Jordan University of Science and Technology
Faculty of Engineering
Biomedical Engineering Department

BME 431 Physiological Modeling and Control Systems

Course Catalogue

3 Credit hours (3 h lectures). Design of system elements, case studies of physiological system examples, design of subsystems, Dynamic modeling and control of selected biological and physiological processes. Lumped / distributed/ compartmental models, particular and complementary solution, analytical and numerical solutions, Respiratory/ Cardiovascular/Muscular / gas exchange/ transport Modeling, transient response, Laplace, time and frequency responses and analysis, open and closed-loop systems, negative feedback, Forward feedback, impulse and step response of physiological control systems and transfer function, state-space design and control.

Textbooks

Mathematical and Computer Modeling of physiological systems. Vincent C.Rideout. Prentice Hall (1996)
Physiological Control Systems - Analysis, Simulation, and Estimation. Michael C.K Khoo. IEEE Press/John Wiley (2000)

References

Books

Quantitative Human Physiology: An Introduction . Joseph J Feher. Academic Press Series in Biomedical Engineering (2012)
Modelling Dynamic Biological Systems. Bruce Hannon & Matthias Ruth (1997)
A First Course in Mathematical Modeling. Franck R. Giordano, William P. Fox, Steven B. Horton & Maurice D. Weir (2009)
Mathematical Modeling in The Life Sciences. Paul Doucet & Peter B. Sloep (1992)
Modeling Differential Equation in Biology. Clifford Henry Taubes (2008)
Modeling and Simulating in Medicine and the life sciences. Franck C.Hoppensteadt and charles S.Peskin. Springer (2002)
Introduction to Biomedical Engineering. John ENderle. Elsevier. (1999)

Journals

Annals of Biomedical Engineering
Journal of Medical Engineering and Technology
Computer Programs and Methods in Medicine
Medical Engineering and Physics
IEEE EMBS Book Series
IEEE Transactions on Biomedical Engineering
IEEE Transactions on Information Technology in Biomedicine

Internet links

http://www.bmes.org/
http://arjournals.annualreviews.org/loi/bioeng?cookieSet=1
http://www.aami.org/publications/BIT/index.html
http://www.biophysj.org/
http://emb-magazine.bme.uconn.edu/
http://emb-magazine.bme.uconn.edu/
http://www.iee.org/Publish/Journals/ProfJourn/MBEC/
http://spie.org/app/Publications/index.cfm?fuseaction=journals&type=jbo
http://www.biomedical-engineering-online.com/start.asp

Instructor

Instructor Dr. Enas Abdulhay E-mail: ewabdulhay@just.edu.jo

Prerequisites

Prerequisites by topic	Signals, computer tools
Prerequisites by course	BME 230, BME 321
Co-requisites by course	BME 433 (can be taken as co.)

Prerequisite for BME 562 (Control and Communication in the Nervous System)
BME 564 (Bioinformatics)

Topics Covered

Topics	Chapters in Text
Mathematical Modeling	**Chapter 2 (Text 2)**
Static analysis of physiological systems	**Chapter 3 (Text 2)**
Dynamic analysis of physiological systems	**Chapter 4 (Text 2)**
Cardiovascular modeling.	**Chapter 4 (Text 1)**
Respiratory system modeling	**Chapter 5 (Text 1) and notes**
Mass Transport :Compartment Modeling	**Chapter 2-3 (Text 1) and notes**
Multiple Modeling	**Chapter 6 (Text 1) and notes**

Evaluation

Assessment Tool	**Expected Due Date**	**Weight**
Homework & Quizzes	One week after homework problems are assigned	10%
First Exam	According to the department schedule	25 %
Second Exam	According to the department schedule	25 %
Final Exam	According to the University final examination schedule	40 %

Objectives and Outcomes[1]

Objectives	Outcomes
To provide the students with a guide to mathematical modeling techniques [1,2]	Learn how to describe systems using Laplace transform and differential equations Solving the mathematical models using different numerical and analytical method. Understand state-space and transfer function Understand linear and nonlinear, lumped and distributed models Understand generalized models
Understand how to build, analyze and develop models for physiological systems [1,2,8,7,9]	Develop and build engineering models that describe pressure flow systems such as cardiovascular and respiratory function Develop and build engineering models that describe chemical ventilation, Glucose balance, muscle reflex.
Understand the simulation and control of selected physiological processes and biological systems [1,2,5,8]	Simulate Respiratory, cardiovascular systems and Mass-Transport compartement modeling Understand control systems (types, feedback, stability, transient and steady state, Impulse and step responses)

Contribution of Course to Meeting the Professional Component

The course contributes to building the fundamental basic concepts, applications, and design of physiological systems in Biomedical Engineering.

Relationship to Program Outcomes (%)

1	2	3	4	5	6	7	8	9
31	24		2	2		5	34	2

Relationship to Biomedical Engineering Program Objectives

PEO1	PEO2	PEO3	PEO 4
√			√

Prepared by: Dr. Enas Abdulhay
Last Modified: October 3rd, 2019

[1] Lower-case letters in brackets refer to the Program outcomes