Code No: 07A50206 **R07** **Set No. 2**

III B.Tech I Semester Examinations,November 2010
LINEAR SYSTEMS ANALYSIS
Electrical And Electronics Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) Discuss the properties of LC admittance function.
   (b) Check whether the following functions are LC admittance functions or not?
      i. $Z(s) = \frac{Ks(s^2+8)}{(s^2+3)(s^2+5)}$
      ii. $Z(s) = \frac{K(s^2+5)(s^2+10)}{(s^2+2)(s^2+7)}$
      iii. $Z(s) = \frac{K(s^2+2)(s^2+7)}{s(s^2+5)}$
      iv. $Z(s) = \frac{s^5+4s^3+6s}{2s^4+4s^2}$ [8+8]

2. (a) Distinguish between continuous and discrete time signals with appropriate examples.
   (b) Define discrete time sinusoidal and discrete time exponential signals with examples.
   (c) Distinguish between Laplace, Fourier and Z-transforms clearly making out the limitations of each. [4+4+8]

3. (a) Explain the concept of state, state variables and state model with the help of examples?
   (b) Explain about the Laplace transform method for solving the state equations. [8+8]

4. (a) Determine the Fourier series of the repetitive waveform as shown in figure 1 up to 7^{th} harmonic.
   (b) Determine the fundamental frequency current in the circuit as shown in figure 2 with voltage waveform as in (a). [8+8]

5. Consider the following circuit as shown in figure 3. Where x(t) is the input and y(t) is the output.
   (a) Obtain its impulse response.
   (b) From the result of (a) obtain the step response. [8+8]

6. Check whether the following polynomials are Hurwitz or not?
   (a) $s^4 + 6s^3 + 2s^2 + s + 1$
   (b) $s^4 + s^3 + 7s^2 + 4s + 6$ [8+8]

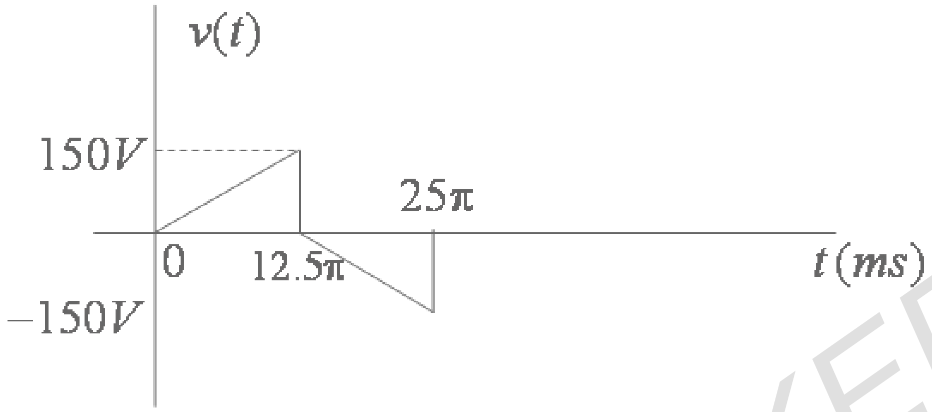

Figure 1:

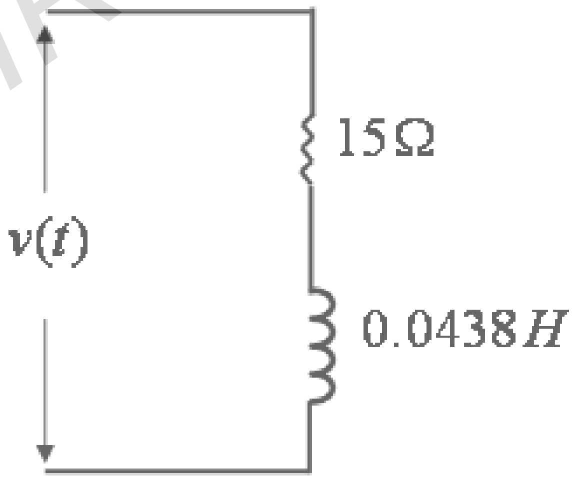

Figure 2:

