Code No: RR320201 **Set No. 1**

**III B.Tech II Semester Supplementary Examinations,**
**November/December 2005**
**ANALYSIS OF LINEAR SYSTEMS**
**(Electrical & Electronic Engineering)**

**Time: 3 hours** **Max Marks: 80**

**Answer any FIVE Questions**
**All Questions carry equal marks**

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1. (a) Discuss about the mechanical coupling devices used and the corresponding electrical network elements.
   (b) Describe a mechanical lever systems, develop the mathematical model for it and hence draw the relevant electric analogous circuits. [8+8]

2. (a) Explain what is meant by state variable and Mention the advantages of state space approach
   (b) Develop the state variable model equations of the following network using equivalent source approach. figure 1
   (c) Obtain the state-space representation of the series R-L-C circuit excited by e(t) and the response is i(t). [4+6+6]

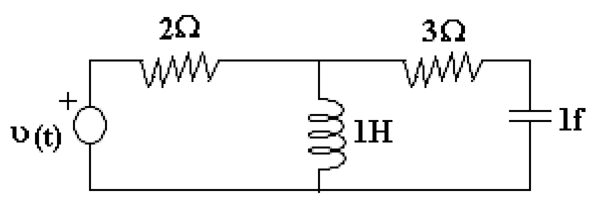


Figure 1:

3. (a) Distinguish between unit impulse function and unit doublet function and hence develop the Laplace transform of these functions.
   (b) Find the expressions for the current i(t) in a series R-L-C circuit, with R=5Ω, L=1H, C=$\frac{1}{4}$ F, when it is fed by a ramp voltage of 12 r(t-2). [3+3+10]

4. (a) Find the Laplace transforms function of the periodic waveform shown in figure 2
   (b) State and prove convolution theorem
   (c) Show that convolution of any function with unit impulse function is the functions itself [6+5+5]

5. (a) A voltage of v(t) =192 cos (cot - 22.50) + 104 $\left[\cos 3 \text{ cot } \frac{-\cos 5wt}{5} \frac{-\cos 7wt}{7}\right]$ is applied to a series R-L-C circuit with R = 10Ω, L = 0.1H, C = 100 micro-farads. Find the expression for the current. Assume the frequency of source is 50 Hz.

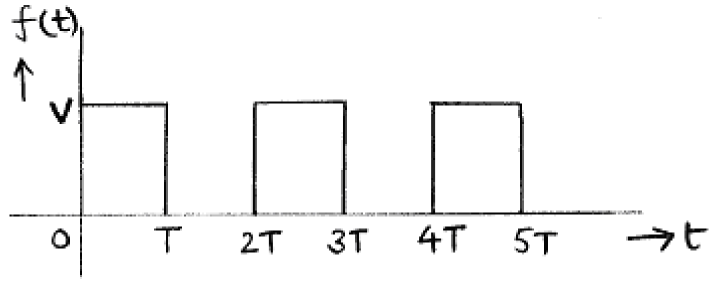


Figure 2:

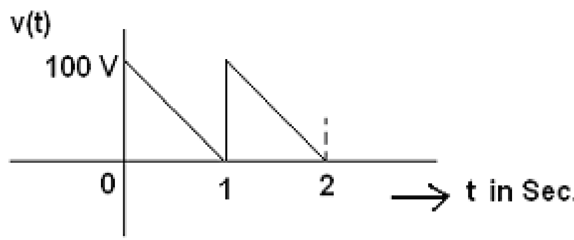


Figure 3:

(b) Find the fourier series for the waveform shown in figure 3 In real form.[10+6]

6. (a) State and explain the properties of Fourier Transform.

