German Jordanian University
School of Applied Medical Sciences
Department of Biomedical Engineering

BM3288: Physiological Modeling and Control Systems Lab

Course Catalog
1 Credit hour (3 hrs laboratory) Introduce the concepts learned in the course through practical experiments using software application such as Matlab and Simulink. Topics covered include basics of different mathematical concepts (complex variables, Laplace transform, transfer function, zeros/ poles, and frequency domain plots), lumped/ distributed models of different physiological systems, control systems analysis and modeling in time domain and frequency domain, performance of first order, second order and higher order systems, block diagram, reduction of multiple subsystems, and root locus.

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Evaluation		
Assessment Tool	**Weight**	**Expected Due Date**
Lab Reports	30%	Each report is due at the beginning of the next lab session
Quizzes	10%	At any time in any lab session
Midterm Exam	20%	Assigned at the beginning of each semester
Final Exam	40%	Assigned at the beginning of each semester
Total	100%	After completing the final exam

Topics Covered		
Week	**Experiment No**	**Topic**
1	----------	Lab Introduction
2	Experiment 1	Introduction to MATLAB
3	Experiment 2	Mathematical Foundation
4	Experiment 3	Introduction to Simulink
5	Experiment 4	System Modeling in Time Domain
6	Experiment 5	System Modeling in Frequency Domain
7	**Exam**	**Midterm Exam**
8	Experiment 6	Converting between transfer function an differential equation
9	Experiment 7	Performance of first order and second order systems
10	Experiment 8	System Response with zeros and additional poles
11	Experiment 9	Reduction of multiple subsystems
12	Experiment 10	Root Locus
13	**Exam**	**Final Exam**

Objectives and Outcomes	
Objectives	**Outcomes**
1. Understand some basics of different mathematical concepts.	1.1. Find the Laplace transforms using MATLB. 1.2. Find different representations of Transfer Function using MATLAB. 1.3. Analyze Poles and Zeros with MATLAB. 1.4. Use MATLAB to draw different frequency domain plots (Polar, Bode, and Mag-Phase plots).
2. Use graphical user interface diagrams in system modeling for the purpose of design and analysis of control systems.	2.1. Introduction to SIMULINK. 2.2. Build different control models using MATLAB/ SIMULINK.
3. Understand the modeling in time domain.	3.1. Develop appropriate mathematical models of different systems (mechanical, electrical, etc...) by deriving their differential equations. 3.2. Use MATLAB/SIMULINK to solve the previously derived models.
4. Understand the modeling in frequency domain.	4.1. Use transfer function in frequency domain to develop appropriate mathematical models of different systems (mechanical, electrical, etc...). 4.2. Use MATLAB/SIMULINK to solve the previously derived models.
5. Understand the performance characteristics of first and second order systems.	5.1. Design first order system using MATLAB/ SIMULINK and analyze its transient response. 5.2. Design second order system using MATLAB/ SIMULINK and analyze its transient response.

	5.3. Find the settling time, peak time, percent overshoot, and rise time for an underdamped second-order system using MATLAB/SIMULINK. 5.4. Analyze the performance characteristics of higher-order systems and systems with zeros and approximate their response as first- or second-order systems.
6. Develop techniques to reduce multiple subsystems to a single transfer function.	6.1. Reduce a block diagram of multiple subsystems to a single block representing the transfer function from input to output. 6.2. Analyze and design the transient response for a system consisting of multiple subsystems Use MATLAB/ SIMULINK to.
7. Develop graphical method for sketching the locus of roots in the s-plane.	7.1. Define a root locus and state its properties. 7.2. Sketch a root locus by hand and using MATLAB. 7.3. Find the coordinates of points on the root locus and their associated gains using MATLAB.

Lab Report Requirements	
Report section	**Description**
Introduction	This section should provide the context and motivation for the experiment, briefly explain relevant theory in sufficient detail, introduce any relevant laws, equations or theorems, and clearly state the aim or research question that the experiment is designed to address. You should try to write it in your own words, rather than paraphrasing the lab manual (but if you have to, be sure to include the appropriate references). It's always a good idea to read the entire experiment in the manual before you begin your introduction.
Procedure	This section must include a description of the procedure followed. It should not simply be a re-statement of the procedure section of this manual. You should interpret the procedure section and develop your own step-by step method.
Results	In this section, you present the main data collected during your experiment. Each key measurement needs to be reported appropriately. Data are often presented in graphs, figures or tables. These need to be labelled appropriately to clearly indicate what is shown. Tables should be labelled numerically above the table as Table 1, Table 2, etc. Everything else (graphs, images, diagrams etc.) is labelled numerically below the figure as Figure 1, Figure 2, etc.
Discussion	This section should demonstrate how will you understand what happened in the experiment. You should identify and comment on any trends you have observed, compare the experimental results with any predictions, identify how any sources of error might impact on the interpretation of your results, suggest explanations for unexpected results, and where appropriate, suggest how the experiment could have been improved.

Conclusion	This section should provide a message summing up what has been learned from the experiment such as: briefly restate the purpose of the experiment (the question it was seeking to answer), identify the main findings (answer to the research question), note the main limitations that are relevant to the interpretation of the results, summarize what the experiment has contributed to your understanding of the problem.
References	List all sources that you have referred to in the body of your report. These can include references to accepted literature values or equations you use in your calculations. You should use proper referencing techniques.
Appendix	It contains material that is too detailed to include in the main report, such as tables of raw data, software code or detailed calculations.
Formatting	Font type: Times New Roman. Font size: 12 for the main paragraphs and 14 bold for the titles. Justify the paragraphs. Numbering. Figures should be inserted in the center of the page and they should be labeled below the figure with font size 10. Tables should be inserted in the center of the page and they should be labeled above the table with font size 10.

Policy	
Attendance	Attendance will be checked at the beginning of each lab session. University regulations will be strictly followed for students exceeding the maximum number of absences (20%).
Reports	Each student must hand his\her own separate report. Laboratory reports are due to ***one week after*** the experiment was carried out and it will be collected at the beginning of each laboratory. If any report is not submitted to the TA by the deadline, it will be judged as "**LATE**".
Examinations	The midterm and the final exams are closed book tests. Students who are not able to attend an examination (medical or another emergency) must notify the instructor. Make up tests require a ***valid university*** excuse.
Student Conduct	It is the responsibility of each student to adhere to the principles of academic integrity. Academic integrity means that a student is honest with him/herself, fellow students, instructors, and the University in matters concerning his or her educational endeavors. Cheating will not be tolerated in at all. University regulations will be pursued and enforced on any cheating process.