UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2009/2010

SUBJECT NAME	: ELECTRIC NETWORK ANALYSIS & SYNTHESIS
SUBJECT CODE	: BEE 3113
COURSE	: 2 & 3 BEE
EXAMINATION DATE	: NOVEMBER 2009
DURATION	: 2 ½ HOURS
INSTRUCTION	: ANSWER **FOUR (4)** QUESTIONS ONLY.

THIS PAPER CONSISTS OF 12 PAGES

Q1 Please use Table Q1 for your reference.

(a) Determine the Laplace transform of the following function:

(i) $f(t) = t^2 \sin(2t)$

(3 marks)

(ii) $g(t) = te^{-3t}$

(3 marks)

(iii) $h(t) = \sin at \cos at$

(3 marks)

(b) Obtain the Laplace transforms of the waveform shown in Figure Q1(b).

(6 marks)

(c) Solve the following functions:

(i) $G(s) = \dfrac{-2s+1}{(s-1)^2}$

(4 marks)

(ii) $\dfrac{d^2y}{dt^2} + 2\dfrac{dy}{dt} + 5y = 0$ Given: $y = 1$, $\dfrac{dy}{dt} = 0$ when $t = 0$.

(6 marks)

Q2 (a) Given a function, $h(t) = \left[3 - 3e^{-2t} + 2te^{-2t}\right]u(t)$.

(i) Find the transfer function, H(s)

(4 marks)

(ii) Construct a pole-zero map of the waveform H(s)

(3 marks)

(iii) Determine the output, y(t) if an input of $x(t) = te^{-3t}u(t)$ is applied to the system.

(8 marks)

(b) The convolution integral is used in finding the output response, y (t) of a system to an excitation input, x (t). A linear circuit has an impulse response, $h(t) = \left[u(t) - 2u(t-1) - u(t-2)\right]$ as shown in Figure Q2 (b). An input, $x(t) = \left[u(t) - u(t-1)\right]$ is applied to the linear circuit.

(i) Sketch the input response, x (t).

(1 mark)

(ii) Find the response, y (t) using the convolution integral.

(9 marks)

Q3 (a) Explain the impedance characteristic of an RLC series circuit at resonance condition.

(4 marks)

(b) Based on Figure Q3 (b);

(i) Prove the resonant frequency, ω_n is given by $\omega_n = \frac{1}{\sqrt{LC}}\sqrt{1-\frac{L}{R_2{}^2C}}$.

(6 marks)

(ii) Determine the resonant frequency ω_n if the value of R_1=1kΩ, R_2=10kΩ, L=1mH and C=0.4uF.

(3 marks)

(c) Based on Figure Q3 (c);

(i) Find the transfer function $H(s)=\frac{I_0}{V_s}$.

(4 marks)

(ii) Construct the Bode magnitude and phase plots for H(s).

(8 marks)

Q4 (a) State the definition of frequency selective filter.

(1 mark)

(b) Name two different groups of filters. For each group, list two (2) advantages and two (2) disadvantages offered by them.

(10 marks)

(c) Using a table, explain 4 basic types of filter and sketch its frequency response.

(8 marks)

(d) Determine the values of inductor and resistor to design an RLC band stop filter given the $f_0 = 8\ kHz$, $C = 500\ nF$ and $Q = 6$.

(6 marks)

Q5 (a) Find the *h* parameters for the two port network shown in Figure Q5(a). Use the following values: R_1=2Ω, L_1=2H, L_2= 1H and C_1=2F.

(10 marks)

(b) A linear network has *y* parameters as below.

$$y = \begin{bmatrix} 0.75 & -0.5 \\ -0.5 & 0.625 \end{bmatrix} \text{S}$$

(i) Find the resistive circuit.

(7 marks)

(ii) Determine the *z* parameters and draw the equivalent circuit.

(8 marks)

Q6 (a) (i) State the definition of Exponential Fourier Series.

(2 marks)

(ii) Determine the Exponential Fourier Series of the waveform shown in Figure Q6(a)(ii). Plot the magnitude spectrum of this waveform (from n = -4 to n = 4) and label the diagram. What can be deduced from the observation of magnitude spectrum?

(9 marks)

(b) The input current to the circuit shown in Figure Q6(b) is a sawtooth wave having the following Fourier series expansion:

$$i(t)=\frac{1}{2}-\frac{1}{\pi}\sin(\pi t)-\frac{1}{2\pi}\sin(2\pi t)-\frac{1}{3\pi}\sin(3\pi t)\ -\cdots$$

The circuit is designed to produce the output voltage, $v_o(t)$ so that the magnitude of the fundamental component is 80 % less than the magnitude of the input signal.

(i) Determine the value of inductor.

(6 marks)

(ii) Find the first three (3) nonzero terms of the output signal, $v_o(t)$ using the value of inductor obtained in part (b)(i).

