UNIVERSITY OF SWAZILAND

MAIN EXAMINATION, SECOND SEMESTER 2008

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: SIGNALS I

COURSE CODE: E342

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

1.   Answer any <u>FOUR</u> (4) of the following five questions.
2.   Each question carries 25 marks.

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THIS PAPER CONTAINS EIGHT (6) PAGES INCLUDING THIS PAGE

QUESTION ONE

a) For the following signals, analytically determine which are periodic and if periodic give the period. Also, sketch the signals

(i) $x(t) = 4u(t) + 2\sin(3t)$ [4]

(ii) $x[n] = 4\cos(\pi n)$ [4]

b) Let x(t) be the following continuous-time signal

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

(i) Sketch $x(t+2)$ [3]

(ii) Find the even and odd parts of $x(t)$ [3]

c) Express the following signals as the sum of an even signal and an odd signal

(i) $v(t) = rect(5t)$ [3]

(ii) $v(t) = sinc(2t\text{-}1)$ [3]

d) Plot the graph of the following signal which is represented in terms of the unit step and unit ramp signals.

$$x(t) = u(-t+2) + u(t+2) + r(-t-1)$$ [5]

QUESTION TWO

a) Differentiate between a 1-Dimensional signal and a 2-Dimensional signal.   [1]

b) What is the average value of the signal $v(t) = 2 + 12\cos(2\pi 500t)$ [2]

c) Differentiate between even signals and odd signals. Further, sketch and label
   the even and odd components of the following signal   [8]
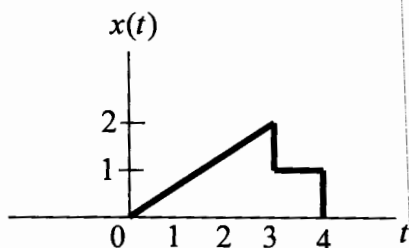
d) Let $x[n]$ be a discrete-time signal, that is, $x[n] = nu[n]$, where $u[n]$ is a unit step
   function. Find its even and odd components and sketch (and label) a few
   points for each of the components.   [6]

e) Find the exponential Fourier series for the following periodic signal. Simplify
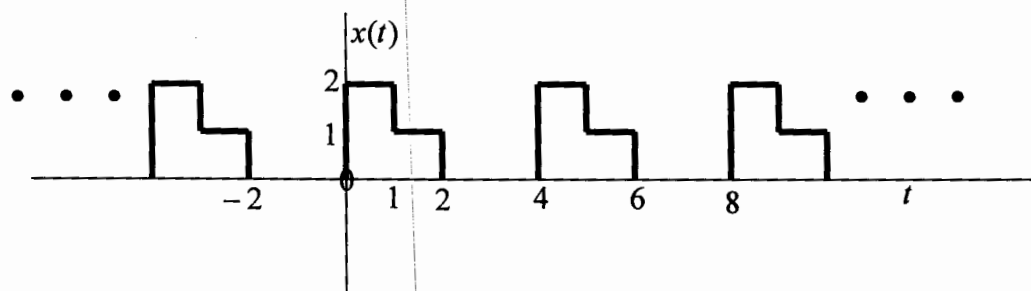   your coefficient as much as possible.   [8]
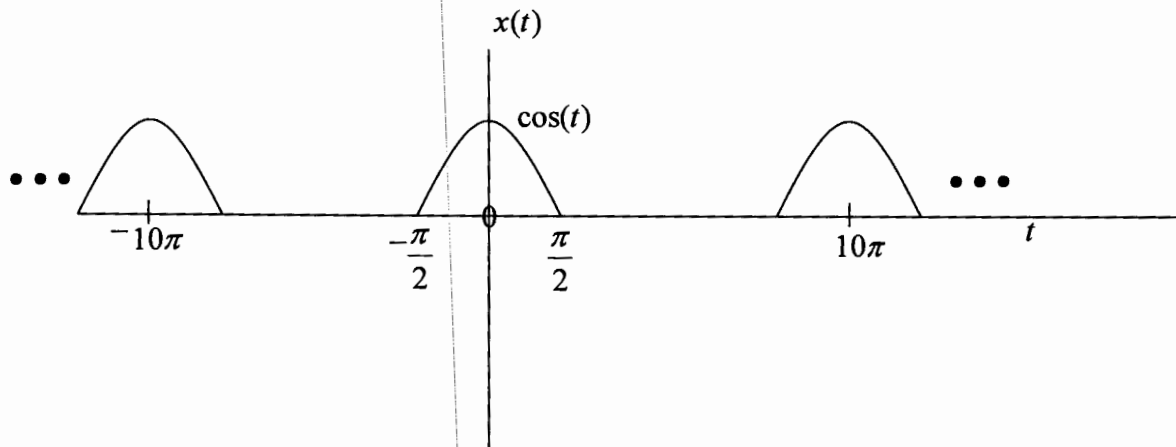
QUESTION THREE

a) Sketch and label the Frequency spectra for the following signal:

$$x(t) = 2 + 4\cos(50t + \pi/2) + 12\cos(100t - \pi/3)$$ [10]

