MACHAKOS UNIVERSITY

University Examinations for 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FOURTH YEAR SEMESTER ONE EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 410: SIGNALS AND SYSTEMS

DATE:19/6/2017 **TIME: 8.30-10.30 AM**

INSTRUCTIONS.

This paper consists of **FIVE** questions. Answer Question **ONE** and any other **TWO** questions

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Let . Sketch the following waveforms;

i. $y_1(t) = x(t)$

ii. $y_2(t) = x(2t)$

iii. $y_3(t) = x(\frac{t}{2})$

(3 marks)

b) (i) Evaluate the Fourier transform of the impulse function, $\delta(t)$

(ii) State the significance of the result in b(i) in system identification (2 marks)

c) (i) Explain the sifting property of the delta function

(ii) State the Nyqust sampling theorem (3 marks)

d) State **two** properties of a linear time invariant (LTI) system

(2 marks)

e) Prove the time shifting property of the Fourier transform

(3 marks)

f) Explain the following characteristics of systems

i. Linearity;
ii. Time invariance. (2 marks)

g) With the aid of waveforms, describe following forms of modulation

i. ASK
ii. FSK (4 marks)

h) Check the following systems for **linearity** and **time invariance**

i) $y(t) = x(t-2)$
j) $y(t) = x(2t)$

(8 marks)

j) Find the Fourier transform of $g(t) = e^{-at}u(t)$ (3 marks)

QUESTION TWO (20 MARKS)

a) State the Parseval's theorem

(2 marks)

b) (i) Determine the energy in the signal $f(t) = e^{-at}u(t)$

(ii) Determine the bandwidth W such that 95% of the energy in b(i) is contained below W

(9 marks)

c) Evaluate the convolution integral for a system with input x(t) and output h (t) as shown in Figure 1.

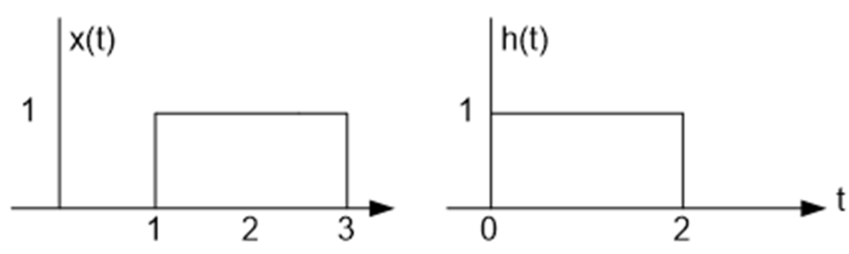


Figure 1

(9 marks)

QUESTION THREE (20 MARKS)

(a) Consider the first order linear time invariant system given by

$$\frac{dy}{dx} + 4y(t) = x(t)$$

where the system is initially at rest.

(i) When the input, $x(t) = e^{-t}u(t)$ determine the solution $y(t)$ for all $t > 0$

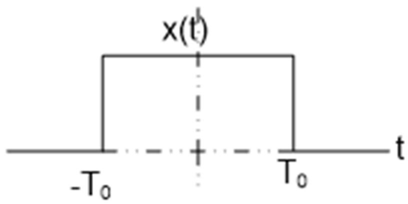
(ii) For the case where the input is $\delta(t)$ show that the impulse response $h(t) = e^{-4t}u(t)$

(iii) Using the impulse response of (b) and input x(t) of (a), determine $y(t) = x(t) * h(t)$ and compare with y(t) found in (a).

(14 marks)

(b) Figure 2a shows a rectangular pulse defined as $x(t) = \begin{cases} 1 & -T_0 < t < T_0 \\ 0 & |t| > t \end{cases}$

i. **Find the Fourier** transform of x (t).
ii. Draw the spectral diagram of x(t)



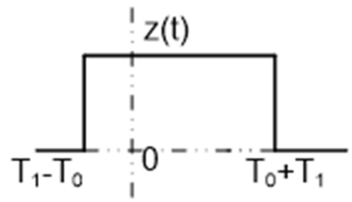


Figure 2(a) **Figure 2(b)**

(c) State the **time shift** property of the Fourier transform and use it to obtain the Fourier transform of the rectangular pulse z(t) of Figure 2(b) (6 marks)

QUESTION FOUR (20 MARKS)

Consider two signals and shown in Figure 3

a) (i) From the direct definition of the Fourier transform as an integral equation show that the transform of the signal x(t) is given by:

$$X(\omega) = \frac{2\sin\left(\frac{\omega}{2}\right)}{\omega}$$

(ii) Show that the Fourier transform of $z(t)$ is given by

$$Z(\omega) = \frac{1}{j\omega}\left(\frac{2sin\left(\frac{\omega}{2}\right)}{\omega}\right)e^{-\frac{j\omega}{2}}$$

(iii) Suppose a system with impulse response (x) is driven by an input z(t). Find the expression for the output in the frequency domain.

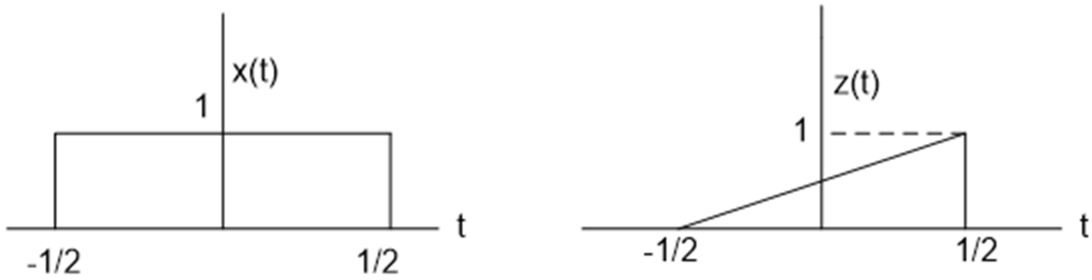


Figure 3 (14 marks)

(b) (i) Find the Fourier transform of the functions:

I. $x(t) = 2e^{-2t}u(t)$

II. $h(t) = e^{-4t}u(t)$

(ii) Use the result to determine a time domain expression for: $y(t) = x(t) * h(t)$

(6 marks)

QUESTION FIVE (20 MARKS)

(a) (i) Define the following with respect to FM

I. Frequency deviation

II. Modulation index

(ii) State two problems associated with sampling

(iii) With relevant examples describe aliasing as applied to signal processing.

(9 marks)

(b) Consider *a square law detector* using a nonlinear device whose transfer characteristic is defined by

$v_2(t) = a_1v_1(t) + a_2v_1(t)$ where $a_1$and a_2 are constants and $v_1(t)$ is the input and $v_2(t)$ is the output. The input consists of the AM wave $v_1(t) = A_c[1 + k_am(t)]cos2\pi f_ct$

i. Evaluate the output $v_2(t)$

ii. Find the conditions for which the message signal m(t) may be recovered from $v_2(t)$

(11 marks)