	<ul style="list-style-type: none"> • The document is visually appealing and easily navigated. • Appropriate typography and usage of white space are used as appropriate to separate blocks of text and add emphasis. 			<ul style="list-style-type: none"> • The document is organized. • Use of white space and typography help the reader navigate the document, although the layout could be more effective. 			<ul style="list-style-type: none"> • Errors in the Table of Contents are present. • Within sections, the order in which ideas are presented is occasionally confusing. 			<ul style="list-style-type: none"> • The document is not visually appealing and there are few "cues" to help the reader navigate the document. • There is no apparent ordering of paragraphs, and thus there is no progressive flow of ideas. 		
Language (Word Choice, Grammar)	<ul style="list-style-type: none"> • Sentences are complete and grammatical. They flow together easily. • Words are chosen for their precise meaning. • Engineering terms and jargon are used correctly. • No misspelled words are present. 			<ul style="list-style-type: none"> • For the most part, sentences are complete and grammatical, and they flow together easily. Any errors are minor and do not distract the reader. • Repetition of words and phrases is mostly avoided. • For the most part, terms and jargon are used correctly with some attempt to define them. • There are one or two misspelled words. 			<ul style="list-style-type: none"> • In a few places, errors in sentence structure and grammar distract the reader and interfere with meaning. • Word choice could be improved. • Occasionally, technical jargon is used without definition. • There are a few misspelled words. 			<ul style="list-style-type: none"> • Errors in sentence structure and grammar frequently distract the reader and interfere with meaning. • There is unnecessary repetition of the same words and phrases. • There is an overuse of jargon and technical terms without definition. • There are many misspelled words. 		
Use of appendices	<ul style="list-style-type: none"> • Information is placed appropriately in either the main text or an appendix. • Appendices are documented and referenced in the text. 			<ul style="list-style-type: none"> • Appendices are used when appropriate. • Selection and/or extent of material in appendix may not be optimal. 			<ul style="list-style-type: none"> • While appendices are present, material in appendix is not referred to properly in text. • Content in appendix is not complete. 			<ul style="list-style-type: none"> • Appendices were not utilized when appropriate. • There is unnecessary inclusion of detailed information in the main body of the text. 		

All of the exams will be online (most probably from Friday evening until Sunday midnight), and the students will have 48 hours+ to upload their solutions to provided Google Form. Late uploads of the exams will NOT be accepted.

Please be aware that you **MUST** use your student email address (student_email_id@mail.csuchico.edu) and make sure that you logged out from other Gmail addresses while using the resources from Google Drive.

You will also receive an email regarding a shared folder Fall_2021_MECA_482_student_email_id where I will share with you any documents (e.g., exam or HW results). You need to use the name of the folder with the suffix of the assignment dedicated to you to upload your work.

Online Education

Online education requires skills and habits that may be less essential in traditional courses. In order to be successful in your online course you will need:

- **Space:** Establish a comfortable and well-organized physical workspace.
- **Time management skills:** Set personal study and “classroom” time as you would do for a traditional course.
- **Organization skills:** Print out all class material (modules, PowerPoints, assignments, additional resources, and any work you generate) and keep everything in a single location (binder). Maintain electronic backups of all class material in a structured way.
- **Communication skills:** Demonstrate a willingness to interact with your instructor and classmates through email, phone calls, discussion boards, and active participation in all class activities.
- **Initiative:** Review information on Blackboard.
- **Discipline:** Pace yourself, complete all activities and assignments before the due date, follow through on all class requirements to completion.
- **Technology support:** Making sure that you have an appropriate hardware (suggested computer and monitor size -not following the class from the cell phone screen) and software setup.

The more closely you adhere to the recommendations above the greater your chances of having a successful semester and a rewarding online experience.

Note:

1. These are subject to change with a fair notification.
2. Late homework will be accepted with additional penalties.

Topics/ Tentative Schedule (Please note that the topics are subject to change with a fair notification.)

