

**UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE
DEPARTMENT OF ELECTRONIC ENGINEERING**

MAIN EXAMINATION 2006/2007

TITLE OF PAPER : SIGNALS I

COURSE NUMBER : E342

TIME ALLOWED : THREE (3) HOURS

INSTRUCTIONS : ANSWER ANY FOUR OUT OF THE FIVE QUESTIONS

EACH QUESTION CARRIES 25 MARKS

**MARKS FOR DIFFERENT SECTIONS ARE SHOWN
IN THE RIGHT-HAND MARGIN**

THIS PAPER HAS 6 PAGES, INCLUDING THIS PAGE

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THE INVIGILATOR**

QUESTION ONE

(a) With the help of an appropriate sketch discuss *aliasing* (5 marks)

(b) Distinguish between the following classifications of signals. Qualify your answers with sketches.

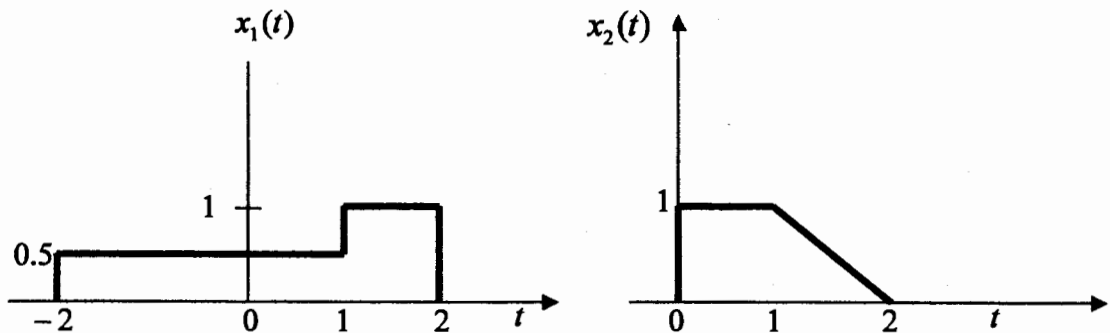
(i) deterministic and random signals

(4 marks)

(ii) even and odd signals

(4 marks)

(c) The signals $x_1(t)$ and $x_2(t)$ are depicted below:



(i) sketch and label $y_1(t) = x_1(2-2t)$

(4 marks)

(ii) sketch and label $y_2(t) = x_2\left(\frac{3}{2}t+1\right)$

(4 marks)

(d) Evaluate the following signal

$$\int_{-5}^3 \delta(t-4) dt$$

(2 marks)

(e) A force of 120 Newtons displaces an object by 2.5 metres. If the angle between the line of action of the force and the line of the displacement is 50° , find the work done by the force.

(2 marks)

QUESTION TWO

(a) Determine if the following signals are periodic or not. If periodic find the fundamental period

(i) $x(t) = \sin(5t + 1)$ (3 marks)

(ii) $x[n] = \cos\left(\frac{1}{4}n\right)$ (3 marks)

(b) Identify the Fourier coefficients of the following signal

$$x(t) = \sin \omega_0 t - \frac{1}{2} \sin 2\omega_0 t + \frac{1}{3} \sin 3\omega_0 t$$
 (2 marks)

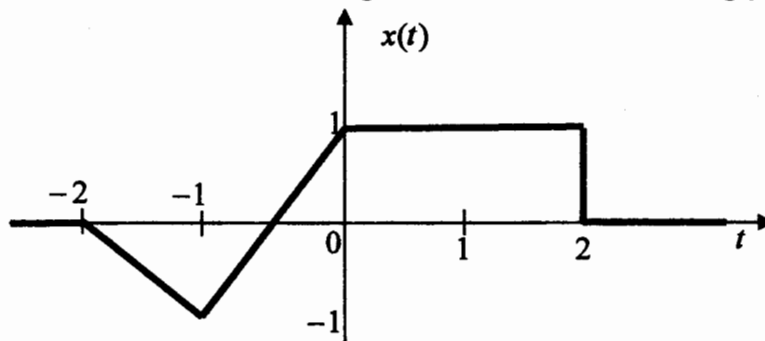
(c) Compute the following parameters in the following signals

(i) energy for $x(t) = e^{-2t}u(t)$ (3 marks)

(ii) power for $x(t) = \cos(t)$ (3 marks)

$$[\text{note: } \int \cos^2(t) dt = \frac{1}{2}t + \frac{1}{4}\sin 2t]$$

(d) Let $x(t)$ represent the signal shown in the following plot.



(i) sketch $y(t) = x(2t + 2)$ (3 marks)

(ii) Given that $x(t)$ can be written as the sum of an even part ($x_e(t) = x_e(-t)$) and an odd part ($x_o(t) = -x_o(-t)$), prove that $x_e(t)$ is uniquely determined by $x(t)$ (5 marks)

(iii) Sketch $x_e(t)$ (3 marks)

QUESTION THREE

- (a) A pulse signal has the value 5 for $-\tau < t < \tau$ and is zero at all other times. Show that this signal will be orthogonal to all cosine signals with frequencies $\omega = k\pi/\tau$, where k is an integer (4 marks)

