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

Course: **System Dynamics** - 0908351 (3 Credit hours – Core course)

Instructor: Dr. Adham Alsharkawi

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Office Hours: **Sun & Tue: 10.00-12.00; Mon & Wed: 09.30:11.00**

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

Catalog Data: Introduction to System Dynamics, Laplace Transform, Block Diagram and Signal Flow Graph, Time Domain Analysis, Modeling of Electrical Systems and Modeling of Mechanical Systems.

Prerequisites by Course:
1. Engineering Mathematics (0301202)
2. Computer Applications for Mechatronics (0908231)

Prerequisites By Topic: Students are assumed to have sufficient knowledge pertaining to the following:
1. Laplace Transform.
2. Linear Differential Equations
3. Engineering Mechanics
4. Programming with MATLAB

Textbook: System Dynamics by Katsuhiko Ogata. 4th Edition, Prentice Hall

References:
- *Control Systems Engineering, by Norman S. Nise*, 6th Edition, Johm Wiley
- *Modern Control Systems . Richard Drof and Robert Bishop*, 12th Edition, Prentice Hall.
- *Modern Control Engineering , Katsuhiko Ogata*, 5th Edition n, Prentice Hall

Schedule & Duration: 14 Weeks, 28 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. Classworks and homeworks.

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

Course Objectives: This course provides the students with a general overview of the dynamical behaviour of translational mechanical systems and electrical systems. Heavy reliance will be placed on the use of Matlab and Simulink to reinforce student understanding.

Course Learning Outcomes and Relation to ABET Student Outcomes:

Upon successful completion of this course, a student should:

1. Understand the concept of dynamical systems and their classifications. [-]
2. Introduce the Mathematical Modeling process and its main activities. [-]
3. Know the motivations of teaching Mathematical Modeling to engineering students. [-]
4. Apply and use the Laplace transform and the inverse Laplace transform to functions. [-]
5. Solve linear ordinary differential equations using Laplace transform method. [-]
6. Be familiar with partial fraction expansion. [-]
7. Understand the block diagram representation of dynamical systems. [-]
8. Introduce the concept of transfer functions for linear dynamical systems. [-]
9. Use and apply the block diagram reduction technique. [-]
10. Use the signal flow graphs for representation of dynamical systems. [-]
11. Apply and use the Mason's Gain formula to determine the transfer function of dynamical systems. [-]
12. Construct the state diagrams from differential equations. [-]
13. Obtain the state space representation of linear dynamical systems. [-]
14. Find the transient and the steady state response of linear dynamical systems [-]
15. Study the response of first and second order systems. [-]
16. Introduce the unit step specifications of linear dynamical systems. [-]
17. Derive and obtain the mathematical models of Electrical systems. [-]
18. Derive and obtain the mathematical model of mechanical systems. [-]
19. Be able to use MATLAB to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions. [6]

Course Topics:

	Topic Description	Hrs
1.	**Introduction to System Dynamics:** Define system dynamics, discuss the type of systems, discuss the mathematical modeling procedure, definition of analysis, design, synthesis, discuss the design procedure.	**4**
2	**The Laplace Transform**: Defines the Laplace transformation, gives properties of Laplace transforms, partial fraction expansion, solve differential equation using Laplace transform.	**7**
3.	**Block Diagram and Signal Flow Graph:** Study block diagrams, their components, and their underlying mathematics, obtain the transfer function of systems through block diagram manipulation and reduction, the signal flow graph, Mason's gain formula, state diagram and state space representation.	**7**
4.	**Time Domain Analysis:** Define the transient response of dynamic system, transient response of first and second order system.	**4**
5.	**Modeling of Electrical Systems**: Components of electrical system, the mathematical modeling of electrical system.	**4**
6.	**Modeling of Mechanical Systems:** Component of mechnacial system, the mathematical modeling of mecahnical system.	**4**
7.	**MATLAB Programming**	**6**

Ground Rules:

- **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.

- **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.

- **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 and Assignments.

Grading Policy:

MATLAB Programming Exam	**10 %**
Quizzes and Assignments	**10 %**
Midterm Exam	**30 %**
Final Exam	**50 %**
Total	**100 %**

Last Updated: September, 2019