PP2

TECHNICAL UNIVERSITY OF MOMBASA

School of Engineering & Technology
DEPARTMENT OF MEDICAL ENGINEERING

UNIVERSITY EXAMINATION FOR:
BACHELOR OF TECHNOLOGY IN MEDICAL ENGINEERING
TMD 4409: TELEMEDICINE
END OF SEMESTER EXAMINATIONS
SERIES: MARCH, 2025
TIME: 2 Hours
DATE: MARCH, 2024

INSTRUCTIONS TO CANDIDATES
You have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of FIVE QUESTIONS; Attempt any THREE questions
Do not write on the question paper

Question ONE (Compulsory 20 marks)

a) Define the following terms
i) modulation ii) AM modulation factor 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 a frequency ω_1 and peak voltages V_1. 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
(8marks)

QUESTION TWO

a) Draw the circuit diagram of a balanced modulator derive the expression for the output voltage
(7 marks)

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

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 24kW 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 and the carrier component is reduced by 26 dB **(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 with the aid of a suitable block diagram, the construction and operation of an A.M "Superhet" Receiver **(10 marks)**

b) Compare the advantages and disadvantage of a TRF and "Superhet" Receiver **(5 marks)**

b) Distinguish between narrow band and wideband FM and give a practical application of each **(5 marks)**

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 4MHz.The coil used in the parallel tuned circuit of the oscillator has an inductance of 10μH.If the modulated waveform is frequency multiplied to give an output of 103MHz with a maximum frequency deviation of 140kHz, determine

i) the tuning circuit capacitance
ii) the multiplication factor
iii) the frequency deviation
iv) 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) 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

i) the maximum isotropic radiated power EIRP

ii) Flux density at the receiving point

iii) the path loss in dB

iv) the power received by an antenna with effective area of $10m^2$. **(6 marks)**

QUESTION FIVE

a) Draw a block diagram of the main components of an optical fiber link and explain the function of each block **(6 marks)**

b) With the aid of a sketch, describe the construction of a optical fiber cable **(8 marks)**

c) Show that the acceptance angle is given by

Acceptance angle $\theta_a = \sin^{-1}\left(\sqrt{n_1^2 - n_2^2}\right)$

where n_1 and n_2 are the refractive indices of the media

(4marks)

d) A silica optical fiber has a core refractive index of 1.50 and cladding refractive index of 1.47.Determine ; i) the critical angle at the core -cladding interface

ii) the Numerical aperture for the fibre

(**2marks)**