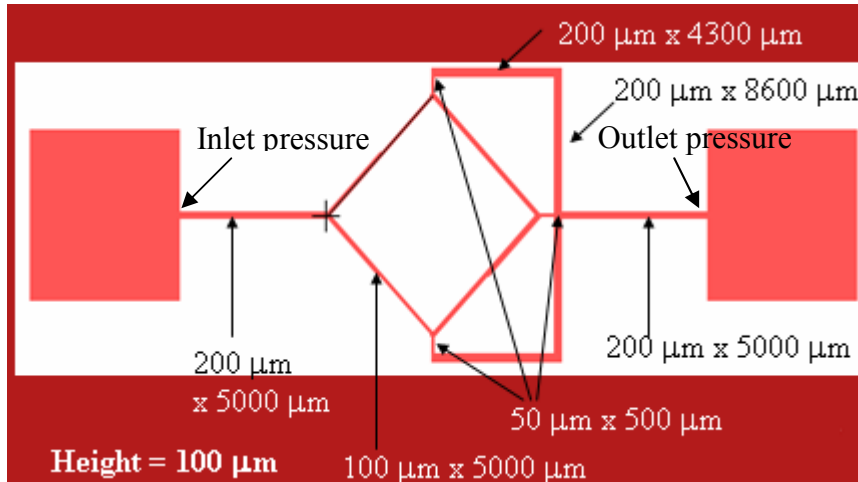


MATLAB Tutorial for Blood Flow Calculations

ECE1810 – Flow in a Microchip

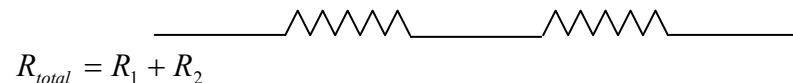
The “flow_network_update.m” MATLAB code will calculate the individual flow rates in each of the channels on your microchip. You will have to input: (1) inlet pressure, (2) outlet pressure, and the (3) diameter and (4) length of each vessel. You already have (3) and (4). How will you get (1) and (2)? (2) Outlet pressure, you can figure out, because your fluid flowed into an open waste container—what was the ambient pressure in that open waste container? (1) Inlet Pressure, you can figure out based on your flow rate and the total resistance of your channel network.



As you learned in lecture: $\Delta P = \frac{12\mu QL}{wh^3}$ for a single rectangular closed channel.

$\frac{12\mu L}{wh^3}$ is your channel resistance R . In general, $\Delta P = QR$ or $Q = \frac{\Delta P}{R}$ through any system of channels, whether you're talking about a single channels or a whole channel network. For a channel network, $\Delta P = QR_{eff}$ where R_{eff} is the effective resistance of the whole network, calculated using the individual resistances of each channel. Using Kirchoff's Laws, we come up with how to calculate R_{eff} in a channel network:

Two resistors in series:



Two resistors in parallel:



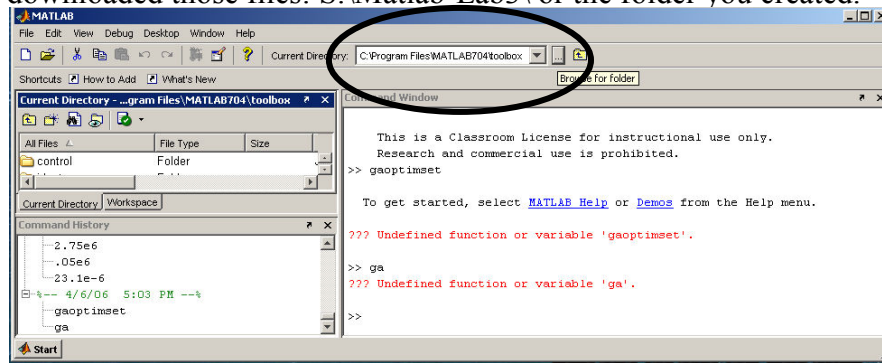
$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2}$$

Using these rules, you can calculate the total resistance of the channel network. Then, using R_{total} , $\Delta P = QR$, and your flow rate, you can determine ΔP and therefore your **inlet pressure**.

Now you can use MATLAB to calculate flow rates and pressure drops.

1. Open Matlab 7.0.4 from the Start Menu

- You need to change your Working Directory to the same folder in which you downloaded those files: S:\Matlab-Lab3\ or the folder you created.