Topic	Wk	Hours	Sections	Suggested Problems	HW DUE
1- Introduction to (Control) Systems Design	1-2	4 hrs	N/A	See Exercises	HW 1 See Calendar
2- Modeling in Frequency Domain	2-4	9 hrs	2.1-2.11	See Exercises	
3- Modeling in Time Domain	5-7	9 hrs	3.1-3.7	See Exercises	HW2 See Calendar
Exam 1	7				
4- Time Response	8-9	6 hrs	4.1-4.11	See Exercises	HW3 See Calendar
5- Design via State Space	10-12	9 hrs	12.1-12.7	See Exercises	
6- Reduction of Multiple Subsystem	13	3 hrs	5.1-5.8	See Exercises	HW4 See Calendar
Exam 2	13				
No Class Week 14					
7- Stability	15	3 hrs	6.1-6.5	See Exercises	HW5 See Calendar
8- Steady-State Error	16	3 hrs	7.1-7.8	See Exercises	
Final Exam	17				

The details of the Evaluation for the Group Projects:

A team must consist of three to five students, and you will fill requested Google Spreadsheets (e.g., the description of the project and problem, team members, project milestone, etc.) that provided during the semester.

The project consists of the presentation and a concise documentation similar to provided examples on Blackboard. The overall evaluation criteria for the projects are as follows:

- Theoretical rigor (20%)
- Complexity of application (15%)
- Documentation and presentation (25%) - the presentations are limited to 5 mins
- Results and final implementation (40%)
- The vote from other groups/ group members - if the students give free points the instructor has the veto and change power for fairness. Your project is 20% of the total grade of the class. The groups can ask more questions during the office hours.

Following the provided procedure will assist you to gain easier credits. From each percentage, the appropriateness of the content will result in the corresponding grade. For example, a documentation with a lot of typos and unstructured text will be graded poorly from the corresponding percentage 5 out of 25.

Irrespective the percentages above, incomplete projects will be evaluated by 60% of the total -in other words, starting from 60.

Projects should be extra work to support as pre- or post- learning activities. You don't need to expect to finish the corresponding chapters to start working on the project. Hence, in your homework there will be questions regarding the projects.

Dropping and Adding:

You are responsible for understanding the policies and procedures about add/drops, academic renewal, etc., found in the CSU Chico University Catalog. You should be aware of the new deadlines and penalties for adding and dropping classes.

Classroom Protocol:

Needlessly to highlight, during class, please do not engage in any activities that are not related to the class, i.e. personal web surfing, online shopping, e-mail, Facebook, LinkedIn, Snap Chat, Kik, etc.

University Policies and Campus Resources

Academic Integrity

Students are expected to be familiar with the University's Academic Integrity Policy. Your own commitment to learning, as evidenced by your enrollment at California State University, Chico, and the University's Academic Integrity Policy requires you to be honest in all your academic course work. Faculty members are required to report all infractions to the Office of Student Judicial Affairs (Office of Student Conduct, Rights & Responsibilities). The policy on academic integrity and other resources related to student conduct can be found on the Student Judicial Affairs (Office of Student Conduct, Rights & Responsibilities) web site.

Student Services

Student services are designed to assist students in the development of their full academic potential and to motivate them to become self-directed learners. Students can find support for services such as skills assessment, individual or group tutorials, subject advising, learning assistance, summer academic preparation and basic skills development. Student services information can be found on the current students' page of the CSU Chico web site.

Americans with Disabilities Act

If you need course adaptations or accommodations because of a disability or chronic illness, or if you need to make special arrangements in case the building must be evacuated, please make an appointment with me as soon as possible or see me during office hours. Please also contact Accessibility Resource Center (ARC) as they are the designated department responsible for approving and coordinating reasonable accommodations and services for students with disabilities. ARC will help you understand your rights and responsibilities under the Americans with Disabilities Act and provide you further assistance with requesting and arranging accommodations.

Accessibility Resource Center

530-898-5959, Student Services Center 170, arcdept@csuchico.edu

Student Learning Center

The mission of the Student Learning Center (SLC) is to provide services that will assist CSU, Chico students to become independent learners. The SLC prepares and supports students in their college course work by offering a variety of programs and resources to meet student needs. The SLC facilitates the academic transition and retention of students from high schools and community colleges by providing study strategy information, content subject tutoring, and supplemental instruction. The University Writing Center has been combined with the Student Learning Center. You can also visit the Student Learning Center web site.