DEPARTMENT OF BIOTECHNOLOGY, IIT, MADRAS

CHENNAI – 36

BT 6220 Introduction to Computational Neuroscience

Class : Btech/MTech/PhD Date : 25-9-2014

Time : MID SEMESTER Examination Marks: 30

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1. Find ALL the fixed points of the system given as, dx/dt = x-y, dy/dt = x^3-x-y. Make rough sketches of nullclines and classify ALL the fixed points. (5 marks)
2. How many limit cycles does the following system exhibit?

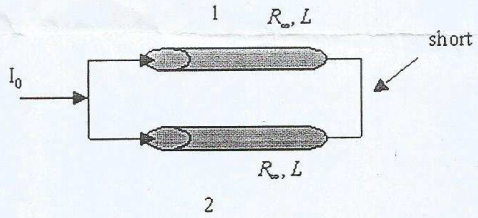
   $\dot{r} = r(1-r^2)(4-r^2)$

   $\dot{\theta} = 2-r^2$

   Which of the limit cycles are stable? What is the direction of motion (clockwise or anticlockwise) of a point on each of these limit cycles? (5 marks)

3. Two semi-infinite cables of electrical properties, R_{m1}, ρ_1 and R_{m2} and ρ_2 respectively, have the same diameter, d. The two cables are joined such that together they form a single infinite cable. Find the steady state voltage distribution along the newly formed infinite cable, when a steady current, I_0, is injected at the point where the two cables meet. (5 marks)

4. 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_∞, L, find the currents going into cable 1 and cable 2. (6 marks)



5. Dynamics of FitzHugh-Nagumo neuron is given as:

$$\frac{dv}{dt} = Kv(v-a)(1-v) - w + I_0$$

$$\frac{dw}{dt} = bv - \gamma w$$

where K = 1, I_0=0, a=0.5, b = 0.1, γ = 0.1.

a) Draw the null-clines. b) Indicate the fixed points. c) Prove their stability. (6 marks)

6. Put the following events in the correct temporal order: (3 marks)

a) entry of Ca2+ ions into the presynaptic terminal, b) opening of ion channels on the postsynaptic terminal, c) arrival of an action potential on the presynaptic terminal, d) EPSP/IPSP, e) binding of neurotransmitter with receptors on the postsynaptic terminal, f) release of neurotransmitter