BME 355 Assignment 3: Cardiovascular Modelling

Due 11:59pm, April 2, 2021.

For this assignment, you can discuss your approach with your classmates, but you must perform all the technical work and write the report **independently**. Submit a PDF document (not a Word document) that includes answers to questions, and requested plots. Also submit your Python code in a zip file. You must use the partially completed code on Learn.

This assignment is based on a model from Ferreira, A., Chen, S., Simaan, M. A., Boston, J. R., & Antaki, J. F. (2005). A nonlinear state-space model of a combined cardiovascular system and a rotary pump. *Proceedings of the 44th IEEE Conference on Decision and Control, and the European Control Conference, CDC-ECC '05*, *2005*, 897–902.

1) Complete the unfinished sections of the code (circulation.py) based on the Ferreira et al. paper and the lecture slides. The Circulation constructor requires several arguments. Use values from the paper, $E_{max} = 2.0$, $E_{min} = 0.06$, and heart rate 75 beats/min.
2) Simulate the model for five seconds. Plot the atrial pressure, ventricular pressure, arterial pressure (i.e. x_3), and **the aortic pressure just outside the aortic valve** (i.e. between D2 and R4). Start the simulation with all the blood in the atrium, so that the initial ventricular blood volume is the slack volume.
3) Perform and document suitable verification and validation activities. This part of the assignment is entirely open-ended. You should spend 2-4 hours on this question.