CSEN 1099 – Introduction to Biomedical Engineering
Problem Set #1

Question 1

Using as many appropriate anatomical terms as apply, write sentences that describe the positional relationship between your mouth and (a) your left ear, (b) your nose, and (c) the big toe on your right foot.

Question 2

Find the volume of a cell if it contains 2×10^{16} molecules of Na^+ if the intracellular concentration of Na^+ is 15mM.
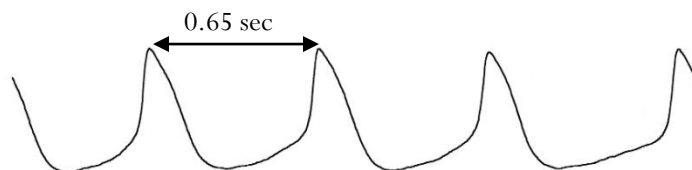
Question 3

Consider a cell with the following intracellular and extracellular concentrations:

- Na^+: Intracellular = 12 mM   Extracellular = 145 mM
- K^+:   Intracellular = 139 mM   Extracellular = 4 mM
- Cl^-: Intracellular = 4 mM   Extracellular = 116 mM
- Ca^{2+}: Intracellular = 0.8 mM   Extracellular = 1.8 mM

a) Determine the diffusion gradient for each of those ions.
b) If the cell contains Anions of 138 mM, determine whether the cell is in electrical equilibrium or not.

Question 4

Consider the membrane potential measurement of a pacemaker cell given below:

0.65 sec

a) Find the heart rate in bpm (beats per minute).
b) Find the cardiac output of the heart if the stroke volume is 80 ml.
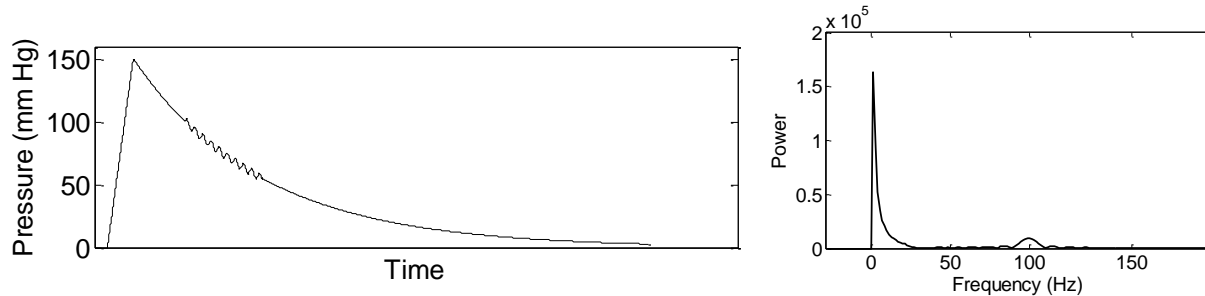
Question 5

Why are R waves in ECG used to determine heart rate rather than T waves?

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Question 6

Consider the pressure measured from a cuff of an oscillometer (left figure) and the corresponding frequency-domain of the pressure (right figure) given below:

i – **Determine** the approximate maximum and minimum blood pressures.

ii – **State** the purpose of each of the low-pass and band-pass filters that are used in the oscillometer block diagram.

iii – From the figures above, **determine** how to set the cutoff frequencies of each filter.

Question 7

Consider the Action Potential waveform given below:
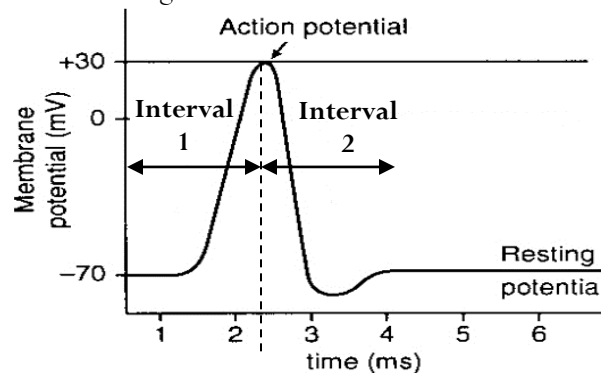
i – For Interval 1, **choose** one or more of the following that could correspond to this interval.
  Justify your answer:
    1 – Na^+ moves out of the cell
    2 – Na^+ moves into the cell
    3 – Cl^- moves into the cell

ii – For Interval 2, **choose** one or more of the following that could correspond to this interval.
  Justify your answer:
    1 – K^+ moves out of the cell
    2 – K^+ moves into the cell
    3 – Cl^- moves into the cell

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Question 8

Consider designing a system that can determine the location of a subject based on his brain activity. Draw a general block diagram that describes such system indicating which part of the brain to interface with. Explain the steps that should be undertaken to train the system.

Question 9

Consider designing a system that can be used to move a cursor on a screen using brain activity. Draw a general block diagram that describes such system indicating which part of the brain to interface with. Explain the steps that should be undertaken to train the system.