TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED & HEALTH SCIENCES

DEPARTMENT OF MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS

EEE 4309: SIGNALS & COMMUNICATION.

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES SEPTEMBER 2018

TIME: 2 HOURS

DATE: SEPTEMBER 2018

Instructions to Candidates
You should have the following for this examination
-*Answer Booklet, examination pass and student ID*
This paper consists of FIVE questions. Attempt **Question ONE (Compulsory)** and any other **TWO Questions**
Do not write on the question paper.

Question ONE

a. The system shown in **Figure Q1 (a)** is formed by connecting two systems in ***cascade.*** The impulse responses of the systems are given by $h_1(t)$ and $h_2(t)$ respectively, and $h_1(t) = e^{-2t}u(t)$ and $h_2(t) = 2e^{-t}u(t)$

i. Find the impulse response $h(t)$ of the overall system.
ii. Determine if the overall system is **BIBO** stable. (10 marks)

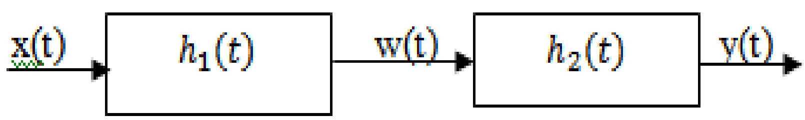

Figure Q1 (a)

b. Consider the system in **Figure Q1 (b).** Determine whether the system is:
i. Memoryless
ii. Causal
iii. Linear
iv. Time-invariant
v. Stable (10 marks)

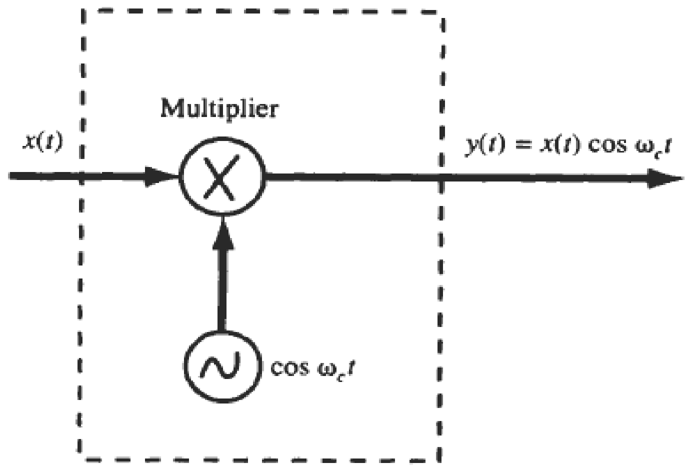

Figure Q1 (b)

c. A carrier wave signal $y_1(t) = Asin\omega_c t$ is amplitude modulated by a single frequency sinusoidal signal $y_2(t) = Bsin\omega_m t$. Determine the expressions for the upper side and lower side frequency components of the modulated wave (6mks)

d. Classify the following signal in terms of power and energy
$x(t) = Acos\left(\omega t + \frac{\pi}{4}\right)$ (4 marks)

Question TWO

a. Consider the periodic square $x(t)$ wave in **Figure Q3 (a).** Determine the complex Fourier series of $x(t)$.
(10 marks)

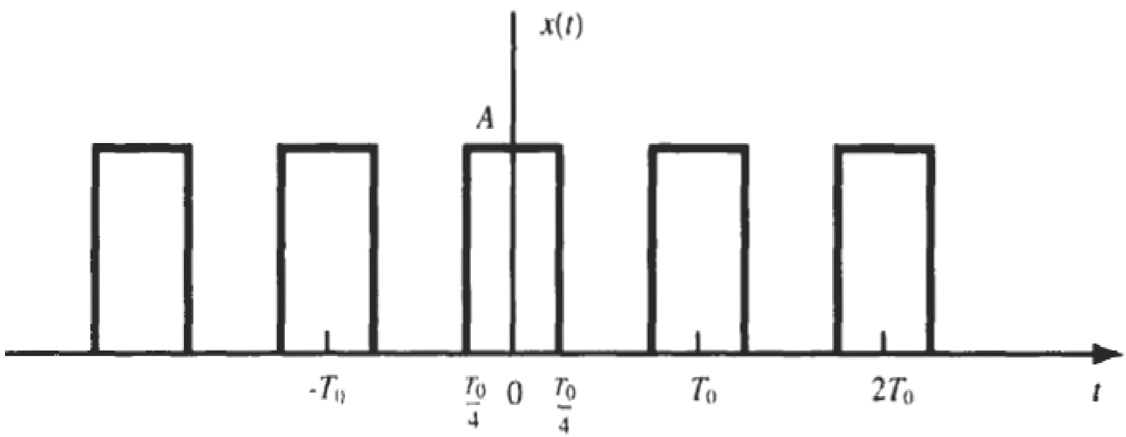

Figure Q3 (a)

b. (i) Mathematically define the term linear modulation and explain all the relevant terms involved

(ii) Highlight THREE types of linear modulation involving a single message signal. (4 marks)

c. (i) Distinguish between a baseband and a pass-band PCM transmission system.

