

## 1810 Assignment to accompany microfluidic lab

Fall 2011

Show all work, including circuit simplifications. Also, identify which laws you are using.

1. Calculate the hydraulic resistance of every channel in your microfluidic device. Then find the total hydraulic resistance of your device. Then find the pressure drop across the entire device. Then find the pressure drop across each channel and the average linear flow velocity (not volumetric flow rate) in each channel of your microvascular device **before blockage**. Assume your syringe pump is set to 2uL/min (this is the amount of flow through your device per minute). This flow rate can be set to not depend on the resistance of the network (the syringe pump can be seen as a constant current source). Then use the MATLAB program to find the pressure drop across each channel and the average flow velocity in each channel of your microvascular device. Compare MATLAB values with the ones you calculated by hand.

2. a. Calculate the total resistance of your blocked device with **channel 2 blocked**. Use the MATLAB program to find the pressure drop across each channel and the average linear flow velocity in each channel of your microvascular device. Assume your syringe pump is set to 2uL/min (this is the amount of flow through your device per minute).

b. What does it mean if MATLAB returns a negative value for a flow rate?

c. What can you conclude about what happens to blood pressure in a person with atherosclerosis?

3. Your syringe pump has a minimum flow rate of 10uL/hr. But you need to send exactly 2uL/hr through your microfluidic device. Design a workaround solution to use your existing pump and get the necessary flow rate through your device. Note: you do not need to know the specifics of this hypothetical device in order to solve this problem: you can treat it as a "black box."

4. Using the themes of integration and miniaturization discussed in lecture, and your imagination, describe three devices or systems that you would like to implement at the microscale.

5. The membraneless H-filter was one of the microfluidic devices discussed in lecture. Using the H-filter, design a system to filter mammalian cells from bacteria. In this problem, you want to obtain a sample at the output from your system that is at least 99.9% pure mammalian cells (meaning the sample contains no more than .1% bacteria). You are not interested in collecting a sample of pure bacteria. You can assume that upon passing a mixed solution (containing both mammalian cells and bacteria) through an H-filter, the bacteria, being much smaller and consequently possessing a greater diffusion coefficient, diffuse across the channel and adopt a uniform distribution profile (equal concentration across the channel) before reaching the outlet of

the H-filter. You can also assume that the mammalian cells, being much larger than the bacteria, possess a much smaller diffusion coefficient and remain confined to the half of the H-filter to which they were introduced. You can assume that a negligible number of mammalian cells will have a chance to diffuse to the other half of the H-filter before reaching the outlet of the H-filter.

Please provide a drawing of your system.