2. Run the code to determine calculated blood flow rates and pressure drops using example data:

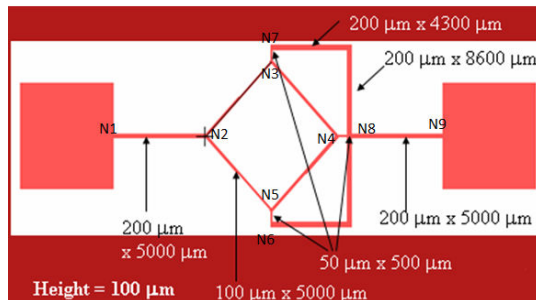
- In the Matlab Command Window, type “Flow_network_update”
- This program will calculate the flow rates in a given network of vessels that *you* specify.
 - a. The program will prompt “Enter the name of the data set you want to use and include .txt extension.” Enter “data.txt”.
 - b. Next it will ask you for information about the nodes, elements, pressures, and viscosity in your channel network. Enter accordingly.

MATLAB wants pressures in units of Pascals:

$$1 \text{ Pa} = 1 \text{ kg/m-s}^2 = 1 \text{ kg/mm-s}^2$$

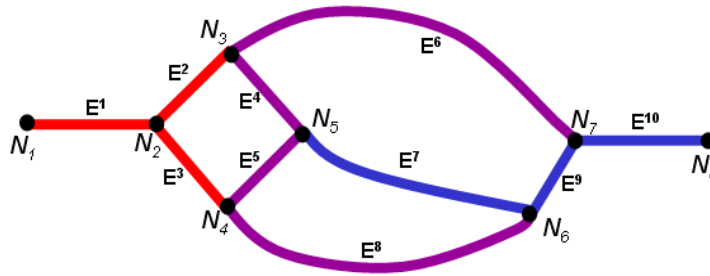
Viscosity for your fluid is .89cP (centipoise). Enter .89

MATLAB is expecting a value in units of centipoise.



- c. Next, you will be asked “Enter filename to save pressure data to” and “Enter filename to save flow data to.” Enter file names of your choice.
- d. Next, it will display the pressures at each of your nodes. Using this, you can calculate pressure drops in each channel. It will also display flow rates in each

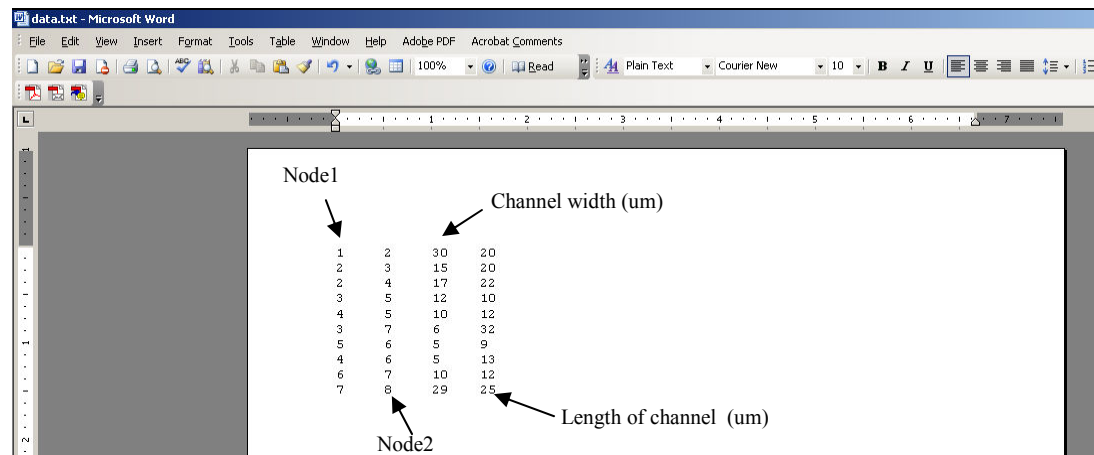
element. You will find copies of your pressure and flow data files in the S:\Matlab-Lab3\ folder or whatever you specified as your Working Directory.



Here is a graphical version of the example channel data specified in data.txt.

3. Prepare your own data file

- Label your channel network in the same manner as the example network in step 4. Each intersection between channels is called a “node.” Label each node a number in your microchip channel network, where the first node is at the inlet pressure, and the last node is at the outlet pressure. Now, each channel can be specified as an “element,” and specified by indices—(node1, node2)—node1 at one end of the element, and node2 as the other end. Note the number of “elements” that you have.
- Create a text file in Wordpad or Word, and fill in the data in the following format:



- Save the text file “Name_of_you_choice.txt” into your Working Directory folder.
- In the MATLAB Command Window, type “Flow_network_model”
- Read/Follow steps (a) through (d) under Step 4 to run the code, but when it asks for your data file name, type in the filename for your own data file, including the “.txt” extension.
- You need to enter the Inlet pressure you calculated using the resistance formula for **your velocity** in Lab 3.

NOTE: You can use this code to confirm that you properly calculated your resistance!