The University of Jordan
School of Engineering
Department of Mechatronics Engineering
1st Semester – A.Y. 2019/2020

Course: Modern and Digital Control Systems – 0908454 (3 Cr. – Core Course)
Lecture Time (Mon, Wed: 12:30 – 14:00)

Instructor: Prof. Zaer S. Abo-Hammour
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Office Hours: (Mon, Wed: 9.30-11.00)

Course Website: `http://elearning.ju.edu.jo`

Catalog Data: Introduction to state Space Model, Mathematical Modeling in state Space, Decomposition of transfer function, Controllability and Observability of state Space, Pole Placement Technique, Design Control Law and Observer Introduction to Optimal Control Systems.

Prerequisites by Course: Automatic Control (0908353).

Prerequisites By Topic: Students are assumed to have sufficient knowledge pertaining to the following:
1. Signals and Systems
2. Elementary Matrix Theory and Linear Algebra.
3. Laplace transform.
4. Modeling and Simulation of Physical systems.
5. Programming with MATLAB.
6. Ordinary Differential Equations.

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: 15 Weeks, 30 lectures (75 minutes each) plus exams.

Minimum Student Material: Text book, class handouts, and an access to Personal Computer with MATLAB

Instructional Methods
1. Lecture/Problem solving sessions.
2. Case studies using MATLAB.
3. Bonus homeworks.

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 function to state space model and vice versa using decomposition method.
3. To teach students solving the time invariant state equation.
4. To teach students analysis techniques in state space model: stability, controllability and observability.
5. To teach students design techniques in state space model: Pole placements, 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.
10. Design of full state observer.

Course Topics:

	Topic Description	Hrs
1.	**Fundamentals of Matrix Algebra:** Rank of matrix, determinant of matrix, cofactors, gauss elimination, and matrix inverse.	**3**
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 function:** Convert the transfer function to Direct Canonical and Observable form, Cascade From and Parallel Form.	**9**
4.	**Similarity Transformation for State Space:** Definition of similarity transformation, similarity transformation to diagonal and Jordan form, similarity transformation to canonical from.	**6**
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.	**9**
8.	**Controller Design:** design servo system, introduction to optimal quadratic controller	**3**

Ground Rules:

- **<u>Attendance:</u>**

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.

- **<u>Make up Examinations</u>**

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.

- **<u>Special Notes</u>**

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:

Assessments	Mark	ABET SOs
Team Projects	10	2
Class Activates and HomeWorks	10	
Midterm Exam	30	
Final Exam	50	
Total	**100**	

Last Updated:

September. 2019