



SAINT LOUIS UNIVERSITY
MADRID

ESCI-3410-M01: Analysis and Control of Linear Systems
Spring 2018

Class Days and Time: MW, 16:00-17:15

Classroom: PAH-20

Prerequisite(s): Linear Vibrations and MATH-3270

Credit(s): 3

Instructor: Usama Abou-Kheder

Instructor's Email: usama.kheder@slu.edu

Instructor's Campus Phone: 91 554 58 58, ext. 266. **Mobile Phone:** 600 742 339

Office: Sciences and Engineering Office (PAH) or Physics Lab (PAH-21)

Office Hours: W, 17:30-20:30

Course Description: Linear Time-Invariant Systems. Laplace transform. Transfer functions, block diagrams and signal flow graphs. Stability of feedback systems, time and frequency response. Root locus analysis. Bode diagrams. Nichols charts. Compensator design in time and frequency domain.

Course Goals and Student Learning Outcomes: At the end of the course, students will:

- Model dynamic systems with differential equations
- Use the Laplace transform to solve differential equations and get the transfer function of processes and systems
- Represent systems with block diagrams and flow graphs
- Understand the usefulness of feedback and improve systems response with feedback
- Analyze the behaviour, performance and characteristics of feedback control systems
- Control the transient response and the stability of feedback control systems using the Routh-Hurwitz stability criterion and the Root Locus method
- Analyze systems in the frequency domain using Bode diagrams and Nichols Charts
- Design effective control systems using various approaches and techniques (phase lead, phase lag, PID controllers, prefilters)

Saint Louis University - Madrid Campus is committed to excellent and innovative educational practices. In order to maintain quality academic offerings and to conform to relevant accreditation requirements, the Campus regularly assesses its teaching, services, and programs for evidence of student learning outcomes achievement. For this purpose anonymized representative examples of student work from all courses and programs is kept on file, such as assignments, papers, exams, portfolios, and results from student surveys, focus groups, and reflective exercises. *Thus, copies of student work for this course, including written assignments, in-class exercises, and exams may be kept on file for institutional research, assessment and accreditation purposes.* If students prefer that Saint Louis University - Madrid Campus does not keep their work on file, they need to communicate their decision in writing to the professor.

Required Texts and Materials:

- Textbook: Modern Control Systems (12th Edition), Prentice Hall
Richard C. Dorf and Robert H. Bishop

- **Computer Simulation Package:** The completion of the homework assignments shall require the use of a numerical simulation software package. MATLAB is the one that shall be used for this class. MATLAB is widely used in the academic and industrial communities. Student Edition of MATLAB is available for purchase from the Mathworks website.

Attendance Policy: Attendance is not mandatory, but doing homework and coming to the lectures regularly will have a positive influence on the overall grade.

Course Requirements and Grading Rationale/System: The grade will be obtained from the following areas:

Homework and attendance: **20%**

1st mid-term exam: **20%**

2nd mid-term exam: **20%**

Final exam: **40%**

Grading Scale:

A	90-100%
A-	87-89%
B+	84-86%
B	80-83%
B-	77-79%
C+	74-76%
C	70-73%
C-	66-69%
D	60-65%
F	< 60%

E-mail: Campus and course announcements will often be handled by e-mail. Students should check their “@slu.edu” e-mail regularly.

University Statement on Academic Integrity: Academic integrity is honest, truthful and responsible conduct in all academic endeavors. The mission of Saint Louis University is "the pursuit of truth for the greater glory of God and for the service of humanity." Accordingly, all acts of falsehood demean and compromise the corporate endeavors of teaching, research, health care and community service via which SLU embodies its mission. The University strives to prepare students for lives of personal and professional integrity, and therefore regards all breaches of academic integrity as matters of serious concern.

The governing University-level Academic Integrity Policy can be accessed on the Provost's Office [website](#). Additionally, SLU-Madrid has posted its academic integrity policy online: <http://www.slu.edu/madrid/academics>. As a member of the University community, you are expected to know and abide by these policies, which detail definitions of violations, processes for reporting violations, sanctions and appeals.

