Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER 1
SESSION 2019/2020

COURSE NAME	:	TRANSFORM CIRCUIT ANALYSIS
COURSE CODE	:	BEF 22803
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) Draw the signal for the given equations.

(i) $f(t) = 2t[u(t) - u(t-1)] + (-2t+4)[u(t-1) - u(t-3)] + (2t-8)[u(t-3) - u(t-4)]$

(5 marks)

(ii) $f(t) = 5t[u(t) - u(t-2)] + 10[u(t-2) - u(t-6)] + (-5t+40)[u(t-6) - u(t-8)]$

(5 marks)

(b) Two electrical signals are given in **Figure Q1(b)(i)** and **(ii)**.

(i) Find $v_o(t) = v_{s1}(t) * v_{s2}(t)$ using convolution technique

(10 marks)

(ii) Plot $v_o(t)$ from **Q1(b)(i)** over the range of 0s < t <15s

(5 marks)

Q2 (a) **Figure Q2(a)** shows the RC circuit in the time domain with $V_S = 20$ V

(i) Draw the equivalent circuit in frequency domain

(2 marks)

(ii) Determine the current, $i(t)$ and the voltage, $v(t)$ of the circuit when $t > 0$.

(4 marks)

(iii) When the V_S increase to 50 V, determine the current, $i(t)$ and the voltage, $v(t)$ of the circuit.

(4 marks)

(b) **Figure Q2(b)** shows the RLC circuit in the time domain with $i(t) = e^{-2t}u(t)$ A

(i) Draw the equivalent circuit in frequency domain

(3 marks)

(ii) Determine the $i(t)$ of the circuit.

(6 marks)

(iii) When the $i(t) = e^{-5t}u(t)$ A, determine the current, $i(t)$ of the circuit.

(6 marks)

Q3 (a) **Figure Q3(a)** shows the time domain and frequency domain of RC circuit.

(i) Express the transfer function Vo/Vs for frequency domain RC circuit.
(5 marks)

(ii) Sketch the amplitude and the phase response of the results in **Q3(a)(i)**.
(4 marks)

(b) A new system with a transfer function is cascaded to the existing system to get the new transfer function as below:

$$H_{new}(S) = \frac{250S}{(S+5)(S+10)}$$

(i) Analyze its characteristics by illustrating its magnitude response in Bode plot.
(10 marks)

(ii) Analyze the phase response in Bode plot.
(6 marks)

Q4 (a) Draw **one (1)** odd symmetry periodic function and **one (1)** even symmetry periodic function.
(4 marks)

(b) A voltage source, $v_s(t)$ is given in Fourier series equation as below. Determine the first three AC terms of the voltage source. Provide answers in polar form ($A\angle\theta$).

$$v_s(t) = \frac{1}{2} + \frac{2}{\pi}\sum_{k=1}^{\infty}\frac{1}{n}\sin(n\pi t)\ V, \quad n = 2k-1$$

(5 marks)

(c) An output voltage, $v_o(t)$ is given in Fourier series equation as below. Sketch the amplitude and phase spectrums of the output voltage.

$$v_o(t) = 0.5\cos(\pi t - 52°) + 0.2\cos(3\pi t - 75°) + 0.13\cos(5\pi t - 81°) + \cdots V$$

(6 marks)

(d) Compute the first three AC terms of the current $i(t)$ given in **Figure Q4(d)**. The input voltage is given below. Provide answers in polar form ($A\angle\theta$).

$$v(t) = 3 - \frac{6}{\pi}\sum_{n=1}^{\infty}\frac{1}{n}sin(2\pi nt)\ V$$

(10 marks)

– END OF QUESTIONS –

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2019/2020	PROGRAMME	: BEV
COURSE NAME	: TRANSFORM CIRCUIT ANALYSIS	COURSE CODE	: BEF 22803