- (b) Given the continuous-time signal specified by

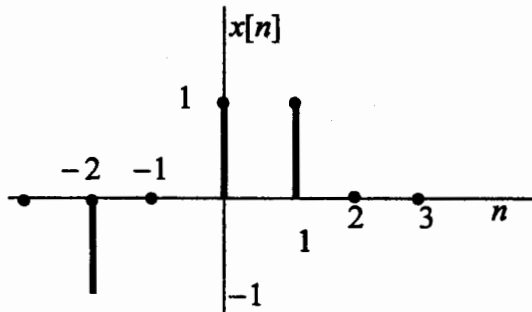
$$x(t) = \begin{cases} 1-|t| & -1 \leq t \leq 1 \\ 0 & \text{otherwise} \end{cases}$$

determine the resultant discrete-time sequence obtained by uniform sampling of $x(t)$ with a sampling interval of 0.25 seconds (5 marks)

- (c) Find the trigonometric Fourier series of a periodic signal represented by

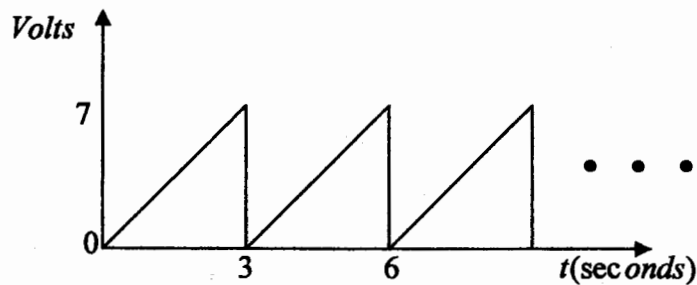
$$x(t) = x(t+2) = \begin{cases} 1, & -1 \leq t \leq 0 \\ 2, & 0 \leq t \leq 1 \end{cases} \quad (10 \text{ marks})$$

- (d) Let $x[n]$ represent the following signal. The signal is zero outside the range $2 \leq n \leq 1$



Sketch and label $y[n] = x[2n+2]$ (3 marks)

- (e) Calculate the Root Mean Square value of the following voltage signal



(3 marks)

QUESTION FOUR

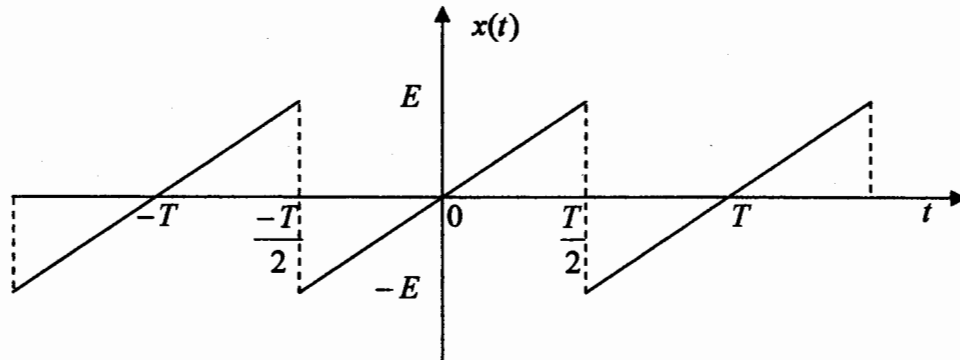
(a) The analogue signal $v(t)$ is given by

$$v(t) = 2 \cos 2000 \pi t + 3 \sin 6000 \pi t + 8 \cos 12000 \pi t$$

Calculate the Nyquist rate

(2 marks)

(b) Consider the saw-tooth signal given below



Find the trigonometric Fourier series representation

(10 marks)

(c) Calculate the average power of the given signal

$$x(t) = 2 + \cos\left(\frac{2\pi t}{3}\right) + 4 \sin\left(\frac{5\pi t}{3}\right)$$

(9 marks)

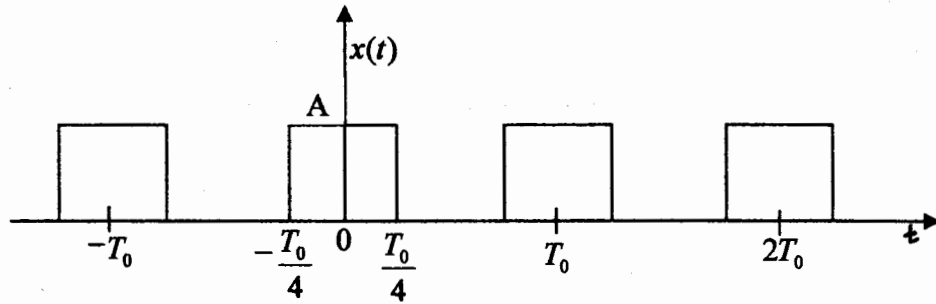
(d) Sketch and label the even and odd components of the signal defined below

$$x(t) = 4 \prod(4t - 3)$$

(4 marks)

QUESTION FIVE

(a) Find the exponential Fourier series corresponding to the function



(8 marks)

(b) Find the total energy of the signal

$$v(t) = \begin{cases} Ve^{-t/4} & \text{for } t \geq 0 \\ 0 & \text{for } t < 0 \end{cases}$$

(5 marks)

(c) Sketch the line spectra of the following signal

$$x(t) = 1 + \sin \omega_0 t + 2 \cos \omega_0 t + \cos(2\omega_0 t + \pi/4)$$

(10 marks)

(d) Evaluate $\int_{-\infty}^{\infty} \{ [e^{-5t} \cos(2t) + t^2] \delta(t) + (2t+1)\delta(t-2) \} dt$

(2 marks)