UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2010/2011

COURSE NAME	:	ELECTRIC NETWORK ANALYSIS AND SYNTHESIS
COURSE CODE	:	BEX 31303 / BEE 3113
PROGRAMME	:	BACHELOR OF ELECTRICAL ENGINEERING WITH HONOURS
EXAMINATION DATE	:	APRIL / MEI 2011
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, $f(t) = 2t^2 + 10\,e^{-2t}\cosh at\,u(t)$. By using the Laplace Transform definition, determine the Laplace Transform of the time integration $f(t)$. Given that $\cosh x = \frac{1}{2}\left(e^x + e^{-x}\right)$.

(6 marks)

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

(6 marks)

(c) Determine the time domain function, *v(t)* for $V(s) = \frac{14s^2+10}{s(s+8)(s+6)^2}$.

(6marks)

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

(2 marks)

Q2 (a) Convolution is important tools as it relates the input, output and transfer function of a system. **Figure Q2(a)** shows the system's impulse function, $h(t)$ and input, $x(t)$. Find the output, $y(t)$ of the system using convolution integral.

(8marks)

(b) A system has a circuit shown in **Figure Q2(b).** With all the component values given and assuming there is no initial energy stored,

(i) find the system's transfer function, $\frac{Vo(s)}{Vi(s)}$.

(7 marks)

(ii) plot the pole-zero diagram for the system.

(2 marks)

(iii) is the system producing a stable response? Please justify your answer.

(3 marks)

Q3 (a) Consider the circuit shown in **Figure Q3(a)**. The input to this circuit is $V_{in}(t)$, and the output is $V_{out}(t)$. Assuming that there is no initial condition in the circuit,

(i) derive the circuit transfer function, $H(s) = \frac{V_O(s)}{V_i(s)}$.

(6 marks)

(ii) let R = 4Ω, L = 2H and C = 5mF, sketch the magnitude and phase bode plot for the transfer function, $H(s)$ derived in part Q3(a)(i).

(9 marks)

(b) The Quality Factor (Q) and the value of resistor (R) in the circuit shown in **Figure Q3(b)** are given by Q = 5 and R = 10KΩ. Based on the given Q and R values,

(i) find the inductance value of the inductor (L) shown in **Figure Q3(b)**.
(3 marks)

(ii) determine the Bandwidth (B) for the response.
(2 marks)

Q4 (a) Describe the magnitude response for each type of the following filter:

(i) Bandpass filter.
(2 marks)

(ii) First order low pass Chebychev Type 1 filter.
(2 marks)

(iii) Second order high pass Butterworth filter.
(2 marks)

(b) An engineer has proposed a filter network given in **Figure Q4(b)**. Assume zero initial condition. Let $R_{in} = 10k\Omega$.

(i) Solve for the transfer function $H(s) = V_o(s)/V_s(s)$ in symbolic form. Simplify your expression as much as possible.
(6 marks)

(ii) Identify the type of filter
(2marks)

(iii) Find the values of capacitor, C, resistors, R_1 and R_2 if the gain is 5 and the cutoff frequency is 3 kHz.
(4 marks)

(iv) In your opinion, suggest how to increase the overall gain of the filter.
(2 marks)

Q5 (a) Define a two port network
(2 marks)

(b) Determine the y-parameter of the two-port network if **Figure Q5(a)**.
(11 marks)

(c) Determine the h- parameter based on the y-parameter obtained from part Q5(b).
(7 marks)

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

Q6 (a) For the periodic functions in **Figure Q6(a)**,

(i) identify the type of symmetry.

(2 marks)

(ii) determine the frequency, ω_o in radians per second.

