

Name: _____

Roll No.: _____

BM2053 Mathematical Models & Systems Biology

Lab Exam

Duration: 90 mins

Total marks: 50

1. Write the answers clearly and within the space provided. Do not use a pencil to write answers.
2. You can use any resource, including the Internet. You are not allowed to talk to each other or anyone else (except invigilators in case of any doubt) either orally or electronically.
3. You cannot use your phone during the exam.

Parameter values Use only the following values wherever you need to solve the problems in this exam

- Hill's function parameters $K = 2$ mM and $n = 4$.
- Protein synthesis and degradation rates $\alpha = 5$ mM/s, $\beta = 1$ /s
- At the nodes with two or more incoming arrows, you have to combine the signals using AND logic.

1. Network 1

$$\begin{aligned}\dot{x} &= \alpha \frac{k^4}{k^4 + x^4} \times \frac{k^4}{k^4 + y^4} - \beta x \\ \dot{y} &= \alpha \frac{z^4}{k^4 + z^4} \times \frac{k^4}{k^4 + x^4} - \beta y \\ \dot{z} &= \alpha \frac{k^4}{k^4 + z^4} \times \frac{x^4}{k^4 + x^4} - \beta z\end{aligned}$$

2. Network 2

$$\begin{aligned}\dot{x} &= \alpha \frac{k^4}{k^4 + x^4} \times \frac{y^4}{k^4 + y^4} - \beta x \\ \dot{y} &= \alpha \frac{z^4}{k^4 + z^4} \times \frac{k^4}{k^4 + x^4} - \beta y \\ \dot{z} &= \alpha \frac{k^4}{k^4 + z^4} \times \frac{x^4}{k^4 + x^4} - \beta z\end{aligned}$$

3. Network 3

$$\begin{aligned}\dot{x} &= \alpha \frac{k^4}{k^4 + x^4} \times \frac{y^4}{k^4 + y^4} - \beta x \\ \dot{y} &= \alpha \frac{z^4}{k^4 + z^4} \times \frac{x^4}{k^4 + x^4} - \beta y \\ \dot{z} &= \alpha \frac{z^4}{k^4 + z^4} \times \frac{x^4}{k^4 + x^4} - \beta z\end{aligned}$$

4. Network 4

$$\begin{aligned}\dot{x} &= \alpha \frac{x^4}{k^4 + x^4} \times \frac{k^4}{k^4 + y^4} - \beta x \\ \dot{y} &= \alpha \frac{z^4}{k^4 + z^4} \times \frac{k^4}{k^4 + x^4} - \beta y \\ \dot{z} &= \alpha \frac{k^4}{k^4 + z^4} \times \frac{x^4}{k^4 + x^4} - \beta z\end{aligned}$$