UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2023/2024

COURSE NAME	:	TRANSFORM CIRCUIT
COURSE CODE	:	BEV 20203
PROGRAMME CODE	:	BEV
EXAMINATION DATE	:	JULY 2024
DURATION	:	3 HOURS
INSTRUCTIONS	:	1. ANSWER ALL QUESTIONS 2. THIS FINAL EXAMINATION IS CONDUCTED VIA ☐ Open book ☒ Closed book 3. STUDENTS ARE **PROHIBITED** TO CONSULT THEIR OWN MATERIAL OR ANY EXTERNAL RESOURCES DURING THE EXAMINATION CONDUCTED VIA CLOSED BOOK

THIS QUESTION PAPER CONSISTS OF **EIGHT (8)** PAGES

PART A

Q1 (a) Consider the following function.

$$f(t) = u(t-1) - u(t-3)$$

(i) Sketch the graph of the function.

(2 marks)

(ii) Write the piecewise function.

(2 marks)

(b) Consider the two signals shown in **Figure Q1(b)**. where $y(t) = x_1(t) * x_2(t)$.

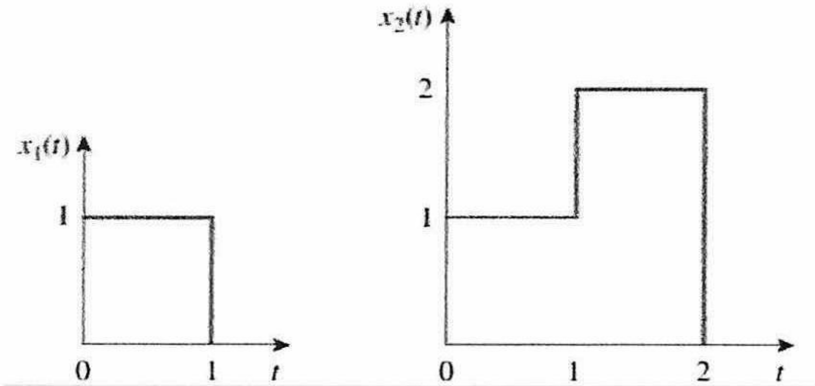

Figure Q1(b)

(i) Convolve $x_1(t)$ and $x_2(t)$ Graphically. Show step by step of the convolution to determine output signal, $y(t)$.

(12 marks)

(ii) Write the piecewise function, $y(t)$.

(2 marks)

(iii) Sketch the output signal.

(2 marks)

(c) Please refer to **APPENDIX B,** determine the Inverse Laplace Transformation of the following functions.

(i) $F(s) = 5 + \frac{6}{s+4} - \frac{7s}{s^2+25}$

(2 marks)

(ii) $F(s) = \frac{3}{s} - \frac{5}{s+1} + \frac{6}{s^2+4}$

(3 marks)

Q2 (a) Consider the circuit shown in **Figure Q2(a)**. Since the input voltage is multiplied by $u(t)$, the voltage source is a short for all $t < 0$ and $i_L(0) = 0$ A.

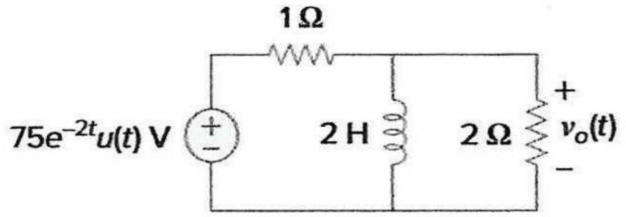

Figure Q2(a)

(i) Draw the circuit in s-domain.

(2 marks)

(ii) Determine $V_o(s)$.

(4 marks)

(iii) Find $v_o(t)$.

(4 marks)

(b) Considering $i_L(0) = 1$ A in **Q2(a)**,

(i) Draw the circuit in s-domain.

(2 marks)

(ii) Determine $V_o(s)$.

(8 marks)

(c) The output of a linear system is $y(t) = 10e^{-t} \cos 4t\, u(t)$ when the input is $x(t) = e^{-t}\, u(t)$. Calculate:

(i) Transfer function, $H(s)$ of the system.

(4 marks)

(ii) Impulse response, $h(t)$.

(1 mark)

Q3 Bode plots show the frequency response, that is, the changes in magnitude and phase as a function of frequency. This is done on two semi-log scale plots. The top plot is typically magnitude or "gain" in dB. The bottom plot is phase, most commonly in degrees.

(a) Draw the magnitude and phase plots (Bode plot) of the following transfer function using the logarithmic graph paper provided.

$$H(s) = \frac{800s}{(s+20)(s+400)}$$

(15 marks)

(b) In Fourier series circuit analysis, voltage and current source is given in periodic function. Draw one (1) odd symmetric periodic function and one (1) even symmetric periodic function.

(4 marks)

(c) Fourier series of a periodic signal is given as below, plot the amplitude and phase spectra for $n = 1, 3$ and 5.

$$f(t) = \sum_{n=odd}^{\infty} \frac{2}{n\pi} cos(n\pi t - 90\,°)$$

(6 marks)

Q4 The Fourier Series Equation is given as:

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

$$a_0 = \frac{1}{T}\int_0^T f(t)\,dt, \quad a_n = \frac{2}{T}\int_0^T f(t) cos\; n\omega_0 t\, dt, \quad b_n = \frac{2}{T}\int_0^T f(t) sin\; n\omega_0 t\, dt,$$

where $a_0, a_n and\ b_n$ are Fourier coefficients.

