Modern Control

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

2. **Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours per week

3. **Instructor's or course coordinator's name:** Jean Sawma

4. **Instructional materials:** Instructor's PowerPoint slides, textbook.

5. **Specific course information**
   a. **Catalog description:**
   Modeling a multi-variable system, interpretation, and linearization. Response and matrix transfer. Realization in controllability, observability, and Jordan forms. Controllability, and its properties, partial controllability. Observability and its criteria. Minimum implementation, stabilization, and detection. Directions of the poles and zeros, simplification. Pole placement control, error integration, and observers. Optimal quadratic control (LQG): introduction, Riccati equation, Kalman filter, validity conditions. Guided mini project: modeling, design, and simulation.

   b. **Prerequisite:** Linear Control (020AULES2).

   c. **Required** for EE students, **Selected Elective** for ME students.

6. **Educational objectives for the course**
   a. **Specific outcomes of instruction:**
   - 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.
     - State variables estimation by an observer.
     - LQG control and Riccati equation.

   b. **PI addressed by the course:**

PI	1.1	1.2	1.3
Covered	x	x	x
Assessed	x	x	x

7. Brief list of topics to be covered

- Modeling of multi-variable systems: interpretation and linearization.
- Response and matrix transfer in system analysis.
- Realization in terms of controllability, observability, and Jordan forms.
- Controllability: properties, and partial controllability.
- Observability: criteria and considerations.
- Minimum implementation techniques, stabilization methods, and detection approaches.
- Analysis of pole and zero directions, simplification techniques.
- Pole placement control, error integration, and observer design.
- Introduction to optimal quadratic control (LQG): Riccati equation, Kalman filter, and validity conditions.