

JK Lakshmipat University Jaipur

INSTITUTE OF ENGINEERING AND TECHNOLOGY

END Term Examination, May, 2019

B. Tech. in ECE..... Engineering, Semester IV.....

Roll No.....

ECE408 : Signals & Systems

Time: 3 hours

Max. Marks: 100

Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

Sr.No.	Answer any 10 questions	Marks	LO
1.	The phenomenological model of a electromechanical system is given by the differential equation $\frac{d^3y(t)}{dt^3} + 6\frac{d^2y(t)}{dt^2} + 11\frac{dy(t)}{dt} + 6y(t) = x(t)$ The above system is subjected to the following external input $x(t) = e^{-4t}u(t)$. What will be the system response when the initial conditions are zero (i.e zero state response). Suppose the electromechanical system have already some stored energy in it and have the following initial conditions $y(0^-) = 1, \dot{y}(0^-) = -1, \ddot{y}(0^-) = 1,$ What will be the response of the system under this condition only, i.e the system is not under the influence of external input (i.e zero-state response). Now also determine what will be the system response when both the input as given above and initial conditions is present (i.e total response of the system).	10	5
2.	A linear time invariant system is described by the following differential equation with specified input and initial conditions: $\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 6y(t) = -4x(t) - 3\frac{dx(t)}{dt}, \quad x(t) = e^{-t}u(t)$ and $y(0^-) = -1, \dot{y}(0^-) = 5$ What will be the response of the system due to poles of the system (natural response) only and due to the poles of the input only (forced response)	10	7
3.	A linear time invariant system has a unit step response given by $s(t) = (1 - e^{-t} - te^{-t})u(t)$. For a certain input $x(t)$, the output is observed to be equal to $y(t) = (2 - 3e^t + e^{-3t})u(t)$, so what will be the input $x(t)$?	10	7
4.	Consider a continuous -time LTI system for which the input $x(t)$ and output $y(t)$ are related by the differential equation $\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$ Lets $X(s)$ and $Y(s)$ denote the Laplace transform of $h(t)$, the system	10	4

impulse response.

- (a) Determine $H(s)$ as a ratio of two polynomials in s . Sketch the pole-Zero pattern of $H(s)$.
- (b) Determine $h(t)$ for the following cases:
 1. The system is stable
 2. The system is causal
 3. The system is neither stable nor causal

4

5. Find the inverse z - transform of

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

When

- (a) ROC $|z| > 1/3$;
- (b) ROC $|z| < 1/3$;

You may use any method of your choice i.e residue method, power series expansion method or partial fraction method.

6. A causal discrete-time LTI system is described by

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$$y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n)$$

where $x(n)$ and $y(n)$ are the input and output of the system, respectively.

- (a) Determine the system function $H(z)$ for causal system function.
- (b) Find the impulse response $h(n)$ of the system
- (c) Find the step response system.

7. Determine the z -transform and ROC of the following finite-duration signals:

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- (a) $x_1(n) = \{1, 2, 6, -2, 0, 3\}$
- (b) $x_2(n) = \{1, 2, 6, -2, 0, 3\}$
- (c) Determine the Z -transform of a unit impulse function $x(n) = \delta(n)$
- (d) unit step function $x(n) = u(n)$

8. Find the final value of the response $y(t)$ of a system whose transfer function is.

10 6

$$H(s) = \frac{s+2}{s^2+4s+5}$$

when the system is excited by

- (a) a unit step. i.e., $x(t) = u(t)$
- (b) a unit impulse, i.e., $x(t) = \delta(t)$

9. Consider the continuous-time signal

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$$x(t) = 3 \cos(2000\pi t) + 5 \sin(6000\pi t) + 10 \cos(1200\pi t)$$

- (a) What is the Nyquist rate for this signal
- (b) Assume now that we sample this signal using a sampling rate $f_s = 5000$ samples/s. what will be the discrete time signal obtained after sampling?
- (c) What is the continuous-time signal $y(t)$ we can reconstruct from the samples ($f_s = 5000$ samples/s) if we use ideal interpolation?

10. Find the inverse Laplace transform of

10 5

$$X(s) = \frac{-5s - 7}{(s + 1)(s - 1)(s + 2)}$$

If the ROC is

- (a) $\text{Re}\{s\} > 1$
- (b) $\text{Re}\{s\} < -2$
- (c) $-1 < \text{Re}\{s\} < 1$
- (d) $-2 < \text{Re}\{s\} < -1$

11. Given that $x(t)$ has the Fourier transform $X(\omega)$, express the Fourier transforms of the signal listed below in terms of $X(\omega)$, 10 3

(a) $x_1(t) = x(1 - t) + x(-1 - t)$

(b) $x_2(t) = x(3t - 6)$

(c) $x_3(t) = \frac{d^2}{dt^2} x(t - 1)$

12. For each of the following Fourier transform, use Fourier transform properties to determine whether the corresponding time-domain signals is 10 3

(i) real, imaginary, or neither

(ii) even, odd, or neither

Do this without evaluating the inverse of any of the given transforms.

(a) $X_1(\omega) = u(\omega) - u(\omega - 2)$

(b) $X_2(\omega) = \cos(2\omega)\sin(\omega/2)$

(c) $X_3(\omega) = A(\omega)e^{jB(\omega)}$ where $A(\omega) = \sin(2\omega)/\omega$ and $B(\omega) = 2\omega + \frac{\pi}{2}$

All the best!!!

