CHUKA  **UNIVERSITY**

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EENG 483: COMMUNICATION SYSTEMS

STREAMS: BSc. EENG **TIME: 2 HOURS**

DAY/DATE: WEDNESDAY 16/04/2025 **11.30 A.M. – 1.30 P.M.**

INSTRUCTIONS:

- **Answer question ONE and any other TWO questions**
- **Do not write on the question paper**

QUESTION ONE (30 marks)

a. What is communication? (1 marks)

b. With the help of a well labelled block diagram describe the main components of a communication system? (4 marks)

c. Explain the need for Modulation in Communication systems? (4 marks)

d. Calculate the bandwidth given the frequencies of the carrier wave and modulating wave are 50 MHZ and 30 MHZ respectively. (3 marks)

e. In an amplitude modulator circuit, the carrier wave is given by, $C(t) = 4 \sin (20000\pi t)$, while modulating signal is given by, $m(t) = 2 \sin (2000\pi t)$. Find,

   i. Modulation index (2 marks)

   ii. Lower side band frequency (2 marks)

f. A telephonic communication service is working at a carrier frequency of 10 GHz. Only 10% of it is utilized for transmission. How many telephonic channels can be transmitted simultaneously if each channel requires a bandwidth of 5 kHz? (3 marks)

g. With the help of a well labelled diagram explain how the working of AM transmitter. (5 marks)

h. Explain three differences between narrowband and wideband frequency modulation (FM). (3 marks)

i. What is signal-to-noise ratio (SNR) and give two reasons why is it important in communication systems? (3 marks)

QUESTION TWO (20 marks)

a. A sinusoidal modulating waveform of amplitude 5 V and a frequency of 2 KHz is applied to FM generator, which has a frequency sensitivity of 40 Hz/volt. Calculate: (6 marks)

i. The frequency deviation (2 marks)

ii. The modulation index (2 marks)

iii. The bandwidth (2 marks)

b. Consider a 3-bit analog-to-digital converter (ADC) that converts an analog signal ranging from 0V to 5V.

i. Calculate the number of levels (2 marks)

ii. Determine the step size (Δ) (2 marks)

iii. Calculate the quantization error (2 marks)

c. With the help of a circuit diagram discuss how a FM Transmitter works (5 marks)

d. Using a well labelled diagram discuss FM demodulator using phase discrimination method. (4 marks)

QUESTION THREE (20 marks)

a. The equation of amplitude wave is given by $s(t) = 20[1+0.8 \cos(2\pi X10^3 t)] \cos(2\pi X10^5 t)$. Assuming R=1Ω, find: (6 marks)

i. the carrier power (2 marks)

ii. the total sideband power (2 marks)

iii. the band width of AM wave. (2 marks)

b. An FM wave is given by $s(t) = 20cos\left(8\pi x10^6 t + 9sin(2\pi x10^3 t)\right)$. Calculate

i. The frequency deviation (2 marks)

ii. Bandwidth (2 marks)

iii. Power of FM wave (2 marks)

c. Explain the reasons why FM transmitters are most preferred by broadcasting stations in Kenya. (4 marks)

d. Explain the requirement a receiver must have for it to function effectively (4 marks)

QUESTION FOUR (20 marks)

a. State the sampling theorem. (1 mark)

b. A signal x(t) is band-limited with a maximum frequency component of: f_m=5 kHz Find:

i. The minimum sampling frequency f_s (1 mark)

ii. The time interval T_s between consecutive samples (2 marks)

c. A Double Sideband Suppressed Carrier (DSB-SC) system transmits a message signal with a power of 5 W and a modulation index of 1. The channel introduces additive white Gaussian noise (AWGN) with a power spectral density of 10^{-9} W/Hz. Given that the message signal has a bandwidth of 10 kHz and the receiver noise bandwidth is twice the message bandwidth, determine the signal-to-noise ratio (SNR) at the receiver in both linear and decibel (dB) scales. (4 marks)

d. How do Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK)

i. Differ in terms of signal modulation (3 marks)

ii. What are the key variations of PSK (3 marks)

e. Derive the formula for the figure of merit in an AM receiver (6 marks)

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