PP1

TECHNICAL UNIVERSITY OF MOMBASA

School of Applied Sciences

Department of Mathematics & Physics

UNIVERSITY EXAMINATION FOR:

Bachelor of Technology in Applied Physics

EEE 4423 TELECOMMUNICATION SYSTEMS

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.

Assume speed of electromagnetic waves **=3x**10^8 **m/s**

Question ONE (Compulsory 20 marks)

a) State the reasons for using **modulation** in Communication systems **(4 marks)**

b) Draw the block diagram of an AM receiver **(2marks)**

c) 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)**

d) For an FM system, the maximum frequency deviation is 75kHz and maximum modulating frequency is 15kHz.Calculate the modulation index **(2marks)**

e) With the aid of diagrams, describe the following satellite multiple access methods

i) Frequency Division Multiple access (FDMA)

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

f) Explain THREE advantages of Optical fiber as a medium of transmission compared to copper wires **(3 marks)**

QUESTION TWO

a) i) Explain the meaning of the term **super-heterodyning** as used in modern receivers

ii) Explain any TWO advantages of employing super heterodyning in receivers **(4 marks)**

b) Given that the amplitude modulated wave is given by;

$v_{AM}(t) = V_c(1+m\cos\omega_s t)\cos\omega_c t$

where V_c is the peak carrier voltage and ω_c is the angular frequency of the carrier, m is the modulation index , ω_s is the modulating signal angular frequency, Show that the ratio of sideband power to the Total power A.M signal is given by:

$$\frac{P_{sideband}}{P_{Total}} = \frac{m^2}{2+m}$$ **(5 marks)**

c) Draw the circuit of an envelope detector and explain its operation **(6 marks)**

d) An AM transmitter has an output of 40kW when modulated to a depth of 100%. Determine the

i) power of the un-modulated carrier

ii) the power output when after modulation to a depth of 60% one sideband is suppressed **(5 marks)**

QUESTION THREE

a) Define the following terms used in FM

i) deviation ratio ii) percentage modulation **(2 marks)**

b) Given that the carrier signal is given by $v_c(t) = V_c \sin\omega_c t$ and the modulating signal voltage is given by

$v_m(t) = V_m \sin\omega_m t$. Show that the frequency modulated wave is given by;

$v_{FM} = V_c \sin(\omega_c t - m_f \cos\omega_m t)$

Where m_f is the modulation index **(5marks)**

c) i) Distinguish between narrow band and wideband FM and give an application of each

ii) Draw the block diagram of an Armstrong FM transmitter and explain the effect of the mixing and multiplication process on the carrier frequency and frequency deviation **(8marks)**

d) The modulation in a frequency modulated transmitter is achieved by variation of the tuning capacitance of an oscillator operating at a mean frequency of 5MHz.The coil used in the parallel tuned circuit of the oscillator has an inductance of 22μH.If the modulated waveform is frequency multiplied to give an output of 100MHz with a maximum frequency deviation of 150kHz,

determine i) the capacitance of the oscillator tank circuit

ii) the multiplication factor required

iii) the initial frequency deviation

iv) the change in value of the capacitance to be produced by the modulating signal **(5 marks)**

QUESTION FOUR

a) Draw a well labelled simplified block diagram of C band(6GHz/4GHz) communication satellite transponder and briefly 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 FIVE

(a) Describe any THREE radio Frequency Spectrum, and in each state its frequency range, mode of propagation and its application in communication **(10 marks)**

(b) A Sinusoidal modulating signal, $m(t)=4\cos 2\pi 4\times 10^3 t$ is applied to an FM modulation that has a frequency deviation constant gain of 10kHz/V. Compute:

i) The peak frequency deviation ii) The modulation index **(4 marks)**

(c) A 880 MHz carrier signal is frequency modulated using a 100kHz sinusoidal modulating waveform. The peak deviation of the FM signal is 500kHz. If this

FM signal is received by a super heterodyne receiver having an IF frequency of 5kHz, determine the IF bandwidth necessary to pass the signal. **(6 marks)**