(1 mark)

(b) Sketch the amplitude and phase spectra for a function if the trigonometric Fourier series of the function is given by:

$$f(t) = 6 + 4\cos\left(t + 50^{\circ}\right) + 2\cos\left(2t + 35^{\circ}\right) + \cos\left(3t + 25^{\circ}\right) + 0.5\cos\left(4t + 20^{\circ}\right)$$

(3 marks)

(c) The periodic triangular wave in Figure **Q6(c)(i)** is applied to the RC circuit shown in Figure **Q6(c)(ii).** Let the values of $T_0 = 2\pi$ ms, $R = 10\ \text{k}\Omega$ and $C = 50\,\text{nF}$. If the Fourier coefficients of the input are:

$$a_0 = 0 \qquad a_n = 0 \qquad b_0 = \frac{160}{(n\pi)^2}\sin\left(n\frac{\pi}{2}\right)$$

(i) express $v_0(t)$ in terms of $v_i(t)$.

(3 marks)

(ii) find the first three nonzero terms in the Fourier series of $v_0(t)$.

(9 marks)

(iii) based on your result in part (c)(ii), what can you conclude about the magnitude of the nth harmonic as $n \to \infty$.

(2 marks)

Q7 (a) Determine the Fourier transform of the following signal,

$$f(t) = \begin{cases} \dfrac{At}{B}; & 0 \le t \le B \\ 0 \ ; & otherwise \end{cases}$$

(7 marks)

(b) Let the signal calculated in part Q7(a) be the input voltage, V_i, to an ideal op-amp filter circuit shown in **Figure Q7(b)**. Based on the circuit,

(i) determine the circuit transfer function, $H(\omega)$.

(9 marks)

(ii) find the Fourier transform of the output voltage, V_o, of the corresponding circuit.

(4 marks)

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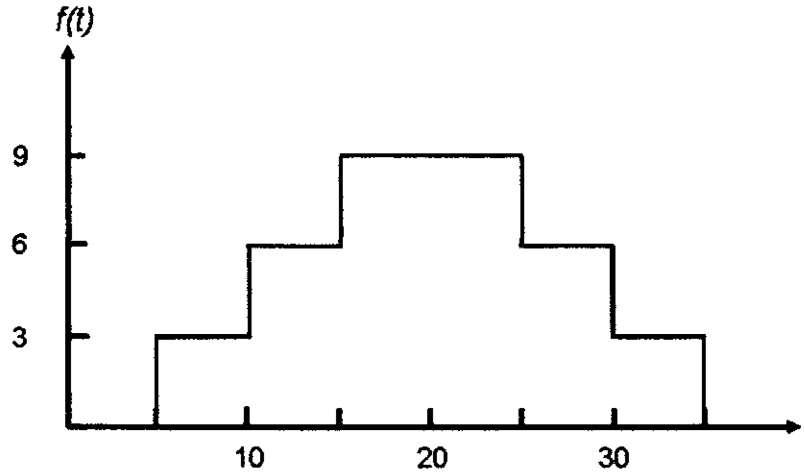

Figure Q1(b)

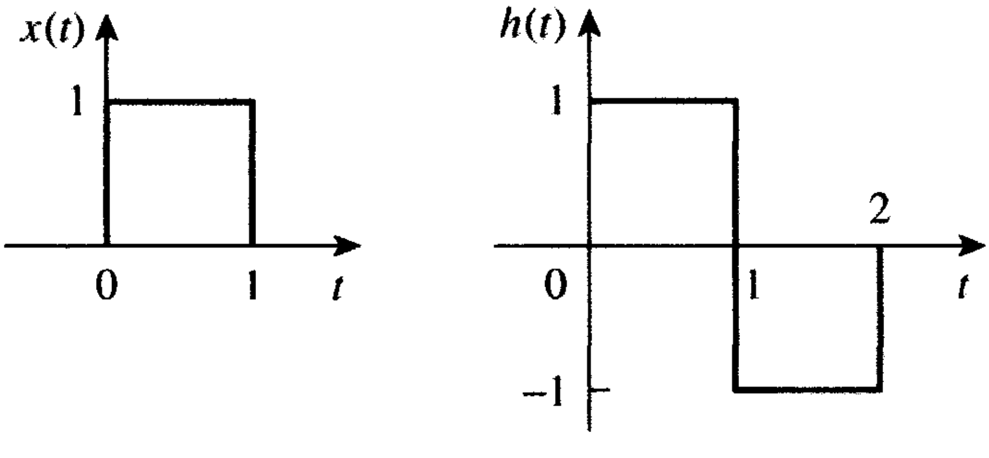

Figure Q2(a)

