

DEPARTMENT OF BIOTECHNOLOGY, IIT, MADRAS
CHENNAI - 36

BT 5270 Introduction to Computational Neuroscience

Class : Btech/MTech/MS/PhD

Date : 18-9-2018

Time : 11 AM - 12:00noon

Midsemester Examination

Marks: 25

1. For the linear dynamical system, $\dot{x} = Ax$, where

$A = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$, what kind of a fixed point is the origin? (1 marks)

2. If Δ and τ denote the discriminant and trace of the Jacobian of a 2-D dynamical system at a fixed point, find the type of the fixed point in the following two cases:

a. $\Delta > 0, \tau > 0, \tau^2 - 4\Delta < 0$

b. $\Delta < 0, \tau > 0, \tau^2 - 4\Delta > 0$ (4 marks)

3. An extended form of Romeo and Juliet dynamics is given below.

$$\dot{R} = -R + J$$

$$\dot{J} = bR - J$$

The parameter 'b' represents the efforts of a friend of J, to push to couple towards marriage and to "settle down". If the range of b is $[-1, 2]$, determine for what values of b does J's friend succeed. Justify your answer. (5 marks)

4. Imagine a variation of Hodgkin-Huxley model which has only voltage-dependent Na^+ channels; no K^+ channels. (Neurobiologically you can produce something like that by blocking K^+ channels). Write the equations of dynamics for the modified model. There is no need to give explicit form of α, β functions. Give the circuit representation of the model. (5 marks)

5. A constant current I_0 is injected into a composite dendrite with two segments shown below (fig. 2):

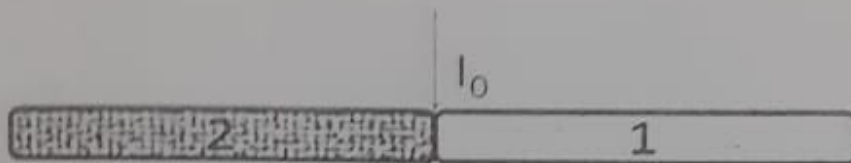


figure 1

For segment 1: $R_m = R_{m1}$, and $L = L_1$. For segment 2: $R_m = R_{m2}$, and $L = L_2$.

Find the steady state voltage distribution over the cable. The far ends of the two cable segments are sealed. (4 marks)

6. In the parallel two cable system shown in figure below, a DC current I_0 is injected from the left. The right ends of the two cables are shorted together. If the two cables are identical with properties, R_m, L , find the currents going into cable 1 and cable 2. What is the voltage distribution across the two cables? (6 marks)

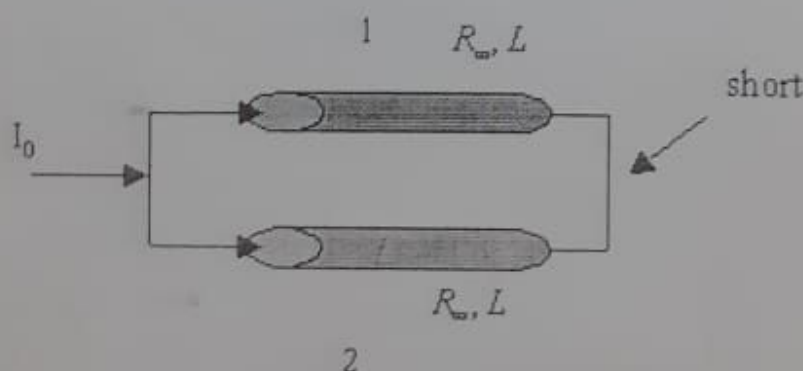


figure 2