Kurdistan Region Government
Ministry of Higher Education
and Scientific Research
Erbil Polytechnic University

Module (Course Syllabus) Catalogue

2025-2026

College/ Institute	**Technical College of Computer and Informatics Engineering**	
Department	**Artificial Intelligence and Robotics Engineering**	
Module Name	**Fundamentals of Control Systems**	
Module Code	**FCS301**	
Degree	**Technical Diploma** ☐ **Bachelor** ■ **High Diploma** ☐ **Master** ☐ **PhD** ☐	
Semester	**3**	
Qualification	**PhD In Computer Engineering**	
Scientific Title	**Assist. Prof**	
ECTS (Credits)	**6**	
Module type	**Prerequisite** ☐ **Core** ■ **Assist.** ☐	
Weekly hours		
Weekly hours (Theory)	**(2)hr Class**	**(84)Total hrs Workload**
Weekly hours (Practical)	**(2)hr Class**	**(78)Total hrs Workload**
Number of Weeks	**14**	
Lecturer (Theory)	**Shahab Wahhab Kareem**	
E-Mail & Mobile NO.	**Shahab.kareem@epu.edu.iq**	
Lecturer (Practical)		
E-Mail & Mobile NO.		
Websites		

Course Book

Course Description	This module introduces the fundamental principles used to model, analyse, and interpret continuous-time feedback control systems. It covers control-system components and feedback concepts, mathematical modelling of physical systems, transfer-function representation, block-diagram reduction, and time-domain analysis. Particular emphasis is placed on first-order and second-order system responses, transient-response characteristics, poles and zeros, damping ratio, natural frequency, and standard performance measures such as rise time, peak time, overshoot, and settling time. Exercise sessions develop analytical problem-solving skills using representative electrical, mechanical, and electromechanical systems.
Course objectives	The objectives of this course are to: 1. Introduce the terminology, structure, objectives, and applications of open-loop and closed-loop control systems. 2. Develop mathematical models of basic physical systems and express them using transfer functions. 3. Enable students to construct, simplify, and interpret block-diagram models of feedback systems. 4. Build students' ability to calculate and evaluate first-order and second-order transient responses. 5. Relate pole locations, zeros, damping ratio, and natural frequency to system performance and stability behaviour. 6. Train students to solve control-system analysis problems systematically through exercises and technical reports.
Student's obligation	Students are expected to attend lectures and exercise sessions, participate in class discussions, complete homework and reports by the announced deadlines, and independently solve assigned analysis problems. Collaboration for discussion is encouraged where permitted, but submitted work must be the student's own. Students should review derivations before each exercise session and maintain academic integrity in quizzes and examinations.
Required Learning Materials	

