TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Electrical and Electronic Engineering

EEE 4419 SIGNALS AND COMMUNICATION II

END OF SEMESTER EXAMINATION

SERIES: NOVEMBER 2024

TIME: 2 HOURS

DATE: NOVEMBER 2024

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 and any other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) Describe the following types of noise associated with electronic components
   i) Thermal Noise
   ii) Shot Noise **(4 marks)**

b) Three two port networks having individual noise factors as F_1, F_2, F_3 and individual gains are G_1, G_2, G_3respectively are connected in cascade. Show that the overall noise factor of the combination is given by ;

$$\mathrm{F} = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + .. \quad \textbf{(6 marks)}$$

c) Desscribe the following multiple access systems used by satellite communication
   i) CDMA
   ii) TDMA **(4 marks)**

d) Explain any THREE factors to be considered in the design of an earth station **(6 marks)**

e) Show that in AM system with envelope detection, the output signal to noise ratio is given by

$$SNR = \frac{\mu^2}{2+\mu^2}$$

Where μ is the modulation index for AM (assume sinusoidal modulation) **(4 marks)**

f) A broadcast AM receiver has a tuning range of 530kHz to 1640kHz and an IF of 455kHz.The loaded Q of the coupling circuit is 80.calculate the image frequency rejection in dB at 1MHz **(3 marks)**

g) e Explain any THREE factors used in the choice of IF for a radio receiver (**3 marks)**

Question TWO

a) **i)** Explain why double conversion is used in communication receivers

ii) Explain why the Tuned radio Frequency (TRF) receivers were superseded by the superheterodyne receivers **(4 marks)**

b) Draw a block diagram of a typical HF communication receiver and explain the function of each block **(6 marks)**

c) Show that for a series RLC circuit , the ratio a of the magnitude of the current at resonance frequency ω_o to the magnitude of the current at any frequency ω is given by;

$A = \sqrt{(1+Q^2\rho^2}$ where

$Q = \frac{\omega L}{R}$ and $\rho = \frac{\omega}{\omega_o} - \frac{\omega_o}{\omega}$ **(7 marks)**

d) A double super heterodyne receiver has an intermediate frequencies (IFs) of 4MHz and 100kHz and is tuned to receive a signal at 20MHz.Calculate the frequency of the first and second local oscillators. **(3 marks)**

Question THREE

a) Draw a well labelled simplified block diagram of C band(6GHz/4GHz) earth station (transmitter side) and explain its operation **(6 marks)**

b) A satellite earth station transmitter has an output power P_T and an aerial gain G_T.The receiving aerial on the satellite distant D meters has a power gain G_R.If the gain of an aerial is $\frac{4\pi}{D^2}$ times its effective aperture, derive an expression for the received power P_R at the satellite. **(4 marks)**

c) A satellite operating at 6GHz at a distance of 40000km from a point on the earth's surface radiates a power of 2W from an antenna with a gain of 17dB. Determine

i) the maximum isotropic radiated power EIRP

ii) Power density at the receiving point

iii) the path loss in dB

iv) the power received by an antenna with effective area of $10m^2$. **(10 marks)**

Question FOUR

a) State the Wiener –Khinchine theorem **(2 marks)**

b) The input to the RC low pass filter of Figure 4b is white noise with power spectral density $\frac{N_o}{2}$.

Determine

i) the output power spectral density
ii) the average noise power **(7 marks)**

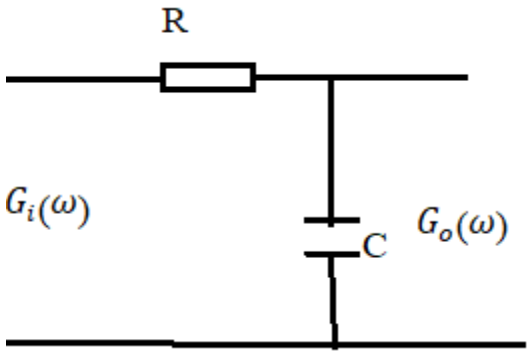

Figure Q4b

c) Three amplifiers have the following characteristics shown in Table Q4c.The three amplifiers are connected in cascade .Determine how the three amplifiers should be connected in order to achieve the lowest overall noise figure **(6 marks)**

Table Q4c

Amplifier	Power gain G (dB)	Noise Figure F
A	6	2.0
B	12	1.7

C	20	4.0

d) i) Use Wiener Khinchine theorem to determine the auto correlation function of white noise

ii) Sketch the variation of R(τ) with respect to τ and explain the significance of the results **(5 marks)**

Question FIVE

a) Briefly explain the meaning of the following terms
   i) Source coding
   ii) Channel coding
   iii) Source Entropy **(6 marks)**

b) State the Shannon Hartley theorem **(2 marks)**

c) A source emits one of four possible symbols during each signalling interval the symbols occurrence have the following individual probabilities

P_o**=0.5,** P_1**= 0.4,** P_2 **= 0.2,** P_3**= 0.1** **(3 marks)**

Determine the entropy of the source

d) Consider a discrete memoryless source with alphabet (x has five symbols S_o, S_1, S_2, $S_3$0 with the following probabilities of occurence

P(S_o**)= 0.5 P(**S_1**)=0.2 P(**S_2**)= 0.15 P(**S_3**)= 0.15**

i) Compute the Huffman tree for this source
ii) Determine the average code word length **(5 marks)**

e) i)Distinguish between Forward error Correction (FEC) and Automatic repeat request error correction

ii) Give an application of each (**4marks)**