

**Mechanical and Mechatronics Engineering Department**

**Advanced Control Systems ENMC 5310**

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| **M, W** | **10:00 – 11:00** | **Aggad303** |

**Instructor: Dr. Ahmad Al-Balasie Email: abalasie@birzeit.edu**

**Office No.: Aggad 316 Spring Semester 2022/2023**

**Course Description:**

Bode plots and Nyquist stability tests. Compensator’s design of linear systems using Bode plots. State space models. Nonlinear systems, linearization of nonlinear systems, and exact feedback linearization technique. Lyapunov and boundary-input-boundary-output (BIBO) stability tests. Controllability and observability tests. Pole placement and Linear Quadratic Regulator (LQR). Regulator’s design. Tracking systems design with or without an integral action. Robust control design. Full and reduced states observer’s design.

**Pre-request (if any):**

Control Theory: ENME 4380

**Text books (References):**

1. Ogata, (2010), *Modern Control Engineering (5th edition)*, Prentice-Hall, Inc.
2. Nise, Norman S*.*(2020)*, Control systems engineering.* John Wiley & Sons*.‏*

**Recommended Text Books:**

1. Slotine, J-J. & Li, W. (1991). *Applied Nonlinear Control*, Prentice Hall.
2. Franklin, G. F., Powell, J. D. and Emami-Naemi, A., (2006). *Feedback Control of Dynamic Systems*, (6th ed.), Prentice Hall.
3. Dorf, R., & Bishop, (2008), *Modern Control System*, Prentice-Hall.

**Course Assessment:**

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| **Evaluation method** | **%** |
| Project | 10 |
| Midterm Exam | 30 |
| Quizzes | 10 |
| Assignments | 10 |
| Final Exam | 40 |

**Objectives of this course:**

1. Introduce the modern control systems.
2. Analyze and design the modern control system for several applications based on the design requirements.
3. Introduce the nonlinear systems, their analysis, and their controller design.
4. Familiarize students to the use of software tools for modern control.
5. Introduce bode plots for linear systems and study the Nyquist stability criterion.
6. Compensator design of linear systems using Frequency method.

**Learning Outcomes:**

1. Examine systems for stability, controllability and observability using modern control theory.
2. Design s regulator or tracking using various methods according to specified desired performances.
3. Design state observer using various methods according to specified desired performances.
4. Use software tools in the simulation and design of modern control systems interpret the data.
5. Study the nonlinear system and examine its stability.
6. Perform a design project in groups on the implementation of modern controller in target applications and present the results in oral and writing exam.
7. Design compensator for linear systems based on bode plots.

**This course serves to the following ABET outcomes:**

1. Ability to apply mathematics, science and engineering principles.
2. Ability to identify, formulate and solve engineering problems.
3. Ability to use the techniques, skills and modern engineering tools necessary for engineering practice.

*Good Luck*