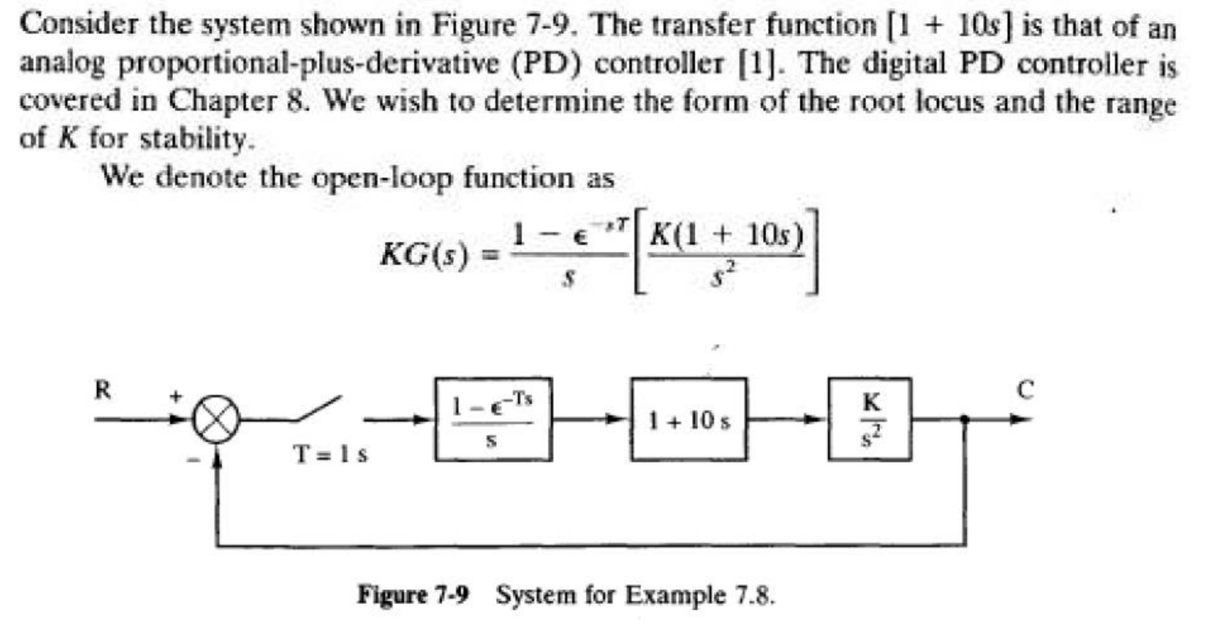
	Task		**Weight (Marks)**	**Due Week**	**Relevant Learning Outcome**
Evaluation	Paper Review				
	Assignments	Homework	5	5	
		Class Activity	2	7	
		Report	5	8	
		Seminar			
		Essay			
		Project	5	11	

	Quiz	8	4	
	Lab.	10	6	
	Midterm Exam	25	7	
	Final Exam	40	12	
	Total	100		
Specific learning outcome:	At the end of the course, students will be able to: Define control-system terminology and distinguish open-loop from closed-loop feedback arrangements. Develop mathematical models and transfer functions for elementary physical systems. Represent interconnected systems using block diagrams and perform diagram reduction. Derive and interpret first-order responses to standard inputs and identify gain and time constant from response data. Analyse second-order systems using damping ratio, natural frequency, pole position, and transient specifications. Evaluate the effect of poles, zeros, and delays on transient-response quality.			
Course References:	▪ Key references: • Ogata, K. Modern Control Engineering. 5th ed. Prentice Hall, 2010. • Nise, N. S. Control Systems Engineering. 6th ed. John Wiley & Sons, 2010. • Franklin, G. F., Powell, J. D., and Emami-Naeini, A. Feedback Control of Dynamic Systems. 6th ed. Prentice Hall, 2009. • Astrom, K. J., and Murray, R. M. Feedback Systems: An Introduction for Scientists and Engineers. Princeton University Press, 2008. • Issa, A. H. Control Theory I - Lecture 08: Time Domain Analysis, Part 2. Department of Control and Systems Engineering. • Issa, A. H. Control Theory I - Lecture 09: Time Domain Analysis, Part 3. Department of Control and Systems Engineering.			

Course topics (Theory)	**Week**	**Learning Outcome**
Orientation and prerequisite review Open- and closed-loop examples	1 and 2	Recognise variables, signals, Laplace-transform use, and feedback notation.
Physical-system modelling exercises Modelling practice	3 and 4	• Construct models for simple mechanical and electrical systems. Develop governing differential equations for basic components
Fundamental Control	5 and 6	Transform differential equations to transfer-function form.

		• Identify poles/zeros and discuss their qualitative effects.
Block-diagram construction Block-diagram reduction	7 and 8	Convert system descriptions into block diagrams. • Reduce cascaded, parallel, and feedback configurations.
Standard input-response problems First-order step response	9 and 10	• Apply impulse and step inputs in time-domain analysis. • Calculate time constant, final value, and transfer-function parameters.
First-order applied examples	11	• Represent discrete-time LTI systems using difference equations, transfer functions, and state-space forms. • Analyze stability and frequency response in the z-domain.
Second-order model parameters	12	Obtain damping ratio and natural frequency from transfer functions or pole locations.
Transient-response specifications Integrated analysis problem	13 and 14	Calculate rise time, peak time, percentage overshoot, and settling time. Analyse a complete feedback model and interpret transient behaviour
Final Exam		

