ROLL NO. ___________________

Code: AE57/AC57/AT57/AE112 **Subject: SIGNALS AND SYSTEMS**

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **December – 2017 (Special)** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **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. The process of converting from continuous – time domain to discrete – time domain is called

(A) sampling **(B)** quantization
(C) fourier analysis **(D)** None of these

b. Which system is non-causal system

(A) y(n) = x(n - 1) **(B)** y(n) = 2x(n)
(C) y(n) = x(n) + A **(D)** y(n) = x(2n)

c A band pass signal extends from 1 KHz to 4 KHz. The minimum sampling frequency needed to retain all information in the sampled signal is

(A) 1 KHz **(B)** 6 KHz
(C) 3 KHz **(D)** 4 KHz

d. The discrete-time signal x(n) shown in Fig.1 is periodic with fundamental period

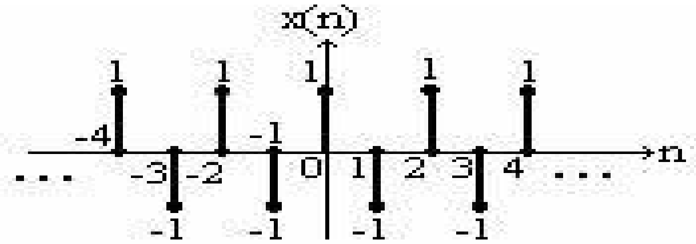

Fig.1

(A) 6 **(B)** 4
(C) 2 **(D)** 0

e. The transform of discrete time signal x(-n) will be

(A) $X(e^{-j\omega})$ **(B)** $X(e^{j\omega})$
(C) $X(e^{-2j\omega})$ **(D)** $X(e^{-3j\omega})$

f. For a signal which is bandlimited to a frequency of 500 Hz, the Nyquist Rate will be
(A) 100 Hz **(B)** 1000 Hz
(C) 50 Hz **(D)** 150 Hz

g. The unit step response of an LTI system with impulse response $h(n) = \delta(n) - \delta(n-1)$ is
(A) $\delta(n-1)$ **(B)** $\delta(n)$
(C) $u(n-1)$ **(D)** $u(n)$

h. A system characterized by the system function $H(z) = \frac{1}{2}\left(1 + z^{-1}\right)$ is a
(A) lowpass filter **(B)** highpass filter
(C) bandpass filter **(D)** bandreject filter

i. The impulse response of a system is given by $h(n)=(1/2)^n\, u[n]$. Then step response of the system is
(A) $2\left[1-\left(\frac{1}{2}\right)^{n+1} u[n]\right]$ **(B)** $2\left[1-\left(\frac{1}{2}\right)^{n-1} u[n]\right]$
(C) $2\left[1-\left(\frac{1}{2}\right)^{n} u[n]\right]$ **(D)** $1-\left(\frac{1}{2}\right)^{n-1} u(n)$

j. In filter, the width of the 'Transition Band' is Characteristics of ________.
(A) Fourier series **(B)** Fourier Transform
(C) Frequency domain **(D)** Time domain

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

Q.2 a. (i) Explain the transformations done on the independent variable **(4)**
(ii) Find out the power of the signal x(t) = A sin t **(4)**

b. Given x(t) as shown in Fig.2 **(8)**
Sketch the following
(i) x(-2t) (ii) x(t-3)
(iii) x(t)u(t) (iv) x(-t+1)

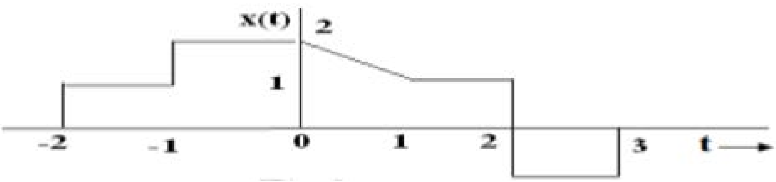

Fig. 2

Q.3 **a**. Determine the complex exponential fourier series of a square wave x(t) shown in Fig.3 **(6)**

