

<b>Identification</b>	<b>Subject</b>	ME475, System Dynamics and Control, 8 ECTS
	<b>Department</b>	Mechanical Engineering
	<b>Program</b>	Undergraduate
	<b>Term</b>	Spring 2026
	<b>Instructor</b>	Dr. Mehdi Kiyasatfar
	<b>E-mail:</b>	<a href="mailto:mkiyasatfar@khazar.org">mkiyasatfar@khazar.org</a>
	<b>Phone:</b>	
	<b>Classroom/hours</b>	
	<b>Office hours</b>	
<b>Prerequisites</b>	Dynamics, Differential equations	
<b>Language</b>	English	
<b>Compulsory/Elective</b>	Compulsory	
<b>Required textbooks and course materials</b>	Modern Control Engineering- Fifth Edition, Katsuhiko Ogata, Pearson 2010 Modern Control Systems-14th Edition, Dorf & Bishop- Pearson 2021	
<b>Course website</b>		
<b>Course outline</b>	System Dynamics and Control is a core course in mechanical engineering that focuses on the modeling, analysis, and performance evaluation of dynamic systems. The course introduces fundamental concepts and methods for analyzing and controlling engineering systems, with emphasis on both time-domain and frequency-domain approaches. It equips senior-level students with the theoretical foundation and practical tools necessary to analyze and understand control systems commonly encountered in mechanical and multidisciplinary engineering applications.	
<b>Course objectives</b>	This course is designed to provide students with a comprehensive understanding of the fundamental principles of system dynamics and control, including mathematical modeling, time-domain and frequency-domain analysis, and basic control strategies. Emphasis is placed on the analysis and evaluation of dynamic system behavior using analytical methods and standard control techniques. By the end of the course, students will be able to apply system dynamics and control concepts to analyze and assess the performance of engineering systems commonly encountered in mechanical and multidisciplinary engineering applications.	
<b>Learning outcomes</b>	Upon successful completion of this course, students will be able to: <ul style="list-style-type: none"> <li>• Describe the basic structure and components of control systems.</li> <li>• Model and analyze dynamic systems using mathematical representations.</li> <li>• Analyze the transient response of linear control systems.</li> <li>• Apply basic control algorithms and PID tuning methods.</li> <li>• Perform stability analysis of control systems using standard analytical techniques.</li> <li>• Apply fundamental frequency-response design methods.</li> <li>• Analyze controller design approaches based on representative industrial application examples.</li> </ul>	
<b>Teaching methods</b>	<b>Lecture</b>	x

	<b>Group discussion</b>		x
	<b>Experiential exercise</b>		-
	<b>Tutorials once a month on weekends</b>		-
	<b>Case analysis and assignments</b>		x
	<b>Course paper</b>		-
	<b>Others</b>		--
<b>Evaluation</b>	<b>Methods</b>	<b>Date/deadlines</b>	<b>Percentage (%)</b>
	<b>Midterm Exam</b>		30
	<b>Attendance &amp; Activity</b>	At each lesson	5
	<b>Quiz (4 quizzes)</b>	During the semester	15
	<b>Assignment</b>	During the semester	10
	<b>Final Exam</b>		40
	<b>Total</b>		100
<b>Policy</b>	<ul style="list-style-type: none"> <li>▪ <b>Ethics</b> Copying other students' work is highly discouraged. All assignments must be handled by the student himself. This is a university policy and violators will be reprimanded accordingly.</li> <li>▪ <b>Preparation for class</b> The structure of this course demands your individual effort outside the classroom for extra practice of many problems within the textbook. After each session, every student needs to put sufficient time to practice and finish the assignments by the predetermined date.</li> <li>• <b>Withdrawal (pass/fail)</b> This course strictly follows the grading policy of the School of Science and Engineering. Thus, a student is expected to achieve a mark of at least 60% to pass. In case of failure, he/she will be required to repeat the course the following term or year.</li> <li>▪ <b>Cheating/plagiarism</b> Cheating or other plagiarism in handling the assignments, Mid-term and Final Examinations will lead to course failure. In this case, the student will automatically get zero (0), without any considerations.</li> <li>▪ <b>Professional behavior guidelines</b> The students shall behave in a way to create a favorable academic and professional environment during the class hours.</li> <li>▪ <b>Attendance &amp; Activity</b> Attendance and in-class activity constitute 5 marks out of the total 100 marks for this course. Students who attend and actively participate in class activities will receive these marks. For each unexcused absence, 1 mark will be deducted from the attendance and activity score.</li> <li>▪ <b>Quiz</b> Quizzes constitute 15 marks out of the total 100 marks for this course. Four quizzes will be conducted throughout the semester: two quizzes before the midterm examination and two quizzes before the end of the semester. Quiz questions will primarily focus on system modeling, dynamic analysis, and</li> </ul>		

