

Name : .....

Roll No. : .....

Invigilator's Signature : .....

**CS/B.Tech (BME-NEW)/SEM-3/BME-301/2011-12**

**2011**

**BIOPHYSICAL SIGNALS & SYSTEMS**

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) Fourier series is obtained for ..... signal.

- a) finite periodic signal
- b) infinite periodic signal
- c) finite non-periodic signal
- d) infinite non-periodic signal.

ii) In wavelet analysis, increased frequency leads to

- a) increasing window width
- b) increasing window height
- c) decreasing window width
- d) decreasing window height.



- iii) Nominal characteristics resistance of the BPF  $R_k$  is
- |                         |                         |
|-------------------------|-------------------------|
| a) $\sqrt{LC}$          | b) $\frac{\sqrt{L}}{C}$ |
| c) $\frac{\sqrt{C}}{L}$ | d) $L\sqrt{C}$ .        |
- iv) In the electrical model of Blood vessel the capacitor incorporate to indicate its
- |                 |                  |
|-----------------|------------------|
| a) resistivity  | b) elasticity    |
| c) permeability | d) conductivity. |
- v) Distortion can be reduced by
- |                      |                      |
|----------------------|----------------------|
| a) negative feedback | b) positive feedback |
| c) both of these     | d) none of these.    |
- vi)  $y[n] = x[n] + x[n+1]$  is a
- |                  |                      |
|------------------|----------------------|
| a) Causal system | b) Non-causal system |
| c) Stable system | d) Both (b) & (c).   |
- vii) 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. |
- viii) To eliminate the interference of power line signal during measurement of Bio-Signal, we need
- |                     |
|---------------------|
| a) Low pass filter  |
| b) High pass filter |
| c) Band pass filter |
| d) Notch filter.    |



ix) By using negative feedback in a system we can reduce

- a) Temperature
- b) External sensitivity to the system
- c) Humidity
- d) All of these.

x)  $X(n) = 1/3 [x(n) + x(n+1) + x(n+2)]$  is

- a) BIBO stable
- b) Not BIBO stable
- c) Linear system
- d) None of these.

**GROUP - B**

**( Short Answer Type Questions )**

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

2. State and prove the Parseval theorem.

3. a) Sketch the signal

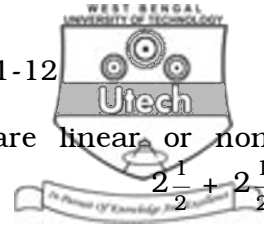
$$1 + \frac{|n|}{3}; -3 \leq n \leq -1$$

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

0; elsewhere.

b) What do you mean by the time scaling property of Fourier transform ? 3 + 2

4. Write the properties of Z-transform.



5. Check whether the following systems are linear or non linear :

a)  $\frac{d}{dt}[y(t)] + 3[y(t)] + 5 = x(t)$

b)  $y(u) = n \times (n)$ .

6. Design an active B.P.F. having gain 10 and  $f_H = 400$  Hz and  $f_L = 1$  kHz .

7. How is the ionic concentration across a cell membrane is maintained ? Explain with the proper electrical equivalent diagram.

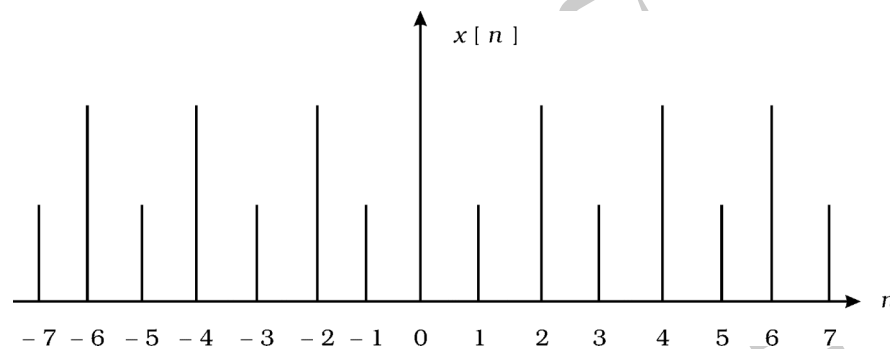
**GROUP - C**

**( Long Answer Type Questions )**

Answer any *three* of the following.  $3 \times 15 = 45$

8. a) Derive the synthesis and analysis equations of the Fourier transformation. 4

b) A discrete time signal  $x [ n ]$  is shown in the figure below : 7





Sketch and label each of the following carefully :

i)  $2x [ n ]$

ii)  $x [ n/2 ]$

iii)  $x [ 3n ]$

iv)  $\left(\frac{1}{2}\right) \times [3n - 1]$

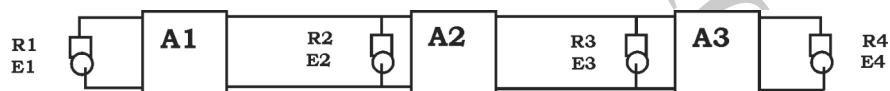
v)  $x [ 3n + 1 ]$ .

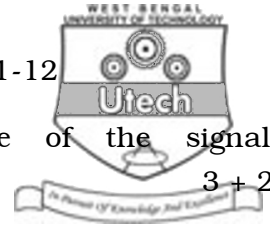
c) Draw a model to show recording of nerve action potential. 4

9. a) What is noise figure ? Find out the net noise figure of a 3-cascade amplifier having fed with an input resistor noise at the first amplifier. Consider the gain and noise figure of the stages of amplifiers be  $G_1, F_1; G_2, F_2$  and  $G_3, F_3$  respectively. 6

b) What is the meaning of noise in physiological signals ? 2

c) What is the equivalent resistance of the 3-stage cascade amplifier as shown in figure below : 7





10. a) Find the power and rms value of the signal  $x(t) = A \cos(\omega_0 t + \varphi)$ . 3 + 2

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. 5

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

c) Find the Z-transform and the region of convergence (ROC) of the discrete time signal  $x(n)$  given as  $x(n) = a^n$  for  $n \geq 0 = 0$  for  $n < 0$ . 5

11. a) Obtain the electrical analogue of fluid flow through a rigid tube and elastic tube. 6

b) What are the electrical and mechanical analogies of

i) fluid flow

ii) volume? 2

c) Briefly explain the Huxley cross bridge model with mathematical expression. 7



12. a) Draw the electrical model of Rigid & Elastic model of a vessel. 5
- b) Represent the immune response by a single system with different block diagram considering different system equations and also find out the transfer function of such system. 4 + 3
- c) Model the coronary circulation. 3
13. Write short notes on any *three* of the following : 3 × 5
- a) System linearity
- b) Time reversal and time shifting
- c) Even and odd signals
- d) Sensitivity analysis by Feedback
- e) Notch filter and its importance for biomedical signal analysis.
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