Total number of printed pages–5

53 (EC 302) LSYS

2021

LINEAR SYSTEMS AND SIGNALS

Paper : EC 302

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1. *(a)* Represent a colour image in mathematical form. 4

   (b) Define impulse signal in continuous time domain. 4

   (c) Distinguish between discrete-time signal and digital signal. 4

   (d) Differentiate between energy signal and power signal. 4

   (e) Show how one can represent a real valued signal as a sum of even and odd part. 4

Contd.

2. *(a)* Given $x(t)=\begin{cases}2 & ; \quad -2<t<0\\ t & ; \quad 0<t<2\\ 0 & ; \quad \text{elsewhere}\end{cases}$,

plot the following transformed functions :

(i) $x(t-1)$

(ii) $x(2t)$

(iii) $x(-t)$

(iv) $x(1-t)$.

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(b) Find the period of the signal,

$$x(t)=\sin\frac{\pi}{3}t+\cos\frac{\pi}{4}t.$$ 4

(c) What are orthogonal signals ? Explain how any well behaved signals can be expressed as a linear combination of signals belonging to an orthogonal set.

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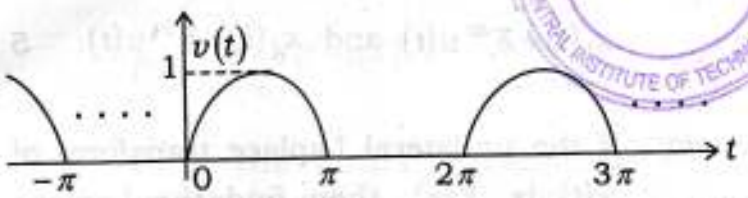
3. *(a)* The output of a half wave rectifier is given below :



Express $v(t)$ in terms of exponential Fourier series. 10

(b) Derive the formulae to find the coefficients of trigonometric Fourier series. 5

(c) For a signal with half wave symmetry show how the trigonometric coefficients are simplified. 5

4. *(a)* Check whether the following systems are *(i)* causal *(ii)* linear *(iii)* time-invariant. 10

System – 1 : $y(t) = 5x(t) + 3$

System – 2 : $y(t) = \dfrac{x(t) + x(t+1)}{2}$

(b) Show that the zero-state output a LTI system can be written as convolution of the input and its impulse response. 5

(c) Find the convolution between the signals :

$x_1(t) = \bar{e}^{at} u(t)$ and $x_2(t) = \bar{e}^{bt} u(t)$. 5

5. (a) If the unilateral Laplace transform of $x(t)$ is $X(s)$, then find the Laplace transform of : 10

(i) $x(t-\tau)$

(ii) $e^{j\omega_0 t} x(t)$

(iii) $t\,x(t)$

(iv) $\dfrac{dx(t)}{dt}$

(b) Show that the initial value and final value of a signal in time domain can be determined directly from its Laplace transform. 10

6. (a) Find the Fourier transform of the following functions — 10

(i) $e^{-at}u(t) - e^{at}u(-t)$

(ii) $\sin \omega_0 t \; u(t)$

(iii) $\sum_{n=-\infty}^{\infty} \delta(t-nT)$

(b) Find the Fourier transform of a triangular pulse and plot its spectrum. 6

(c) Explain why and ideal low pass filter cannot be practically realized. 4

7. (a) Find the bilateral z-transform of the following discrete-time functions — 10

(i) $u(n)$

(ii) $a^n u(n)$

(iii) $a^n n u(n)$

(b) Find the inverse z-transform of the following function assuming it corresponds to a causal signal : 10

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