Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (BME)/SEM-8/BME-802/2010

2010

MODELING OF PHYSIOLOGICAL SYSTEM

Time Allotted : 3 Hours Full Marks : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for the following : $10 \times 1 = 10$

   i) The nature of urine in proximal tubule is

      a) Hypotonic b) Hypertonic

      c) Isotonic d) None of these.

   ii) Integral equation models are used in

      a) non-parametric approach

      b) parametric approach

      c) modular approach

      d) none of these.

iii) In electrical analogue model of blood flow, flow is equivalent to

a) voltage

b) current

c) resistance

d) none of these.

iv) Most real system are

a) non-linear

b) linear

c) partly linear & partly non-linear

d) none of these.

v) Black box models are derived by applying

a) input-output relationship

b) internal functioning of the system

c) fundamental laws

d) none of these.

vi) Ligament is modeled by

a) Spring

b) Dashpot

c) Combination of Spring and Dashpot

d) none of these.

vii) The Nernst potential of K+ is

a) 77 mV

b) – 57 mV

c) – 59·5 mV

d) 67 mV.

viii) Compartmental models are not used to describe

a) Blood flow distribution

b) Temperature distribution

c) Neural network distribution

d) None of these.

ix) The ionic diffusion (F) across the cell membrane is given by [Fick's law, dx = membrane thickness, [I] = ion cone., D= diff. coeff.]

a) $F = D^2 \frac{d^2[I]}{dx}$

b) $F = -D\frac{d[I]}{dx}$

c) $F = D\frac{dx}{d[I]}$

d) None of these.

x) The Nernst potential for a particular cation is calculated by the equation [e = conc. of extra cellular fluid, i = conc. of intra cellular fluid]

a) $E_x = \frac{RT}{q} \ln \frac{[x^+]_e}{[x^-]_i}$ b) $E_x = \frac{RT}{q} \ln \frac{[x^+]_i}{[x^-]_e}$

c) $E_x = \frac{RT}{q} \ln \frac{[x^+]_e}{[x^+]_i}$ d) $E_x = q\,RT \ln \frac{[x^+]_e}{[x^-]_i}$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Write is mathematical modeling ? Why are mathematical models useful in medical field ? 2 + 3

3. What do you mean by black box and building block approach of a modeling system ? What is compartmental model ? 3 + 2

4. Briefly explain about the modeling of coronary circulation with transfer function. 5

5. How do you measure the renal blood flow ? Write down the equation for renal blood flow. 4 + 1

6. Explain briefly about the time invariant and time varying systems for physiological modeling with example. 5

7. Briefly describe the electromotive, resistive and capacitive properties of cell membrane. 5

GROUP – C
(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. Derive an expression for solute transfer between different compartment of a physiological system. Describe the model of Henle's loop for NaCl transport. 5 + 10

9. Briefly explain about the different types of nonlinear model with example. Why are model specification and estimation important is successful modeling ? Describe the technique of linearization for nonlinear system. 5 + 5 + 5

10. a) Draw the schematic diagram of EMG – modeling. 5

b) Describe the Huxley's mode of Isotonic muscle contraction. 5

c) Consider a section of artery shown in the figure of length 6 cm, diameter 0·5 cm. The vessel wall has a thickness of 0·4 mm. Calculate the electrical equivalent of this segment of blood vessel.

Use blood velocity η = 0·04 g. cm^{-1}. s^{-1}; ρ = 1 gcm^{-3}; Young's modulus of arteries $E = 2 \times 10^6$ g. cm^{-1} s^{-2} 5

11. a) Describe about the significance and importance of the mathematical modeling. 5

b) What do you mean by model specification and model estimation ? 4

c) Explain about the electrical analogue model of a blood vessel. 6

12. (a) Briefly describe the model of strength duration curve of skeleton muscle. 8

(b) Briefly explain about the counter current model of urine formation. 7

13. What is nerve action potential ? How is it developed ? Draw and briefly discuss about the electrical equivalent circuit of the nerve membrane. Briefly discuss about the step response of 'potassium conductance' with its non-linear model.

3 + 7 + 5