



MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION
TECHNOLOGY)

SPH 405: COMMUNICATION SYSTEMS

DATE:

TIME:

INSTRUCTIONS

Answer question one and any other two questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- (a) Define signal as used in communication system (1 mark)
- (b) With the aid of diagrams, differentiate between amplitude and wavelength of sinusoidal signal (4 marks).
- (c) Explain the term modulation stating its importance in a communication system (3 marks).
- (d) 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)
- (e) Describe a duplexer, outlining its three functions in a monostatic radar system (4 marks)
- (f) List two applications of satellite systems and two applications of radar system (4 marks)
- (g) 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)
- (h) State the commonly used frequency bands in satellite communication (2 marks)
- (i) List at least three primary functions of International Telecommunications Union (ITU) (3 marks)
- (j) State three types of satellites based on the services provided (3 marks)

QUESTION TWO (20 MARKS)

- (a) With the aid of a block diagram, describe the components of a communication system (6 marks)
- (b) Define noise and give its effects in communication systems (3 marks)
- (c) Explain the reasons for designing higher uplink than downlink frequencies in a satellite communication system (2 marks)
- (d) Explain the principle of operation of a radar system, clearly describing components involved in a well labeled diagram (5 marks)
- (e) Outline two primary advantages of fiber optic communication over satellite communication systems (2 marks)
- (f) List two sources of optical energy in fiber optic communications (2 marks)

QUESTION THREE (20 MARKS)

- a) Differentiate between baseband and carrier type communication systems (2 marks)
- b) 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 θ 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 (6 marks)
- (c) Outline the satellite communications system parameters that fall under the regulatory criteria (3 marks)
- (d) List two advantages and two disadvantages of using satellite communication (4 marks)
- (e) Define a transducer, giving at least an example in communication system (2 marks)
- (f) Outline the characteristics of fiber optic communication (3 marks)

QUESTION FOUR (20 MARKS)

- (a) With reference to optical communication, describe Snell's law (2 marks)
- (b) With the aid of a well labeled diagram, describe the operation of fiber optic communication system (6 marks)
- (c) Discuss the basic elements of a fiber optic communication system (6 marks)

- (d) With the aid of a well labeled diagram, describe the structure of fiber optic cable
(6 marks)

QUESTION FIVE (20 MARKS)

- (a) Explain the reason of using laser as source of light in fiber optic communication
(2 marks)
- (b) According to Shannon Harley law, what is the maximum achievable bit rate for a computer modem operating over a telephone channel with 10 MHz bandwidth and maximum allowable signal to noise ratio of 1×10^5
(4 marks)
- (c) State two types of RADAR systems based on the antennas used in radiating the electromagnetic waves
(2 marks)
- (d) 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 1×10^{-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)
- (e) With the help of mathematical design assumptions, show that the radar range equation is given by $R_{Max} = \sqrt[4]{\frac{P_t G A_e \sigma}{(4\pi)^2 S_{min}}}$
(6 marks)
- (f) Describe a repeater station, outlining its significance in a communication system
(2 marks)