Total No. of printed pages = 4

EI 181405

11/07/23

Roll No. of candidate | | | | | | | | | | |

2023

B.Tech. 4th Semester End-Term Examination

SIGNALS AND SYSTEMS

New Regulation

(w.e.f. 2017-18) & New Syllabus (w.e.f. 2018-19)

Full Marks – 70 Time – Three hours

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

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

1. Choose the correct answers from the following multiple choice questions : $(10 \times 1 = 10)$

(i) The unit impulse is a signal with

(a) infinite magnitude and zero duration

(b) infinite magnitude and zero duration but with unit area

(c) finite magnitude and zero duration but with unit area

(d) finite magnitude and infinite duration

(ii) The signal $x(t) = \cos(2500t)$ is a

(a) periodic and even signal (b) aperiodic and even signal

(c) periodic and odd signal (d) aperiodic and odd signal

(iii) The response of an LTI system is called the impulse response if the input signal is

(a) a unit step signal (b) a unit ramp signal

(c) a unit parabolic signal (d) a unit impulse signal

[Turn over

(iv) The system characterized by the equation $y(t) = ax(t) + b$ is

(a) linear for any value of b (b) linear for $b > 0$

(c) linear for $b < 0$ (d) non-linear

(v) The only non-zero Fourier series coefficient(s) of the signal $x(t) = \cos \omega t$ is/are

(a) 1 (b) $\frac{1}{2}$

(c) $\frac{1}{2}$ and $\frac{1}{2}$ (d) 1 and 1

(vi) If the Fourier series coefficients of a signal are periodic, then the signal must be

(a) continuous-time, periodic

(b) continuous-time, non-periodic

(c) discrete-time, periodic

(d) discrete-time, non-periodic

(vii) If the notation * is used to denote the convolution, $X(\omega)$ and $Y(\omega)$ are the Fourier transform of $x(t)$ and $y(t)$ respectively then the Fourier transform of $x(t) * y(t)$ is

(a) $X(\omega)Y(\omega)$ (b) $X(\omega) * Y(\omega)$

(c) $\frac{1}{2\pi} X(\omega)\, Y(\omega)$ (d) $\frac{1}{2\pi}[X(\omega) * Y(\omega)]$

(viii) The discrete time Fourier transform is periodic with period

(a) π (b) 2π

(c) $\pi/2$ (d) $\pi/4$

(ix) The z- transform and ROC of a signal $x(n) = u(n)$ is

(a) $X(z) = 1$ and ROC, $|z| = 0$

(b) $X(z) = z$ and ROC, $|z| > 1$

(c) $X(z) = z/(z-1)$ and ROC, $|z| > 1$

(d) $X(z) = z/(z-1)$ and ROC, $|z| < 1$

(x) The Nyquist rate of the signal $x(t) = \sin(200\pi t)$

(a) 400 Hz (b) 200 Hz

(c) 100 Hz (d) 1/200 Hz

2. (a) Plot the following signals :

(i) $x(t) = u(t+1) - u(t-1)$

(ii) $g[n] = \sum_{m=-1}^{m=1} \delta[n-2m]$. 6

(b) Determine energy and power of the signal: 5

$x(t) = e^{-3t} u(t)$

(c) What is meant by impulse response of an LTI system? The impulse response of an LTI system is $h[n] = e^{-4n} u[n-1]$. Is the system causal? Justify your answer. 4

3. (a) Compute the convolution of the following two signals: 5

$x[n] = \{0, 1, -1\}$ and $h[n] = \{0, 1\}$

(b) Examine the stability of a continuous-time LTI system whose impulse response is $h(t) = e^{-2t} u(t-1)$. 5

(c) Show that an LTI system with impulse response $h_1[n] = \delta[n-1]$ is the inverse of another LTI system with impulse response $h_2[n] = \delta[n+1]$. 5

4. (a) Determine the fundamental frequency and the Fourier series coefficients of continuous time periodic signal, $x(t) = 1 + \cos\left(\frac{2\pi}{5}\right)t + \sin\left(\frac{3\pi}{5}\right)t$. 7

(b) A continuous-time periodic signal $x(t)$ has the fundamental frequency ω_0 and Fourier series coefficient a_k. Determine the Fourier series coefficient of the following signals using properties:

(i) $x(t - t_0)$ and

(ii) $\frac{dx(t)}{dt}$ where t_0 is a time – shift. 8

5. (a) Determine the Fourier transform of the continuous-time signal and plot the magnitude and phase spectrum: $x(t) = e^{-2t}\,u(t)$. 7

(b) The impulse response of a discrete-time LTI system is given by $h[n] = \left(\frac{1}{2}\right)^n u[n]$. Determine the output response $y[n]$ for the input $x[n] = \left(\frac{3}{4}\right)^n u[n]$ using Fourier Transform. 8

6. (a) State sampling theorem. Describe briefly the steps associated with the discrete-time processing of continuous-time signals. 6

(b) What is meant by "aliasing"? What corrective measures will you put forward to combat the effect of aliasing? 6

(c) Define Nyquist rate and Nyquist interval for sampling of a signal. 3

7. (a) Determine the z-transform of

$x[n] = \left(\frac{1}{2}\right)^n u[n] + 2^n\,u[n]$ and depict the ROC and the locations of poles and zeros in the z-plane. 5

(b) Explain at least two properties of z-transform. 4

(c) Define FIR and IIR system. A system is described by the following system function. Derive its difference equation assuming $x[n]$ and $y[n]$ as input and output respectively. State whether the system is IIR or FIR? 6

$$H(z) = \frac{1 - 2z^{-1}}{1 - \frac{2}{3}z^{-1}}.$$

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