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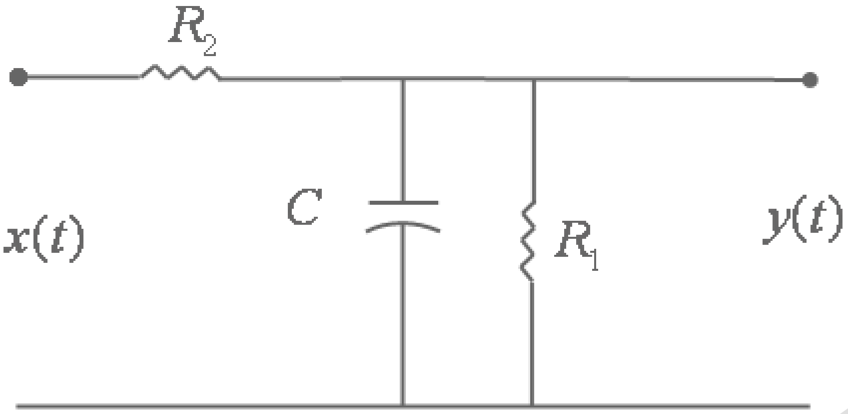

Figure 3:

7. (a) A signal g(t) consists of two frequency components $f_1 = 3.9kHz$ and $f_2 = 4.1kHz$ in such a relationship that they just cancel each other out when the signal g(t) is sampled at the instants $t = 0, T, 2T, ...,$ where $T = 125\mu s$. The signal g(t) is defined by $g(t) = \cos(2\pi f_1 t + \frac{\pi}{2}) + A\cos(2\pi f_2 t + \phi)$. Find the values of amplitude A and phase of the second frequency component.

   (b) Let E denotes the energy of a strictly band-limited signal g(t). Show that E may be expressed in terms of the sampled values of g(t), taken at the Nyquist rate, as follows
   $E = \frac{1}{2W} \sum_{n=-\infty}^{\infty} |g(\frac{n}{2W})|^2$
   Where W is the highest frequency component of g(t). [8+8]

8. (a) A signal x(t) = ASin w_0t, $w_o = 2\pi$/T with T being the time period, is passed through a full- wave rectifier. Find the spectrum of the out put waveform.

   (b) If the Fourier Transform of h(t) is H(w), prove that $\Delta T_1\ \Delta w_1 = 1$, where , $\Delta T_1 = \int_{-\infty}^{\infty} h\,(t)dt/h\,(0) \quad and \quad \Delta w_1 = \left[{}^1\!/_{2\pi} \int_{-\infty}^{\infty} H\,(w)\,dw\right]/H\,(0).$ [8+8]

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1. (a) State and prove the shifting theorem.
   (b) Obtain the impulse response of the following RLC network. as shown in figure 4 [8+8]

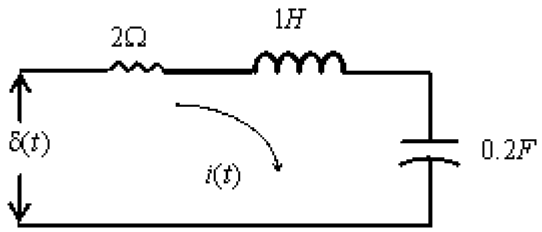

Figure 4:

2. (a) Explain the procedure by which the impedance function can be synthesized using Cauer form I.
   (b) Using the Cauer form I, synthesize the LC impedance function $Z(s) = \frac{s(s^2+4)(s^2+6)}{(s^2+3)(s^2+5)}$ [8+8]

3. (a) What are the conditions to be satisfied for the function H(s) to be positive real function .
   (b) What are the properties of positive real function? [8+8]

4. Write the state equations for the following network using as shown in figure 5
   (a) Equivalent source method
   (b) Network topological method [8+8]

5. (a) State and prove Rayleigh's energy theorem.
   (b) Determine the energy of the sinc pulse using Rayleigh's energy theorem. [8+8]

6. A series RL circuit with $R = 5\,\Omega$ $L = 20mH$, has an applied voltage $v = 100 + 50\sin\omega t + 25\sin 3\omega t\ V$, with $\omega = 300\,\text{rad/sec}$. Find the instantaneous current and power dissipated in the resistor. [16]

