Syllabus 332:506 Applied Controls – Fall 2023

Instructor: Omer Lateef, omer.lateef@rutgers.edu

Textbooks: Gene F. Franklin, J. David Powell, Michael L. Workman, *Digital Control of Dynamic Systems* (3rd Edition).

References:

(Many more will be shared during the lectures)

i. Gene Franklin, David Powell and Abbas Emami-Naeini, *Feedback Control of Dynamic Systems.*
ii. A. Sinha, *Linear Systems: Optimal and Robust Control*, Taylor& Francis, 2007.
iii. Stephen Boyd and Lieven Vandenberghe, *Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares,* Cambridge University Press, 2018

Pre-Requisites:

- An introductory course on control systems in undergraduate degree.
- Working knowledge of differential equations and Linear Algebra.

Mode of instruction: In person lectures.

This is an applied course in which several applications of control systems theory will be discussed. Emphasis will be placed on the qualitative understanding of the theoretical results and its implementation in digital domain. Numerous case studies from different domains will be discussed.

Topics to be covered (*Tentative*):

<u>Mathematical Modeling of Systems.</u>

- Modeling of physical systems from various domains, simplifying assumptions along with their validity, the importance of feedback and its many real-world applications, A brief review of classical and modern control system theory.

<u>Digital Control:</u>

- Digitization, effect of sampling, PID control, linear difference equation, the discrete transfer function, z-transform, external stability, discrete models of sampled-data systems, signal analysis and dynamic response, spectrum of a sampled-data system, block-diagram analysis of sampled-data systems, discrete equivalents, system specification, design by emulation, discrete equivalent controllers, evaluation of design, direct design by root locus in the z-plane, z-plane specification, the discrete root locus, frequency response methods, design specification in frequency domain, compensator design, design using state-space method, control law design, estimator design, regulator design, integral control and disturbance estimation, effects of sensor and actuator delays, quantization effects.

<u>System identification:</u>

- Defining the model set for linear systems, identification of nonparametric models, models and criteria for parametric identification, deterministic estimation (least squares and recursive least squares), stochastic least squares, maximum likelihood, subspace identification method.

<u>Introduction to Optimal and Non-Linear Control:</u>

- Decoupling and its advantages, time-varying optimal control, optimal estimation, multivariable control design, analysis techniques of non-linear systems, non-linear control structures, design with nonlinear cost functions.

Office Hours: Will be decided after the first week of the class.

GRADING: Assignments: 20%; Quizzes: 20%; Mid-Term Exam: 25%; Final: 35%.

Grading Scale (Tentative): A >= 90%, B+ >= 82%, B >= 75%, C+ >= 67%, C >= 60.