   (b) Define Signum function and hence develop the expression for Fourier transform of it. [8+8]

7. (a) Test whether the following polynomial is Hurwitz or not?
   $H(s) = s^4 + 2s^3 + 2s^2 + 6s + 10$

   (b) Test whether the following function is positive real or not?
   $F(s) = (s^3 + 2s^2 + 1)/(s^4 + s^3 + 3s^2 + s + 1)$ [8+8]

8. The driving point impedance of a one port L- C network is given by
   $Z(s) = 4(s^2 + 1)(s^2 + 9)(s^2 + 25)/s(s^2 + 4)(s^2 + 16)$
   Obtain the first and second Foster form of equivalent networks. [8+8]

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1. (a) For the figure 1 shown below , draw the mechanical system. And hence write the equilibrium equations
   (b) Draw the electrical analogous circuits for the mechanical system shown in figure2 [8+8]

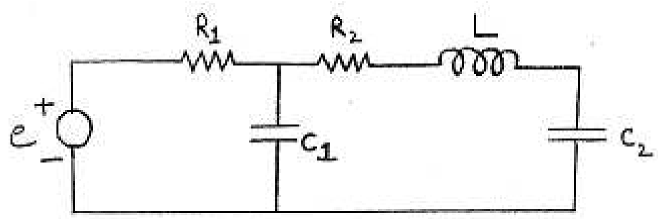


Figure 1:

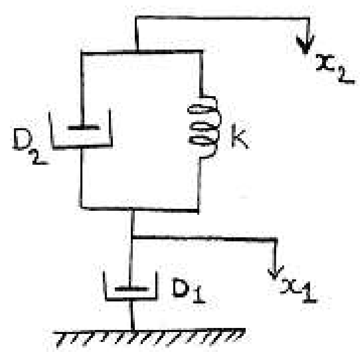


Figure 2:

2. (a) The transfer function of a system is $G(s) = \frac{2}{(s+1)(s+2)}$ obtain the state variable representation of the systems. [8+8]
   (b) Determine the state transition matrix for the system represented by the characteristic matrix $A = \begin{bmatrix} 3 & 0 & 0 \\ 0 & -2 & 1 \\ 1 & 4 & 1 \end{bmatrix}$

3. (a) A pulse voltage of width '2'sec. and magnitude of 10V is applied at time t=0 to a series R-L circuit consisting of resistance 4 Ω and inductor of 2H. Find the current I(t). Assume zero current through the inductor before the application of the voltage.

(b) Find the current i(t) is a series R-C circuit consisting of R=2Ω, C = $\frac{1}{4}$ Farads, when the input voltage 2r(t-3) [8+8]

4. (a) Find the Laplace transforms function of the periodic waveform shown in figure 3

(b) State and prove convolution theorem

(c) Show that convolution of any function with unit impulse function is the functions itself [6+5+5]

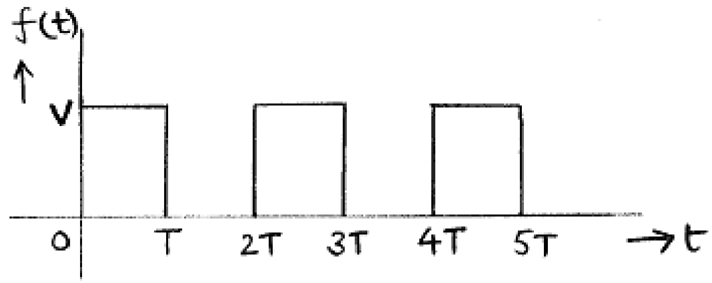


Figure 3:

5. (a) Derive the expression for Average power of a complex wave which is expressed in terms of fourier series.

(b) The current waveform shown in figure 4 is applied to a circuit containing 0.01 micro-farads in parallel with 1 kilo ohm with a range of frequency 13 to 14 kHz. Find the average power delivered to the resistor. [6+10]

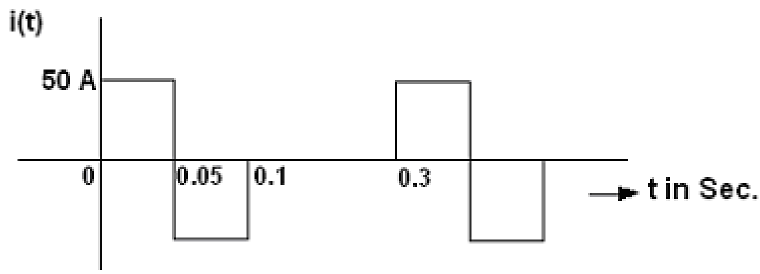


Figure 4:

6. (a) State and explain Parseval's theorem.

(b) Derive the expression for Fourier transform of unit step function. [7+9]

7. (a) Check whether the following polynomial is Hurwitz or not?
$P(s) = 2s^4 + 5s^3 + 6s^2 + 2s + 1$

(b) " All driving point immittances of passive networks are positive real functions". Substantiate the statement.

