VNIT NAGPUR
Department of Electronics and Communication
ECL211: Signals and Systems Analysis
Mid-Sem Exam
B.Tech

Slot: F
Date: Sept 27, 2025 (Sa)

Time: 90 mins

Weightage: 30%

Important Instructions:

- Assume suitable data wherever required.
- Support your answers with steps, elaborate explanation, calculations.

1. Consider a CT system with input output relation $y(t) = x(\sin(t))$. Is the system (i) causal ? (ii) linear? [CO-1] [3+3]

2. Let $x[n]$ be a periodic signal with period $N = 8$ and Fourier series coefficients $c_k = -c_{k-4}$. A signal $y[n] = \left(\frac{1+(-1)^n}{2}x[n-1]\right)$ with period $N = 8$ is generated. If d_k denotes the Fourier series coefficients for signal $y[n]$, find $f(k)$ such that $d_k = f(k)c_k$. [CO-3] [6]

3. [CO-2] A signal $x(t)$ has period $T = 2$ and is defined over one period by $x(t) = \begin{cases} e^t, & -1 < t < 1, \\ 0, & \text{otherwise.} \end{cases}$

   (a) If the Fourier series coefficients take the form,

   $$a_k = \frac{(A)^k \sinh(B)}{1 - C} \qquad \text{for all integers } k \neq 0,$$

   determine the values of A, B, C. [3]

   (b) Compute the value of DC component a_0. [3]

4. [CO-3] Consider the signal

   $$x(t) = \frac{\sin(200\pi t)}{\pi t} + \cos(100\pi t) \cdot \text{rect}\left(\frac{t}{0.01}\right)$$

   where

   $$\text{rect}\left(\frac{t}{T}\right) = \begin{cases} 1, & |t| \leq \frac{T}{2}, \\ 0, & \text{otherwise.} \end{cases}$$

   (a) Determine the Fourier Transform $X(\Omega)$ of $x(t)$. [3]

   (b) Plot the magnitude and phase spectra of $X(f)$. [3]

5. [CO-4] Answer the following.

   (a) Verify Parseval's theorem for the signal $x(t) = \begin{cases} e^{-t}, & t \geq 0, \\ 0, & t < 0. \end{cases}$ [3]

   (b) Verify property of Fouries series for convolution in time domain for the sequences $x_1[n] = \{1, 2, 3, 4\}$, $x_2[n] = \{5, 6, 7, 8\}$, $n = 0, 1, 2, 3$. [3]

Wish you all the best!

End of exam

Visvesvaraya National Institute of Technology, Nagpur
Department of Electronics and Communication Engineering
ECL 211- Signals and Systems Analysis
End Semester Examination, Nov 2025

Time: 03 Hours   B. Tech. (ECE) Semester-3   Marks: 60

1. (a) Why are sinusoidal signals given such importance in engineering? (b) Give an example of a useful unstable system. [CO-2], $\{1+1\}$

2. Find inverse Laplace transform of $X(s) = \frac{-5s-7}{(s+1)(s-1)(s+2)}$ if the region of convergence is given by (i) $\mathcal{R}(s) > 1$, (ii) $\mathcal{R}(s) < -2$, (iii) $-1 < \mathcal{R}(s) < 1$ and (iv) $-2 < \mathcal{R}(s) < -1$. [CO-4], $\{2.5 \times 4 = 10\}$

3. Consider a continuous-time linear time invariant system for which input $x(t)$ and output $y(t)$ are related by $\frac{d^2y(t)}{dt^2} - \frac{dy(t)}{dt} - 2y(t) = x(t)$.

   1. Determine the system transfer function and plot its pole zero pattern. [CO-4], $\{3\}$
   2. Determine the impulse response if the system is (i) stable, (ii) causal and (iii) neither stable nor casual. [CO-4], $\{3\}$

4. A causal discrete-time linear time invariant system for which input $x[n]$ and output $y[n]$ are related by $y[n] - \frac{3}{4}y[n-1] + \frac{1}{8}y[n-2] = x[n]$.

   1. Determine the system transfer function. [CO-5], $\{3\}$
   2. Determine the impulse response of the system. [CO-5], $\{3\}$

5. The signals $x_1(t) = 10\cos(100\pi t)$ and $x_2(t) = 10\cos(50\pi t)$ are both sampled with $f_s = 75$ Hz. Show that two sequences so obtained are identical. [CO-4], $\{6\}$

6. Find the Fourier transform of CT unit step function. [CO-3], $\{6\}$

7. Find the final value of signals corresponding to z-transforms (i) $X_1(z) = \frac{1+z^{-1}}{1-0.25z^{-2}}$ and $X_2(z) = \frac{1}{1+2z^{-1}-3z^{-2}}$. [CO-5], $\{3 \times 2 = 6\}$

8. Determine $x(0)$ and $x(\infty)$ if $X(s) = \frac{10(2s+3)}{s(s^2+2s+5)}$. [CO-5], $\{6\}$

9. If $x_p(t)$ represents an impulse train for any $x_c(t)$, obtain equations for $X_c(\Omega)$, $P(\Omega)$, $X_p(\Omega)$, and $X_d(\omega)$. In addition, neatly sketch and label them. [CO-4], $\{6\}$
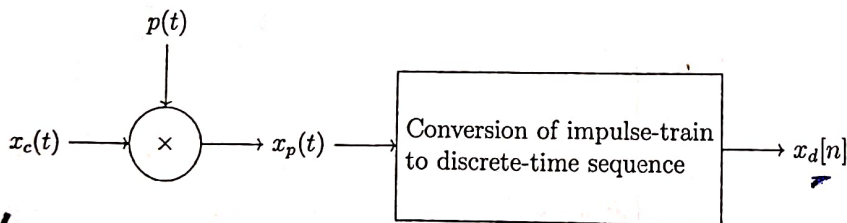
10. Neatly sketch and label the magnitude spectra after upsampling by 2 and downsampling by 9 for $x[n]$ whose spectrum is $X(\omega) = \begin{cases} 1 - \frac{|\omega|}{\omega_0}, & |\omega| \leq \omega_0, \\ 0, & |\omega| > \omega_0. \end{cases}$. Here $\omega_0 = 2\pi/9$. [CO-5], $\{6\}$

End of exam