UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2010/2011

COURSE NAME	:	ELECTRIC NETWORK ANALYSIS AND SYNTHESIS
COURSE CODE	:	BEE 3113 / BEX 31303
PROGRAMME	:	2 BEE / 3 BEE
EXAMINATION DATE	:	NOVEMBER / DECEMBER 2010
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	THIS EXAMINATION PAPER CONSISTS OF PART A AND PART B. ANSWER ONLY FOUR (4) QUESTIONS FROM PART A & ONE (1) QUESTION FROM PART B.

THIS PAPER CONSISTS OF NINE (9) PAGES

PART A: ANSWER **FOUR (4)** QUESTIONS ONLY

Q1 (a) Given a function, $f(t) = 2t^2 \sinh at\, u(t)$. By using the Laplace Transform definition, determine the Laplace Transform of the time integration $f(t)$. Given that $\sinh x = \frac{1}{2}\left(e^x - e^{-x}\right)$.

(6 marks)

(b) Obtain the Laplace Transform of the function in Figure **Q1(b)**.

(6 marks)

(c) Determine the time domain function, *i(t)* for $I(s) = \dfrac{31s^2 + 8}{s(s+10)(s+9)^2}$.

(6marks)

(d) Find the initial value for the function, $F(s) = \dfrac{14s^2 + 6}{s(s+1)(s+5)}$.

(2 marks)

Q2 (a) A system has a transfer function, $H(s) = \dfrac{1}{(s+2)} + \dfrac{s}{(s^2+4)} - \dfrac{2}{(s^2+4)}$.

Based on the transfer function given,

(i) plot the poles and zeros diagram.

(2 marks)

(ii) find the output, $y(t)$ if given an input, $x(t) = 2e^{-2t}$.

(6 marks)

(iii) justify if this is a stable system or not.

(2 marks)

(b) The voltage across a 500Ω resistor in a series RLC circuit is $V_R(t) = 10e^{-500t}\sin(3500t)$. How much additional resistance is needed for the response to become critically damped response?

(3 marks)

(c) Convolution is an invaluable tool for the engineer because it provides a means of viewing and characterizing physical systems. Figure **Q2(c)** shows the system's impulse function, $h(t)$ and input, $x(t)$. Find the output, $y(t)$ of the system using convolution integral.

(7 marks)

Q3 (a) Refer to Figure **Q3(a)**, find:

(i) the resonance frequency, ω_0.

(2 marks)

(ii) the transfer function, $\frac{V_o(s)}{V_s(s)}$.

(3 marks)

(iii) the output voltage, V_o at resonance frequency.

(2 marks)

(b) The transfer function for the circuit in Figure **Q3(b)** is given by $\frac{V_o(s)}{V_s(s)} = \frac{s(s+1)}{(s+10)^2}$,

(i) draw the magnitude and phase plot for the transfer function, $\frac{V_o(s)}{V_s(s)}$.

(8 marks)

(ii) find the value of capacitance, C, resistance, R_1 and R_2.

(5 marks)

Q4 (a) Describe FOUR (4) basic types of filter and sketch its frequency response.

(12 marks)

(b) Given a filter circuit in Figure **Q4(b)**,

(i) obtain the transfer function.

(6 marks)

(ii) identify the type of filter the circuit represents, if $R_f = R_i$.

(2 marks)

Q5 (a) Two sets of measurements are made on a two-port resistive circuit. The first set is made with port 2 open-circuited, and the second set is made with port 2 short-circuited. The results are as follows:

Port 2 open circuited	**Port 2 short circuited**
$V_1 = 10\text{mV}$	$V_1 = 24\text{mV}$
$I_1 = 10\mu\text{A}$	$I_1 = 20\ \mu\text{A}$
$V_2 = -40\text{V}$	$I_2 = 1\text{mA}$

Find the hybrid (h) parameter for this network.

(12 marks)

(b) Figure Q5(b) shows the Z parameter equivalent network for non-reciprocal case.

(i) By using Kirchhoff's Voltage Law, prove the following equations:-

$$V_1 = z_{11}I_1 + z_{12}I_2$$
$$V_2 = z_{21}I_1 + z_{22}I_2$$

(4 marks)

(ii) Draw and completely label the reciprocal equivalent network.

(2 marks)

(iii) Define reciprocal properties. Explain the reciprocal condition for impedance and admittance parameter.

(2 marks)

PART B: ANSWER **ONE(1)** QUESTION ONLY.

Q6 (a) Fourier series is used in circuit analysis when the input supplied to a particular network is a type of periodic non-sinusoidal signal. Explain with the aid of a diagram how the principle of superposition is employed in analysing this type of network.

