Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
(TAKE HOME)
SEMESTER II
SESSION 2020/2021

COURSE NAME	:	SIGNALS AND SYSTEMS
COURSE CODE	:	BEJ 20203 / BEB 20203
PROGRAMME CODE	:	BEJ
EXAMINATION DATE	:	JULY 2021
DURATION	:	3 HOURS
INSTRUCTION	:	**SECTION A**: ANSWERS **ALL** QUESTIONS **SECTION B**: ANSWERS **ALL** QUESTIONS **OPEN BOOK EXAMINATION**

THIS QUESTION PAPER CONSISTS OF **TEN (10)** PAGES

SECTION A: ANSWERS ALL QUESTIONS (60 MARKS)

Q1 (a) A signal $d(t)$ is given in Figure Q1(a). Express $p(t), q(t)$ and $s(t)$ in terms of $d(t)$.

(i) $p(t)$ as shown in Figure Q1(a)(i)

(1 mark)

(ii) $q(t)$ as shown in Figure Q1(a)(ii)

(2 marks)

(iii) $s(t)$ as shown in Figure Q1(a)(iii)

(2 marks)

(b) Given a composite signal as below

$$g(t) = \sin\left(3t - \frac{2\pi}{7}\right) + \cos 0.1(t - 0.5) + \sin(0.2t)$$

Determine if $g(t)$ is periodic or aperiodic signal. Specify its period if $g(t)$ is periodic.

(7 marks)

Q2 (a) Given an output response, $y(t)$ of a system;

$$y(t) = x^2(t)e^{-ax(t)}$$

Determine the homogeneity of the system.

(4 marks)

(b) Test the stability of the following system with assumption $k > 0$:

(i) $h(t) = k^2 e^{-\frac{t}{k}} u(t)$

(4 marks)

(ii) $h(t) = k^2 e^{-kt}\, u(-t)$

(4 marks)

Go to Question:

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

Q3 (a) Explain in brief the relation between magnitude and phase of Amplitude-Phase Fourier Series to the Exponential Fourier Series and Trigonometric Fourier Series coefficients for harmonics $n \neq 0$.

(4 marks)

(b) A signal $c(t)$ is given as:

$$c(t) = \frac{1}{2} + \sum_{\substack{n=1 \\ n=odd}}^{\infty} C_n \cos(\frac{n\pi t}{2})$$

(i) Find the coefficients of the first two harmonics of Exponential Fourier Series. Given that $a_n = \frac{n\pi}{2}$ and $b_n = 0$.

(5 marks)

(ii) Sketch the magnitude and phase for the answer in the **Q3(b)(i)**.

(3 marks)

Q4 (a) Consider a signal $w(t)$ is defined by

$$w(t) = 2\text{rect}\left(\frac{t-4}{3}\right)$$

Find the Fourier Transform (FT) of the following signals by using FT properties.

(i) $w(t)$

(3 marks)

(ii) $y(t) = t^2 w(t)$ (Hint: Leave your answer without simplifying it.)

(2 marks)

(iii) $s(t) = \int_{-\infty}^{t} w(t)dt$

(2 marks)

(b) The Fourier Transform of $x_1(t) = tri(t)$ and $x_2(t) = rect(t)$ are

$$X_1(f) = \text{F}[tri(t)] = \text{sinc}^2(f)$$

$$X_2(f) = \text{F}[rect(t)] = \text{sinc}\,(f)$$

Determine the inverse Fourier Transform of

(i) $Y(f) = 2\,tri(f)$

(2 marks)

(ii) $Z(f) = e^{-j2\pi f}\text{sinc}(f)$

(3 marks)

Go to Question:

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

Q5 (a) Find the Laplace transform of $e^{3t}u(t)$ by using definition.

(2 marks)

(b) Given the following facts about a real signal $x(t)$ with Laplace transform of $X(s)$.

$X(s)$ has exactly two poles.

$X(s)$ has no zeros in the finite s-plane.

$X(s)$ has poles at $s = -2 + 3j$ and $s = -2 - 3j$.

$X(0) = 2$.

$e^{3t}x(t)$ is not absolutely integrable, therefore $e^{3t}x(t)$ is not stable.

Determine $X(s)$ and specify its region of convergence.