The professor will review these matters during the first weeks of the term. Please direct questions about any facet of academic integrity to your faculty, the chair of the department of your academic program, or the Academic Dean of the Madrid Campus.

University Title IX Statement: Saint Louis University and its faculty are committed to supporting our students and seeking an environment that is free of bias, discrimination, and harassment. If you have encountered any form of sexual misconduct (e.g. sexual assault, sexual harassment, stalking, domestic or dating violence), we encourage you to report this to the University. If you speak with a faculty member about an incident of misconduct, that faculty member must notify SLU's Title IX deputy coordinator, Marta Maruri, whose office is located on the ground floor of Padre Rubio Hall, Avenida del Valle, 28 (mmaruri@slu.edu; 915-54-5858, ext. 213) and share the basic fact of your experience with her. The Title IX deputy coordinator will then be available to assist you in understanding all of your options and in connecting you with all possible resources on and off campus.

If you wish to speak with a confidential source, you may contact the counselors at the SLU-Madrid's Counseling

Services on the third floor of San Ignacio Hall (counselingcenter-madrid@slu.edu; 915-54-5858, ext. 230) or Sinews Multilingual Therapy Institute, the off-campus provider of counseling services for SLU-Madrid (www.sinews.es; 917-00-1979). To view SLU-Madrid's sexual misconduct policy and for resources, please visit the following web address: <http://www.slu.edu/Documents/Madrid/campus-life/SLUMadridSexualMisconductPolicy.pdf>.

Students with Special Needs: In recognition that people learn in a variety of ways and that learning is influenced by multiple factors (e.g., prior experience, study skills, learning disability), resources to support student success are available on campus. Students who think they might benefit from these resources can find out more about:

- Course-level support (e.g., faculty member, departmental resources, etc.) by asking your course instructor.
- University-level support (e.g., tutoring/writing services, Disability Services) by visiting the Academic Dean's Office (San Ignacio Hall) or by going to <https://www.slu.edu/madrid/academics/student-resources>.

Students with a documented disability who wish to request academic accommodations must contact Disability Services to discuss accommodation requests and eligibility requirements. Once successfully registered, the student also must notify the course instructor that they wish to access accommodations in the course. Please contact Disability Services at disabilityservices-madrid@slu.edu or +915 54 58 58, ext. 230 for an appointment. Confidentiality will be observed in all inquiries. Once approved, information about the student's eligibility for academic accommodations will be shared with course instructors via email from Disability Services. For more information about academic accommodations, see "Student Resources" on the SLU-Madrid webpage.

Note: Students who do not have a documented disability but who think they may have one are encouraged to contact Disability Services.

(IF APPLICABLE): Mandatory Trips/Activities: Students enrolled in this class must participate and make payment for all mandatory trips/activities. The prices posted on the web are approximate; the final price will be based on the number of students enrolled on the last day of the Add/Drop period. All students, including those who withdraw from the class after this date, are required to pay these fees, which are non-refundable, unless the trip is cancelled due to low enrollment. Please review SLU-Madrid's trip policies, available on-line.

Course Outline:

Week	Topic	Book Chapters
1	Introduction to Automatic Control Systems	1
2	Laplace Transform and Transfer Function	2
3	Block Diagrams and Signal Flow Graphs	2
4	State Variable analysis	3
5	Sensitivity and Disturbance Signals	4
6	Transient Response of 2nd Order Systems	5
7	Steady-state Error Analysis	5
8	Routh-Hurwitz Stability	6
9	Root Locus Analysis	7
10	Frequency Domain Analysis – Bode Plots	8
11	Nyquist Stability Criterion	9
12	Gain and Phase Margin, Nichols Chart	9
13	Design with phase-lead and phase-lag Controllers	10
14	Design with lead-lag controllers	10
15	PID Controller Design	7.6, 9.9, 10.6