(c) State the analytical tests to be considered for a polynomial to check whether it is a positive real function or not? [7+5+4]

8. The driving point impedance of a one port L- C network is given by
$Z(s) = 4(s^2+1)(s^2+9)(s^2+25)/s(s^2+4)(s^2+16)$
Obtain the first and second Foster form of equivalent networks. [8+8]

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1. For the mechanical system shown in figure1.
   (a) Draw the mechanical network and write the equilibrium equations.
   (b) Develop the force-voltage and force-current analogous networks and hence write the corresponding equations [6+10]

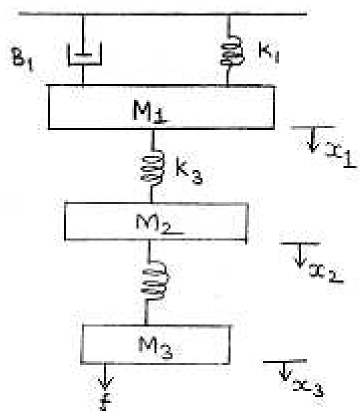


Figure 1:

2. (a) Obtain the state equations for the network shown in figure. 2 Where $i_1(t)$ *and* $i_2$ (t) are loop currents.
   (b) Evaluate the complete state response of the system characterized by $A = \begin{bmatrix} 2 & 0 \\ 1 & 1 \end{bmatrix}$ $B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ with initial state vector $X(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$ [8+8]

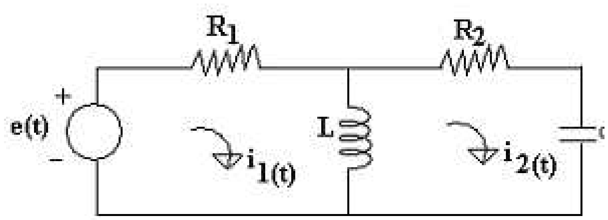


Figure 2:

3. (a) A pulse voltage of 3V between 1 to 2 sec. is applied to a series R-L circuit with R=3 Ω, L=1H, Find the current i(t).

(b) Find the current is i(t) in a series R-L-C circuit with R=3 Ω, L=1H, C=$\frac{1}{2}$F when it is driven by an impulse voltage of $\delta$ (t-2). [6+10]

4. (a) Show that Laplace transform of a full-wave rectified sine wave with amplitude of 1 is: $F(s) = \frac{1}{(s^2+1)}$ cot $h$ $\left(\frac{\pi s}{2}\right)$

   (b) Using the convolution integral find f(t) if $F(s) = \frac{10}{s(s+5)}$

   (c) Obtain Laplace transform of a train of unit impulses with a period of 1 sec [6+5+5]

5. A full-wave rectified output voltage, with an input voltage of 230 V, 50Hz, is applied to a series R-L circuit with R=2Ω, L = 3.18mH. Find [4x4=16]

   (a) Fourier coefficients

   (b) RMS value of voltage

   (c) RMS value of current

   (d) Average power consumed in the circuit and power factor of the load.

6. (a) Find the Fourier transform of a gate function

$$\begin{aligned} G(t) &= 1 \quad for \quad -\tfrac{T}{2} < t < \tfrac{T}{2} \\ &= 0 \qquad\qquad otherwise \end{aligned}$$

   (b) Find the Fourier transform of the constant signal f(t) = $A(-\infty < t < \infty)$ [8+8]

7. (a) Check whether the following polynomial is Hurwitz or not?
   $H(s) = s^4 + 2s^2 + 3s + 6$

   (b) Find the range of values of 'a' so that $H(s) = s^4 + s^3 + as^2 + s + 3$ is Hurwitz. [7+9]

8. (a) Explain how the removal of pole at infinity of an impedance Z(s) can realize an element in the network.