(a) Determine the Fourier series expansion of the backward sawtooth waveform of **Figure Q4(a)**.

(6 marks)

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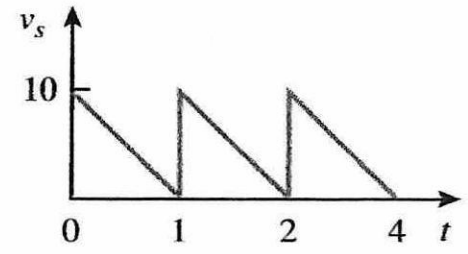


Figure Q4(a)

(b) The voltage source of the circuit in **Figure Q4(b)** is $v_s(t) = 5 + \sum_{n=1}^{\infty} \frac{10}{n\pi} sin2n\pi t$, determine the response $i_o(t)$ of the circuit.

(10 marks)

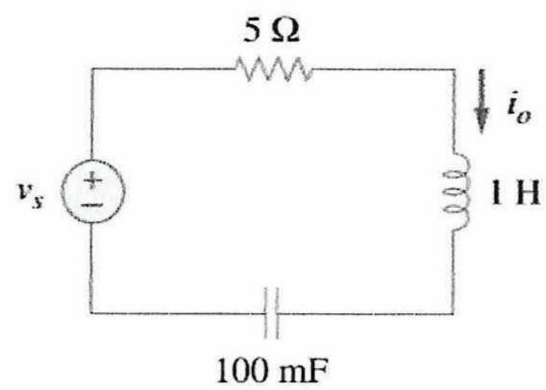


Figure Q4(b)

(c) The input currents of the circuit in **Figure Q4(c)** is $i(t) = 20+16\cos(10t+45^{O})$. Calculate the resistor voltage, $v(t)$ and average power dissipated in the resistor, P [W].

(9 marks)

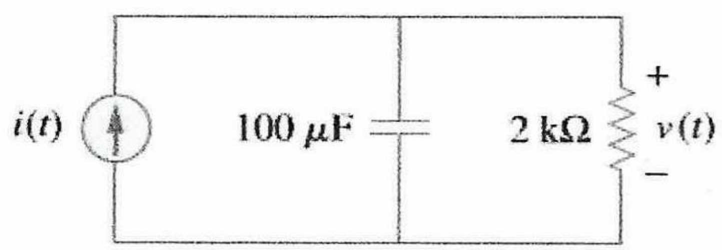
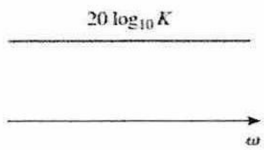
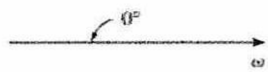
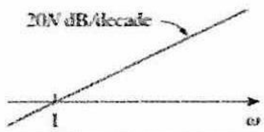
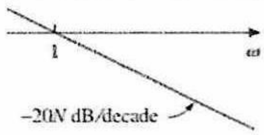
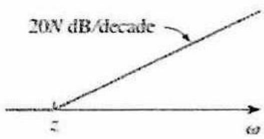
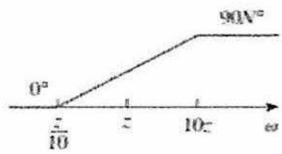
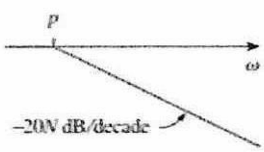
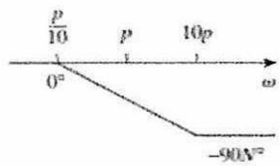
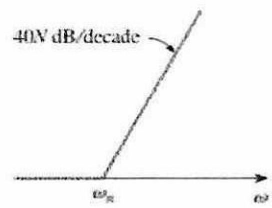
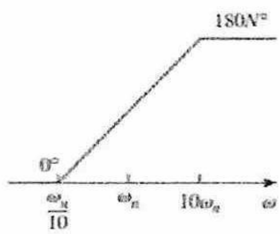
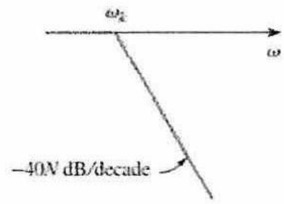
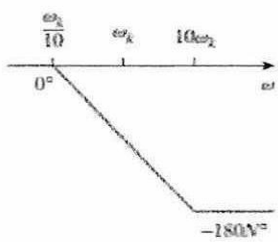


Figure Q4(c)

- END OF QUESTIONS -

APPENDIX A

Table APPENDIX A.1

Factor	Magnitude	Phase
K		
$(j\omega)^N$		
$\dfrac{1}{(j\omega)^N}$		
$\left(1+\dfrac{j\omega}{z}\right)^N$		
$\dfrac{1}{(1+j\omega/p)^N}$		
$\left[1+\dfrac{2j\omega\zeta}{\omega_n}+\left(\dfrac{j\omega}{\omega_n}\right)^2\right]^N$		
$\dfrac{1}{[1+2j\omega\zeta/\omega_k+(j\omega/\omega_k)^2]^N}$		

APPENDIX B

Table APPENDIX B.1

$f(t)$	$F(s)$	$f(t)$	$F(s)$
$\delta(t)$	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 $t < 0$.

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