(10 marks)

Go to Question:

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

SECTION B: ANSWERS ALL QUESTIONS (40 MARKS)

Q6 (a) (i) Sketch the periodic signal $k(t) = \sum_{c=-\infty}^{\infty} m(t + cT)$ where the period $T = 3\ s$ for a given signal $m(t)$ in Figure Q6(a). Proof that by using the exponential Fourier Series, the signal expansion of $k(t)$ is given by the following expression: (Hint: Simplify the coefficient x_n in term of sinc function)

$$k(t) = \frac{1}{3}\sum_{n=-\infty}^{\infty} e^{-\frac{j\pi n}{3}(1-2t)} sinc\left(\frac{n}{3}\right)$$

(6 marks)

(ii) Based on the answer in Q6(a)(i), predict the amplitude spectrum of the non-periodic signal $m(t)$ in Figure Q6(a) with $T = 200\ s$.

(2 marks)

(b) Based on your understanding, give a suggestion to calculate the frequency domain of signal $x(t) = e^{at}u(t)$ and state your justification.

(2 marks)

Q7 A signal $x(t)$ with period $T_0 = 2 \times 10^{-5}\ s$ in Figure Q7(a) is passed through a low pass filter with the frequency response as per illustrated in Figure Q7(b) and Figure Q7(c). The input $x(t)$ is given as:

$$x(t) = \frac{1}{2} + \sum_{n=1}^{\infty} a_n \cos(\pi n t)$$

(a) Find the value of $x(t)$ for $0 \leq n \leq 5$ given that

$$a_n = \frac{2}{\pi n}\sin\left(\frac{\pi n}{2}\right) \quad \text{and} \quad b_n = 0.$$

(4 marks)

(b) Determine the output of the filter $y(t)$.

(6 marks)

Go to Question:
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

Q8 (a) A basic modulator circuit is shown in Figure Q8(a). Modulation is multiplication between data signal, $m(t)$ and a carrier signal, $c(t)$. The process yields a new signal, $v(t)$.

(i) Analyze the Fourier Transform of the signal $v(t)$ by using modulation properties.

(3 marks)

(ii) Sketch the spectrum of signal $v(t)$.

(1 mark)

(b) The voltage across a $4\,\Omega$ resistor of an RC circuit in Figure Q8(b) is given by $v_R(t) = 2e^{-6t}u(t)V$. Determine the total energy dissipated by this resistor using Parseval's Theorem.

(6 marks)

Q9 Find the system response $v_0(t)$ for the circuit illustrated by Figure Q9.

(10 marks)

-END OF QUESTIONS-

Go to Question:

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

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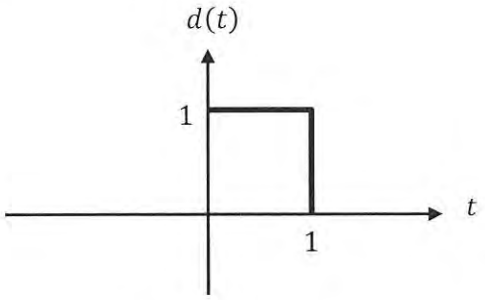

Figure Q1(a)

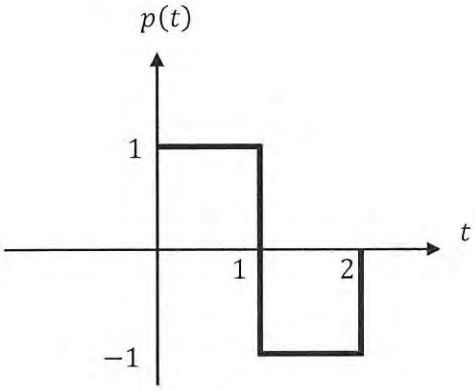

Figure Q1(a)(i)

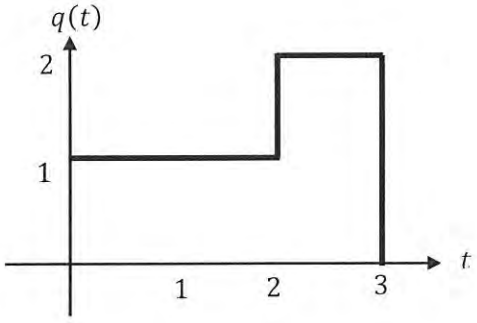

Figure Q1(a)(ii)

Go to Question:
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

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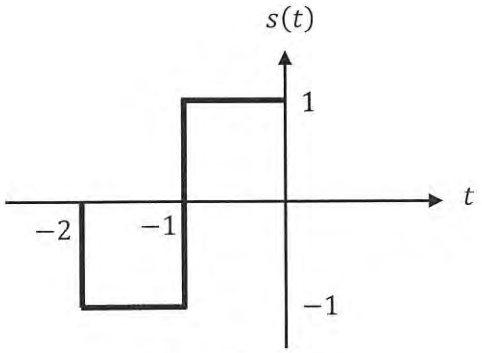