(ii) Sketch a block diagram of a baseband transmission system explaining the functional operation. (6 marks)

Question THREE

a. State the Dirichlet conditions that a periodic signal x(t) must satisfy for it to have a Fourier transform representation. (3 marks)

b. i. Define convolution

ii. Prove the time convolution theorem, that is,
$x_1(t) * x_2(t) \leftrightarrow X_1(\omega)X_2(\omega)$ (9 marks)

c. i. Let $x(t)$ be the complex exponential signal $x(t) = e^{j\omega_o t}$ with radian frequency ω_0 and fundamental period $T_o = {2\pi}/{\omega_o}$. Consider the discrete-time sequence $x[n]$ obtained by uniform sampling of $x(t)$ with sampling interval T_s. That is, $x[n] = x(nT_s) = e^{j\omega_o nT_s}$

Find the condition on the value of T_s so that $x[n]$ is periodic.

ii. Find the even and odd components of $x(t) = e^{jt}$ (6 marks)

d. Define the following terms as used in signals and communication
   i. Spectral density
   ii. Random process (2 marks)

Question FOUR

a. Suppose that the modulating signal *m(t)* is a sinusoid of the form

$$m(t) = a\cos 2\pi f_m t \qquad f_m << f_c$$

Determine the DSB-SC AM signal and its upper and lower sidebands (7 marks)

b. The message signal m(t) has a bandwidth of 15 kHz, a power of 14 W and a maximum amplitude of 5. It is desirable to transmit this message to a destination via a channel with 70-dB attenuation and additive white noise with power-spectral density $S_n(f) = \frac{N_0}{2} = 10^{-12}\, W/Hz$, and achieve an SNR at the modulator output of at least 60 dB. Determine the required transmitter power and channel bandwidth if the following modulation schemes are employed.
   i) SSB AM
   ii) Conventional AM with modulation index equal to 0.4 (13 marks)

Question FIVE

a. Prove the Parseval's theorem. (4 marks)

b. Consider the RC circuit in **Figure Q5**. Find the relationship between the input $x(t)$ and the output $y(t)$ if:

i. $x(t) = v_s(t)$ *and* $y(t) = v_c(t)$

ii. $x(t) = v_s(t)$ *and* $y(t) = i(t)$ (8 marks)

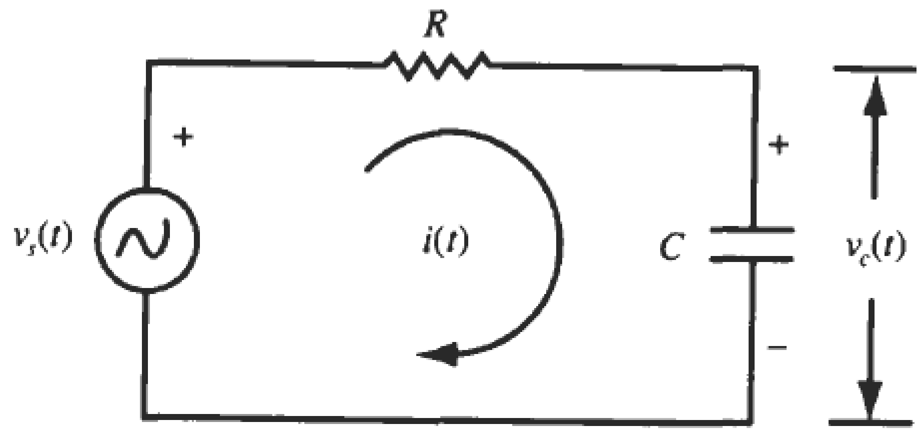

Figure Q5

c. Consider the signal x[k] defined as follows:

$$x[k] = \begin{cases} 0.2k & 0 \le k \le 5 \\ 0 & elsewhere \end{cases}$$

Determine and plot signals $p[k] = x[k-2]$ and $q[k] = x[k+2]$

(8 marks)