UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE
DEPARTMENT OF ELECTRONIC ENGINEERING

SUPPLEMENTARY 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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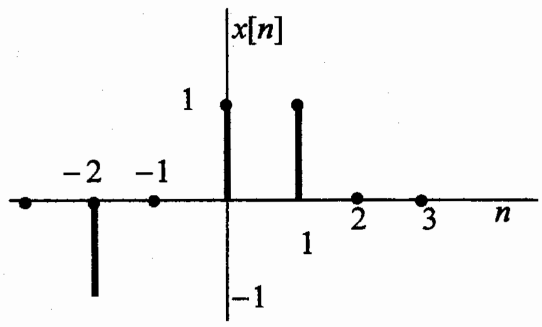
QUESTION ONE

(a) With the help of appropriate sketches, differentiate between *periodic* and *non-periodic* signals (6 marks)

(b) Consider $x[n] = (-1)^n$ for all integer values of *n*. Show that $\cos(\pi t)$ and $\cos(3\pi t)$ are envelopes of $x[n]$ if they are each sampled with sampling period T=1. What can be said about $\cos(\pi t)$ and $\cos(3\pi t)$?

(6 marks)

(c) Let *x[n]* represent the following signal



(i) Sketch $y[n] = x[n-1]$ (2 marks)

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

(iii) Sketch $x_o[n]$ (4 marks)

(d) Evaluate $\int_{-\infty}^{\infty} y_1(t)y_2(t)$ given that

$$y_1(t) = 2\sin(2000\pi t)$$
$$y_2(t) = \partial(t - 0.25 \times 10^{-3})$$

(2 marks)

QUESTION TWO

(a) State the Nyquist sampling theorem. What happens when a signal is under-sampled? (4 marks)

(b) Determine if the following signals are periodic. If periodic, determine the fundamental period

(i) $x(t) = 4\cos(5\pi t)$ (3 marks)

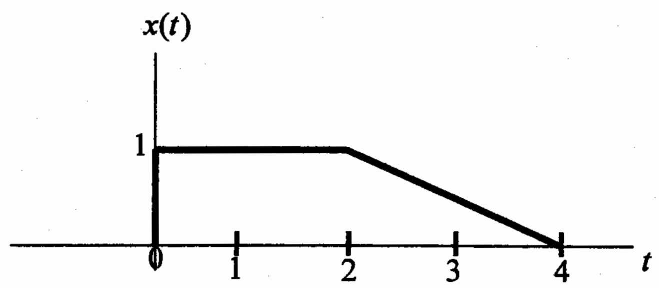
(ii) $x[n] = 2\sin(3n)$ (3 marks)

(iii) $x(t) = 2\cos(10t+1) - \sin(4t-1)$ (3 marks)

(c) Simplify the following expression. Give your answer both in polar and in rectangular form

$$3e^{\frac{j\pi}{4}} + 4e^{\frac{-j\pi}{2}}$$ (3 marks)

(d) The signal $x(t)$ is given below

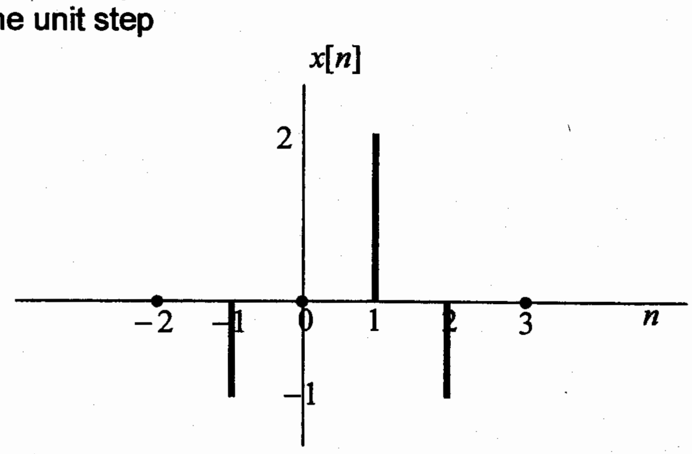


Transform it to $x(-2t+6)$ (5 marks)

(e) Express the following signal $x[n]$ solely in terms of shifted scaled superposition of

