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

Supplementary Examination – July 2018

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) List and describe 3 examples of communication channels [6]

b) Given the following input signal $s(t) = \{1 + 3i; 3 + 3i; -3 + 1i\}$ and the noise signal, $n(t) = \{0.8 + 1.1i;\ 0.9 - 0.4i; -0.6 + 0.1i\}$ find the received signal $r(t)$ of an additive channel [4]

c) Given the signal **Figure 1** below, perform the operations below and draw the sketch of the new signal

  i) Time shift by $n = 2$ [4]

  ii) Time reversal [4]

d) Show that the SNR for a DSB-SC is given by the equation below

$$\left(\frac{S}{N}\right)_{0DSB} = \frac{P_R}{N_0 W}, \text{ where } P_R = \frac{A_c^2 P_M}{2} \qquad [7]$$

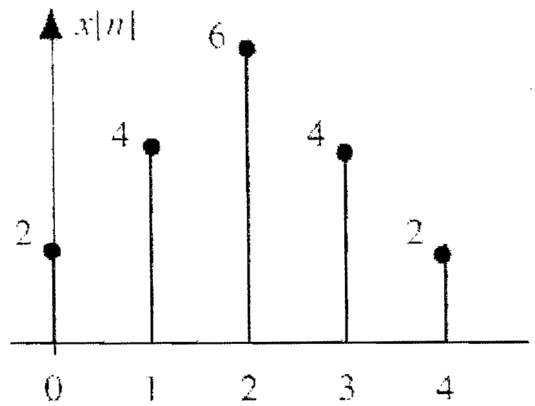

Figure 1

Question 2

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) Calculate the modulation indexes β_f and β_p [4]

  ii) Write the signal expression of the phase modulated signal and the frequency modulated signal using the modulation indexes above [6]

b) Let the message signal be $m(t)$ and the carrier signal $c(t) = 5\cos(2\pi(600)t)$

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

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

  iii) Find the power of the modulated signal $u(t)$ given that $P_m = 3mW$ [5]

Question 3

a) Given the autocorrelation of a signal to be $R_X(\tau) = \frac{A^2}{2}\cos(2\pi f_0 \tau)$.

i) Find the power spectral density of the signal [4]

ii) From the power spectral density, find the power of the signal [4]

iii) Show that $P_x = R_X(0)$ [3]

b) Draw the geometric representation of the following digital modulation schemes

i) Binary Antipodal signals [4]

ii) Binary Orthogonal signals [4]

c) Show that the code below is a linear block code [6]

$$C = \{00000, 10100, 01111, 11011\}$$

Question 4

a) Given the Tanner graph **Figure 4(a)** below,

i) Derive the parity check matrix **H** [10]

ii) Find the density r of the code [2]

iii) State whether the code is regular or irregular and justify your answer. [2]

iv) Write the definition of the code i.e. *(n, k)* [2]

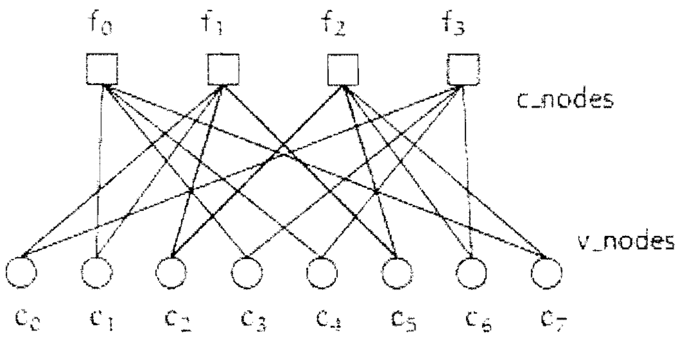

Figure 4(a)

b) The figure below, **Figure 4(b)**, shows a convolutional encoder,

i) Find the generator sequences [6]

ii) Find the rate of the code for $k = 1$ and the number of states [3]

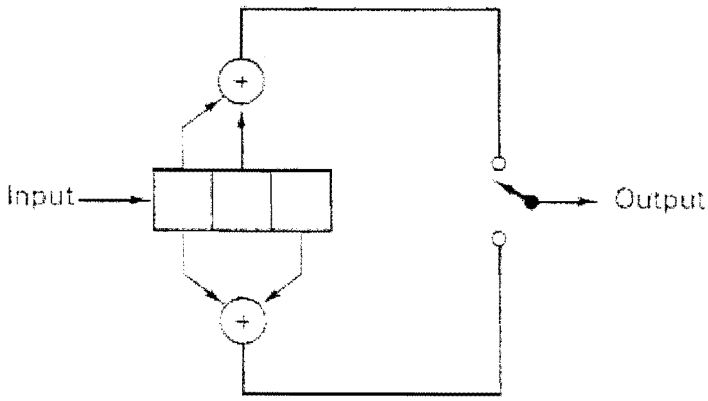

Figure 4(b)

Question 5

a) In a binary communication system, the input bits transmitted over the channel are either 0 or 1 with probabilities 0.3 and 0.7, respectively. When a bit is transmitted over the channel, it can be either received correctly or incorrectly (due to channel noise). Let us assume that if a 0 is transmitted, the probability of it being received in error (i.e., being received as 1) is 0.01, and if a 1 is transmitted, the probability of it being received in error (i.e., being received as 0) is 0. 1.

   i) What is the probability that the output of the channel is 1? [6]

   ii) Assuming we observe a one at the output of the channel, what is the probability that the input to the channel was a 1? [6]

b) Show that the SNR of a conventional AM system is given by [8]

$$\left(\frac{S}{N}\right) = \eta\left(\frac{S}{N}\right)_b$$

$$\eta = \frac{a^2 P_{M_n}}{\left[1 + a^2 P_{M_n}\right]}$$

c) Find the SNR in a baseband signal with a bandwidth of 5kHz with a noise power spectral density given by $\frac{N_0}{2} = 10^{-14} W/Hz$. The transmitter power is 1kW and the channel attenuation is $a = 10^{-12}$ [5]