Spring 2018 Course Schedule:

JANUARY	
Wednesday 10	First Day of Classes
Thursday 11	
Friday 12	
Monday 15	
Tuesday 16	
Wednesday 17	
Thursday 18	
Friday 19	
Sunday 21	Last Day to Drop a Class without a Grade W and/or Add a Class; Last Day to Choose Audit (AU) or Pass/No Pass (P/NP) Options
Monday 22	
Tuesday 23	
Wednesday 24	
Thursday 25	
Friday 26	No Classes Application Deadline for Spring Semester Degree Candidates
Monday 29	
Tuesday 30	
Wednesday 31	
FEBRUARY	
Thursday 1	
Friday 2	
Monday 5	
Tuesday 6	
Wednesday 7	
Thursday 8	
Friday 9	
Monday 12	
Tuesday 13	
Wednesday 14	Ash Wednesday Registration for Summer 2018 Begins
Thursday 15	
Friday 16	
Monday 19	First mid-term exam
Tuesday 20	
Wednesday 21	
Thursday 22	
Friday 23	No Classes (Winter Break)
Monday 26	
Tuesday 27	Professors' Deadline to Submit Midterm Grades
Wednesday 28	
MARCH	
Thursday 1	
Friday 2	
Monday 5	
Tuesday 6	
Wednesday 7	
Thursday 8	
Friday 9	Last Day to Drop a Class and Receive a Grade of W
Monday 12	
Tuesday 13	

Wednesday 14	
Thursday 15	Last Day to Submit Transfer Application for Fall Semester
Friday 16	
Monday 19	
Tuesday 20	
Wednesday 21	Second mid-term exam
Thursday 22	
Friday 23	
Monday 26	Semana Santa Holiday (Campus Closed)
Tuesday 27	
Wednesday 28	
Thursday 29	Jueves Santo (Campus Closed)
Friday 30	Viernes Santo (Campus Closed)
APRIL	
Monday 2	
Tuesday 3	
Wednesday 4	Registration for Fall 2018 Semester Begins
Thursday 5	
Friday 6	
Monday 9	
Tuesday 10	
Wednesday 11	
Thursday 12	
Friday 13	
Monday 16	
Tuesday 17	
Wednesday 18	
Thursday 19	
Friday 20	
Monday 23	
Tuesday 24	
Wednesday 25	
Thursday 26	
Friday 27	
Monday 30	
MAY	
Tuesday 1	Día del Trabajador (Campus Closed)
Wednesday 2	Día de la Comunidad (Campus Closed)
Thursday 3	Spring 2018 Final Day of Classes
Friday 4	Spring 2018 Final Exams
Monday 7	Spring 2018 Final Exams
Tuesday 8	ESCI-3410 Final Exam (15:30)
Wednesday 9	Spring 2018 Final Exams
Thursday 10	Spring 2018 Final Exams
Friday 11	University Housing Move-out Date
Saturday 12	Commencement
Sunday 13	Professors' deadline to submit spring 2018 final grades

Final Exam Schedules Spring 2018

	4 May (Fr)	7 May (Mn)	8 May (Tu)	9 May (Wd)	10 May (Th)
08:30-11:30	Mn classes that meet at 9:00 & 9:30	Mn classes that meet at 10:00	Mn classes that meet at 11:00 & 11:30	Tu classes that meet at 9:30	Tu classes that meet at 8:00
12:00-15:00	Tu classes that meet at 11:00	Mn classes that meet at 13:00	Tu classes that meet at 14:30	Mn classes that meet at 12:00 & 12:30	Tu classes that meet at 12:30
15:30-18:30	Mn classes that meet at 14:30	Tu classes that meet at 17:00 & 17:30	Mn classes that meet at 16:00	Tu classes that meet at 16:00	Mn classes that meet at 17:30
19:00-22:00	---	---	Mn classes that meet at 18:30 & 19:00	Tu classes that meet at 19:00	---