University of Swaziland
Faculty of Science and Engineering
Department of Electrical and Electronic Engineering

Main Examination 2016

Title of paper: **Communication System Principles**

Course Number: **EE442**

Time allowed: 3 hours

Instructions:

1. Answer any FOUR (4) questions
2. Each question carries 25 marks
3. Marks for each question are shown at the right hand margin

This paper contains 4 pages including this one.

This paper should not be opened until permission has been granted by the invigilator.

Question 1

a) Draw the block diagram of a communication system and briefly describe the function of each block [10 marks]

b) Calculate the **energy** and the **power** of each of the following signals

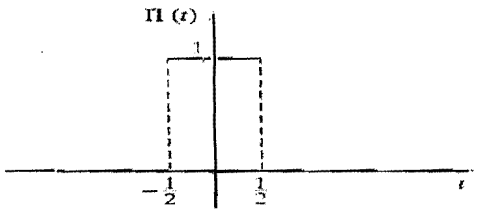
i) $x(t) = \frac{A}{2}\cos(2\pi ft)$ [5 marks]

ii) $x(t) = Ae^{j2\pi ft}$ [5 marks]

c) State and describe 2 operations on signals [5 marks]

Question 2

a) Find the Fourier Transform of the following signals

i) 

[5 marks]

ii) $x(t) = \cos(2\pi f_0 t)$ [5 marks]

b) Let the message signal be $m(t)$ and the carrier signal $c(t) = A\cos(2\pi(600)t)$

i) For the DSB-SC modulated signal $u(t)$, find the Fourier transform $U(f)$ and express it in terms of $M(f)$ [5 marks]

ii) Sketch the spectrum of the signal $M(f)$ and $U(f)$ assuming $M(f)$ has a bandwidth $W = 200$ [5 marks]

iii) Find the power of the modulated signal $u(t)$ [5 marks]

Question 3

a) An angle modulation (AM) system uses a carrier signal $c(t) = 10\cos(2\pi 10^8 t)$ and a message signal $m(t) = 6\cos(2\pi 10^4 t)$. Given that $k_f = 50$, and $k_p = 30$

i) Write the signal expression of the phase of the output for the phase modulated signal [3 marks]

ii) Write the signal expression of the phase of the output for the frequency modulated signal [3 marks]

iii) Write the signal expression of the phase modulated signal [4 marks]

iv) Write the signal expression of the frequency modulated signal [4 marks]

v) Find the modulation indexes β_f and β_p [4 marks]

vi) Calculate the power content of the carrier signal [3 marks]

b) Given that the modulated signal contains 98% of the signal power, calculate the bandwidth of the signal in both FM and PM cases. [4 marks]

Question 4

a) Calculate the noise voltage produced in a 10kΩ resistance on a 1MHz bandwidth at a temperature of 27°C [3 marks]

b) An amplifier having a bandwidth of 20MHz, a gain of 20dB, generates its own noise power of 10.2×10^{-14}W measured at the output. If a signal of –100dBm is applied to the amplifier input with a signal to noise ratio of 20dB, Assuming a physical temperature of 290^0K, calculate

i) The noise temperature of the amplifier [5 marks]

ii) The signal to noise ratio at the output of the amplifier [5 marks]

c) An UHF receiver system is shown in **Figure Q4.** Given that the input power at the antenna is 5mW, $N_0 = 6dB$, and the signal has a bandwidth of 4kHz

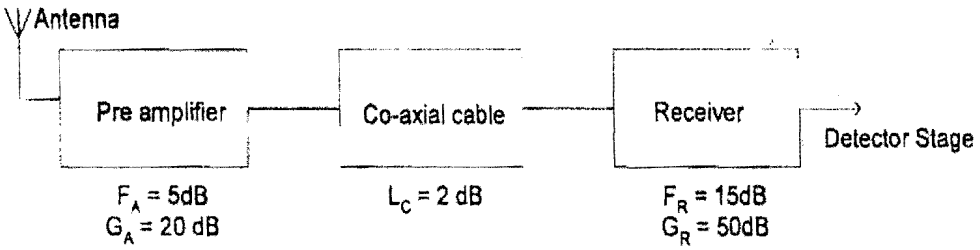


Figure Q4

Note that F, G and L represent noise figure, gain and loss respectively.

i) Calculate the power at the output of the receiver [5 marks]

ii) Calculate the noise total noise figure of the system [3 marks]

iii) Calculate the signal to noise ratio at the output [4 marks]

Question 5

a) Define up-sampling and down-sampling [4 marks]

b) Given that the down-sampling and up-sampling rate is 2. Sketch the resulting up-sampled and down-sampled signals of the signal in **Figure 5** below [6 marks]

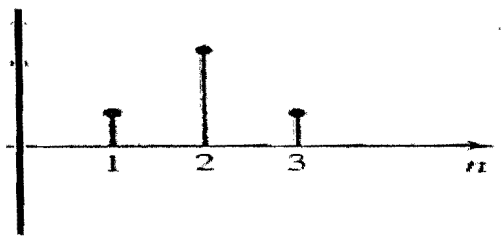


Figure 5

c) State the Nyquist sampling theorem [2 marks]

d) A band limited signal has a bandwidth of 3400Hz. What sampling rate should be used to guarantee a guard band of 1200 Hz. [4 marks]

e) Define quantization [3 marks]

f) Given the signal $x(t) = 10\cos(2\pi ft)$ is quantized and the quantization power of the quantizer is 5W. Find the SQNR of the output signal. [6 marks]

Question 6

a) Apply the Gram-Schmidt Orthogonalization Procedure to the signals in **Figure 6** below [10 marks]

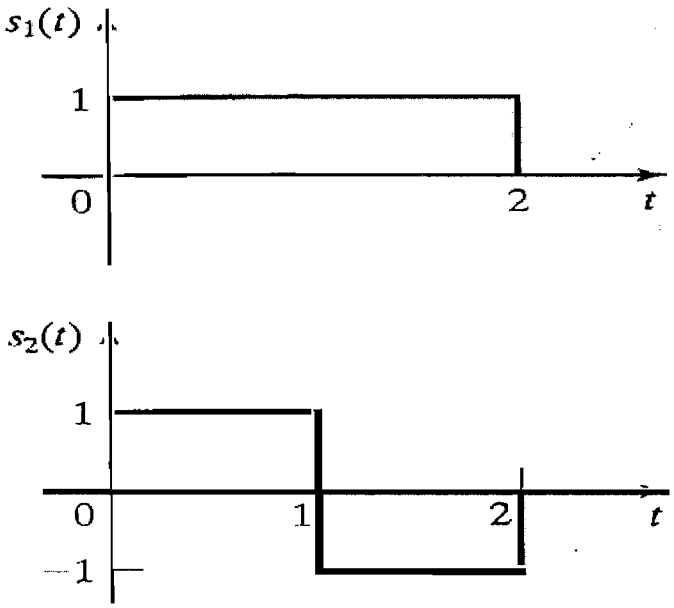


Figure 6

b) Draw the geometric representation following

i) Binary PAM signals [4 marks]

ii) Binary orthogonal signals [4 marks]

c) For frequency shift keying (FSK) write the expressions of $s_1(t)$and $s_2(t)$. Assuming unit energy determine $\psi_1(t)$and $\psi_2(t)$. [7 marks]