CG2023 Signals & Systems
AY2019/20-2
Midterm Quiz (Close Book)

Date: 5 March 2020   Time Allowed: 1.5 Hours

INSTRUCTIONS TO CANDIDATES:

1. This paper contains **FOUR (4)** questions and comprises **TEN (10)** printed pages.

2. Answer all 4 questions. Each question carries 10 marks.

3. This is a closed book quiz.

4. You are allowed to bring **ONE (1)** self-prepared, handwritten, A4 size crib sheet to the quiz.

5. Programmable and/or graphic calculator is not allowed.

6. Tables of formulas are given on a separate sheet.

7. Write your **answers** in the spaces indicated in this question paper. Attachment is not allowed.

8. Write your **name, matric number** and **group number** in the spaces indicated below.

Name   :   _____

Matric №   :   _____

Group №   :   _____

Question №	Marks
1	
2	
3	
4	
Total Marks	

Q.1 Two signals $x(t) = \text{sinc}^2(2t - 2)$ and $y(t) = x(t)\sin(200\pi t)$.

(a) Find the Fourier transform, $X(f)$, of $x(t)$. (4 marks)

(b) Sketch the magnitude spectrum and phase spectrum of $x(t)$ with proper labelling. (2 marks)

(c) Determine the Fourier transform, $Y(f)$, of $y(t)$ and its first-null bandwidth. (4 marks)

Q.1 ANSWER

Q.1 ANSWER ~ continued

Q.2 Signal $x(t) = 2\sin\left(\sqrt{2}\pi t\right) + 4\cos\left(\sqrt{2}\pi t\right) - 6\cos\left(3\sqrt{2}\pi t\right) + (-1 + j)e^{-j2\sqrt{2}\pi t}$.

    (a) What are the fundamental frequency of $x(t)$ and DC value of $x(t)$?   (3 marks)

    (b) Determine the Fourier series coefficients, c_k, of $x(t)$.   (4 marks)

    (c) What is the average power of $x(t)$?   (3 marks)

Q.2 ANSWER

Q.2 ANSWER ~ continued

Q.3 The signal $x(t)$ shown in Figure Q3(a) is repeatedly replicated to form the sawtooth wave $y(t)$ shown in Figure Q3(b). The Fourier transform of $x(t)$ is given by
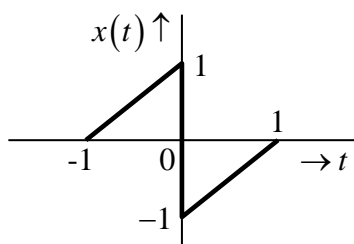
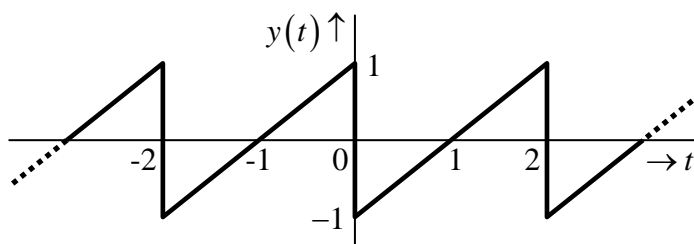$$X(f) = \frac{j}{\pi f}\left[1 - \text{sinc}(2f)\right].$$

Figure Q3(a)

Figure Q3(b)

(a) Find the energy spectral density, $E_x(f)$, of $x(t)$. (2 marks)

(b) What is the value of $X(0)$? Justify your answer. (2 marks)

(c) Express $y(t)$ in terms of $x(t)$. (2 marks)

(d) Express the power spectral density, $P_y(f)$, of $y(t)$ in terms of $X(f)$. (4 marks)

Q.3 ANSWER

Q.3 ANSWER ~ continued

Q.4 Figure Q4 shows the signal $q(t) = A\,\mathrm{rect}\left(\dfrac{t-B}{C}\right) + \alpha\,\mathrm{tri}\left(\dfrac{t-\beta}{\gamma}\right)$ where A, B, C, α, β and γ are constants.
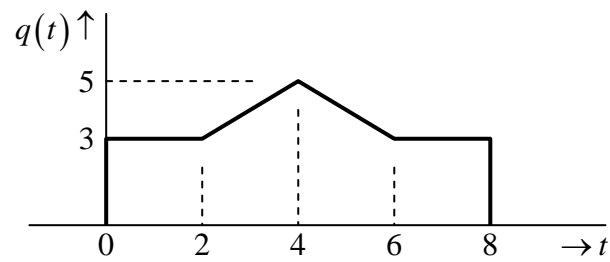
Figure Q4

(a) Find the values of A, B, C, α, β and γ.   (2 marks)

(b) Find the spectrum, $Q(f)$, of $q(t)$.   (3 Marks)

(c) What is the energy of $q(t)$?   (3 marks)

(d) For the signal $s(t) = Q(t)$, sketch the magnitude spectrum, $|S(f)|$, of $s(t)$ with proper labelling.

    (2 marks)

Q.4 ANSWER

Q.4 ANSWER ~ continued

Q.4 ANSWER ~ continued

Q.4 ANSWER ~ continued

End of Paper