PP1

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: AUGUST 2024

TIME: 2 HOURS

DATE: AUGUST 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) Sketch and discuss the variation of the sky noise temperature as a function of frequency **(6 marks)**

b) i) A receiver has a noise figure of 10dB .Determine the system noise temperature if the noise temperature of the receiver aerial is

II) 300K II) 60K (quoted noise factors are referred to 293K

ii) It is proposed to improve its sensitivity by adding a preamplifier having a noise figure of 3dB and a power gain of 10dB,determine the extent to which the receiver will improve the noise temperature of the aerial are the same as in part b(i) **(8 marks)**

c) The ground receiver of a satellite to ground SHF communication link is shown in Figure Q1c.The various stages may be considered matched for maximum power transfer. Calculate the equivalent noise temperature of the system at the waveguide input and hence calculate the signal to noise power ratio at the input of the demodulator when the available signal power from the aerial is 7x 10^{-13}W and the equivalent noise bandwidth of the receiver is 10MHz.Take the Boltzmann's constant k=1.38x10^{-23} and standard temperature is 290K. **(9 marks)**

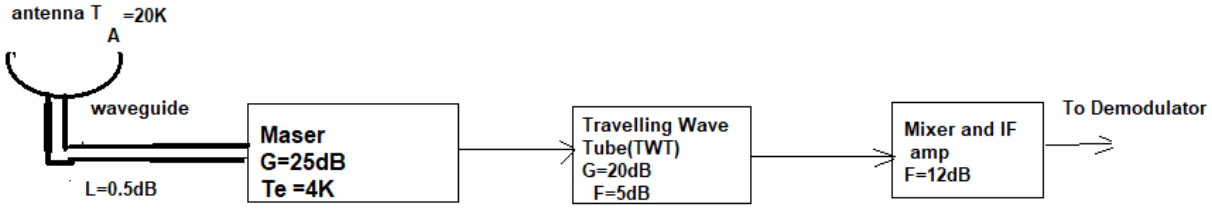

Figure Q1c

d) With the aid of a well labelled diagram, explain the operation of a Super-heterodyne FM radio receiver **(7 marks)**

Question TWO

a) State TWO advantages of FM over AM radio receivers **(2marks)**

b) Explain FOUR factors that influence the choice of the intermediate frequency(IF) in any radio system **(4 marks)**

c) Given that the output noise voltage from the FM discriminator $V_d(t)$ is

$$V_d(t) = K\frac{V_n f_n}{V_c}\cos\omega_n t$$

Where V_n is the noise voltage, f_n is the noise frequency component and V_c is carrier voltage,

Show that the ratio of the FM output Signal to noise ratio to AM signal to output Noise ratio is given by

$$\frac{SNR(FM)}{SNR(AM)} = 3\beta^2$$

Where β is the modulation index **(7 marks)**

a) A double conversion receiver has its RF section tuned to a 30MHzz carrier. RF section and First IF stage both have a Q of 75. The 1^{st} and2^{nd} IF are 2MHz and 200KHz respectively. Determine the overall receiver image rejection ratio in dB **(7 marks)**

Question THREE

a) Draw a block diagram of a C band Communications satellite transponder and briefly explain its operation **(6 marks)**

b) With aid of suitable sketches, describe the following multiple access methods used by satellite communication

i) Frequency Division multiple Access (FDMA)

ii) Time Division Multiple Access (TDMA) **(6marks)**

c) A satellite communication link has the following parameters;

Transmitter power =15W

Diameter of parabolic dish =5m

Antenna efficiency =60% for both transmit and receive antennas

Distance of satellite =36000km

Frequency of operation=15GHz

Determine

i) The antenna gain
ii) The received power
iii) The power flux density in the link **(8 marks)**

Question FOUR

a) State the Wiener-Khintchine theorem **(2marks)**

b) White noise is passed through low pass filter with a bandwidth $\pm B$ Hz

i) Show that the auto correlation R_τ of filtered white noise is given by ;

$$R_\tau = \frac{N_o B Sin\, 2\pi B\tau}{2\pi B\tau}$$

Where N_o is the power spectral density per Hz for positive frequencies only

ii) Sketch the variation of R_τ with respect to τ and explain its significance **(8 marks)**

c) The input to an RC Low pass filter shown in Figure Q4c is white noise with a power spectral density of $\frac{N_o}{2}$ watts/Hz, determine

i) The transfer function H(ω) of the RC network
ii) The output power spectral density $G_o(\omega)$
iii) The average noise power (P_{av}) **(6 marks)**

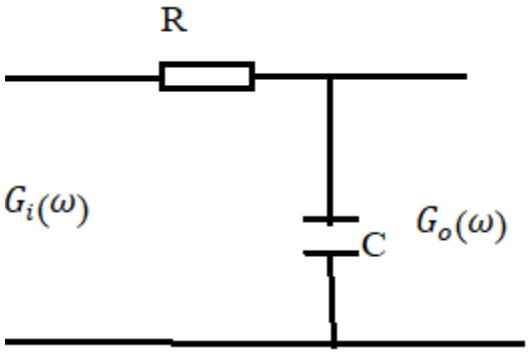

Figure Q4c

d) The auto correlation function of an RC network is given by ;

$$R_\tau = \frac{(N_o \omega_o)}{9} e^{-j\omega_{o|\tau|}}$$

Where N_o is the power spectral density $(\omega>0)$ and $\omega_o = \frac{1}{RC}$ use Wiener -Khinchine theorem to determine

i) the average power
ii) the rms output voltage of the network **(4 marks)**

Question FIVE

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

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

P_o**=0.4 ,** P_1**= 0.3,** P_2 **= 0.2,** P_3**= 0.1** **(2 marks)**

Determine the entropy of the source

c) Describe the following between error correction methods
i) forward
ii) feedback **(4 marks)**

d) A discrete memoryless source x has five symbols x_1, x_2, x_3, x_4 and x_5

P(x_1**) = 0.4 P(**x_2**)=0.19 P(**x_3**)= 0.16 P(**x_4**)= 0.15P(**x_5**)= 0.10**

i) Construct a Shannon -Fano code for x and determine the efficiency of the code
ii) Repeat for the Huffman code
iii) Compare the results in part d i) and ii) and give a suitable comment **(8 marks)**