

Course Name: Feedback Control Design

Course code: EE514

Credits: 3-0-0-3

Prerequisites: EE 301 Control Systems

Intended for: UG/PG

Elective/Core: Elective

Semester: Odd/Even

Course Preamble: This course is designed for senior undergraduate and first-year graduate students, assuming that they are already introduced to the first level UG control theory course. This course provides an in-depth knowledge on the analysis of SISO as well as MIMO systems. In addition, emphasis on modern control design techniques will be given, which leads to a more practical and hands-on approach to the subject. Several fundamental concepts, such as poles, zeros and their directions, performance limitations due to RHP-zeros and input delay will be introduced in the course. Stability analysis via Nyquist plot will be discussed for both SISO and MIMO systems. Furthermore, robust stability and advanced controller design techniques will be discussed.

Course Outline: The course is divided in five modules. In the first module, mathematical preliminaries, such as matrix norms, signal and system norms, singular value decomposition will be introduced. Second and third module cover the analysis of linear time invariant systems and the interconnection of plant and controller. Fourth module introduces the concept of uncertainty and robust stability of a system. In the last module students will learn several controller synthesis procedures for dynamic output feedback control, LQR and LQG control.

Modules:

1. Mathematical Preliminaries: [4 Lectures]

Vector and matrix norms, Signal and system norms (2-norm and infinity norm), Singular value decomposition.

2. System Analysis: [10 Lectures]

System representation, sensitivity and complementary sensitivity function, concept of poles and zeros, pole and zero directions, controllability & observability, performance limitations.

3. Feedback interconnection & Stability theory: [5 Lectures]

Well-posedness of feedback loop, Internal stability of feedback system, Nyquist plot, Small gain theorem.

4. Uncertainty and robustness: [8 Lectures]

Uncertainty representation, robust stability and robust performance, applications of robust control in physical systems (power systems, electro-mechanical systems and aerospace etc.).

5. Controller Synthesis: [9 lectures]

Stabilizing controllers, Introduction to H_2 and H_∞ control (including LQR and LQG control).

Textbook:

1. S. Skogestad and I. Postlethwaite, *Multivariable Feedback Control: Analysis and Design*, John Wiley & Sons, 2001. (second edition)

Reference books:

1. K. Zhou, J. C. Doyle and K. Glover, *Robust and Optimal Control*, Prentice-Hall, Englewood Cliffs, NJ, 1995.
2. O. H. Bosgra, H. Kwakernaak, and G. Meinsma, *Design Methods for Control Systems*, Notes for a course of the Dutch Institute of Systems and Control, Winter term 2000–2001.