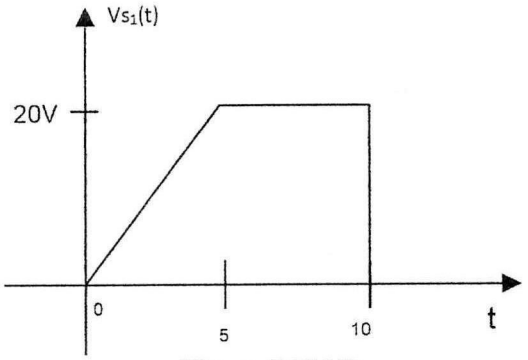

Figure Q1(b)(i)

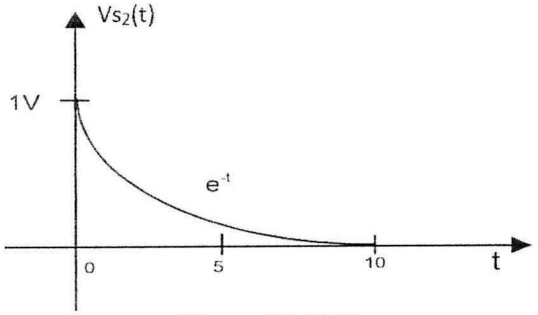

Figure Q1(b)(ii)

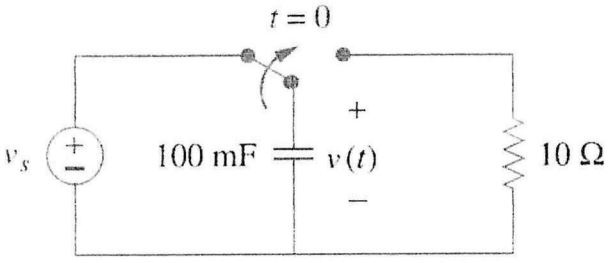

Figure Q2(a)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2019/2020	PROGRAMME	: BEV
COURSE NAME	: TRANSFORM CIRCUIT ANALYSIS	COURSE CODE	: BEF 22803

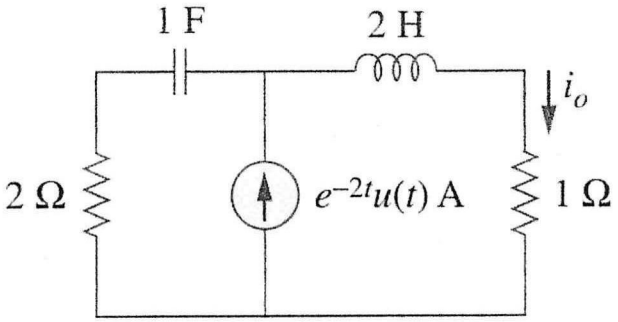

Figure Q2(b)

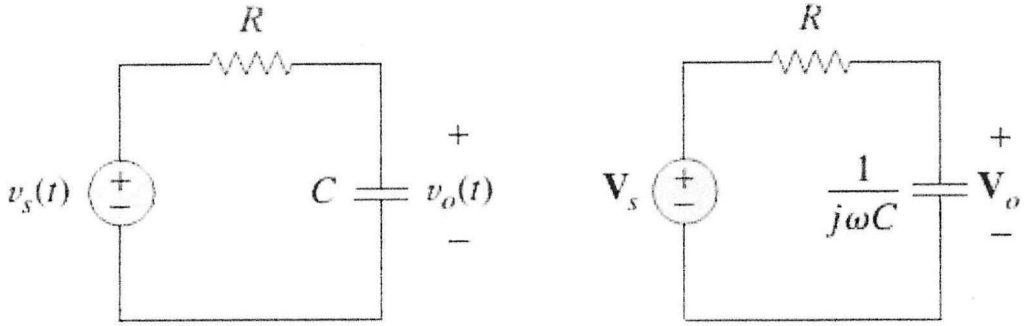

Figure Q3(a)

