



# Robust Control Systems

University of Kurdistan  
Faculty of Engineering  
Department of Power and Control Engineering

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- **Course Description**

Robust Control Systems (RCS) provides a postgraduate course to learn most basic/common concepts and methods in robust control theorems. First, an introduction on Robust Control with basic definitions, concepts, main differences with other control theorems, and a brief history are presented. Then, uncertainty modeling and robust control synthesis using loop shaping method are explained. The lecture makes a bridge between the fundamental knowledge of linear control systems and main concepts of robust control theorems. It means that the analytical/graphical tools used in linear control systems such as Bode and Nyquist diagrams, as well as loop transfer function model are used to perform the synthesis elements of a robust controllers. Both single-input single-output (SISO) and multi-input multi-output (MIMO) dynamic systems are considered as examples.

Topics given in this course cover the most important issues in robust control analysis and synthesis approaches. After successful completion of this course, the students will learn some robust control design methodologies. The lectures are supplemented by several application examples.

- **Topics**

1. An Introduction
2. Frequency Response Analysis: A Review
3. Kharitonov Theorem-based Control Design
4. Uncertainty, Robust Stability/Performance
5. Loop Shaping Control Design
6.  $H_\infty$  Control Design
7.  $H_2$  and Mixed  $H_2/H_\infty$  Control Design
8. Structured Singular Value ( $\mu$ ) Control Design

- **Grading**

- Pre-tasks/Homework 30%
- Project 40%
- Final Exam 30%

- **Course Project**

The project is organized to be performed on seven steps during term-time and includes many aspects of the courses. Each student must choose a benchmark plant based on his/her interest and implements taught control methods for the selected plant. Everyone should provide seven detailed written reports with simulation files. At the end, the project report must be presented in the class.

- **Objectives**

Completing the course must give the following knowledge, skills and capabilities to the students who attend all lectures actively:

- 1- A deep knowledge on the main concepts, frameworks, and components of Robust Control systems,
- 2- Design a Kharitonov theorem-based controller for a given system by programming and simulation in MATLAB environment,
- 3- Design a robust controller based on loop shaping method for a given system by programming and simulation in MATLAB environment,
- 4- Design an  $H_\infty$ -based robust controller for a given system by programming and simulation in MATLAB environment,
- 5- Application of structured singular value ( $\mu$ ) theorem for robust stability analysis of a given closed-loop system,
- 6- Design a  $\mu$ -based robust controller for a given system by programming and simulation in MATLAB environment,
- 7- Making an enough strong background for self-learning of other robust control approaches and tools in a short time.

- **Reference**

- [1] H. Bevrani, *Lecture Notes on Robust Control*, University of Kurdistan, Revised Version in 2023.
- [2] B. R. Barmish, *New Tools for Robustness of Linear Systems*. Macmillan, 1994.
- [3] K. Zhou, *Essentials of Robust Control*, Prentice Hall, 1999.
- [4] S. Skogestad and I. Postlethwaite, *Multivariable Feedback Control; Analysis and Design*, Second Edition, Wiley, 2005.
- [5] M. Fujita, *Lecture Notes on Robust Control Systems*, Tokyo Institute of Technology, 2019.