CP241 Lab Assignment 1

August 21, 2023

- *Submission via Teams:* Assignments will be allocated to you via the Teams "Assignments" feature. You will have to upload your answer sheet via the same feature in Teams. **Answer sheets sent via e-mail will not be considered.**
- *File Logistics:* Put the plots in pdf/jpeg/png format and code in .m or .mlx format in a .zip file with filename "LA_1_'YOUR_SERIAL_NUMBER'" in Teams.

Due Date: Aug 28, 2023
Maximum Marks: 20

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1 Question-1

[10 marks] A prey-predator system modelled by the following equations

$$\dot{x}_1 = ax_1 - bx_1x_2 \tag{1}$$

$$\dot{x}_2 = cx_1x_2 - dx_2 \tag{2}$$

where x_1 and x_2 are dimensionless variables proportional to the prey and predator population densities, respectively. $\dot{x}_1$ and $\dot{x}_2$ represent the instantaneous growth rates of the two populations.

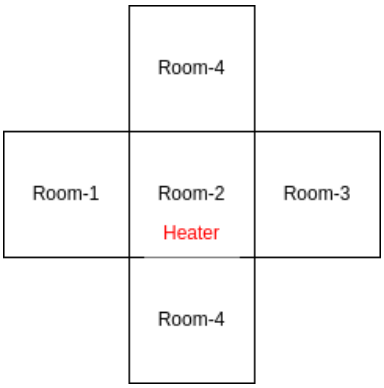
Take the parameters $a = 0.8, b = 0.5, c = 0.5$ and $d = 0.2$.

With the initial conditions: $x_1(0) = 0.1$ and $x_2(0) = 0.5$, solve the system of equations using ODE45 and RK4 solver for a time span of $[0, 50]$ seconds.

1. Plot the x_1 and x_2 with respect to time on the same graph. [4 marks]
2. Plot x_1 with respect to x_2. [3 marks]
3. Find all the equilibrium points of the system above. What happens when the initial conditions are set equal to the equilibrium point? [3 marks]
4. What happens if a or b or c or d are negative? Plot and comment on what is the impact of the parameters on the population densities. For more information visit: `https://en.wikipedia.org/wiki/Lotka%E2%80%93Volterra_equations` [5 marks]

2 Question-2

[5 marks]



The following system of differential equations represents the Temperature diffusion in between the five rooms are shown in the figure.

$$\dot{T}_1 = \alpha(T_2 - T_1) + \alpha_e(T_e - T_1)$$
$$\dot{T}_2 = \alpha(T_1 - T_2) + \alpha(T_3 - T_2) + \alpha(T_4 - T_2) + \alpha(T_5 - T_2) + \alpha_h(T_h - T_2)$$
$$\dot{T}_3 = \alpha(T_2 - T_3) + \alpha_e(T_e - T_3)$$
$$\dot{T}_4 = \alpha(T_2 - T_4) + \alpha_e(T_e - T_4)$$
$$\dot{T}_5 = \alpha(T_2 - T_5) + \alpha_e(T_e - T_5)$$

where T_1,T_2,T_3,T_4,T_5 represents the temperature of room 1,2,3,4 and 5 respectively.

Take the diffusion constants $\alpha = 5\times10^{-2}$, $\alpha_h = 3.6\times10^{-3}$ and $\alpha_e = 8\times10^{-3}$.

With the initial room temperatures as 10^oC, 15^oC, 20^oC, 25^oC and 30^oC for Room 1, 2, 3, 4 and 5, respectively, solve the system of equations using ODE45 solver for a time span of $[0, 50]$ seconds.

Plot the Temperature of all the five rooms as a function of time on the same graph. [5 marks]