(8 marks)

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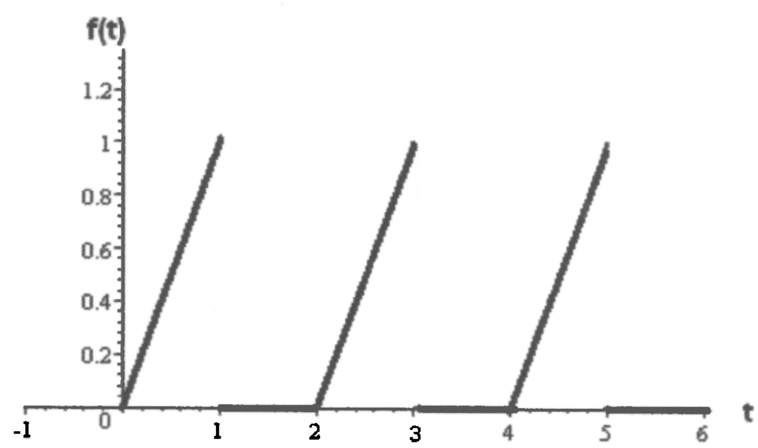

Figure O1 (b)

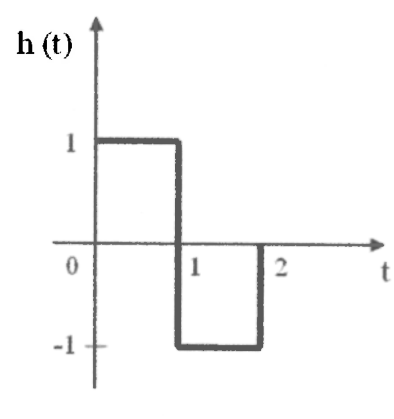

Figure O2 (b)

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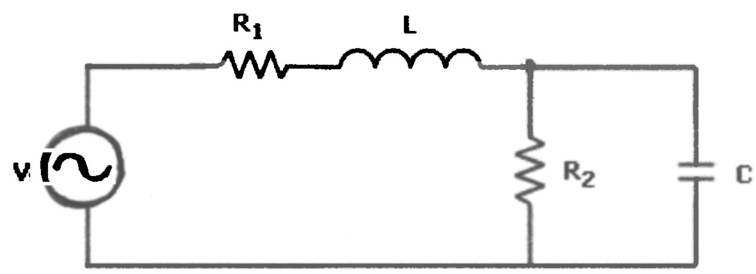

Figure Q3 (b)

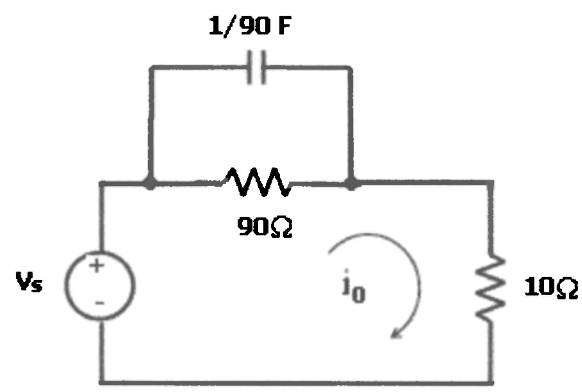

Figure Q3 (c)

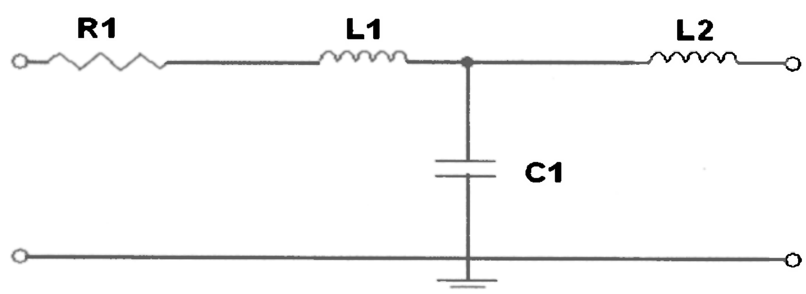

Figure Q5 (a)

