# The University of Jordan
# School of Engineering

| Department | Course Name | Course Number | Semester |
|---|---|---|---|
| Mechanical Engineering | System Dynamics and Control | 0904418 | |

## 2019 Course Catalog Description

Review of complex variables and Laplace transform. Poles and element transfer function and block diagram. Modelling of physical systems, electrical, mechanical, hydraulic and pneumatic systems. Linearization of nonlinear systems. System representations. Thermal, System block diagrams and signal flow graphs. Overall transfer function, block diagrams reduction techniques and Mason's gain formula. Time response analysis and performance indices of first and second order systems. Dominate poles of high order systems. Routh - Hurwitz stability criterion. Stability analysis using root locus. Bode diagrams and Nyquist stability criterion. Introduction to analysis using state-space equations.

## Instructors

| Name | E-mail | Sec | Office Hours | | Lecture Time | |
|---|---|---|---|---|---|---|
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## Text Books

| | Text book 1 | Text book 2 |
|---|---|---|
| **Title** | Modern Control Engineering, | (Handouts) |
| **Author(s)** | K. Ogata | - |
| **Publisher, Year, Edition** | Prentice-Hall, latest Edition | |

## References

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|---|---|
| **Books** | 1. R. Dorf and Bishop, Modern Control System, Prentice Hall<br>2. B. Kuo, Automatic Control System, Wiley |
| **Journals** | |
| **Internet links** | The UoJ ELearning: elearning.ju.edu.jo |

## Prerequisites

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| **Prerequisites by topic** | ODEs, Laplace transforms, statics/dynamics, vibrations, thermodynamics, fluid, heat, circuits |
| **Prerequisites by course** | 0934411 |
| **Co-requisites by course** | - |
| **Prerequisite for** | 0904419 Control Lab., 0904422 Engineering Measurements, 0904521 Robotics, 0904537 Design of Hydraulic and Pneumatic Systems, 0904580 Modern Control Systems., 0904583 Autotronics |

## Topics Covered

| Week | Topics | Chapter in Text | Sections |
|---|---|---|---|
| 1 | Introduction: What is system dynamics? What is control? Terminologies, objectives of for using controllers. Open and closed loop concepts | Chapter1 | |
| 2 | Dynamical System Modeling: First Order system, System Response<br>Applications: Tank Level, Laplace Transform overview | Chapter 1 | |
| 3-4 | Transfer Functions, System Response Analytically and using Matlab. Laplace Inverse using PFD. Input Testing Signals, Applications: RCL circuits | Chapter 2 | |

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| 5 | Poles and Zeroes Concepts and their relation to response, S-Plane, Applications: Cruise | Chapter 2 | |
| 6-7 | First Order System Performance Measures, 2nd Order Systems Performance | Chapter 3 | |
| 8 | Thermal Systems Modeling and Applications | Chapter 4 | |
| 9-10 | Dynamical Systems Stability. Stability theorems Applications | Chapter5 | |
| 11-12 | Root Locus Analysis and Matlab based design, Introduction to P-Controllers Design | Chapter 7 | |
| 13 | PID Controller Design | Chapter8 | |
| 14 | Introduction to Frequency Domain | Chapter 9 | |
| 15 | Frequency Domain Analysis and Controllers Design | Chapter11 | |

## Mapping of Course Outcomes to ABET Student Outcomes

| SOs | Course Outcomes |
|---|---|
| 1 | 1. Master block diagram manipulation techniques<br>2. Use design approach to model, analyze and control real dynamical systems<br>3. Analyze first, second and higher order systems and time response<br>4. Analyze the stability, performance, and disturbance rejection characteristics of closed loop feedback systems<br>5. Utilize the graphical methods of Root locus/Bode plots for analysis and design of feedback loops |
| 2 | 6. Ability to model and write differential equations and transfer functions to model system dynamics using Laplace transform.<br>7. Introduction to controller design to alter system behavior using PID controllers<br>8. Mechanical (thermal and applied) system design<br>9. Use of Matlab to simulate a control system's performance |

## Evaluation

| Assessment Tools | Expected Due Date | Weight |
|---|---|---|
| **Homework** | | 5% |
| **Quizzes** | | 10% |
| **Midterm Exam** | | 25% |
| **Project** | | 10% |
| **Final Exam + Project** | | 50% |

## Contribution of Course to Meet the Professional Components

The course contributes to build the fundamental basic concepts of design and analysis of dynamical systems.

## Relationship to Student Outcomes

| SOs | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **Availability** | X | X | | | | | |

## Relationship to Mechanical Engineering Program Objectives (MEPOs)

| MEPO1 | MEPO2 | MEPO3 | MEPO4 | MEPO5 |
|---|---|---|---|---|
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## ABET Student Outcomes (SOs)

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|---|---|
| **1** | An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics |
| **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 |
| **3** | An ability to communicate effectively with a range of audiences |

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|---|---|
| **4** | An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts |
| **5** | An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives |
| **6** | An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions |
| **7** | An ability to acquire and apply new knowledge as needed, using appropriate learning strategies |

**Updated by ABET Committee, 2024**