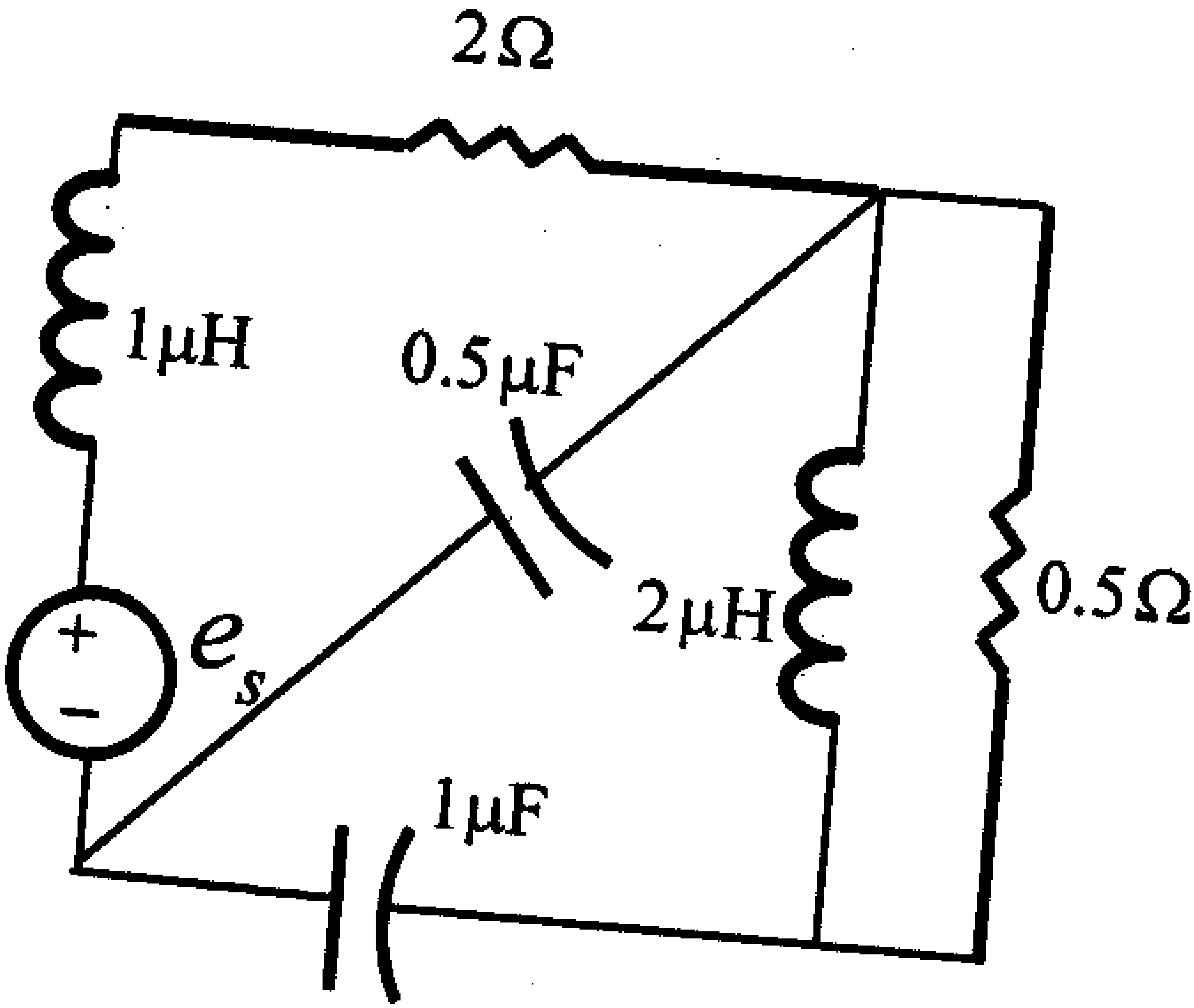

Figure 5:

7. A signal $g_1(t)$ is defined by $g_1(t) = \exp(-\alpha t)\, u(t)$ where u(t) is unit step function and $\alpha > 0$.

   (a) Find the function $g_2(t)$ obtained by convolving $g_1(t)$ with itself.

   (b) Find the Fourier transform of $g_2(t)$ [8+8]

8. The z-transform of a sequence x(n) is given by
   X(z) = z^{20} / (z-1/2) $(z-2)^5$ $(z+5/2)^2$ (z+3)
   Furthermore it is known that X(z) converges for $|z| \leq 1$

   (a) Determine the ROC of X(z)

   (b) Determine x(n) at n= -18 [8+8]

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Code No: 07A50206 **R07** **Set No. 1**

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1. State and prove the following properties of the z- Transform.
   (a) Linearity
   (b) Time Shifting
   (c) Scaling in the z-domain
   (d) Time Reversal [4+4+4+4]

2. Clearly explain with examples the Sturm's test to check positive real functions.[16]

3. (a) Explain the procedure by which the impedance function can be synthesized using Foster form I.
   (b) Using the Foster form I, synthesize the function $Z(s) = \frac{s(s^2+9)}{(s^2+5)(s^2+13)}$ [8+8]

4. (a) State and prove the convolution property of the Fourier Transform.
   (b) State and prove Modulation Theorem. [8+8]

5. Using shifting theorem find the Laplace transform of the following signals as shown in figure 6 [16]

6. Write the state equations for the following network using as shown in figure 7
   (a) Equivalent source method
   (b) Network topological method [8+8]

