Jordan University of Science and Technology

Faculty of Engineering

Biomedical Engineering Department

BME433 Physiological Modeling And Control Systems Lab - JNQF Level: 6

First Semester 2023-2024

Course Catalog
1 Credit Hours. A lab providing modeling and analysis computerized tools for the study of physiological control systems. The lab is an active learning environment to reinforce selected engineering principles of physiology, emphasizing a quantitative model-oriented approach. Topics include: Systems and modeling, linear systems analysis and Control systems design.

Text Book	
Title	Lab tutorial.
Author(s)	Enas Abdulhay
Edition	1st Edition
Short Name	REF1
Other Information	

Instructor	
Name	**Prof. ENAS ABDUL HAY**
Office Location	C5 L1
Office Hours	Sun : 12:45 - 13:30 Mon : 11:30 - 14:30 Tue : 12:00 - 12:15 Wed : 11:30 - 13:30
Email	ewabdulhay@just.edu.jo

Class Schedule & Room

Section 1:
Lecture Time: Sun : 14:30 - 17:30
Room: LAB

Section 2:
Lecture Time: Mon : 14:30 - 17:30
Room: LAB

Section 3:
Lecture Time: Mon : 11:30 - 14:30
Room: LAB

Section 4:
Lecture Time: Thu : 13:30 - 16:30
Room: LAB

Prerequisites		
Line Number	**Course Name**	**Prerequisite Type**
282300	BME230 Tools For Biomedical Engineers	Prerequisite / Study
284310	BME431 Physiological Modeling And Control Systems	Pre./Con.

Tentative List of Topics Covered		
Weeks	**Topic**	**References**
Week 1	Syllabus	
Week 2	Introduction	
Week 3	Introduction to the modeling tools of Berkeley Madonna and SIMULINK	
Week 4	Respiratory mechanics simulation (Part 1: Breathing Pattern Generator)	
Week 5	Respiratory mechanics simulation (Part 2: Artificial Mechanical Ventilation)	
Week 6	Respiratory mechanics simulation (Part 3: Respiratory pathology)	
Week 7	Cardiovascular mechanics simulation (Part 1: Cardiac wave generator)	
Week 8	Free lab (Revision)	
Week 9	MID Exam	
Week 10	Cardiovascular mechanics simulation (Part 2: Cardiopulmonary interactions)	
Week 11	Model of Glucose/Insulin balance	
Week 12	Steady state and dynamic analysis	
Week 13	State-Space model (Blood doping)	

Week 14	Free lab (Revision)	
Week 15	Final Exam	

Mapping of Course Outcomes to Program Outcomes and NQF Outcomes	Course Outcome Weight (Out of 100%)	Assessment method
Appreciate the role of physiological Modeling. [4,9]: 1.1- Recognize the different goals of physiological modeling. 1.2- Appreciate the role of physiological and human ? machine models in medicine, industry and marketing. 1.3- Understand the basic strengths and limitations of quantitative modeling. 1.4- Appreciate the dynamic nature of the models. [50SO2, 50SO4] [1L6K1, 1L6K2, 1L6C4, 1L6C5]	15%	
To integrate previously learned concepts into a rigorous investigation of the quantitative foundations of physiology.(1,7, 2,4,6,8): 2.1- Read, understand, and apply knowledge gained from scientific literature in math, physical science, biology, physiology, computer science, electric networks, and engineering. 2.2- Make explicit mathematical, electrical and mechanical engineering connections among previously learned course materials. 2.3- Explicitly show that many of the underlying physiological concepts actually stem from similar engineering and mathematical ideas. [20SO1, 20SO2, 20SO4, 20SO6, 20SO7] [1L6K1, 1L6K2, 1L6S3, 1L6C3, 1L6C4, 1L6C5]	15%	
To understand complex physiological systems by design and model-oriented explorations. (1,6,2,5,8,9): 3.1- Spans multiple systems from sensory to neural to muscular, and from one system to the next as well as comprehend inter-connections. 3.2 ? Represent a physiological component by another non-physiological one. 3.3 ? Manipulate the physiological parameters and analyse the corresponding results by curve fitting and sensitivity analysis. 3.4- Design physiological systems and conduct computerized model-oriented experiments. [25SO1, 25SO2, 25SO5, 25SO6] [1L6S1, 1L6S3, 1L6C1, 1L6C3, 1L6C4, 1L6C5]	14%	
Apply computerized simulation tools using an instruction manual. (1,2,6,8): 4.1- Master SIMULINK applications of physiological simulation. 4.2- Master Berkeley Madonna applications of physiological simulation. [34SO1, 33SO2, 33SO6] [1L6S1, 1L6S2, 1L6S3, 1L6C1, 1L6C2]	14%	
Understand the variety in the utilities of the simulation tools. (1,2,6,8): 5.1 - Understand the block diagram concept of SIMULINK and blocks interactions (graphical interface). 5.2- Understand the linear programing concept of Berkeley Madonna and subcodes interactions. [34SO1, 33SO2, 33SO6] [1L6S3, 1L6C1, 1L6C2, 1L6C3]	14%	
To encourage a more practical approach rather than a purely didactic approach.(1,2,6,8): 6.1 - Observe and understand how differential equations move through time so that the equations are transformed from their abstract mathematical form to a more concrete engineering form. 6.2 - Observe and understand physiological outputs of computerized linear analysis in time and Laplace domain. 6.3- Observe and understand effect of parameters and initial conditions values on physiological systems and transfer functions. 6.4- Observe and understand effect of physiological feedback. [34SO1, 33SO2, 34SO6] [1L6S1, 1L6S2, 1L6S3, 1L6C1, 1L6C2, 1L6C3]	14%	

To build the numerical skills for evaluating existing biological models and developing new models based on experimental and computational experiment. (1,6,8,9): 7.1- Use the programmed integrators methods in SIMULINK and Berkelry Madonna such as RK2, RK4 and stiff and analyse the results. 7.2- Predict physiological output and identify parameters based on computerised batch runs. 7.3- Process, plot and manipulate vectors of physiological variables by MATLAB, SIMULINK and Berkeley Madonna. 7.4- Apply computerized numerical analysis of steady-state and dynamical behavior. [50SO1, 50SO6] [1L6K1, 1L6S1, 1L6S3, 1L6C2, 1L6C3, 1L6C4, 1L6C5]	14%	

Relationship to Program Student Outcomes (Out of 100%)						
SO1	SO2	SO3	SO4	SO5	SO6	SO7
27.73	27.81		10.5	3.5	27.45	3

Relationship to NQF Outcomes (Out of 100%)									
L6K1	L6K2	L6S1	L6S2	L6S3	L6C1	L6C2	L6C3	L6C4	L6C5
8.25	6.25	9.47	5.13	15.47	10.97	10.63	12.67	10.58	10.58

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