B. Tech.
(Semester-III) Theory Examination, 2011-12
BASIC SYSTEM ANALYSIS

Time : 3 Hours] [Total Marks : 100

Note : Attempt questions from all Sections as per directions.

Section-A

1. Attempt all parts of this question. 2x10 = 20
(a) Differentiate between Loop analysis and Nodal analysis.
(b) Define reciprocity theorem.
(c) State convolution theorem.
(d) Sketch the waveform from the expression:
   \[ i(t) = 1.5 \left( 1 - e^{-4t} \right) u(t) - 1.5 \left[ 1 - e^{-4(t-0.1)} \right] u(t-0.1) \]
   where \( u(t) \) and \( u(t-0.1) \) are unit step functions.
(e) Determine Laplace transform of \( \sinh \alpha t \).
(f) List the properties of a R-L admittance function.
(g) What will be analogous of damping in f-v model?

(h) Define a state variable.

(i) What will be the derivative of a step function?

(j) Find the time constant of series RL circuit.

**Section-B**

2. Attempt all parts of this question. \(6 \times 5 = 30\)

(a) Sketch the waveform from the expression:

\[
V(t) = u(t) + \sum_{k=1}^{\infty} (-1)^k 3u(t-k)
\]

(b) Draw force-current analogy of the mechanical system (Fig. 1):

![Diagram](image)

Fig. 1
(c) Define odd and even function. Also find Fourier coefficient for odd and even function.

(d) Find Laplace inverse of the function:

\[
\left( \frac{s + 4}{2s^2 + 5s + 3} \right).
\]

(e) Define state transition matrix. Explain the properties of state transition matrix.

Section-C

Attempt all questions from this Section. \(10 \times 5 = 50\)

3. Attempt any two parts of the following:

(a) Explain the gate, impulse and ramp signal used in basic system analysis.

(b) Synthesize a triangular wave given in Fig. 2 in terms of ramp and step signals.

\[f(t)\]

\[\begin{array}{c}
A \\
O \\
t_1 \\
t
\end{array}\]

Fig. 2
(t) Determine \( \frac{X(s)}{F(s)} \) of the given system shown in Fig. 3.

![Diagram of a mechanical system](image)

Fig. 3

4. Attempt any one part of the following:

(a) Determine the Fourier series for the sawtooth waveform of unity magnitude.

(b) Find the Fourier series of the function given in Fig. 4. and is represented by:

\[
f(t) = \begin{cases} 
0 & \text{for } 0 \leq t \leq T/2 \\
A & \text{for } T/2 \leq t < T
\end{cases}
\]
5. Attempt any two parts of the following:

(a) Find $L[t^2 \sin \omega t]$ using the following relation:

$$L[t f(t)] = -\frac{d}{ds} F(s).$$

(b) Using Laplace transform, solve differential equation:

$$2\dddot{x} + 7\ddot{x} + 6x = 0,$$
where $x(0) = 0$, $\dot{x}(0) = 1$.

(c) Consider a series RL circuit shown in Fig. 5. The switch is closed at time $t = 0$, find the current $i(t)$ using Laplace transform.
6. Attempt any one part of the following:
   
   (a) Obtain the state transition matrix of the following system:

   $\begin{bmatrix}
   0 & 1 \\
   -6 & -5 
   \end{bmatrix}
   X$ with $X(0)=\begin{bmatrix}
   1 \\
   0
   \end{bmatrix}$

   (b) Define controllability and observability in state variable analysis with suitable example.

7. Attempt any two parts of the following:

   (a) State and explain initial and final value theorem using $z$-transform analysis.

   (b) Find inverse of $z$-transform of the following function:

   $$F(z) = \frac{1}{2(z + 0.5)(z - 1)}.$$
(c) Find the $z$-transform of the following:

(i) $x(n) = a^n u(n)$

(ii) $x(n) = -b^n u(-n-1)$.