Total No. of printed pages = 4

ECE 181305

Roll No. of candidate

5/3/22 2021

B.Tech. 3rd Semester End-Term Examination

ECE, ETE

SIGNALS AND SYSTEMS

(New Regulation & New Syllabus)

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. Answer the following questions : (10 × 1 = 10)

(i) Based on the statements below, pick the correct option

(A) signal $x[n] = \left(\frac{1}{2}\right)^n u[n]$ is energy signal

(B) signal $x[n] = \sin \omega_0 n$ is both energy and power signal.

(C) signal $x[n] = n\, u[n]$ is only power signal.

(a) only (C) is true

(b) only (B) is true

(c) only (A) is true

(d) none of these

(ii) Consider the system $y[n] = \begin{cases} x[n] - x[n-1] & for \quad n \geq 1 \\ x[n] & for \quad n = 0 \\ 0 & else \end{cases}$, then the system is __________

(a) linear and time-variant

(b) causal and stable

(c) both (a) and (b) are true

(d) none of the above

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(iii) Find the Fourier series expansion of $F(x) = \sin^3(x)$

(a) $\frac{1}{4}\sin(x) - \frac{3}{4}\cos(3x)$

(b) $\frac{3}{4}\sin(x) - \frac{1}{4}\sin(3x)$

(c) $\frac{1}{4}\sin(x) - \frac{3}{4}\sin(3x)$

(d) $\frac{1}{4}\cos(x) - \frac{3}{4}\cos(3x)$

(iv) Given a signal $x[n]$ which is not absolutely summable and square summable, then which of following is true as related to $F\{x[n]\}$?

(a) exists

(b) can't say

(c) doesn't say

(d) exists if $x[n]$ is differentiable

(v) Given for a signal $x[n]$, Z transform exists, which of the following is not possibly $x[n]$?

(a) $\left(\frac{1}{2}\right)^n u[n]$

(b) $2^n u[n]$

(c) $\{0, 1, 2, 3, 4\}$

(d) $-\left(\frac{1}{3}\right)^n u[-n-1]$

(vi) A LTI system has simple poles at –2 and –4; zero at –3. If the steady-state output when unit step input is applied is 1, then find impulse response of the system.

(a) $\frac{3(S+3)}{(S+2)(S+4)}$

(b) $\frac{11(S+3)}{4(S+2)(S+4)}$

(c) $\frac{8(S+3)}{3(S+2)(S+4)}$

(d) None of these

(vii) The Nyquist sampling frequency for the signal $x(t) = 5\sin\left(\frac{\pi}{2}\right)t$ is

(a) 0.5 Hz

(b) 1 Hz

(c) 2 Hz

(d) 0.25 Hz

(viii) An analog signal $5 \sin 50\pi t$ is sample at the rate of 75 Hz. The DT signal obtained after sampling is

(a) $5\sin\left(\frac{2\pi}{3}\right)n$

(b) $5\sin 2\pi n$

(c) $5\sin 100\pi n$

(d) $5\sin\left(\frac{4\pi}{3}\right)n$

(ix) If $x[n] = \{1,2,5\}$, $h[n]=\{1,X,3\}$ and $y[n]=\{1,4,12,16,15\}$. The value of X is

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(a) 2

(b) –2

(c) 1

(d) –1

(x) The Fourier transform of a DC signal is

(a) 0

(b) 1

(c) π

(d) $2\pi\partial(\omega)$

2. (a) Sketch the signal $x(t) = 2u(t) + tu(t) - (t-1)u(t-1) - 3u(t-2)$. (5)

(b) Give a performance comparison of multichannel and multidimensional signal. (2)

(c) Find the period of the signal. $x(t)\cos(t) + \sin\left(\frac{1}{\sqrt{2}}t\right)$. (3)

(d) Test the linearity of the following system (5)

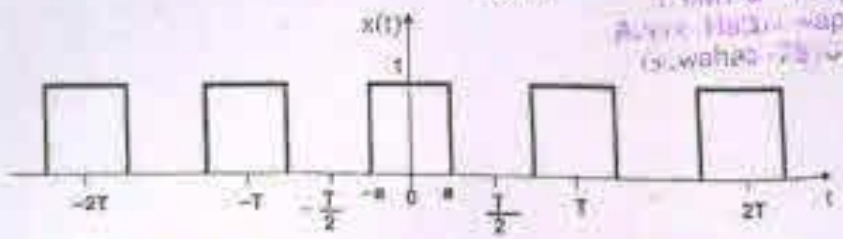
$$\frac{d^2y(t)}{dt^2} + \frac{2dy(t)}{dt} + 3y(t) = x(t)$$

3. (a) Determine the Fourier series representation of the half- wave rectifier output. (9)

(b) State three advantages of Fourier transform. (3)

(c) State the conditions for existence of Fourier Transform. (3)

4. (a) Determine the Fourier transform of the periodic pulse function shown in figure below: (10)



(b) Compute 4- point DFT of causal three sample sequence given by, (5)

$$x[n] = \begin{cases} \frac{1}{3}; & 0 \le n \le 2 \\ 0; & none \end{cases}$$

5. (a) Determine the impulse response $h(t)$ of the following system. Assume zero initial conditions $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 2x(t)$. (7)

(b) Perform the convolution of $x_1(t)$ and $x_2(t)$ using convolution theorem of Laplace transform. (5)

$$x_1(t) = u(t+1), x_2(t) = r(t-2) \text{ where } r(t) = tu(t)$$

(c) Show that $X(j\omega) = X(s)|_{s=j\omega}$. (3)

6. (a) Determine the discrete sequence $x[n]$ given $X(z) = \frac{3 + 2Z^{-1} + Z^{-2}}{1 + 3Z^{-1} + 2Z^{-2}}$. (5)

(b) Find the Z-transform and its ROC of the following discrete time signal (5)

$$x(n) = 0.8^n u(-n-1)$$

(c) What is aliasing? Explain in brief how aliasing can be eliminated. (5)

7. (a) The state-space representation of a continuous time system is given by, (6)

$$A = \begin{bmatrix} 2 & -1 \\ 3 & 1 \end{bmatrix}; \quad B = \begin{bmatrix} 1 \\ 2 \end{bmatrix}; \quad C = [1 \quad 3]; \quad D = [3]$$

Derive the transfer function of the continuous time system.

(b) Find if the signal $x[n] = -\left(\frac{1}{2}\right)^n u(-n-1)$ is energy or power signal. (4)

(c) Explain the zero- order hold sampling circuit in detail. (5)