AMIETE – ET/CS/IT (OLD SCHEME)

Code: AE06/ AC04/ AT04 **Subject: SIGNALS & SYSTEMS**
Time: 3 Hours **JUNE 2010** **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: **(2 ×10)**

a. Given a signal $y(t) = \sin^m 10t \cos^n 10t$

	Values of m & n		Characteristics of signal y(t)
A	m is odd, n is even	1	Odd
B	m & n are odd	2	Even
C	m & n are even		
D	m is even, n is odd		

Which among the following is correct?

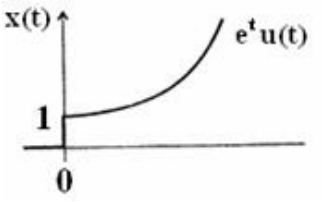
	A	B	C	D
(A)	1	2	1	2
(B)	1	1	2	2
(C)	2	1	2	1
(D)	1	2	2	1

b. The signal $x(t) = A\cos(\omega_0 t+\varphi)$ is

(A) An energy signal
(B) A power signal
(C) An energy as well as a power signal
(D) Neither an energy nor a power signal

c. Which of the following is the correct statement?
The system characterized by the equation y(t) = ax(t) + b is

(A) Linear for any value of b **(B)** Linear if b>0
(C) Linear if b<0 **(D)** Non-linear



d.

For the signal shown above

(A) Only Fourier transform exists
(B) Only Laplace transform exists
(C) Both Laplace and Fourier transforms exists
(D) Neither Laplace nor Fourier transforms exist

e. The Fourier transform of u(t) is

(A) $1/j\omega$
(B) $j\omega$
(C) $1/(1+j\omega)$
(D) $\pi\delta(\omega) + 1/j\omega$

f. Match List-I (Application of Signals) with List-II (Definition) and select the correct answer using the code given below of the lists:

List-I (Application of Signals)	List-II (Definition)
A. Reconstruction	1. Sampling rate is chosen significantly greater than the Nyquist rate
B. Over sampling	2. Aliasing will take place
C. Interpolation	3. To convert the discrete time sequence back to a continuous time signal and resample
D. Decimation	4. Assign value between samples and signals

	A	B	C	D
(A)	3	4	1	2
(B)	2	1	4	3
(C)	3	1	4	2
(D)	2	4	1	3

g. What is the inverse Laplace transform of e^{-as} / s?

(A) e^{-at}
(B) $u(t-a)$
(C) $\delta(t-a)$
(D) $(t-a)\, u(t-a)$

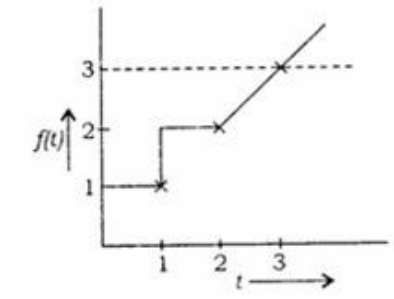
h. What is the Z-transform of the signal $x[n] = \alpha^n u(n)$?

(A) $X(z) = 1 / (z-1)$
(B) $X(z) = 1 / (1-z)$
(C) $X(z) = z / (z-\alpha)$
(D) $X(z) = 1 / (z-\alpha)$

i. The auto-correlation function $Rx(\tau)$ of a random process has the property that $Rx(0)$ is equal to

(A) The square of the mean value of the process
(B) The mean squared value of the process
(C) The smallest value of $R_x(t)$
(D) ½ [$Rx(t) + R_x(-t)$]

j. Consider the following waveform diagram:



Which one of the following gives the correct description of the waveform shown in

the above diagram?

(A) u(t) + u(t-1) **(B)** u(t) + (t-1) u(t-1)
(C) u(t) + u(t-1) + (t-2) u(t-2) **(D)** u(t) + (t-2) u(t-2)

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

Q.2 a. A discrete-time LTI system has the impulse response h[n] depicted in the Fig.1. Use the linearity and time invariance to determine the system output y[n] if the input is **(10)**

(i) x[n] = 3δ[n] - 2δ[n-1]
(ii) x[n] as given in Fig.2

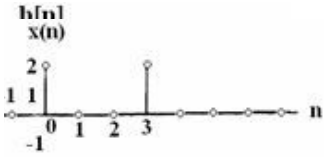


Fig.2
Fig.1

b. A Continuous – time signal x(t) is shown in Fig.3. Sketch and label each of the following signals. **(6)**

(i) x(2t) (ii) x(t/2)
(iii) x(-t)

