UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

MAIN EXAMINATION 2010

TITTLE OF PAPER: COMMUNICATION SYSTEMS

COURSE CODE: **E410**

TIME ALLOWED: **THREE** HOURS

INSTRUCTIONS:

1. Answer **any four** of the following **five** questions.
2. Each question carries 25 marks
3. Marks for different sections are shown in the right hand margin

This paper has 6 pages including this page

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QUESTION 1

A Explain the meaning of following terms as used in communication systems:

i) A transducer

ii) A communication channel

iii) Free space propagation

iv) Signal-to-Noise Ratio

(8 marks)

B i) Describe with the aid of a block diagram a typical communication system explaining the function of each block involved.

(8 marks)

ii) Show that the path loss in dB for LOS transmission is given by $-127.6+20\log_{10} d+20\log_{10} f$, where d is the distance between the transmitter and receiver and f is the frequency of the transmitted signal.

(4 marks)

iii) Describe a suitable mathematic model for estimating the signal power at the receiver location, defining the symbols used and stating the units of all the parameters in the model. **(5 marks)**

QUESTION 2

A) i) Give a table showing the various frequency designations used in communication.

(5 marks)

ii) Determine the number of radio broadcast channels that can be accommodated in the Medium Wave frequency band 0.5 to 1.5 MHz.

(5 marks)

iv) An amplifier is said to have a gain of $30\,dB$. What does this statement mean? The input signal to an amplifier varies between 0.58 mW and 102 mW. Express each power in dBm and state the fluctuation in dB.

(7 marks)

B) i) An amplifier has a gain of $30\,dB$ and generates a noise power, referred to its input terminals, of $3\,\mu W$. If the signal applied to the amplifier input is $-10\,dBm$ with a signal-to-noise ratio of $20\,dB$, calculate the signal-to-noise ratio at the output of the amplifier. **(5 marks)**

ii) Calculate the noise voltage produced in a $10\,k\Omega$ resistance in a $1\,MHz$ bandwidth when the temperature is $20^0\,C$ **(3 marks)**

QUESTION 3

A) i) Differentiate between "modulation factor" and "depth of modulation" asapplied to amplitude modulation. Give the different traditional methods of modulating a carrier signal, comparing them in terms of bandwidth effectiveness. **(8 marks)**

ii) Consider the processes shown in figure 1 and figure 2 below. State what kind of devices are represented by device A and device B for the two processes in figure 1 and figure 2 respectively to be identical. **(2 marks)**

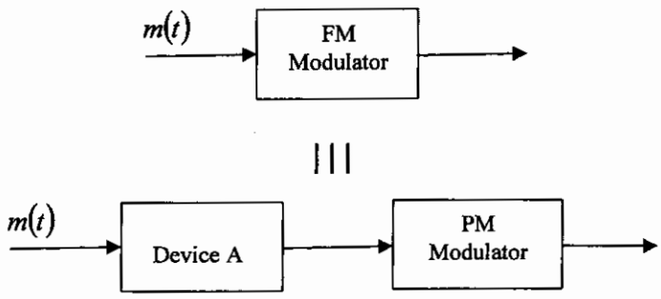

Figure 1

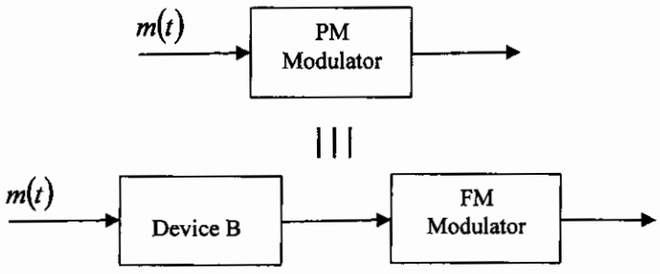

Figure 2

iii) Give a diagram illustrating an FM and PM signal obtained when a square wave signal is used to modulate a sinusoidal carrier signal. **(5 marks)**

B) A VHF radio station operating at a carrier frequency of $f_0 = 80\ MHz$ transmits a PM signal modulated by a message signal of frequency $F = 15\ kHz$. The modulation index $m = 12$.

i) Write down the mathematical model of the PM signal.

ii) Find the limits between which the instantaneous frequency of the signal varies.

(10 marks)

QUESTION 4

i) A carrier wave of amplitude 10 V and frequency 1 MHz is amplitude modulated by a sinusoidal modulating signal. If the lower side frequency is 999 kHz and its voltage is 20dB below the carrier amplitude, calculate the amplitude and the frequency of the modulating signal

(6 marks)

ii) Show that the power developed by an amplitude modulated wave P_{AM} is a function of the maximum modulation factor m, and give the relationship between the powers developed by each of the frequency components at maximum modulation factor.

(8 marks)

iii) The power dissipated by an amplitude modulated wave is 100 W when its depth of modulation is 40 %. What modulation depth, m, is necessary to increase the power to 120 W.

(4 marks)

iv) Write down the expressions of the modulated signal obtained when a sinusoidal message signal is used to

a. frequency modulate a sinusoidal carrier signal, and
b. phase modulate a sinusoidal carrier signal.

(4 marks)

v) The message signal $m(t) = \cos(20\pi t)$ is used to modulate the carrier $c(t) = 10\cos(2\pi f_c t)$. Obtain an expression for the modulated signal when $m(t)$ is used to frequency modulate the carrier signal $c(t)$ with a frequency deviation constant $k_f = 50$ and determine the power content of the carrier signal.

(3 marks)

QUESTION 5

A) Explain the meaning of the following with regards to a superheterodyne radio receiver:

i) Intermediate frequency

ii) Image frequency

iii) Selectivity

iv) Adjacent channel ratio

v) Sensitivity

(10 marks)

B) i) With the aid of a diagram give a brief description of a superheterodyne AM receiver.

(8 marks)

ii) A superheterodyne radio receiver has an intermediate frequency of 465 kHz and is tuned to a frequency of 1000 kHz. Two stations are then heard simultaneously and quite clearly. If one station operates on a carrier frequency of 800 kHz, calculate the carrier frequency of the other station.

(7 marks)