PAPER ID-311710

Roll No: | | | | | | | | | | | | | |

BTECH
(SEM III) THEORY EXAMINATION 2025-26
BASIC SIGNALS & SYSTEMS

TIME: 3 HRS **M.MARKS: 70**

Note: Attempt all Sections. In case of any missing data; choose suitably.

SECTION A

1. Attempt *all* questions in brief. **02 x 7 = 14**

Q no.	Question	CO	Level
a.	Classify signals into energy and power signals. Derive the condition for each.	CO1	K3
b.	Determine whether the system y(t) = t·x(t) + x(−t) is linear and time invariant.	CO1	K4
c.	Write the governing differential equation of a mass–spring–damper system and identify its order.	CO1	K3
d.	State the necessary conditions for the existence of Fourier Transform.	CO2	K2
e.	What is aliasing? Explain its effect on signal reconstruction.	CO2	K3
f.	State and prove the Initial Value Theorem of Laplace Transform.	CO3	K4
g.	Define impulse response of a continuous-time LTI system and state its significance.	CO3	K2

SECTION B

2. Attempt any *three* of the following: **07 x 3 = 21**

Q no.	Question	CO	Level
a.	(a) A signal $x(t) = e^{-2t}u(t) + e^{2t}u(-t)$ (i) Test whether the signal is energy or power signal (ii) Find its total energy (iii) Comment on its causality	1	K4
b.	Explain the phenomenon of sampling with the help of frequency-domain interpretation and derive Nyquist criterion.	2	K4
c.	Express a periodic sawtooth waveform with period T as a sum of shifted ramp functions and determine its Laplace transform.	3	K3
d.	Derive the relationship between the transfer function and the state matrices: $H(s) = C(sI - A)^{-1}B + D$.	4	K3
e.	Define the Region of Convergence (ROC) for Z-transforms. Explain how the ROC determines the causality and stability of a discrete-time system.	5	K4

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SECTION C

3. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	Derive the differential equations of motion and construct the equivalent Force-Current(Mobility) and Force-Voltage(Impedance) electrical circuits.	1	K4
b.	A second-order system is described by $$\ddot{y} + 2\zeta\omega_n\dot{y} + \omega_n^2 y = f(t)$$ If the system is critically damped ($\zeta = 1$), derive the general time-domain solution for a ramp input $f(t) = t \cdot u(t)$using the classical method of undetermined coefficients.	1	K4

4. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	A non-periodic pulse $v(t) = e^{-a\|t\|}$is applied to a bridge T-network. Use the Fourier Transform properties (specifically Convolution and Differentiation) to determine the output voltage $v_o(t)$in the frequency domain. Discuss the physical significance of the "Energy Spectral Density" of the output signal.	2	K3
b.	Mathematically justify why the Discrete-Time Fourier Series (DTFS) exists for any periodic sequence, whereas the Discrete-Time Fourier Transform (DTFT) requires the sequence to be absolutely summable ($\sum\|x[n]\| < \infty$). How does the introduction of the Dirichlet conditions reconcile these differences in practical hardware implementations?	2	K3

5. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	Obtain the Laplace Transform of the following waveform and hence determine its inverse Laplace Transform: $$x(t) = \begin{cases} t, & 0 \le t \le 2 \\ 2, & t > 2 \end{cases}$$	3	K3

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b.	A second-order system has transfer function $$H(s) = \frac{10}{s^2 + 4s + 10}$$ Determine: (i) Impulse response (ii) Stability (iii) Steady-state value of step response using Final Value Theorem	3	K3

6. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	Derive state-space representation of a series RLC circuit and obtain the state equations by selecting appropriate state variables.	4	K3
b.	For the state model $$\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x$$ (i) Find the State Transition Matrix (ii) Determine system stability	4	K3

7. Attempt any *one* part of the following: 07 x 1 = 07

Q no.	Question	CO	Level
a.	Find the Z-transform and ROC of the sequence $$x(n) = (0.5)^n u(n)$$ Also determine whether the system is stable.	5	K4
b.	Solve the following difference equation using Z-transform method: $$y(n) - 0.6y(n-1) = x(n)$$ where $x(n) = u(n)$and initial rest condition applies.	5	K4