Roll No.:......................

National Institute of Technology, Delhi

Name of the Examination: B. Tech. (End Term)

Branch	: ECE	Semester	: 3rd
Title of the Course	: Signals And Systems	Course Code	: ECB 204

Time: 3 Hours — Maximum Marks: 50

Section A

Note: All parts are compulsory of 02 mark each.

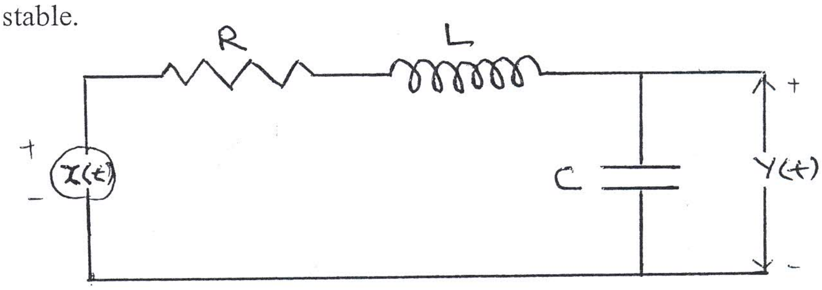
1. Determine whether the signal $x(t) = je^{j10t}$ is periodic or aperiodic. If it is periodic, specify its fundamental period.

2. Determine whether continuous time system with input $x(t)$ and output $y(t)$ related by $y(t) = sin\,(2t\,x(t))$, is causal.

3. Consider a discrete time system with input $x[n] = \sum_{k=n-n_0}^{n+n_0} x[k]$, where n_0 is finite positive integer. Is this system time invariant?

4. Consider an LTI system with input $x[n]$ and unit impulse response $h[n]$ specified as follows:
$$x[n] = 2n\,u[-n],$$
$$h[n] = u[n].$$
Calculate the output response $y[n]$ of the LTI system.

5. Consider the RLC circuit shown in figure below. Show that if R, L, and C are all positive then this LTI system is stable.



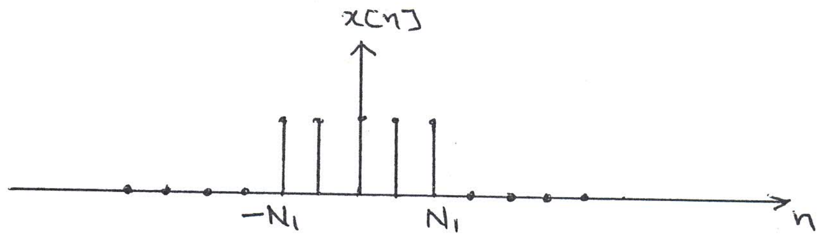
Section B

Note: Attempt any four of 05 mark each.

6. Consider the following discrete time signals with a fundamental period of 6,
$$x[n] = 1 + cos\left(\frac{2\pi}{6}n\right),\ y[n] = sin\left(\frac{2\pi}{6}n + \frac{\pi}{4}\right),\text{ and } z[n] = x[n] \times y[n]$$
   a. Determine the Fourier series coefficients of $x[n]$.
   b. Determine the Fourier series coefficients of $y[n]$.
   c. Use the results of part (a) and (b), along with the multiplication property of DTFS, to determine the Fourier series coefficients of $z[n]$.

7. By considering the Fourier transform pair $e^{-|t|} \overset{CTFT}{\longleftrightarrow} \frac{2}{1+\omega^2}$, find the Fourier transform $G\,(j\omega)$ of the signal $g(t) = \frac{2}{1+t^2}$, using the duality property.

8. Find the DTFT of the following signal $x[n]$,



9. Determine the magnitude and phase spectrum of the following signal

$$y[n] + \frac{1}{2}y[n-1] = x[n] - x[n-1]$$

10. Let us consider an LTI system with system function, $H(s) = \frac{s-1}{(s+1)(s-2)}$, determine the inverse Laplace transform when system is

a. Causal and unstable.
b. Non-causal and unstable.

Section C

Note: Attempt any two of 10 mark each.

11.

a. State and prove the sampling theorem. Explain Nyquist rate and Sampling rate.
b. Determine the Nyquist corresponding to each of the following signals:
   i. $x(t) = 1 + \cos(2000\pi t) + \sin(4000\pi t)$.
   ii. $x(t) = \left(\frac{\sin 4000\,\pi t}{\pi t}\right)^2$.

12. Consider the LTI system for which we are given the following information:

$$X(s) = \frac{s+2}{s-2},$$
$$x(t) = 0, t > 0, \text{ and}$$
$$y(t) = -\frac{2}{3}e^{2t}u(-t) + \frac{1}{3}e^{-t}u(t).$$

a. Determine $H(s)$ and its region of convergence.
b. Determine $h(t)$.

13. Find the inverse z-transform of the following H(z) by the partial fraction method

$$H[z] = \frac{z+2}{(2z^2 - 7z + 3)}$$

If the ROC are

i. $|z| > 3$,
ii. $|z| < \frac{1}{2}$,
iii. $\frac{1}{2} < |z| < 3$.