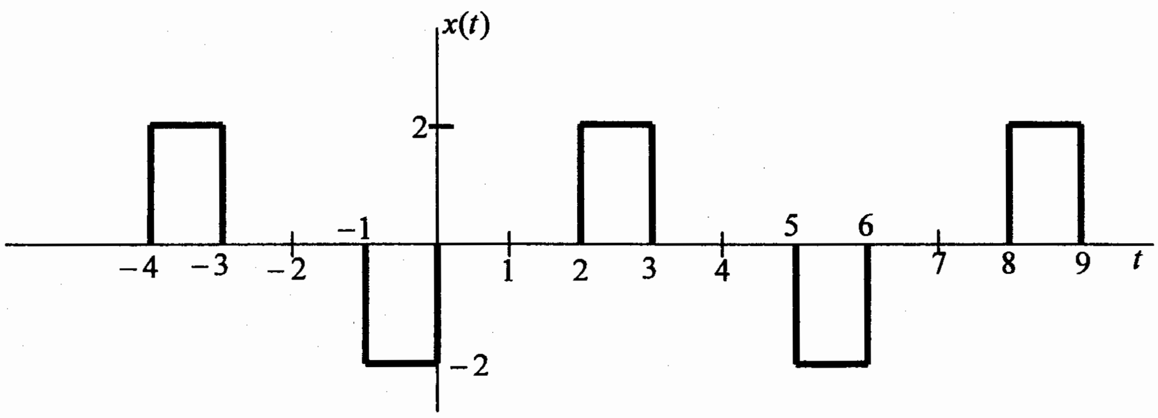
(i) the unit impulse (2 marks)

(ii) the unit step (2 marks)



QUESTION THREE

(a) For the following periodic signal:



(i) Find the Fourier series (10 marks)
(ii) Plot the frequency spectra (8 marks)

(b) Sketch the following signals

(i) $x(t) = -2\prod(4t+3)$ (3 marks)

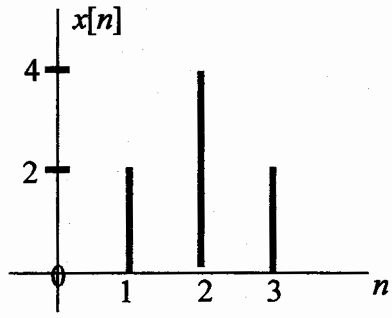
(ii) $x[n+1]$ given than $x[n] = \begin{cases} 0 & if\ n<2 \\ 2n-4 & if\ 2 \le n < 4 \\ 4-n & if\ 4 \le n \end{cases}$ (4 marks)

QUESTION FOUR

(a) Sketch the even and odd components of the following signals

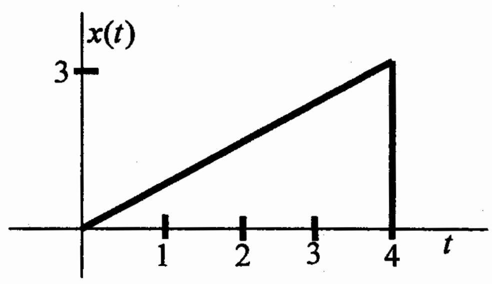
(i) $x(t) = 4\prod(4t-8)$ (6 marks)

(ii)



(4 marks)

(b) Given the following signal



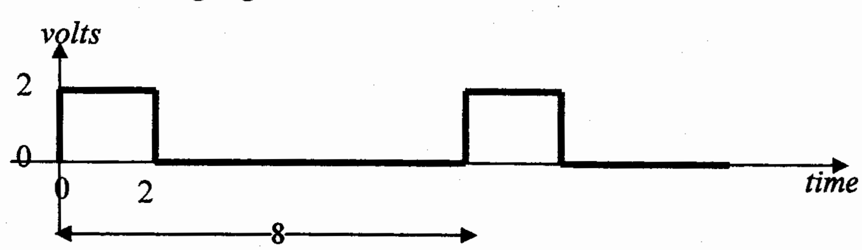
Sketch and label the following signals

(i) $x(2t)$ (2 marks)

(ii) $x\left(-t/2\right)$ (3 marks)

(iii) $x\left(\frac{3}{2}t\right)$ (3 marks)

(c) Given the following signal



(i) Calculate the DC value (average) (3 marks)

(ii) Calculate the RMS value (4 marks)

QUESTION FIVE

(a) Determine the average power of the following signal

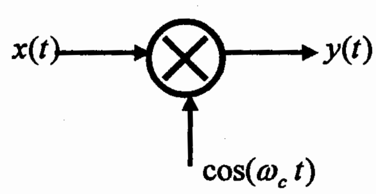
$$x(t) = 7 - 10\cos(40\pi t + \pi/3) + 4\sin(120\pi t)$$ (10 marks)

(b) (i) Distinguish between *energy* signals and *power* signals (4 marks)

(ii) Are all signals either energy or power signals? Justify. (2 marks)

(c) Find the even and odd components of $x(t) = e^{jt}$ (3 marks)

(d) Consider the following system that performs modulation of a carrier signal $\cos(\omega_c t)$ with an input signal $x(t)$ to produce an output, $y(t)$



Show if the system is

(i) linear or nonlinear (3 marks)

(ii) time-invariant or not time-invariant (3 marks)