7. A waveform consists of a single pulse extending from t=-1 to t=1 sec and has amplitude 5 V. Find autocorrelation function and energy spectral density. [16]

8. An electric circuit is excited by a voltage v(t) as $v(t) = v_0 + \sum_{n=1}^{\infty} v_n \cos(n\omega_0 t + \theta_n)$. The corresponding steady state current is $i(t) = I_0 + \sum I_n \cos(n\omega_0 t + \phi_n)$. Define the input power at the input terminals as $P = \frac{1}{T}\int_{-T/2}^{T/2} v(t)i(t)\,dt;\ \ T = 2\pi/\omega_0$. Show that the input power can also be written as $P = V_0 I_0 + \sum \frac{V_n I_n}{2}\cos(\theta_n - \phi_n)$ [16]

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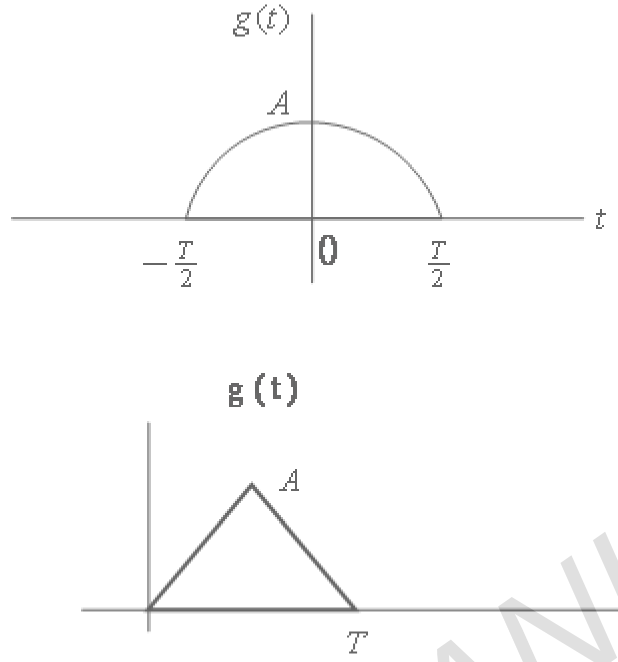

Figure 6:

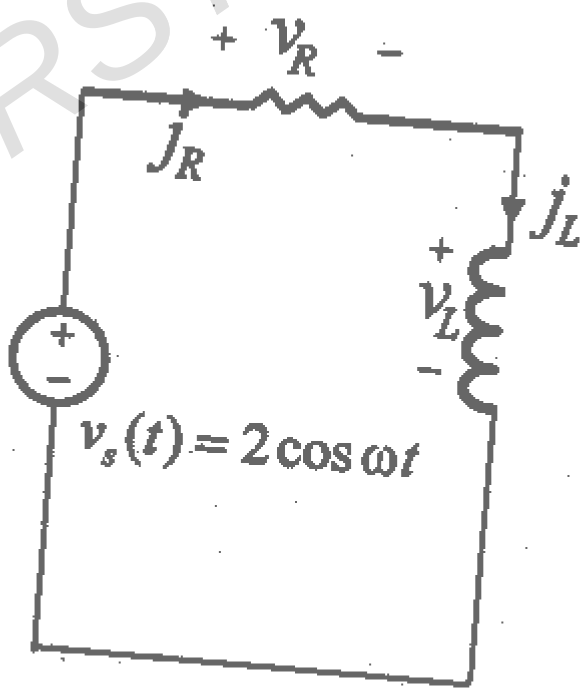

Figure 7:

Code No: 07A50206 **R07** **Set No. 3**

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Time: 3 hours Max Marks: 80

Answer any FIVE Questions
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1. (a) Explain the procedure by which the impedance function can be synthesized using Cauer form II.
   (b) Using the Cauer form II, synthesize the LC impedance function $Z(s) = \frac{s(s^2+4)(s^2+6)}{(s^2+3)(s^2+5)}$ [8+8]

2. (a) Explain the Drichlet conditions.
   (b) Define even symmetry, odd symmetry and half-wave symmetry with examples?
   (c) Explain about power spectrum of a periodic signal. [4+8+4]

3. Determine the z- transform , including the region of convergence, for each of the following sequences :
   (a) $(1/2)^n$ u(n)
   (b) $-(1/2)^n$ u(-n-1)
   (c) $(1/2)^n$ u(-n)
   (d) $(1/2)^n$ [u(n) - u(n-10)]
   (e) $(1/2)^n$ n u(n) Where u(n) is the unit step sequence. [16]

4. Obtain the response of the states of the following system using
   (a) Taylor series expansion
   (b) Laplace transform method. [8+8]

$$\begin{bmatrix} \frac{dx_1(t)}{dt} \\ \frac{dx_2(t)}{dt} \end{bmatrix} = \begin{bmatrix} -7 & 1 \\ 1 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} r(t)$$

   Where r(t) is unit ramp function and $x_0^T = [1 \ \ 0]$.

