2021

ELECTRONICS — HONOURS

Paper : CC-10

(Signals and Systems)

Full Marks : 50

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words
as far as practicable.

Answer **Question No. 1** and **any four** questions from the rest.

1. Answer **any ten** questions :   1×10

   (a) What do you mean by signal?

   (b) What do you mean by LTI system?

   (c) What do you mean by symmetric and anti-symmetric signals?

   (d) What do you mean by one-sided Z-transform?

   (e) State the Dirichlet's conditions in Fourier series of continuous time signals.

   (f) What do you mean by the quarter wave symmetry in Fourier series of continuous time signals?

   (g) State and prove the Time shifting property in Fourier transform of continuous time signals.

   (h) State the difference between the continuous time Fourier series and the discrete time Fourier series.

   (i) What do you mean by the region of convergence (ROC)?

   (j) Determine the ROC of the discrete time signal $x(n) = \{1, 3, 5, 6\}$.
   $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\uparrow$

   (k) What do you mean by an anti-causal signal? Give example.

   (l) Determine the even and odd part of the continuous time signal $x(t) = \sin 2t + \cos t + \sin t \cos 2t$.

2. (a) What do you mean by a periodic signal?

   (b) Draw the waveforms for a periodic and aperiodic signal.

   (c) Write down an important property of a periodic signal.

   (d) State Fourier's theorem.   2+(2+2)+2+2
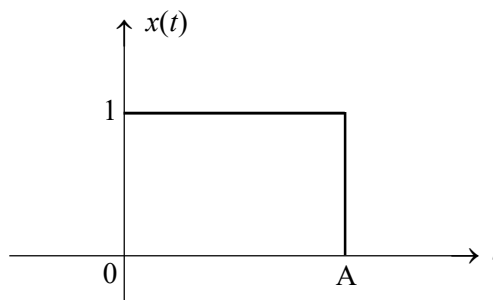
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3. (a) Perform the convolution of the following signals :

$$x_1(t) = te^{-4t}u(t), \ x_2(t) = u(t).$$

(b) Determine the energy and power of a unit step signal.

(c) Determine the unit step response of the following system whose impulse response is given by

$$h(t) = e^{-5t}u(t-2).$$

(d) Sketch the signal $x(t) = 2u(t) + tu(t) - (t-1)u(t-1) - 3u(t-2)$.

(e) Sketch the even and odd part of the following signal :

2+2+2+2+2

4. (a) Determine only the homogeneous solution and the particular solution of the system described by the equation :

$$\frac{d^2 y(t)}{dt^2} + \frac{dy(t)}{dt} + 0.21y(t) = \frac{dx(t)}{dt} + x(t).$$

(b) Verify the stability of LTI system whose impulse response is given by

$$h(t) = 2e^{-3t}\cos t \ u(t).$$

(c) Determine the linearity of the LTI system governed by the following differential equation :

$$\frac{d^2 y(t)}{dt^2} + 0.3\frac{dy(t)}{dt} + 0.5y(t) = 2x(t).$$

(3+2)+2+3

5. (a) Find the Fourier transform of $e^{-at}u(t)$.

(b) What do you mean by linearity of the Fourier transform?

(c) Find the Inverse Fourier transform of $\cos \omega t$.

5+2+3

6. (a) State the frequency shifting and time scaling properties of discrete time Fourier series.

(b) Determine the Fourier series representation of the following discrete time signal :

$$x(n) = \{...1, 2, 3, 4, \ 1, 2, 3, 4, 1, 2, 3, 4,...\}$$
$$\uparrow$$

(c) Obtain the relation between Laplace transform and Z-transform.

(1+1)+5+3

7. (a) State the frequency shifting property of Fourier transform of a continuous time signal. Using frequency shifting property, find the Fourier transform of the following signal :

$$f(t) = Ae^{-at} \cos \omega_0 t \, u(t).$$

Hence draw the amplitude spectrum.

(b) Find the Fourier transform of $e^{-b^2 t^2}$.

(c) Express unit step signal $u(t)$ in terms of signum function $\text{sgn}(t)$ and hence obtain the Fourier transform of the unit step signal. $(1+2+1)+3+(2+1)$

8. (a) State the scaling property of Z-transform. Using scaling property, find the Z-transform of the following function :

$$x(n) = 2^n u(n-2).$$

(b) Determine the initial value $x(0)$ and final value $x(\infty)$ of the following Z-domain function :

$$X(z) = \frac{z^2}{(z-1)(z-0.2)}.$$

(c) Determine the inverse Z-transform of the following Z-domain function :

$$X(z) = \frac{z}{3z^2 - 4z + 1}$$

if the region of convergence are

(i) $|z| > 1$

(ii) $|z| < \dfrac{1}{3}$

(iii) $\dfrac{1}{3} < |z| < 1.$ $(1+2)+(1+1)+5$

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