



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: NOVEMEBR 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 any other **THREE** Questions.

Do not write on the question paper.

Assume speed of electromagnetic waves $= 3 \times 10^8$ m/s

Question ONE (Compulsory 20 marks)

a) Define the following terms

i) modulation ii) AM modulation index iii) Frequency Deviation for FM **(6 marks)**

b) i) State any Two effect of over modulation of a carrier wave

ii) A radio frequency carrier is amplitude modulated by a speech signal having frequencies $\omega_1, \omega_2, \omega_3$ and peak voltages V_1, V_2, V_3 respectively. Derive the expression for the modulated AM wave and sketch the frequency spectrum **(6 marks)**

c) A certain FM tone modulated signal is given by

$$V_c(t) = 100 \cos(2\pi \times 10^8 t + 20 \sin(2\pi \times 10^3 t))$$

Calculate;

- i) the un modulated carrier frequency
- ii) the modulating signal frequency
- iii) the frequency deviation

iv) the Bandwidth

(8 marks)

QUESTION TWO

a) Draw the circuit diagram of a simple Transistor A.M modulator and derive the expression for its the output voltage

(7 marks)

b) Given that an AM waveform is given by: $V_{AM}(t) = V_c(1+m \cos\omega_m t) \cos\omega_c t$.

Show that the total transmitted power in an AM wave is given by;

$$P_t = P_c \left(1 + \frac{m^2}{2}\right)$$

where P_c = power in the carrier

m = modulation index

(5 marks)

c) An AM transmitting station has an output of 24 kW when modulated to depth of 100% .

Determine:-

(i) Output power of the un modulated carrier

(ii) The overall output power when after modulation to a depth of 60% one sideband is suppressed

(5 marks)

d) 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)

QUESTION THREE

(a) Describe any FIVE Parameters of an Aerial.

(10 marks)

(b) Draw a well label diagram of a Yagi Aerial and state the function of each of its elements.

(7 marks)

(c) For the aerial in (b), calculate the length of the Dipole if it is used to tune a Radio Channel operating at a Frequency of 300 MHz.

(3 marks)

QUESTION FOUR

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

(6 marks)

b) Explain any THREE factors to be considered in the design of an earth station

(4 marks)

c) 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)

- d) A satellite operating at 12GHz at a distance of 36000km from a point on the earth's surface radiates a power of 5W from an antenna with a gain of 15Db. Determine
- the maximum isotropic radiated power EIRP
 - Flux density at the receiving point
 - the path loss in dB
 - the power received by an antenna with effective area of $10m^2$.

(6 marks)

QUESTION FIVE

- Draw a block diagram of the main components of an optical fiber link and explain the function of each block
- With the aid of a sketch, describe the construction of a optical fiber cable
- Show that the acceptance angle is given by

$$\text{Acceptance angle } \theta_a = \sin^{-1}(\sqrt{n_1^2 - n_2^2}) \quad (4\text{marks})$$

where n_1 and n_2 are the refractive indices of the media

- A silica optical fiber has a core refractive index of 1.50 and cladding refractive index of 1.47. Determine
 - the critical angle at the core -cladding interface
 - the Numerical aperture for the fibre

(2marks)