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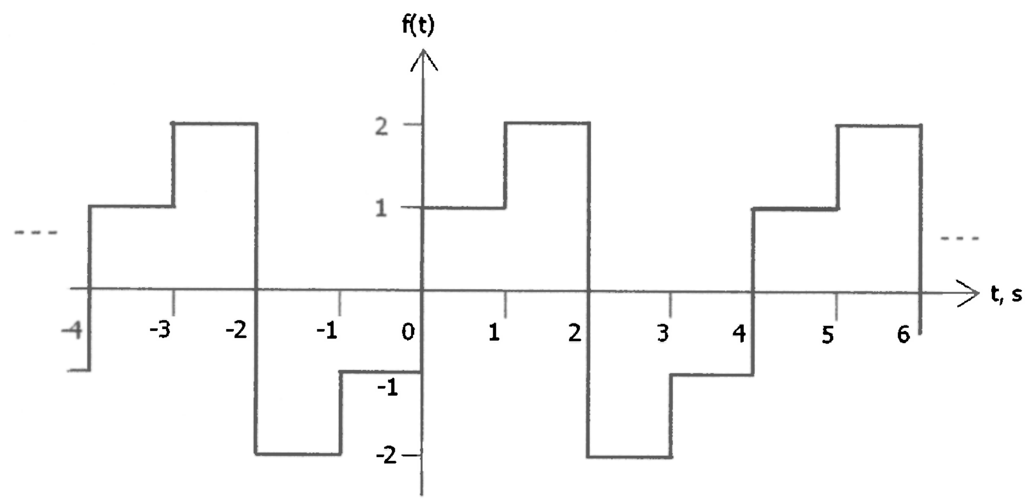

Figure Q6(a)(ii)

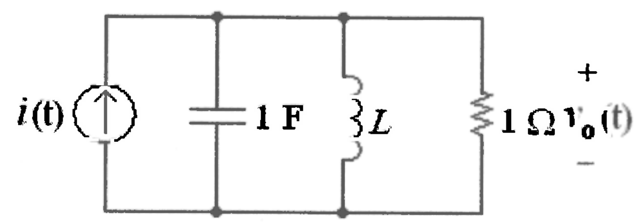

Figure Q6(b)

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Table 1: Properties of Laplace Transform

No.	f(t)	F(s)
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	$t^n u(t)$	$(n!)/s^{n+1}$
5.	$e^{-at} u(t)$	$1/(s+a)$
6.	$\sin \omega t\ u(t)$	$\omega/(s^2+\omega^2)$
7.	$\cos \omega t\ u(t)$	$s/(s^2+\omega^2)$
8.	$f(at)$	$\frac{1}{a}F(\frac{s}{a})$
9.	$e^{-at} f(t)$	$F(s+a)$
10.	$f(t-a)\ u(t-a)$	$e^{-as}F(s)$
11.	$\frac{df}{dt}$ $\frac{d^n f}{dt^n}$	$sF(s)-f(0^-)$ $s^nF(s)-s^{n-1}f(s)$ $-s^{n-2}f'(0)..-f^{(n-1)}(0^-)$
12.	$\int_0^t f(t)dt$	$\frac{1}{s}F(s)$
13.	$tf(t)$	$-\frac{d}{ds}F(s)$
14.	$\frac{f(t)}{t}$	$\int_s^\infty F(s)ds$
15.	$f(t+nT)$	$\frac{F_1(s)}{1-e^{-sT}}$
16.	$f(0)$	$\lim_{s\to\infty} sF(s)$
17.	$f(\infty)$	$\lim_{s\to 0} sF(s)$
18.	$f_1(t)*f_2(t)$	$F_1(s).F_2(s)$

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Table 2: Trigonometric Integrals

$\sin(A \pm B) = \sin A \cos B \pm \cos A \sin B$ $\cos(A \pm B) = \cos A \cos B + \sin A \sin B$ $\sin A \cos A = \frac{1}{2}\sin 2A$
$\int_0^T \sin n\omega_o t \; dt = 0$
$\int_0^T \cos n\omega_o t \; dt = 0$
$\int_0^T \sin n\omega_o t \; \cos m\omega_o t \; dt = 0$
$\int_0^T \sin n\omega_o t \; \sin m\omega_o t \; dt = 0, \quad (m \neq n)$
$\int_0^T \cos n\omega_o t \; \cos m\omega_o t \; dt = 0, \quad (m \neq n)$
$\int_0^T \sin^2 n\omega_o t \; dt = T/2$
$\int_0^T \cos^2 n\omega_o t \; dt = T/2$

Table 3: Fourier Transform Pairs

Pair	$f(t)$	$F(\omega)$
1	$\delta(t)$	1
2	A	$2\pi A\delta(\omega)$
3	$\text{sgn}(t)$	$2/j\omega$
4	$u(t)$	$\pi\delta(\omega) + 1/j\omega$
5	$e^{-at}u(t)$	$1/(a + j\omega), a > 0$
6	$e^{at}u(-t)$	$1/(a - j\omega), a > 0$
7	$e^{-a\|t\|}$	$2a/(a^2 + \omega^2), a > 0$
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega - \omega_0)$
9	$\cos(\omega_0 t)$	$\pi[\delta(\omega + \omega_0) + \delta(\omega - \omega_0)]$
10	$\sin(\omega_0 t)$	$j\pi[\delta(\omega + \omega_0) - \delta(\omega - \omega_0)]$