(5 marks)

(b) The circuit parameters of Figure **Q6(b)(i)** are R = 100 Ω, C = 100 μF and L = 1.2 mH. The input current in Figure Q6(b)(ii) is applied to the circuit. It is a half-wave rectified signal having the following Fourier series expansion:

$$i(t) = \frac{1}{100\pi} + \frac{1}{200} \sin \omega t - \frac{1}{150\pi} \cos 2\omega t + \cdots \text{ where } \omega = 377 \text{ rad/s.}$$

(i) Find the first two non-zero terms of the Fourier series expression for the voltage, $v_o(t)$.

(11 marks)

(ii) What would happen to the components of the voltage, $v_o(t)$ if the positions of capacitor and inductor are swapped? Please justify your answer.

(4 marks)

Q7 (a) Explain how Fourier transform could be determined from Laplace transform.

(5 marks)

(b) An input signals, $v(t) = 10e^{-t}u(t)$ is used to control a valve. The DC component of $v(t)$ is required to actuate the valve while the higher frequency components of $v(t)$ need to be attenuated in order to reduce valve wear. Thus the low pass circuit shown in Figure **Q7(b)** is employed. The circuit is designed so that the magnitude of the output voltage at ω = 5 rad/s is equal to 5 % of the magnitude of the output voltage at ω = 0 rad/s.

(i) Find the Fourier Transform of $v(t)$.

(2 marks)

(ii) Determine the value of inductor, L.

(9 marks)

(iii) Would the circuit behave differently if the output signal, $v_o(t)$ is the voltage across the resistor instead? Justify your answer.

(4 marks)

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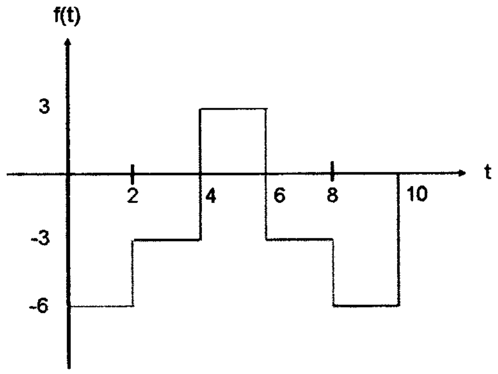

Figure Q1(b)

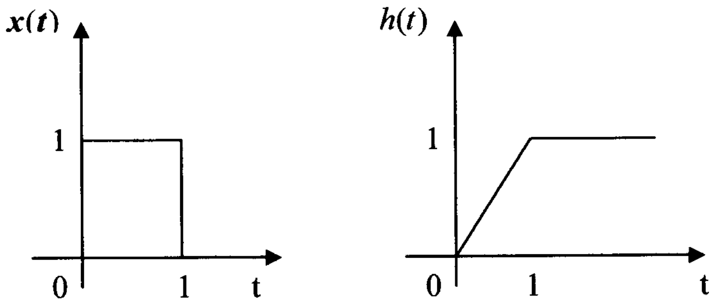

Figure Q2(c)

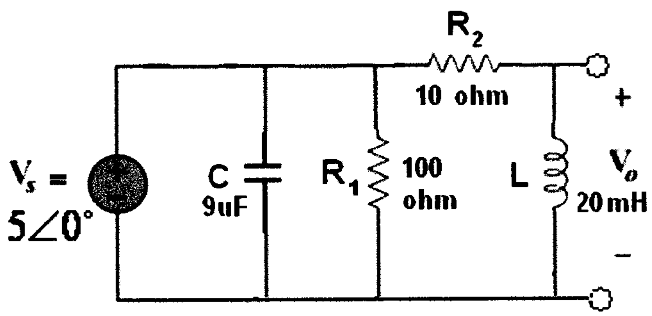

Figure Q3(a)

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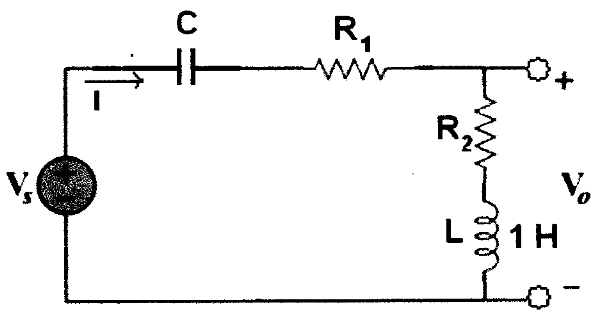

Figure Q3(b)

