Name : .....

Roll No. : .....

Invigilator's Signature : .....

CS/B.Tech (BME)/SEM-3/BME-301/2009-10

2009
BIOPHYSICAL SIGNALS & SYSTEMS SIMULATION

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) In the electrical model of Blood Vessel the Capacitor is incorporated to indicate its

      a) resistivity b) elasticity

      c) permeability d) conductivity.

   ii) The power of the signal $x(t) = A \sin(\omega t)$ is

      a) A^2 b) $A^2/2$

      c) infinite d) none of these.

   iii) The cut-off frequency of RC passive high-pass filter is

      a) $\frac{1}{2\pi RC}$ b) $\frac{R}{2\pi C}$

      c) $\frac{1}{4\pi RC}$ d) $\frac{RC}{2\pi}$.

iv) In wavelet analysis, increased frequency leads to

a) increasing window width

b) increasing window height

c) decreasing window width

d) decreasing window height.

v) Noise in a resistor is due to ..... of electrons.

a) High vibration b) Temperature rise

c) Brownian motion d) Slip motion.

vi) To reduce noise you should prefer

a) positive feedback

b) negative feedback

c) open loop control system

d) all of these.

vii) Sensitivity of a system having system transfer function T & subsystem transfer function G is represented as

a) S_T^G b) S_G^T

c) $\left(S^T\right)^G$ d) $\left(S^G\right)^T$.

viii) To eliminate 50 Hz interference from ECG signal, the filter required is

a) L.P.F. b) H.P.F.

c) B.P.F. d) notch filter.

ix) In cardiovascular system the electrical equivalent of pressure drop across a blood vessel is

a) voltage b) charge

c) current d) capacitance.

x) $f(t)$ will be periodic signal of fundamental time period T if

a) $f(t-T)=f(T)$ b) $f(t+T)=f(t)$

c) $f(-t)=f(T)$ d) none of these.

GROUP – B
(Short Answer Type Questions)

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

2. Check whether the following systems are linear or non-linear :

i) $\frac{d}{dt}[y(t)]+2[y(t)]=x(t)$

ii) $Y(n) = n\,X(n)$.

3. Draw and discuss the equivalent model of nerve membrane.

4. What do you mean by causality, stability & memory of a system ? List an example of each. 3 + 2

5. i) Sketch the signal :

$$1+\frac{|n|}{3} \quad ; -3 \le n \le -1$$

$$x[n]=1 \; ; \; 0 \le n \le 3$$

$$0 \; ; \text{ elsewhere}$$

ii) What is Parseval's theorem ? 4 + 1

6. What do you mean by a signal to be non-stationary ? How can you analyze such a type of signal ? Give example of non-stationary signals in biomedical system. 1 + 2 + 2

7. Design an active B.P.F. having gain 2·5 and $f_H = 40$ Hz and $f_L = 1$ kHz.

GROUP – C
(Long Answer Type Questions)

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

8. a) Find the power and rms value of the signal $x(t) = A\cos(\omega_0 t + \varphi)$.

   b) A pair of sinusoidal signals with a common angular frequency is defined as

   $X_1[n] = \sin(5\pi n)$

   $X_2[n] = \sqrt{3}\cos(5\pi n)$.

   i) Specify the condition, which the period N of both $X_1[n]$ and $X_2[n]$ must satisfy for them to be periodic.

   ii) Evaluate the amplitude and phase angle of composite sinusoidal signal :

   $Y[n] = X_1[n] + X_2[n]$.

c) A discrete time signal defined as $x[n] = C\,\alpha^n$, where C & α both are real.

Draw the curves when

i) $\alpha < -1$

ii) $-1 < \alpha > 0$

iii) $0 < \alpha > 1$

iv) $\alpha = 1$

v) $\alpha > 1$. (3 + 2) + 5 + 5

9. a) What do you mean by time shifting and time scaling of a signal ?

b) Show that time shifting in time domain signal is equivalent to phase shifting in frequency signal.

c) Prove that :

if $x(t) \xrightarrow{FT} x(j\omega)$ & $h(t) \xrightarrow{FT} H(j\omega)$

then, $y(t) = h(t) * x(t) \xrightarrow{FT} Y(j\omega) \times H(j\omega)$. 5 + 4 + 6

10. a) Find out the PSD of noise voltage in the system below :

b) What are the different sources and types of noise ?

c) What is the equivalent resistance of the 3-stage cascade amplifier as shown in figure below :

5 + 3 + 7

11. a) Briefly describe the Voltage-clamp experiment done by Hodgkin and Huxley.

b) Describe by block diagram, the closed loop operation of the cardiovascular system representing the four chambers of heart.

c) Develop the equation for the arterial pressure dynamics with its transfer function. 7 + 4 + 4

12. a) Draw the electrical model of Rigid & Elastic model of a vessel.

b) Represent the immune response by a single system with different block diagrams considering different system equations and also find out the transfer function of such system.

c) For recording of E.C.G. signal (frequency range 0·01 to 100 Hz) power line interference (50 Hz) will be present. What type of filter should you prefer to

i) filter the ECG signal

ii) reduce the power line interference.

5 + (4 + 3) + 3

13. Write short notes on any *three* of the following : 3 × 5

a) System Linearity

b) Even and Odd signals

c) Sensitivity analysis by feedback

d) Notch filter and its importance for biomedical signal analysis

e) Importance of physiologcial system modelling.