The University of Jordan
School of Engineering
Electrical Engineering Department
2nd Semester – A.Y. 2020/2021

Course:	**Control Systems – 0933441 (3 Cr. – Required Course)**
Instructor:	Prof. Othman Alsmadi Office: E306, Telephone: 06/5355000 ext 22857, Email: othmanmk@ju.edu.jo Office Hours: Will be posted soon
Course website:	http://elearning.ju.edu.jo/
Catalog description:	Open-loop and closed-loop (feedback) control systems. Examples of feedback control systems. Review of complex variables and Laplace transform. Poles and element transfer function and block diagram. Modeling of physical systems: electrical, mechanical hydraulic and pneumatic systems. Linearization of nonlinear systems. System representations: system block diagrams and signal flow graphs. Overall transfer function, block diagrams reduction techniques and Mason's gain formula. Introduction to state-space representation. Sensitivity of open loop and closed loop control systems. Time response analysis and performance indices of first and second order systems. Dominant poles of high order systems. Routh-Hurwitz stability criterion. Steady state error coefficients. Design and effects of basic control actions and their combinations: proportional, integral and derivative. Effects of velocity feedback. Stability analysis using root locus. Bode diagrams and Nyquist stability criterion. Gain and phase margins, and obtaining transfer function using Bode diagrams. Introduction to analysis and design using state-space equations.
Prerequisites by course:	**Mt** **0331302** Engineering Math (II) (pre-requisite)
Prerequisites by topic:	Students are assumed to have a background in the following topics: • Electrical circuit analysis techniques. • Signal and system analysis, Fourier series and Fourier transform. • Calculus and differential equations.
Textbook:	**Modern Control Systems by Richard C. Dorf and Robert H. Bishop, Pearson, 13th edition, 2016.**
References:	1. Automatic Control Systems by Farid Golnaraghi and Benjamin C. Kuo, McGraw-Hill Education,10th Edition, 2017. 2. Control Systems Engineering by Norman S. Nise, 7th edition, Wiley, 2015. 3. Feedback Control of Dynamic Systems by Gene F. Franklin, J. David Powell and Abbas Emami-Naeini, 8th edition, Pearson, 2018.

4. Electrical Motor Controls for Integrated Systems by Gary Rockis and Glen A. Mazur, 5th edition, Amer Technical Pub, 2013.
5. Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering by W. Bolton, Pearson, 6th Edition, 2016.
6. Schaum's Outline of Feedback and Control Systems by Joseph Distefano III, Allen R. Stubberud and Ivan J. Williams, McGraw-Hill Education, 2nd Edition, 2013.
7. Modern Control Engineering by Katsuhiko Ogata, Pearson, 5th edition, 209.

Schedule: 16 Weeks, 42 lectures (50 minutes each) plus exams.

Course goals: The overall objective is to introduce the student to the basic principles of control system design techniques using frequency and time-domain methods.

Course learning outcomes (CLO) and relation to ABET student outcomes (SO):

Upon successful completion of this course, a student will:	**[SO]**
1. Understand how to develop differential equation models of physical systems.	**[1]**
2. Be able to write differential equation, transfer function and state space models for a given system.	**[1]**
3. Be able to find the response of dynamic systems to standard inputs.	**[1]**
4. Have knowledge of classical control system analysis techniques, including stability and performance characteristics.	**[1]**
5. Be able to design classical controllers based on Bode and root locus techniques.	**[1]**
6. Understand the frequency domain representation of systems.	**[1]**

Course topics:	**Hrs**
1. Introduction to Control Systems: Open-loop Control Systems. Closed-loop/Feedback Control Systems. Examples on the use of Feedback.	**2**
2. Mathematical Models of Systems: Differential Equations of Physical Systems. Linear Approximations. Laplace Transform. Transfer Function. Signal Flow.	**5**
3. State Variable Models: State Variable of Dynamic Systems. Signal Flow State Models. Transfer Functions from State Equations. Time Response and State Transition Matrix. Discrete Time Response.	**6**
4. Feedback Control System Characteristics: System Sensitivity. Transient Response Control. Disturbance Signal in a Feedback. Steady-State Error.	**5**
5. Performance of Feedback Control Systems: Test Input Signals. Performance of a 2nd Order System. Effect of a 3rd Pole on the 2nd Order System. Performance Index. Simplification of Linear Systems.	**6**
6. Stability of Linear Feedback Systems: Concept of Stability. Routh-Hurwitz Criterion. Stability of State Variable System.	**4**
7. Root Locus Method: Concept of Root Locus. Root Locus Procedure. Parameter Design by Root Locus Method.	**5**
8. Frequency Response Method: Frequency Response Plots. Bode Diagrams. Minimum Phase Transfer Function.	**5**

9.	Design of Control System: PD, PI, and PID Controller. Phase-Lead, Phase-Lag, and Lead-Lag Controller. State Feedback Control.	**4**

Ground rules: Attendance is required and highly encouraged. To that end, attendance will be taken every lecture. Eating and drinking are not allowed during class, and cell phones must be set to silent mode. All exams (including the final exam) should be considered cumulative. Exams are closed book. No scratch paper is allowed. You will be held responsible for all reading material assigned, even if it is not explicitly covered in lecture notes.

Assessment & grading policy:

Assignments	0%	Quizzes	0%
First Exam	30%	Projects	0%
Midterm Exam	30%	Lab Reports	0%
Final Exam	40%	Presentation	0%
		Total	**100%**

Last Revised: March 2021