	<p>control concepts, and full credit will be awarded only for step-by-step solutions supported by clear explanations and properly justified final results.</p> <ul style="list-style-type: none"> <li>▪ <b>Assignment</b> Assignments constitute 10 marks out of the total 100 marks for this course. Students are required to submit assigned homework problems by the specified deadlines. Assignments will emphasize mathematical modeling, system response analysis, and controller design, and full credit will be awarded only for complete, well-structured solutions with clear explanations and properly supported final results.</li> <li>▪ <b>Exam</b> The midterm and final examinations will assess the system dynamics and control topics covered during the course as outlined in the syllabus, with a focus on conceptual understanding, analytical skills, and control system problem-solving.</li> </ul>
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### Tentative Schedule

Week	Date/Day (tentative)	Topics	Textbook/Assignments
1		Syllabus. Introduction and basic concepts. Definition of Control system basic elements. Control Cycle Types. Applications of automatic control system	Chap1, Ref1
2		Laplace transformation: Basics of Laplace transform. Theorems of laplace transform. Laplace transforms of certain functions	Chap 2, Ref1
3		Laplace transformation: Inverse Laplace transform Solution of linear differential equations with partial fraction separate method	Chap 2, Ref1
4		<b>Quiz-1</b> Mathematical modeling of physical systems and system dynamics: Model, Mathematical model and definition of physical model. Simple system elements and similarity.	Chap 3, Ref1
5		Mathematical modeling of physical systems and system dynamics: Generalized Impedance. Impedance in electrical and mechanical systems	Chap 3, Ref1
6		Transfer function: Definition of transfer function. Basic features of transfer function. Calculation of transfer function of open. closed cycle system and system which exposed to disturbing entrance.	Chap 3, Ref1
7		<b>Quiz-2</b> Block diagram: Block diagrams. Basic features of block diagram. Reduction of block diagrams	Chap 3, Ref1
8		Review <b>Midterm Exam</b>	

9		Signal diagrams: Signal flow diagrams, Basic features of signal flow diagram. Operations of signal flow diagram, Signal flow diagrams of control systems. Mason gain formula for signal flow diagrams and its applications.	Chap 3, Ref1
10		Transfer functions of control systems: Electrical systems. Mechanical systems. Mechanical rectilinear systems. Mechanical rotational systems. Including of gears mechanical rotational systems.	Chap 3, Ref1
11		<b>Quiz-3</b> Transfer functions of control systems: Including of gearbox and electric motor mechanical rotational systems. Hydraulic systems. Thermal systems. Electro-mechanical systems. Pneumatic and electro-pneumatic systems.	Chap 4, Ref1
12		Transfer functions of control systems: Proportion element and its dynamic behavior, Capacity, or integral element. Time constant, first order systems, type of vibration element or second order systems.	Chap 5, Ref1
13		Steady state response and error of control systems: Steady state error and classification of systems. Static error coefficients. Disturbing entrance errors.	Chap 5, Ref1
14		<b>Quiz-4</b> Methods of frequency response and bode diagrams: Frequency domain or response of sinusoidal entrance, Bode diagrams and its drawing	Chap 8, Ref1
15		Methods of frequency response and bode diagrams: Polar curves. Nypquist stability criteria.	Chap 8, Ref1
		<b>Final Exam</b>	

This syllabus is a guide for the course and any modifications to it will be announced in advance.