The University of Jordan
School of Engineering
Department of Mechatronics Engineering
First Semester – 2025/2026

Course: Modern and Digital Control Systems – 0908454 (3 Cr. – Core Course)
Lecture Time (Mon, Wed: 8:30 – 10:00)

Instructor: Prof. Zaer S. Abo-Hammour
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***Office Hours:* (Sun, Tue: 11:30-12:30)**

Course Website: Microsoft Teams, YouTube lectures.

Catalog Data: Fundamentals of Matrix Algebra, State Space Representation of Dynamical System, Decomposition of Transfer functions, Similarity Transformation for State Space Models, Controllability and Observability of state Space Models, Pole Placement Technique, Observer Design, Introduction to Optimal Control Systems.

Prerequisites by Course: Automatic Control (0908382).

Prerequisites By Topic: Students are assumed to have sufficient knowledge pertaining to the following:

1. Automatic Control systems.
2. Elementary Matrix Theory and Linear Algebra.
3. Laplace transform.
4. Modeling and Simulation of Physical systems.
5. Programming with MATLAB.

Textbook & References:

- ***Modern Control Engineering*** **,** *Katsuhiko Ogata*, 5th Edition n, Prentice Hall
- ***Modern Control Systems*** . *Richard Drof and Robert Bishop*, 12th Edition, Prentice Hall.
- ***Control Systems Engineering****, by Norman S. Nise*, 6th Edition, Johm Wiley
- ***Automatic Control Systems*** by Benjamin C. Kuo, Farid Golinaraghi. 9th Edition. Wiley

Schedule & Duration:

- **First day of teaching classes is Sunday 05-10-2025.**
- **Last day of teaching classes is Tuesday 12-01-2026.**
- **Mid-term Examinations 23/11/2025-4/12/2025.**
- **End of Withdrawal Period for the first semester 13-01-2026.**
- **Final Examinations 14/01/2026-26/01/2026.**

Minimum Student Material: Course handouts, text books, and an access to Personal Computer with MATLAB

Instructional Methods

1. Lecture/Problem solving sessions.
2. Case studies using MATLAB.
3. Course homeworks and projects.

Minimum College Facilities: Classroom with whiteboard and projection display facilities, library, computational facilities with MATLAB and Simulink.

Course Objectives:

1.To teach students modeling in state space and state space representation of dynamic systems.
2. To teach students the techniques of converting transfer functions to state space models and vice versa using decomposition method.
3. To teach Applying similarity transformation between canonical forms for systems.
4. To teach students analysis techniques of state space models: stability, controllability and observability.
5. To teach students design techniques in state space model: Pole placement, state observer, design servo system, quadratic optimal regulator systems.

ABET SO:

2) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors

Course Learning Outcomes and Relation to ABET Student Outcomes:

Upon successful completion of this course, a student should:

1. Review of basic Linear Algebra Operations including rank, determinant, cofactors, gauss elimination, and matrix inverse, Determination of the eigenvalues and eigenvectors of matrices.
2. Understand the State Space representation of linear dynamical Models. Clarify the difference between classical control theory and modern control theory.
3. Understand the basic concepts of decomposition of transfer functions. Find the state space representation of transfer functions using canonical forms.
4. Understand the theory of similarity transformation. Apply similarity transformation between canonical forms for systems.
5. Derivation of the transition matrix. Study the stability of control systems in state space representation. Solve the state equations of dynamical systems.
6. Determine the controllability and observability of control systems in state space representation
7. Understand the design concept of control systems in state space representation.
8. Apply pole placement design technique for control systems.
9. Design of state feedback control law, Design of full state observer.

Course Topics:

	Topic Description	Lectures
1.	**Fundamentals of Matrix Algebra:** Rank of matrix, determinant of matrix, cofactors, gauss elimination, and matrix inverse.	**6**
2.	**State Space Representation of Dynamical System:** Definitiaon of state space model, advantages of state space model over classical model.	**3**
3.	**Decomposition of Transfer functions:** Convert the transfer function to Direct Canonical and Observable form, Cascade From and Parallel Form.	**6**
4.	**Similarity Transformation for State Space:** Definition of similarity transformation, similarity transformation to diagonal and Jordan form, similarity transformation to canonical from.	**4**
5.	**Response and Stability Issues of State Space Model:** Solve the state equation, the definition of state transition matrix, stability of control system in state space.	**6**
6.	**Controllability and Observability of State Space:** Definition of Controllability and Observaility, the method to check the determine the observability and controllability.	**6**
7.	**Pole Placement Technique:** Advantages of pole placement, design feedback controller, design state observer, design observed- stated feedback controller, design regulator system.	**6**
8.	**Controller Design:** design servo system, introduction to optimal quadratic controller	**5**

❖ **First and second chapters will be of self-reading type based on the recorded lectures and course handouts.**

Ground Rules:

1. **Attendance:**

Students are expected to attend EVERY CLASS SESSION and they are responsible for all material, announcements, schedule changes, etc., discussed in class. The university **policy regarding the attendance will be strictly adhered to**.

2. Make up Examinations

There will be **no make up exams for any exam that will be taken during the course**. exceptions to this rule is restricted only to the following cases:-

1. death of only first order relatives (father, mother, sister, or brother).
2. hospital entry (in-patient) during thr time of the examination.

Any other cases will be given the zero mark in the corresponding exam.

3. Special Notes

1. Seating plan will be as given in the attendance sheet.
2. Students creativity is welcomed and will receive additional marks

Assessments:

Exams, Quizzes, Projects, and Assignments.

Grading policy:

Assessment type	Mark	SOs
Teamwork project	30	2
Midterm Exam	30	
Final Exam	50	
Total	100	