Mid-Sem LS3203 21/2/19 Marks: 20; Time: 90 min. **Q1 and any 5** of Qns 2-7

1. State True/False with reasons [5]

a. Diffusion of a solute molecule starts when its concentration gradient is established.

b. Strength of coulombic interaction between any two charges separated by a distance – is reduced in the presence of mobile ions.

c. The radius of the pore of the voltage-gated Na^+ ion channel linearly increases as a function of membrane potential.

d. Energy cost of immersing an apolar object in a polar media depends on its volume.

e. In equilibrium, every ion species exists at internal concentrations such that their Nernst potentials match the membrane potential of the vesicle/cell.

--------DO ANY 5 of Qns. 2-7-------

2. Stoke-Einstein equation ($\zeta D=k_BT$; where, D: diffusion coefficient; ζ: viscous drag) relates temperature with the diffusion coefficient and viscous drag. Design an experiment which can measure Boltzmann constant experimentally. List the various steps clearly. [3]

3. When fluorescent molecules come too close to eachother there is a possibility of resonance energy transfer (RET) or even quenching. The Forster's distance is a lengthscale at which RET is highly probable. If this distance is ~5 nm, at what concentrations will it start occuring in the sample? [3]

4. How are ion pumps different from ion channels? What role does each have to the generation and propagation of action potential? [3]

5. Consider a –ve plate dipped in a solution of monovalent ions. Express number density of +ve and -ve ions [$c_+(x)$ and $c_-(x)$] in terms of V(x) invoking Boltzmann distribution. c_∞ is the number density before the –ve plate was dipped. Hence, write the expression for the net the charge density $\rho(x)$. Note: Electric energy = zeV(x) where V(x) is the potential, z: valency, e: charge of an electron. [3]

6. You have been given a dye whose fluorescence increases by 25% for every 100mV of depolarization. This is used to label an axon of length 100 μm. [3]

   a. Draw the fluorescent profile in 3 snapshots (assume 10μs apart) of the axon on being excited at the centre by a stimulus above the threshold. Shade with pencil – darker: more fluorescent. Use vel. of prop = 1m/s. Put an approximate scale bar.

   b. Plot the fluorescence at particular pixel changing with time when the stimulus is greater than the threshold.

7. What does the figure represent? Which molecules are responsible for the post-dip sections with arrows? What could have happened to the molecules at the times exactly pointed out by the arrows? [3]