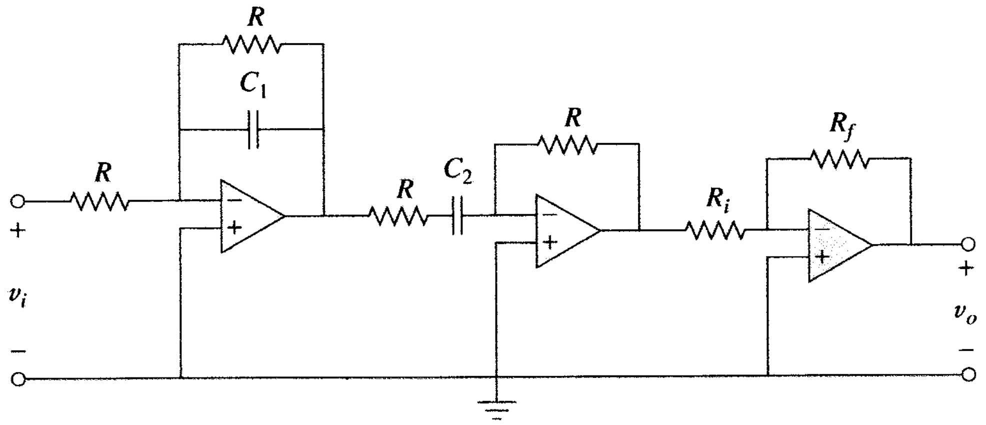

Figure Q4(b)

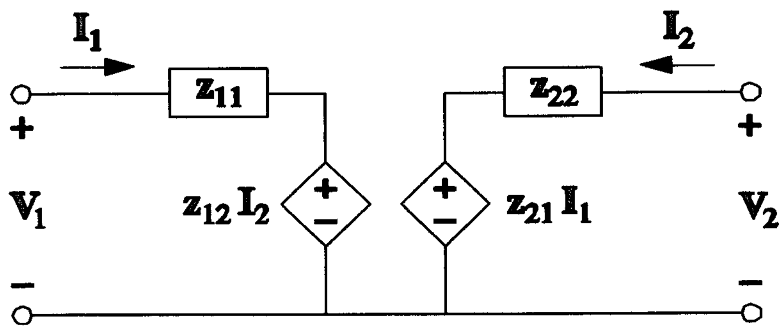

Figure Q5(b)

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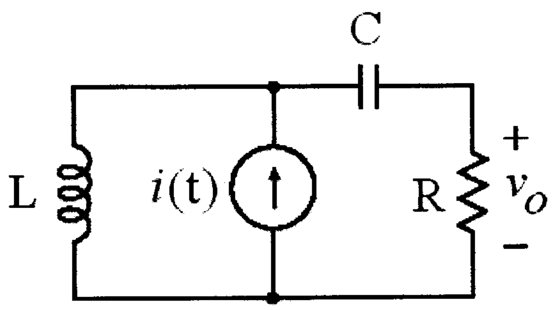

Figure Q6(b)(i)

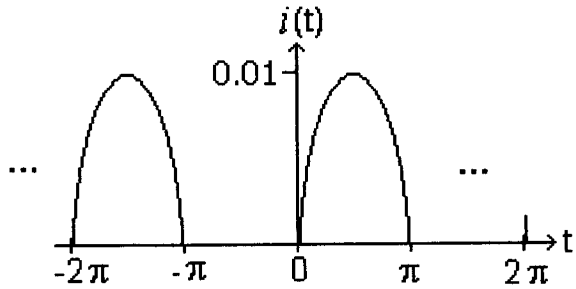

Figure Q6(b)(ii)

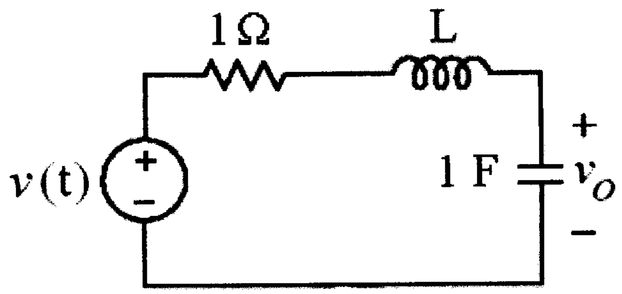

Figure Q7(b)

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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.	$\frac{df}{dt}$ $\frac{d^n f}{dt^n}$	$sF(s)-f(0^-)$ $s^n F(s)-s^{n-1}f(s)$ $-s^{n-2}f'(0)..-f^{(n-1)}(0^-)$
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 sF(s) $s \to \infty$
17.	$f(\infty)$	lim sF(s) $s \to 0$
18.	$f_1(t)*f_2(t)$	$F_1(s).F_2(s)$