Microfluidics and BioMEMS, Design task 3. 3.2.2021

Design task instructions:

Return as a single pdf document to the return box in my courses. **Maximum length of the answer is 1 page.** Formulae written with word or other text editor are preferred but I will accept hand written formulas and answers. If you do not have a scanner, then if you can take a good photograph and make a good looking pdf out of that then that is acceptable.

This task is worth 4 points on the course. Grading will be based on the following: 1pt the answer is correct, 1pt the presentation is clear, 1pt the reasoning and justification is clear and 1pt optimization of the design and other merits.

The main answer that you are returning is the design of a microfluidic chip that fits the criteria given in the task. The design means the dimensions of the microfluidic channel, and its architecture.

There is no single correct solution. You will get good points (about 3pt) if your design roughly satisfies the criteria and you have presented and justified the design well. You will get perfect points (4 pt) if I get the understanding that your design is close to optimal for the given task. **It is possible that satisfying all criteria given is impossible**, i.e. it is not possible to fulfill all of them. In that case, make your own best compromise and make it clear you have understood that this is the case.

In addition to just given the dimensions, add your calculations and reasoning to prove to me that your design is correct and that you have thought about the problem correctly. For example, if the instructions call that the maximum pressure can be 50 kPa, then have a pressure calculation to show that in your system the pressure is only 20 kPa, hence satisfies that criteria.

Task 3: (with bit of roleplay)

The deadline is 10.2.2021 10:00 (right before next weeks session).

The briefing:

Hello! I am a graduate student working in the field of pharmaceutical chemistry! I have heard that you are an expert in designing microfluidic chips and you could maybe help me in my research.

In my research I need to test the toxicity of certain drug molecules every day in the lab. However, the problem is that to get reliable dose response curves, each drug needs to be tested in many different concentrations. Doing these dilutions takes a lot of time and multiple pipetting steps also introduces some inaccuracy and room for human error.

A typical dose response test that I do is with seven different concentrations of 10 µM, 5µM, 1µM, 500nM, 100nM, 50nM and 1nM. I would like roughly equal amounts (in µL) of each dilution, but that is not a strict requirement.

So my question is, can you design for me a microfluidic device that would give me those concentrations starting from just a single concentration of the drug and pure solvent? In the lab we have several pumps available, so that is no problem.

Instructions:

Design a microfluidic concentration generator / dilution generator. For exact concentrations that this briefing requires, it is best to use full mixing and then combining volume ratios of laminar flows.

In this task, you do NOT need to design channel dimensions. Instead, you should design the architecture of the chip, and at each intersection **you should just point out how much of the volumetric flow rate goes to which channel**.

(It is assumed here that you already know how to do this by designing the channel dimensions: the volumetric flow rates are inversely proportional to the hydraulic resistances of the channel elements, taking into account the whole chip.)

See my example below of showing how to design a chip that produces from 10 µM two concentrations, 10 µM and 1µM.

Your design should be presented as a drawing showing the chip architecture, the inlets (2 or more) and the outlets (probably 7 outlets 1 for each concentration, but you can have dummy outlets as well). Use simple lines for the channels and circles for the inlets and outlets

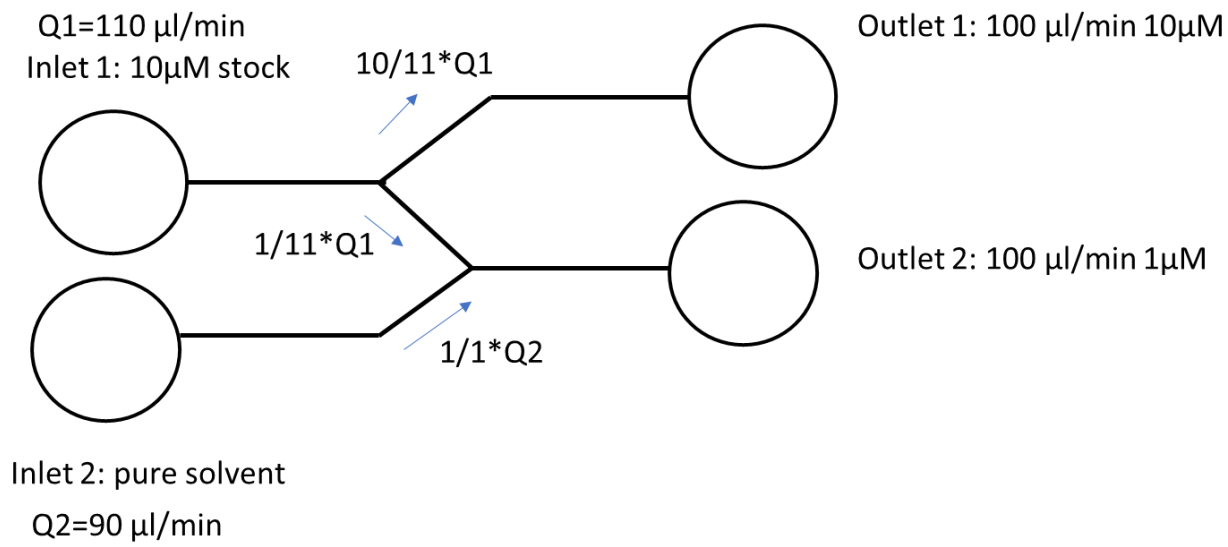

Figure 1: Example design that uses two inlets to make two dilutions. Make your drawing in a similar fashion. I used powerpoint, you can use whatever, including drawing by pen on paper and scanning/photographing.