19. Examinations: The instructor chooses the optimal method of tests according to his suitability and competence: OR:

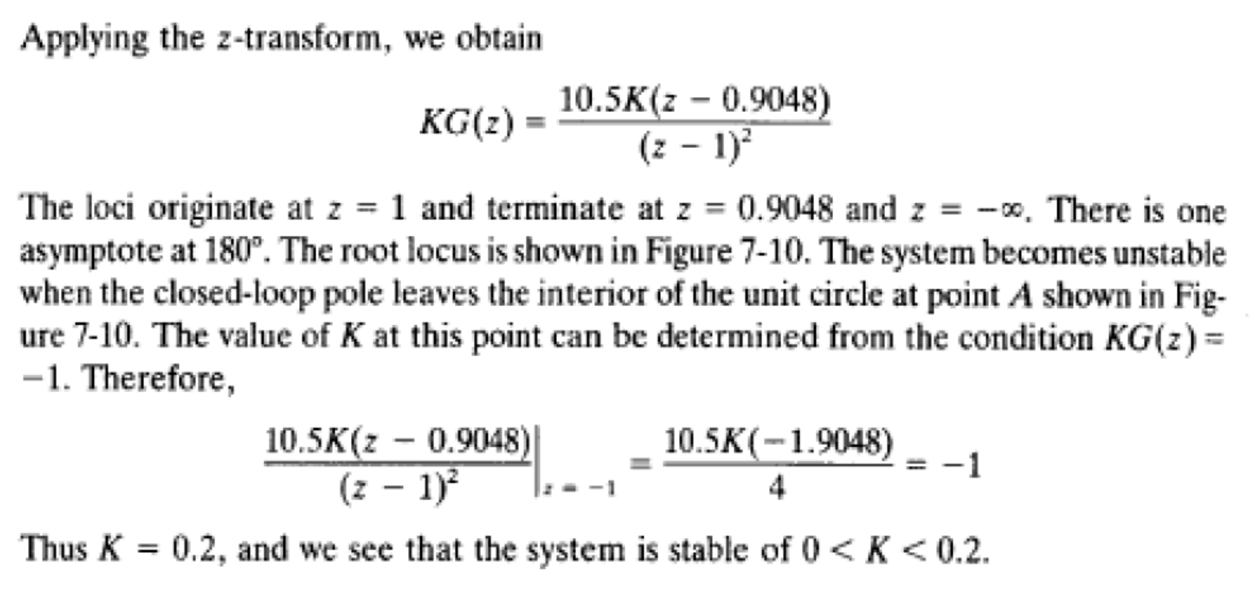


Consider the system shown in Figure 7-9. The transfer function $[1 + 10s]$ is that of an analog proportional-plus-derivative (PD) controller [1]. The digital PD controller is covered in Chapter 8. We wish to determine the form of the root locus and the range of K for stability.

We denote the open-loop function as

$$KG(s) = \frac{1 - \epsilon^{-sT}}{s}\left[\frac{K(1 + 10s)}{s^2}\right]$$

Figure 7-9 System for Example 7.8.



Applying the z-transform, we obtain

$$KG(z) = \frac{10.5K(z - 0.9048)}{(z - 1)^2}$$

The loci originate at $z = 1$ and terminate at $z = 0.9048$ and $z = -\infty$. There is one asymptote at 180°. The root locus is shown in Figure 7-10. The system becomes unstable when the closed-loop pole leaves the interior of the unit circle at point A shown in Figure 7-10. The value of K at this point can be determined from the condition $KG(z) = -1$. Therefore,

$$\left.\frac{10.5K(z - 0.9048)}{(z - 1)^2}\right|_{z=-1} = \frac{10.5K(-1.9048)}{4} = -1$$

Thus $K = 0.2$, and we see that the system is stable of $0 < K < 0.2$.

Extra notes:

External Evaluator