   (b) Realize the network with the following driving point impedance function using first Foster form.
   Z(s) = (s+2) / s(2s+5) [8+8]

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1. (a) Distinguish between translational and rotational mechanical system with suitable examples and develop the analogous relationships between various quantities of these systems.
   (b) Develop the force-current analogous circuit for the system shown in figure 1 and hence develop the nodal equations. [4+4+4+4]

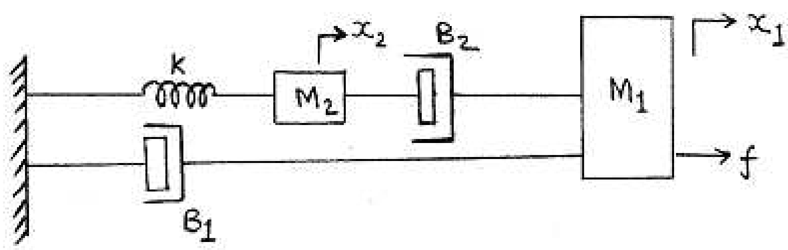


Figure 1:

2. (a) Explain what is meant by state variable and Mention the advantages of state space approach
   (b) Develop the state variable model equations of the following network using equivalent source approach. figure 2
   (c) Obtain the state-space representation of the series R-L-C circuit excited by e(t) and the response is i(t). [4+6+6]

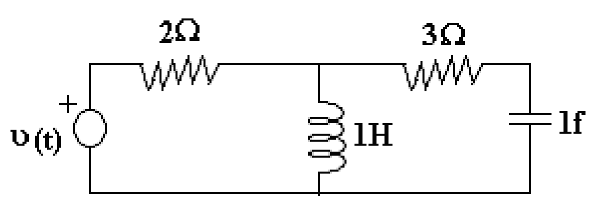


Figure 2:

3. (a) Define the following functions and obtain the Laplace transform of these:
   i. Shifted step function
   ii. Pulse
   iii. Shifted ramp function

iv. Impulse function [4x2=8]

(b) Develop the Laplace transforms of the function to be expressed for the following waveforms. figure 3 [8]

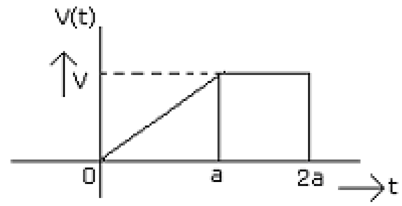


Figure 3:

4. (a) Find the Laplace Transform of the Periodic function shown in figure 4

(b) If h(t)= 2e$^{-3t}$ u(t) and x(t)= u(t)-$\delta$(t). Find y(t)=h(t)*x(t) using convolution in the time domain. [8+8]

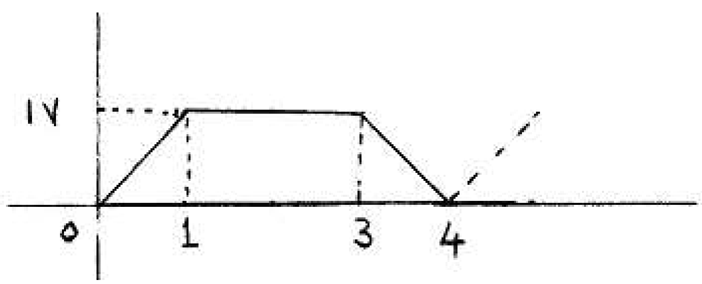


Figure 4:

5. (a) Derive the expression for Average power of a complex wave which is expressed in terms of fourier series.

(b) The current waveform shown in figure 5 is applied to a circuit containing 0.01 micro-farads in parallel with 1 kilo ohm with a range of frequency 13 to 14 kHz. Find the average power delivered to the resistor. [6+10]

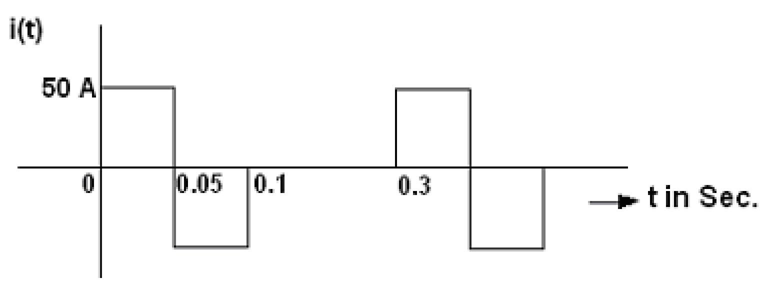


Figure 5:

6. (a) State and explain the properties of Fourier Transform.

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