35598

(3 Hrs.) **[Total Marks : 80]**

QUESTION PAPER SOLUTION

T.E SEM VI BIOMEDICAL ENGG.

SUB: BIOLOGICAL MODELING AND SIMULATION

EXAM : May' 18 ( )

1	**(a)**	Explain with a neat diagram model of a circulatory system	**05**
		Diagram of circulatory system	**01**
		Electrical equivalent	**02**
		Explanation.	**02**
	(b)	Explain the significance of ion pump	**05**
		1. Distribution of charges across the membrane	**01**
		2. Membrane potential	**02**
		3. Working of ion pump	**02**

(c) Differentiate between spindle receptor and golgi tendon organ **05**

Spindle receptor	**Golgi tendon**	
Diagram		01
series	parallel	01
monitors length	force	01
belly of a muscle	between muscle and the bone	01
excitatory response	Inhibitory response	01

(d) Explain different heat generating and heat loosing mechanism in a body **05**

Conduction, convection, evaporation Shivering, exercise, vasoconstriction, vasodilation, Role of hormones

2 **(a)** Using biophysics tools derive Donnan's equilibrium for a membrane permeable to Ca^{2+} and Cl^- ions. **10**

1. Biophysics tools
2. Equilibrium condition
3. Statement of Donnan Equilibrium.

(b) Extracellular and Intracellular concentrations of Na^+, K^+ and Cl^- are as given **T=20°C.** **10**

	ECF	**ICF**
Na^+	230 mM	25 mM
K^+	30 mM	800 mM
Cl^-	1090 mM	72 mM

i) Determine the equilibrium potentials for Na^+, K^+ and Cl^-.

ii) If $P_K=1$; $P_{Na} = 0.019$ and $P_{Cl} = 0.381$, Calculate membrane potential.

$$E_K = -\frac{kT}{qZ} \ln \frac{[K^+]_i}{[K^+]_o} = -82.98 mV; E_{Na} = 56.08 mV \quad E_{Cl} = -68.66 mV$$

$$V_m = -\frac{kT}{q} \ln \left[\frac{P_K[K^+]_i + P_{Na}[Na^+]_i + P_{Cl}[Cl^-]_o}{P_K[K^+]_o + P_{Na}[Na^+]_o + P_{Cl}[Cl^-]_i} \right]$$

$$= -19.86 mV.$$

3 (a) Differentiate with suitable example, **10**

(i) Compartmental and Non-compartmental modelling 05

Definition, description, example diagram

(ii) Lumped parameter and distributed parameter model 05

Definition, description, example diagram

(b) Explain with necessary equation linearized model of immune system **10**

Physiology of immune system 02

Components of the model 04

Block diagram 02

Graphs 02

4 (a) Explain stretch reflex with a neat block diagram. Also explain the role of antagonist muscle in neuromuscular system. **10**

1. Stretch reflex 03
2. Explanation 04
3. Role of antagonist muscle and block diagram 03

(b) Explain the plant model of thermoregulatory system **10**

Plant model of a thermoregulatory system : diagram 4

Plant model of a thermoregulatory system : explanation 6

5 (a) With reference to reciprocal innervation model of eye movement explain, **10**

i) series elasticity 05

Experimental set up

Results

Discussion

ii) force-velocity relationship 05

Experimental set up

Results

Discussion

(b) Draw the electrical model of a membrane and explain the significance of each component 10

Diagram 04

Explanation 06

6 With reference to the Westheimer's eye movement model, 20

i) find the expression for displacement 06

Derivation to find

$$\theta(t) = \frac{1}{K}\left[1 - \frac{e^{-\xi\omega_n t}}{\sqrt{1-\xi^2}}\sin(\omega_d t+\phi)\right]$$

ii) find the time to peak and maximum displacement 06

Derivation to find $t_p = \frac{\pi}{\omega_n\sqrt{1-\xi^2}}$.

$$\theta_{max} = \frac{1}{K}\left[1 + e^{-\xi/\sqrt{1-\xi^2}\cdot\pi}\right]$$

iii) find the time to peak velocity and peak velocity 08

Derivation to find

$$t_{pv} = \frac{\phi}{\omega_n\sqrt{1-\xi^2}}.$$

$$\left(\frac{d\theta}{dt}\right)_{max} = \frac{\omega_n e^{-\phi/\tan\phi}}{K\sqrt{1-\xi^2}} \cdot \sin\phi.$$

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