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10EC44

Fourth Semester B.E. Degree Examination, June/July 2019
Signals and Systems

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions, selecting at least TWO full questions from each part.***

PART – A

1 a. Define signal and system with examples. **(06 Marks)**

b. Prove that

i) $\int_{-a}^{a} x(t)dt = \alpha\int_{0}^{a} x(t)dt$ If x(t) is even ii) $\int_{-a}^{a} x(t)dt = 0$ If x(t) is odd. **(06 Marks)**

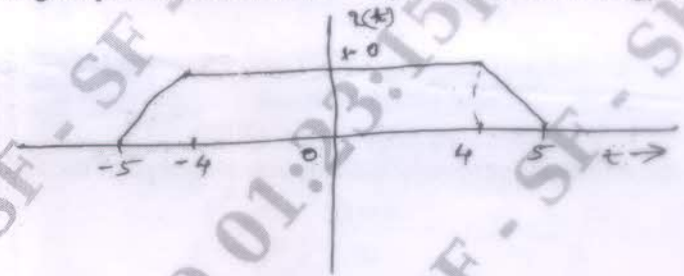
c. For the following system, determine whether the system is a) Linear b) Time invariant c) Memory less d) Causal.

i) $T[x(n)] = g(n)\,x(n)$ ii) $T[x(t)] = e^{x(t)}$ **(08 Marks)**

2 a. The trapezoidal signal as shown in Fig.Q.2(a) applied to differentiator defined by $y(t) = \frac{d}{dt}x(t)$

i) Find the resulting output of differentiator ii) Find the total energy of y(t). **(06 Marks)**

Fig.Q.2(a)



b. Find the discrete-time convolution sum of $y(n) = \beta^n u(n) * \alpha^n u(n)$ $|\alpha| < 1 : |\beta| < 1$. **(06 Marks)**

c. Consider a continuous-time LTI system with unit impulse response. h(t) = u(t) and input $x(t) = e^{-at}u(t)$ $|a| > o$. Find the output y(t). **(08 Marks)**

3 a. Prove that

i) $x(n) * h(n) = h(n) * x(n)$

ii) $x(n) * [h_1(n) + h_2(n)] = x(n) * h_1(n) + x(n) * h_2(n)$ **(08 Marks)**

b. Find the output of the system given by the differential equation:

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 4y(t) = \frac{dx(t)}{dt} \text{ with } y(0) = 0 \quad \frac{dy(t)}{dt}\Big/_{t=0} = 1 \text{ and } x(t) = e^{-2t}u(t).$$

(06 Marks)

c. Draw the direct form I and direct form II implementation of the following system shown below:s

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

ii) $y(n) - \frac{1}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n) + \frac{1}{2}x(n-2)$ **(06 Marks)**

4 a. Determine the DTFS of the signal

i) $x(n) = \cos\left(\pi/3\, n\right)$

ii) $x(n) = \sum_{M=-\infty}^{\infty} \delta(n - 4m)$ (08 Marks)

b. Determine the FS representation for the signal

i) $x(t) = \cos 4t + \sin 8t$ ii) $x(t) = e^{-t}$ $-1 < t < 1$ $T = 2$ (08 Marks)

c. Prove the following properties:

i) If $x(t) \xleftrightarrow{FS, w_o} x(k)$ then $y(t) = x(t - to) \xleftrightarrow{FS, w_o} y(k) = e^{-jkw_o to} x(k)$

ii) If $x(t) \xleftrightarrow{FS, Wo} x(k)$ then $y(t) = e^{jk_o w_o t}\, x(t) \xleftrightarrow{FS, w_o} y(k) = x(k - k_o)$. (04 Marks)

PART – B

5 a. Compute DTFT of the following signals:

i) $x(n) = 2^n u(-n)$ ii) $x(n) = a^{|n|}$ $|a| < 1$ (08 Marks)

b. Find the Fourier transform of $x(t) = e^{-a|t|}$ $a > 0$. Draw its spectrum. (06 Marks)

c. Find the inverse Fourier transform:

i) $x(jw) = \dfrac{5jw + 12}{(jw)^2 + 5jw + 6}$

ii) $x(jw) = \dfrac{jw}{(2 + jw)^2}$ (06 Marks)

6 a. Find the relationship between: i) FT and FS ii) DTFT and DTFS. (08 Marks)

b. Specify the Nyquist rate for each signals :

i) $x_1(t) = \text{sinc}(200t)$ ii) $x_2(t) = \text{sinc}^2(200t)$ (06 Marks)

c. Find the frequency response and impulse response of the following system:

$$\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = -\frac{dx(t)}{dt}$$ (06 Marks)

7 a. Determine the Z-transform, ROC, pole zero location of the following system:

i) $x(n) = \alpha^n u(n)$

ii) $x(n) = -\alpha^n u(-n-1)$

iii) $x(n) = a^n \cos(\Omega_o n)\, u(n)$ for $\Omega_o = 2\pi$. (09 Marks)

b. Explain the properties of ROC. (06 Marks)

c. Prove that

i) $x(n - n_o) \xleftrightarrow{z} z^{-no} x(z)$

ii) $a^n x(n) \xleftrightarrow{z} x\left(\dfrac{z}{a}\right)$ (05 Marks)

8 a. Determine whether the system described below is causal and stable

$H(z) = \dfrac{2z + 1}{z^2 + z - 5/16}$. (06 Marks)

b. Consider a system described by the difference equation.

$$y(n) - 2y(n-1) + 2y(n-2) = x(n) + \frac{1}{2}x(n-1)$$

Find: i) H(z) ii) h(n) iii) Stability. (08 Marks)

c. What is unilateral Z-transform and prove its time shifting property. (06 Marks)

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