b) Calculate the exponential Fourier series for the following signal   [8]
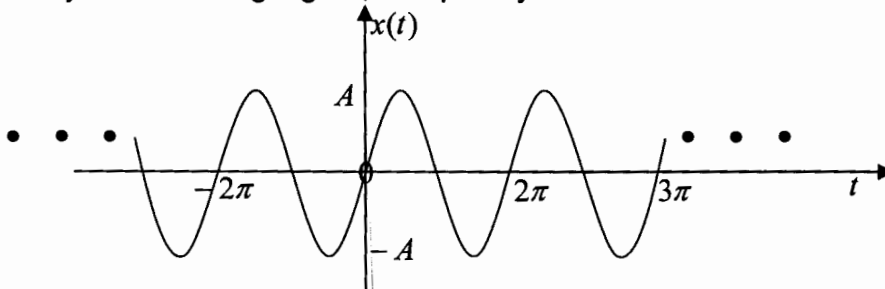

(c) Calculate the average power of the following signal   [7]

$$x(t) = 7 - 10\cos\left(40\pi t - \frac{\pi}{3}\right) + 4\sin(120\pi t)$$

QUESTION FOUR

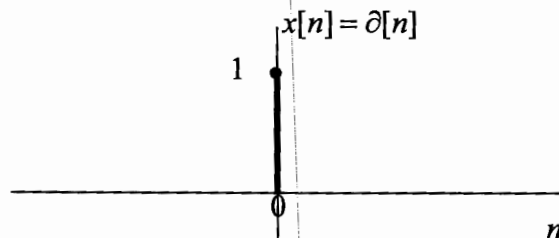a) Classify the following signal, completely   [3]

b) A continuous time signal is made up of sinusoidal components with frequencies up to 250 Hz. It is 100 milliseconds long and is sampled to give a discrete time signal. What is the minimum number of samples that would be sufficient to give a full representation of the signal.

                                                                       [3]

c) Given the following signal, $x[n]$

    Sketch and label the signal $x[-2 + 2n]$ [3]

(d) Using the properties of the impulse delta function simplify the following expressions

        $e^{-5t}\partial(t - 2)$ [3]

(e) Determine if the signal $x(t) = e^{j(\frac{\pi}{2}t-1)}$ is periodic or not, if periodic find the period.   [2]

(f) Sketch the signal $x(t) = \begin{cases} -t &, & -2 \le t < 0 \\ t &, & 0 \le t < 1 \end{cases}$, $Period, T = 3$, for two periods

                                                                        [3]

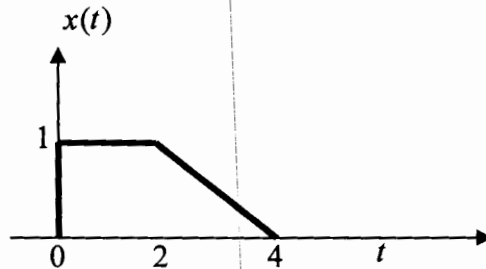(g) Derive the exponential Fourier series representation from the following trigonometric Fourier series representation;   [8]

$$x(t) = \sum_{k=0}^{\infty}(a_k \cos k\omega_0 t + b_k \sin k\omega_0 t)$$

QUESTION FIVE

a) Transform the following signal $x(t)$ to $x(6-2t)$ [5]

b) Determine if the following signal is an energy signal or a power signal.
   If it is an energy signal calculate the energy otherwise calculate its average
   power.   [4]

$$x(t) = 4\cos(t)$$

[useful information: $\int \cos^2(t)dt = \frac{1}{2}t + \frac{1}{4}\sin 2t$]
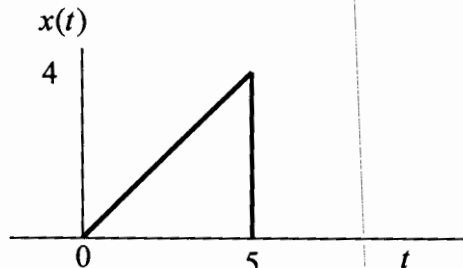
c) Given the following signal

$$x[n] = \begin{cases} 0 & if \quad n < 2 \\ 2n-4 & if \quad 2 \le n < 4 \\ 4-n & if \quad 4 \le n \end{cases}$$

Sketch the first three values of the signal $x[2n+1]$.   [4]
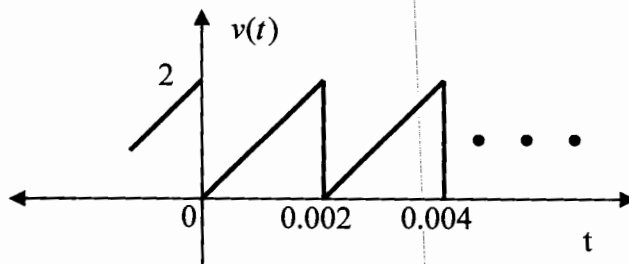
d) Sketch and label the even and odd components of the following signal   [3]

(e) Given the following signal,

   Calculate:

   (i) The DC value.   [4]
   (ii) The RMS value.   [5]