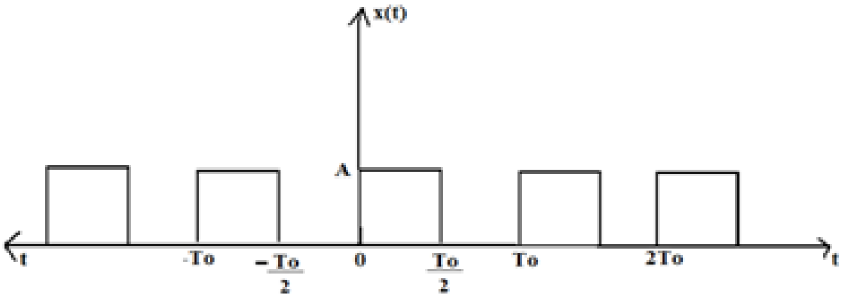

Fig. 3

b. Let X[k] represent the DTFS coefficients of the periodic sequence $x(n)$ with period N . Find the DTFS coefficients of $(-1)^n\, x(n)$ **(5)**

c. Find the Fourier Series representation of the signal x(t) shown in fig.4 **(5)**

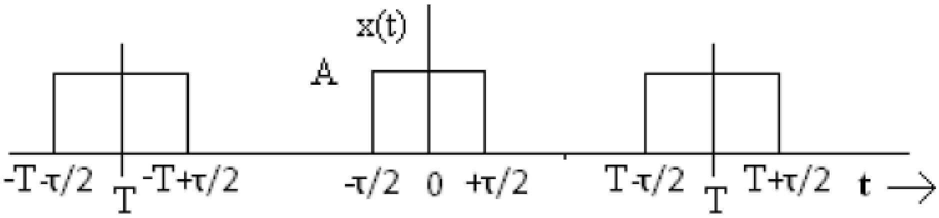

Fig.4

Q.4 a. State and prove the following properties of continuous time Fourier transform:
(i) Time shifting (ii) Frequency differentiation **(4+4)**

b. (i) Verify the integration property, that is **(4)**

$$\int_{-\infty}^{t} x(\tau)\,d\tau \leftrightarrow \pi X(0)\delta(\omega) + \frac{1}{j\omega}X(\omega)$$

(ii) Prove the frequency convolution theorem, that is **(4)**

$$x_1(t)x_2(t) \leftrightarrow \frac{1}{2\pi}X_1(\omega) * X_2(\omega)$$

Q.5 a. For signal $x(n) = \cos w_o n$ with $w_o = 2\pi/5$, obtain and plot $X(e^{jw})$. **(4)**

b. State and prove following properties for discrete time Fourier transforms:
(i) Time shifting (ii) Frequency shifting **(2+2)**

c. State and Prove convolution property of Discrete Time Fourier Transform. Using it, determine the convolution $x(n) = x_1(n) * x_2(n)$ of the sequences, where $x_1(n) = x_2(n) = \delta(n+1) + \delta(n) + \delta(n-1)$ **(8)**

Q.6 a. State and explain Nyquist sampling theorem. Derive the expression for spectrum of a sampled signal. **(8)**

b. Explain the following with suitable example: **(8)**
(i) Response of LTI system with Linear and non-linear phase
(ii) Group delay in LTI system

Q.7 a. Give the properties of ROC of Laplace Transforms. **(10)**

b. Show that for an LTI system, when the input is x(t) = $e^{s_o t}$ u(t), the output is of the form y(t) = H(s_o)$e^{s_o t}$ u(t). How is H(s_o) related to the impulse response of the system? **(6)**

Q.8 a. Find the Z-transform of the following sequences and find their ROC **(8)**

(i) $x[n] = \left[\frac{1}{2}\right]^{n-2} \left(\sin \Omega_0 (n-2)\right) u[n-2]$

(ii) $x[n] = (5)^n u[-n-1] - (3)^n u[n]$

b. Find Inverse Z-Transform of following: **(4×2)**
(i) $X(z) = 1/(1 - az^{-1}), |z| > |a|$
(ii) $X(z) = \log(1 + az^{-1}), |z| > |a|$

Q.9 a. Discuss the following: **(4×2)**
(i) Random processes
(ii) Stationary processes

b A random variable X has the uniform distribution given by

$$f_X(x) = \begin{cases} \dfrac{1}{2\pi}, & \text{for } 0 \le x \le 2\pi \\ 0, & \text{otherwise} \end{cases}$$

Determine its mean and variance **(8)**