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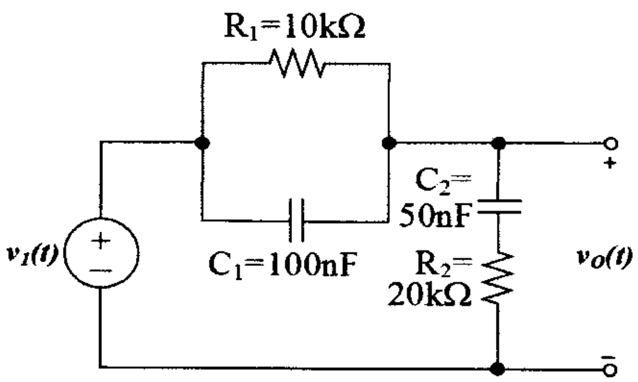

Figure Q2(b)

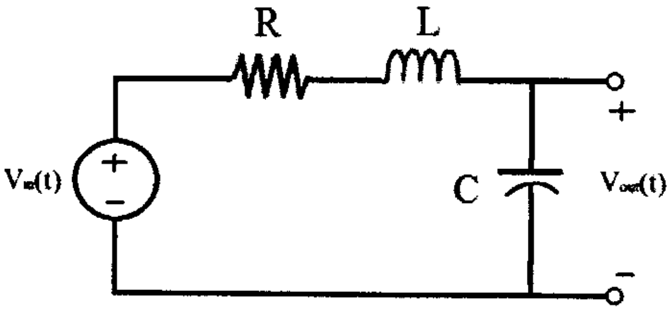

Figure Q3(a)

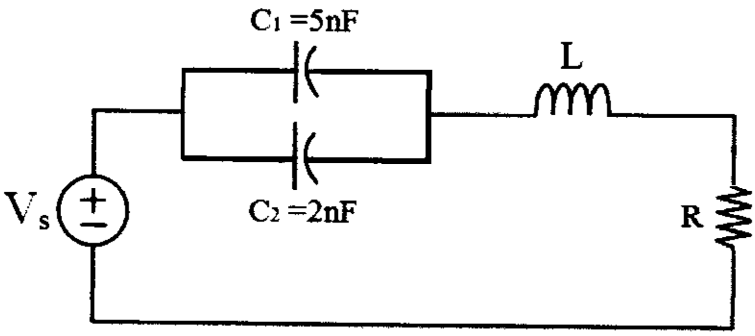

Figure Q3(b)

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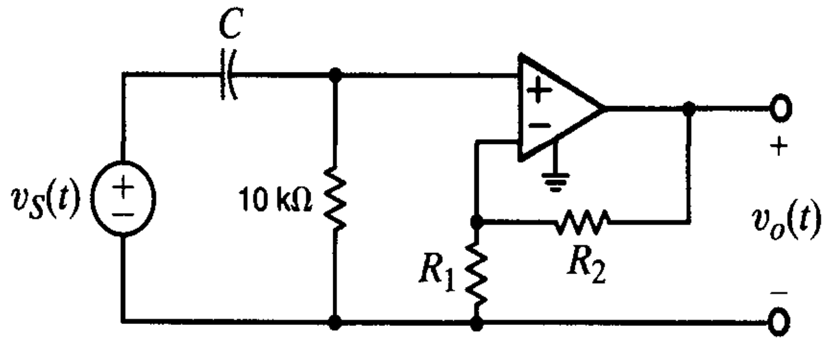

Figure Q4(b)