5. For the first order RC series circuit (with output is taken across the resistor), find the ramp response. Using this response find its step response. [8+8]

6. For the circuit as shown in figure 8 determine i(t) using Fourier series method. [16]

7. (a) Let G(f) denote the Fourier transform of a real-valued signal g(t), and $R_g(\tau)$ its autocorrelation function. Show that $\int_{-\infty}^{\infty} [\frac{dR_g(\tau)}{d\tau}]^2 d\tau = 4\pi^2 \int_{-\infty}^{\infty} f^2|G(f)|^4 df$

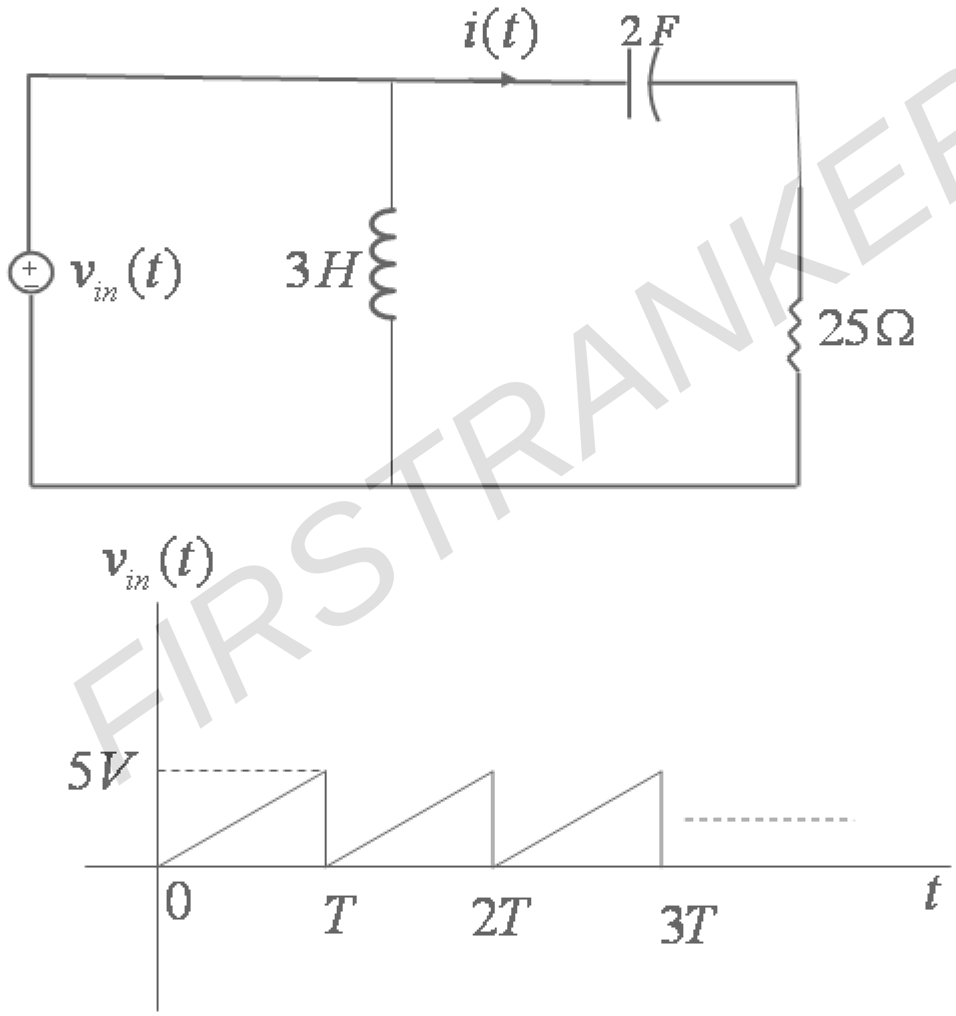

Figure 8:

(b) Consider an energy signal g(t) with its autocorrelation function defined by $R_g(\tau)$. Show that $|R_g(\tau)| \leq R_g(0)$. [8+8]

8. (a) Give two examples to show that if $Z_1(s)$ and $Z_2(s)$ are positive real, then $Z_1(s)/Z_2(s)$ need not be positive real.

(b) Show that, if a one-port is made of lumped passive linear time-invariant elements and if it has a driving-point impedance Z(s), then Z(s) is a positive real function. [8+8]

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