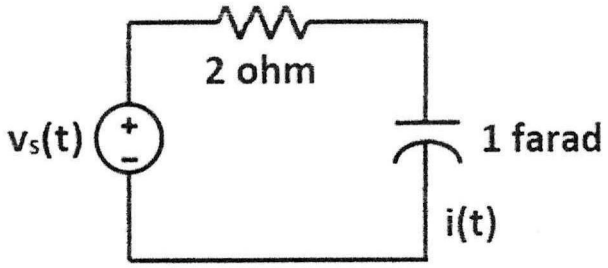

Figure Q4(d)

FINAL EXAMINATION

SEMESTER/SESSION	: SEM I / 2019/2020	PROGRAMME	: BEV
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$$A_n \angle \phi_n = a_n - jb_n$$

$$A_n = \sqrt{a_n^2 + b_n^2}, \qquad \phi_n = -\tan^{-1}\frac{b_n}{a_n}$$

$$f(t) = a_0 + \sum_{n=1}^{\infty} (a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)$$

$$f(t) = a_0 + \sum_{n=1}^{\infty} A_n \cos(n\omega_0 t + \phi_n)$$

Table 1: Laplace Transform Pairs

$f(t)$	$F(s)$	$f(t)$	$F(s)$
$\delta(t)$	1		
$u(t)$	$\frac{1}{s}$	$\cos \omega t$	$\frac{s}{s^2 + \omega^2}$
e^{-at}	$\frac{1}{s + a}$	$\sin(\omega t + \theta)$	$\frac{s \sin\theta + \omega \cos\theta}{s^2 + \omega^2}$
t	$\frac{1}{s^2}$	$\cos(\omega t + \theta)$	$\frac{s \cos\theta - \omega \sin\theta}{s^2 + \omega^2}$
t^n	$\frac{n!}{s^{n+1}}$	$e^{-at}\sin \omega t$	$\frac{\omega}{(s + a)^2 + \omega^2}$
te^{-at}	$\frac{1}{(s + a)^2}$	$e^{-at}\cos \omega t$	$\frac{s + a}{(s + a)^2 + \omega^2}$
$t^n e^{-at}$	$\frac{n!}{(s + a)^{n+1}}$		
$\sin \omega t$	$\frac{\omega}{s^2 + \omega^2}$		

**Defined for $t \geq 0$; $f(t) = 0$, for $t < 0$.*

FINAL EXAMINATION

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Table 2: Laplace Transform Properties

Property	$f(t)$	$F(s)$
Linearity	$a_1 f_1(t) + a_2 f_2(t)$	$a_1 F_1(s) + a_2 F_2(s)$
Scaling	$f(at)$	$\frac{1}{a}F\left(\frac{s}{a}\right)$
Time shift	$f(t-a)u(t-a)$	$e^{-as}F(s)$
Frequency shift	$e^{-at}f(t)$	$F(s+a)$
Time differentiation	$\frac{df}{dt}$	$sF(s) - f(0^-)$
	$\frac{d^2f}{dt^2}$	$s^2F(s) - sf(0^-) - f'(0^-)$
	$\frac{d^3f}{dt^3}$	$s^3F(s) - s^2f(0^-) - sf'(0^-) - f''(0^-)$
	$\frac{d^nf}{dt^n}$	$s^nF(s) - s^{n-1}f(0^-) - s^{n-2}f'(0^-) - \cdots - f^{(n-1)}(0^-)$
Time integration	$\int_{0^-}^{t} f(x)dx$	$\frac{1}{s}F(s)$
Frequency differentiation	$tf(t)$	$-\frac{d}{ds}F(s)$
Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(s)ds$
Time periodicity	$f(t) = f(t+nT)$	$\frac{F_1(s)}{1-e^{-sT}}$
Initial value	$f(0)$	$\lim_{s\to\infty} sF(s)$
Final value	$f(\infty)$	$\lim_{s\to 0} sF(s)$
Convolution	$f_1(t) * f_2(t)$	$F_1(s)F_2(s)$