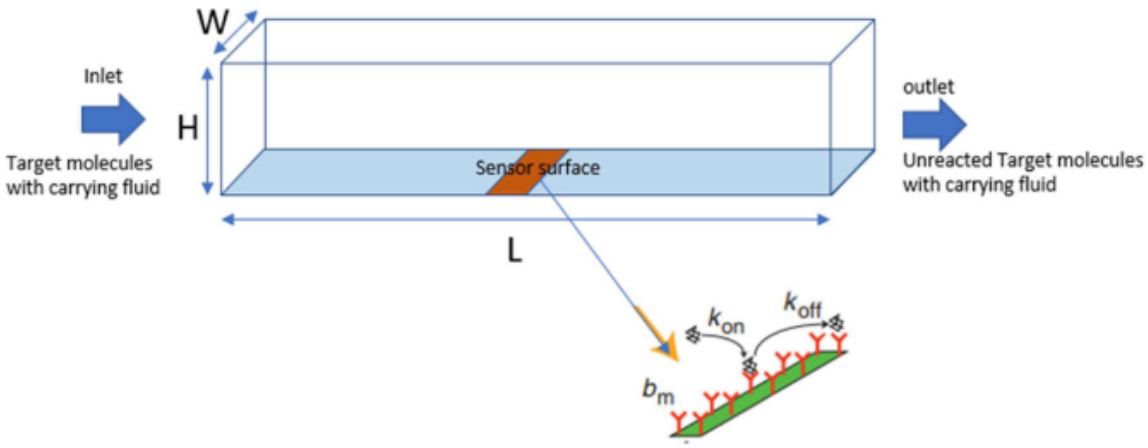
CODE THE PROBLEM
ROUND-1

Point-of-care diagnosis has attracted a lot of attention towards the fabrication of microfluidics-based miniaturized devices, having huge applications in various fields such as health care, environmental monitoring, food quality control, drug discovery, and forensics. All such microfluidic devices are mainly based on the principle of chemical reaction based sensing.

A general 2-dimensional schematic of biosensor is shown below.



The general mechanism is as follows: target molecules (which need to be sensed) enter an inlet with carrying fluid and pass over the sensor surface located at the bottom plate. The sensor surface contains immobilized receptor molecules (shown as orange) which can sense the target molecules due to target-receptor complex formation via chemical reaction. Unreacted target molecules are carried forward and leave the channel at the outlet.

Consider the following information for such biosensor:

Assume fully developed unidirectional uniform flow throughout the channel (no velocity variation).

Inlet volumetric flow rate of fluid containing target molecules: 0.5 µL/min.

L= 1000µm, H= 50 µm, W=50µm

Molecular diffusivity of target molecules, **D** = 10^{-9} m^2/s

Concentration of target molecules at inlet ($\mathbf{C_0}$): 10^{-5} $mole/m^3$

Surface density of immobilized receptor molecules ($\mathbf{b_m}$): 10^{-7} $mole/m^2$

Surface reaction details:

$$\frac{\partial b}{\partial t} = k_{on} c_s (b_m - b) - k_{off} b,$$

b = instantaneous surface density of target-receptor complex
Cs in the reaction is the target concentration just above the sensor surface, which is a function of time.

Forward rate constant, $\mathbf{b_{on}}$ = $10^5 m^3/mol.s$, backward rate constant, $\mathbf{k_{off}}$= $0.1 s^{-1}$

Write a code which should render the following:

Surface concentration (mol/ m^2) on sensor as a function of time. (t = 0 to 10000s). Provide plot for the same.

(Hint: solve for 2-dimensional domain, along the width W assume all physical quantities are uniform).

You will be assessed on the basis on your approach not the final solution.