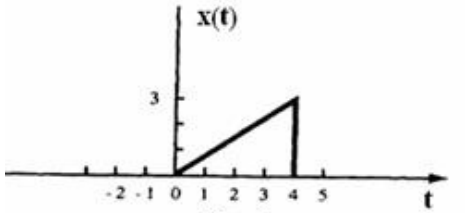


Fig. 3

Q.3 a. Evaluate the following integrals: **(4)**

(i) $\int_1^2 (3t^2+1)\delta(t)dt$ (ii) $\int_{-\infty}^{\infty} (t^2+\cos \pi t)\delta(t-1)dt$

(iii) $\int_{-\infty}^{\infty} e^{-1}\delta(2t-2)dt$ (iv) $\int_{-\infty}^{\infty} e^{-1}\delta'(t)dt$

b. Consider the sinusoidal signal x(t) = cos 15t
(i) Find the value of sampling interval T_s, such that x[n] =x(nT_s) is a periodic sequence.
(ii) Find the fundamental period of x[n] = x(nT_s) if $T_s = 0.1\pi$ seconds. **(4)**

c. A 12V pulse that is 4s wide and centred at t = 5s is applied across the terminals of automotive seat belt warning buzzer. The buzzer can be modeled as a pure resistance of 20Ω. Find the energy absorbed in the buzzer and the signal energies for the signals v(t) and i(t). **(8)**

Q.4 a. State the following properties of Continuous-Time Fourier transform.
(i) Conjugate and Conjugate symmetry
(ii) Differentiation and Integration
(iii) Time and frequency scaling **(2+2+2)**

b. $x_1(t)$ is bandlimited to 2 kHz. $x_2(t)$ is bandlimited to 3 kHz. Using properties of Fourier Transform, find the Nyquist

rate for the following

(i) $x_1(2t)$ (ii) $x_2(t-3)$

(iii) $x_1(t) + x_2(t)$ (iv) $x_1(t)x_2(t)$ (v) $x_1(t)^* x_2(t)$ **(10)**

Q.5 a. Consider an ideal low-pass filter with frequency response $H(\omega) = \begin{cases} 1, & |\omega| < \omega_c \\ 0, & |\omega| > \omega_c \end{cases}$. The input to this filter is $x(t) = \frac{\sin at}{\pi t}$

(i) Find the output y(t) for $a < \omega_c$

(ii) Find the output y(t) for $a > \omega_c$

(iii) In which case does the output suffer distortion? **(6)**

b. Determine the complex exponential Fourier series representation for each of the following signals:

(i) $x(t) = \cos \omega_0 t$ (ii) $x(t) = \sin \omega_0 t$

(iii) $x(t) = \cos\left(2t + \frac{\pi}{4}\right)$ (iv) $x(t) = \cos 4t + \sin 6t$

(v) $x(t) = \sin^2 t$ **(10)**

Q.6 a. Consider the periodic signal $x(n) = \cos \omega_0 n$ find its DTFT. **(4)**

b. Explain the following properties of DTFT

(i) Linearty (ii) Time & frequency shift

(iii) Multiplication property (iv) Parseval's relationship **(12)**

Q.7 Determine the bilateral Laplace transform and the corresponding ROC for the following signals:

(i) $x(t) = e^t \cos(2t)\, u(-t) + e^{-t}\, u(t) + e^{t/2}\, u(t)$

(ii) $x(t) = e^{3t+6}\, u(t+3)$

(iii) $x(t) = e^t \sin(2t+4)\, u(t+2)$

(iv) $x(t) = e^t \frac{d}{dt}\left(e^{-2t}\, u(-t)\right)$ **(16)**

Q.8 Determine the z-transform and ROC for the following time signals:

(i) $x[n] = u[n]$ (ii) $x[n] = (1/4)^n\, (u[n]-u[n-5])$

(iii) $x[n] = (1/4)^n\, u[-n]$ (iv) $x[n] = 3^n u[-n-1]$

(v) $x[n] = (2/3)^{|n|}$ (vi) $x[n] = (1/2)^n u[n] + (1/4)^n u[-n-1]$

Sketch the ROC, poles and zeros in the z-plane **(16)**

Q.9 A noise process has a power-spectral density given by $S_n(f) = \begin{cases} 10^{-8}\left(1 - \frac{|f|}{10^8}\right) & |f| < 10^8 \\ 0 & |f| > 10^8 \end{cases}$ This noise is passed through an ideal bandpass filter with a bandwidth of 2 MHz centered at 50 MHz

(i) Find the power content of the output process.

(ii) Write the output process in terms of the in-phase and quadrature components and find the power in each component. Assume $f_0 = 50$ MHz.

(iii) Find the power-spectral density of the in-phase and quadrature components. **(16)**