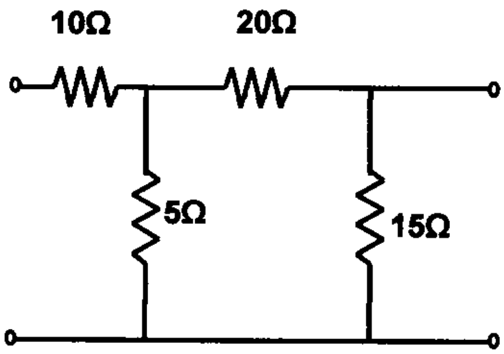

Figure Q5(a)

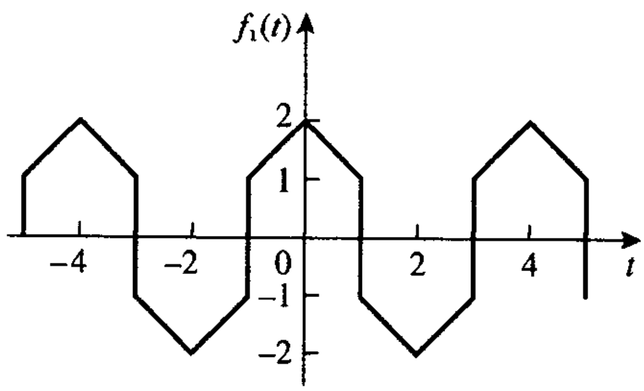

Figure Q6(a)

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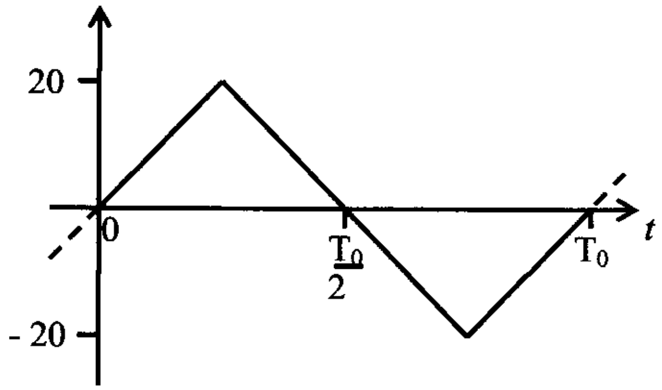

Figure Q6(c)(i)

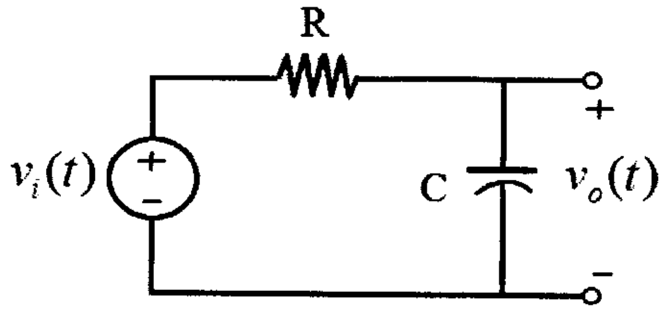

Figure Q6(c)(ii)

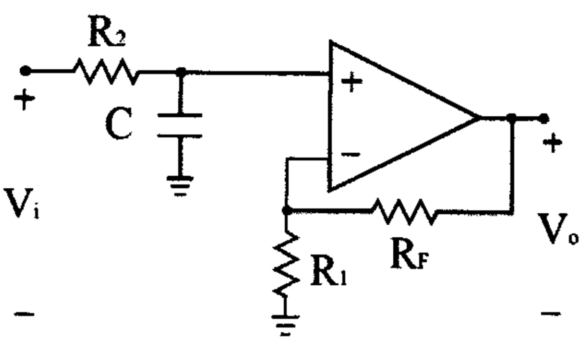

Figure Q7(b)

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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)	$\lim_{s\to\infty} sF(s)$
17.	$f(\infty)$	$\lim_{s\to 0} sF(s)$
18.	$f_1(t)*f_2(t)$	$F_1(s).F_2(s)$