Course Syllabus

1. Course number and name: 020CTMES4 – Modern Control

2. Credits and contact hours: 4 credits and 28x1:15 course hours.

3. Instructor's or course coordinator's name: Akram GHORAYEB

4. Text book :
   a. other supplemental materials:
      Professor course material

5. Specific course information
   a. Brief description of the content of the course (catalog description)
      The objective of this course is the time-domain control by state feedback of multi-variable linear systems. After a practical example showing the difficulty that represents the mutual effect of the inputs on the outputs, the general expression of the response and the definition of the transfer matrix are given as well as the techniques of converting transfer matrix to state equations in canonical forms. The concepts of controllability and observability are then formulated and their validity criteria are justified. Follow the Kalman decomposition and the possible simplification of poles and zeros leading to a minimal realization. Once these concepts are acquired, the following control policies are motivated and established:
      - Pole placement with observer and error integration.
      - Optimal quadratic control and Kalman filter.
      -Introduction to minimax and H_∞ control.

   b. Prerequisites or co-requisites: 020SCNES3 – Digital Systems and Control.

   c. Required/Elective/Selected Elective: Required.

6. Specific goals for the course
   a. Specific outcomes of instruction,
   - Be aware of the difficult task to control intuitively multi-variable systems.
   - Model a system by state equations or by transfer matrix.
   - Convert from transfer matrix to state equations in various forms.
   - Test the controllability and the observability of a model.
   - Study the possibility of simplifying a pole by a zero and deduce a minimal realization.
   - Understand the basics
     - of pole placement control with integration of the error,
     - of state variables estimation by an observer,
     - of LQG control and Riccati equation,
     - of state variables estimation by a Kalman filter.

- Have an idea about minimax and H□ □control.

b. KPIs addressed by the course.

KPI	a1	a2	c1	c3	e2	e3	k3
Covered	x	x	x	x	x	x	x
Assessed	x	x	x	x	x	x	x
Give Feedback		x	x	x	x	x	x

7. Brief list of topics to be covered and approximate lecture hours :

Number of sessions	**Content**
1 and 2	Modeling a multi-variable system, interpretation and linearization.
3 and 4	Response and matrix transfer
4 to 6	Realization in controllability, observability and Jordan forms
7 to 10	Controllability, the gramien and its properties, test of Kalman, partial controllability.
11	Quiz, modal test.
12 and 13	Hautus test, observability and its criteria.
14 and 15	Minimum implementation, stabilization and detection.
16 and 17	Directions of the poles and zeros, simplification.
18 to 20	Pole placement control, error integration, and observer.
21 to 24	Optimal quadratic control (LQG): introduction, Riccati equation, Kalman filter, validity conditions.
25 and 26	Introduction to minimax and H_∞ control.
27 and 28	Guided mini-project: modeling, design and simulation.