Figure Q1(a)(iii)

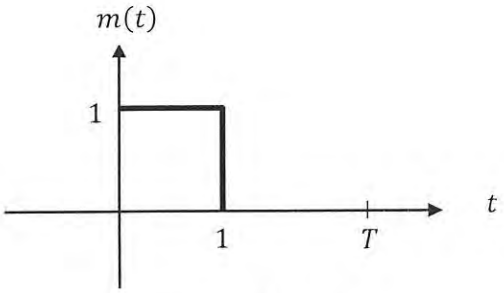

Figure Q6(a)

Go to Question:
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

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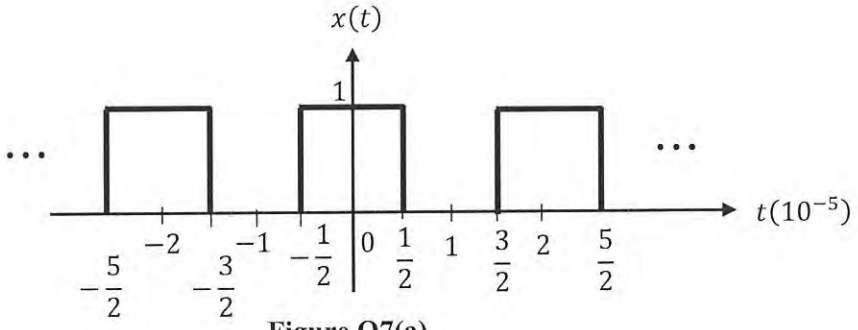

Figure Q7(a)

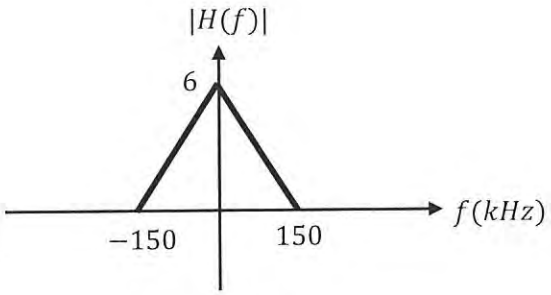

Figure Q7(b)

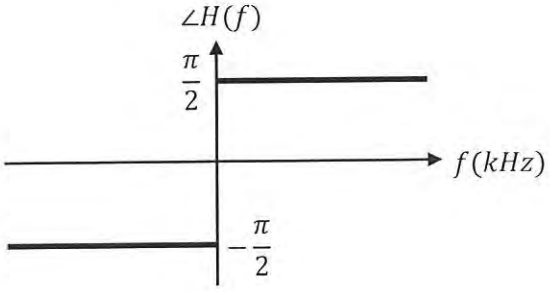

Figure Q7(c)

Go to Question:
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9

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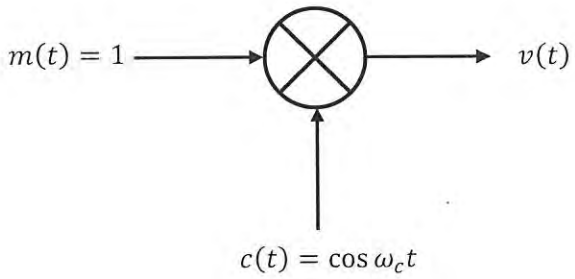

Figure Q8(a)

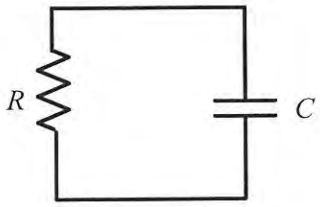

Figure Q8(b)

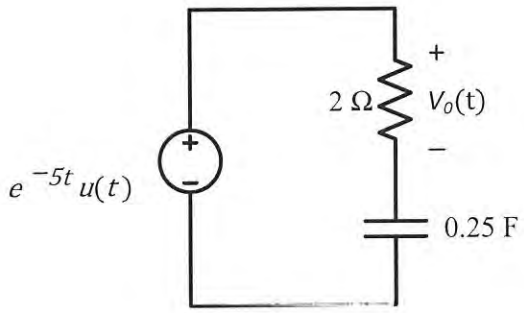

Figure Q9

Go to Question:

Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9