MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN BACHELOR OF SCIENCE IN TELECOMMUNICATION & INFORMATION

SPH 405: COMMUNICATION SYSTEMS

DATE: 15TH JANUARY 2025 **TIME: 2.00 PM – 4.00 PM**

INSTRUCTIONS:
*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE *(COMPULSORY)* (30 MARKS)

(a) State the basic principle used for guiding light in an optical fibre **(1 mark).**

(b) With reference to sky wave propagation, explain why reception of international broadcast is better during the night compared to day time **(2 marks).**

(c) RADAR system operating at 8 GHz has an antenna with a gain of 500 and transmitter power of 4 KW. If it is desired to detect a target with a cross section of 10 m^2 and minimum detectable signal is 10^{-12}. Calculate the maximum range of the radar system. **(3 marks).**

(d) Explain the optimum size of a radio antena **(2 marks).**

(e) Describe a duplexer, outlining its three functions in a monostatic radar system **(4 marks).**

(f) For a satellite channel, signal to noise ratio is 1×10^3 and a usable bandwidth of 5 KHz. Calculate the maximum signal rate through the channel. **(3 marks).**

(g) List at least three primary functions of International Telecommunications Union (ITU) **(3 marks).**

(h) State three types of satellites based on the services provided **(3 marks).**

(i) With reference to long-range wireless communication, justify why satellites are used for long distance TV transmission **(2 marks).**

(j) The core of an optical fibre is made of glass with a refractive index of 1.51 and the cladding has a refractive index of 1.49. Calculate the critical angle for total internal reflection **(2 marks).**

(k) Calculate the wavelength of a radio wave of frequency 60 MHz propagating in space **(1 mark).**

(l) What is modulation? explain its importance in a communication system **(4 marks).**

QUESTION TWO (20 MARKS)

(a) Analyze ground wave propagation and sky wave propagation with the aid of diagram. **(6 marks).**

(b) With the aid of a block diagram, design a basic communication system **(6 marks).**

(c) Differentiate between baseband and carrier type communication systems **(2 marks).**

(d) Explain a repeater station, outlining its significance in a communication system **(3 marks).**

(e) Define noise and give its effects in communication systems **(3 marks).**

QUESTION THREE (20 MARKS)

(a) Outline two primary advantages of fiber optic communication over satellite communication systems **(2 marks).**

(b) Outline disadvantages of fiber optic transmission **(4 marks).**

(c) With the help of relevant optical principles and assumptions, derive the expression for total internal reflection as applied in fiber optic communication **(6 marks).**

(d) For a fiber optic cable, the core has a refractive index equal to 1.4 and a cladding refractive index of 1.3.

i) Calculate the speed of light inside the core

ii) Determine the critical angle at the core-cladding interface

iii) What is the maximum angle t that the rays leaving the source of light should make with the axis of the fiber so that total internal reflections take place at the core cladding interface **(6marks).**

(e) Explain the reason of using laser as source of light in fiber optic communication **(2 marks).**

QUESTION FOUR (20 MARKS)

(a) With the aid of a well labeled diagram, analyze a satellite communication system **(6 marks).**

(b) Evaluate the reasons for designing higher uplink than downlink frequencies in a satellite communication system **(2 marks).**

(c) Outline the satellite communications system parameters that fall under the regulatory criteria **(3 marks).**

(d) With the aid of diagrams, design mesh and star configurations of satellites **(4 marks).**

(e) Evaluate the use of negative voltage in telecommunication equipment **(3 marks).**

(f) Outline two advantages of satellite communication system **(2 marks).**

QUESTION FIVE (20 MARKS)

(a) Analyze the principle of operation of a radar system, clearly describing components involved in a well labeled diagram **(5 marks).**

(a) State two types of RADAR systems based on the antennas used in radiating the electromagnetic waves **(2 marks).**

(b) Calculate the maximum range of RADAR system which operates at 2 cm wavelength with peak power of 700 KW, if the minimum detectable power is $1x10^{-12}$ W, the capture area of its antenna is 3 meter square and radar cross section area of target is 15 meter square **(4 marks).**

(c) With the help of mathematical design assumptions, show that the radar range equation is given by $R_{Max} = \sqrt[4]{\left[\frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}}\right]}$ **(6 marks).**

(a) In relation to emerging technologies and economy, discus the cost of communication services in Kenya. **(3 marks).**