Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.TECH(BME)/SEM-8/BME-802/2011

2011

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 answer of the following : 10 × 1 = 10

i) Differential equation models are used in

a) Parametric approach

b) Non-parametric approach

c) Modular approach

d) Connectionist approach.

ii) In electrical analogue model, pressure changes are considered as

a) current changes b) resistance changes

c) voltage changes d) none of them.

iii) The Nernst potential of Na^+ is

a) 77 mV b) – 57 mV

c) 67 mV d) – 59.5 mV.

iv) In the modeling of blood flow in circulatory system, the reference or ground point is chosen as

a) left atrium b) right atrium

c) left ventricle d) right ventricle.

v) The relation of change of membrane potential (ΔVm) with distance (x) is

a) $\Delta Vm = Vo.e^{-x/\lambda}$ b) $\Delta Vm = Vo.e^{+x/\lambda}$

c) $\Delta Vm = Vo.e^{-\lambda/x}$ d) $\Delta Vm = Vo.e^{+\lambda/x}$

vi) MVC is

a) minimum voluntary contraction

b) moderate voluntary contraction

c) maximum voluntary contraction

d) none of these.

vii) Building block models are derived by applying

a) input-output relationship

b) internal functioning of the system

c) fundamental laws

d) none of these.

viii) The cell membrane potential with distance

a) increases b) decreases

c) remains constant d) none of these.

ix) Which one is the correct one for muscle force (M.F.)

a) Active M. F. = Stimulated M. F + Passive M. F.

b) Active M. F = Stimulated M. F – Passive M. F.

c) Active M. F = Stimulated M. F/Passive M.F

d) None of these.

x) If the capacitive current of a cell membrane I_c , membrane capacitance C_m and change of membrane potential with time (t) is $\frac{dv_m}{dt}$, then what will be the membrane current (I_c) expression ?

a) $I_c = \frac{dv_m}{dt} \frac{1}{C_m}$ b) $I_c = C_m \frac{dv_m}{dt}$

c) $I_c = \frac{dv_m}{dt}$ d) None of these.

GROUP – B

(Short Answer Type Questions)

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

2. What do you mean by model specification and model estimation ?

3. Describe the linearization process of a non-linear model.

4. Briefly explain the electrical analogue model of blood flow.

5. Explain the recording technique of nerve action potential.

6. What are the events which must be considered for developing a linearized model of immune response ? Write down the system equations for the immune response.

7. Briefly describe the "voltage clamp experiment" done by Hodgkin and Huxley.

GROUP – C

(Long Answer Type Questions)

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

8. a) Write down the cross-bridge theory of muscle contraction.

   b) Briefly explain Huxley's model of isotonic muscle contraction. 6 + 9

9. With a block schematic, describe the flow of blood in the human circulatory system. Describe briefly the model of coronary circulation. Consider a section of arteriole of length 6 cm, diameter 0.1 cm and vessel wall thickness of 0.05 mm. Calculate the electrical equivalent of this segment of blood vessel. Use blood vicosity = 0.04 $g.cm^{-1}$, blood density = 1.0 g/cc, young modulus = 2×10^6 $g.\ cm^{-1}\ s^2$.

   5 + 5 + 5

10. What is compartmental model ? Derive an expression for solute transfer between different components of a physiological system. Write down the four different applications of compartmental model in biomedical field. Briefly explain the four compartment model of bone cell formation.

11. What do you mean by immune response ? Describe the linearized model of immune response to germ cells, plasma cells and antibody. Discuss the twitch and force-frequency curve of a muscle. 2 + 7 + 6

12. a) Briefly discuss the purpose of physiological system modelling.

b) Give an experimental data set that can be modelled as a first order step response. Describe how the amplitude constant and time constant may be calculated for the following two cases :

i) $c\,[\,1 - e^{-t/\tau}\,].\,u\,(\,t\,)$

ii) $[\,c + e^{-t/\tau}\,].\,u\,(\,t\,)$

c) With an electrical analogue diagram discuss in brief the following :

i) Fluid flow through a rigid tube

ii) Fluid flow through an elastic tube.

$4 + (\,3 + 3\,) + (\,2\,\frac{1}{2} + 2\,\frac{1}{2}\,)$

13. a) Develop a model of the electromyogram incorporating the muscle fiber action potential.

b) Discuss the effect of Muscle fiber conduction velocity.

c) Discuss the frequency analysis and power spectrum in electromyogram and enumerate the physiological significance. 6 + 3 + 6