NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

DATA COMMUNICATIONS AND NETWORKS

SCS 2111

Examination Paper   **December First Semester Exam 2024**

This examination paper consists of five (5) pages

Time Allowed   : 3 hours
Total Marks   : 100
Examiner's Name   : Mr T. Taapatsa
External Examiner   : Dr C. Gombiro

INSTRUCTIONS

1. Answer any four (4) questions
2. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1	25
2	25
3	25
4	25
5	25
TOTAL	**100**

QUESTION ONE

a) Define the following terms as they are used in data communications and networks
   i.   Protocol
   ii. Attenuation   [4]

b) With the aid of a diagram, analyse the layers of the TCP/IP Model. For each layer in the TCP/IP model, explain its main function(s), list common protocols associated with each layer, and list the network devices that operate at that layer.   [15]

c) You are the network administrator for a medium size business. One of the employees, John, comes to you with a problem. His computer cannot connect to the company network or access the internet. When you check his computer's network settings, you notice that it has an APIPA address (169.254.10.123).

   Explain what an APIPA address is. Explain what steps you would take to ensure that John's computer obtains a valid IP address and connects successfully to the network and internet.   [6]

QUESTION TWO

a) Explain the purpose of the following network protocols
   i.   DNS
   ii. DHCP
   iii. RARP   [6]

b) Explain how the checksum is used to detect errors in computer networks. In your answer, illustrate the step by step computations on both the sender and the receiver side. Use the data unit below and assume that the data unit is divided into segments of 8 bits.
   Data Unit: 10011001   00100010   00100100   00000100   [9]

c) Explain how the following error correction methods work
   i.   Backward error correction
   ii. Forward error correction   [4]

d) Explain why digital transmission is preferred over analogue transmission [6]

QUESTION THREE

a) Explain the following terms as they are used in Cybersecurity
   i. Ethical hacking
   ii. Cybersecurity drill
   iii. Denial of Service
   iv. Phishing [8]

b) "One of the strategic pillars that anchor the 2nd Republic's developmental agenda under Vision 2030 is innovation, science and technology. Prioritization of the digital economy and the emerging importance of technology in our day to day activities requires Government to lead from the front in providing an environment where investment in technology is promoted.

In this vein, I'm pleased to announce that I have approved the licensing of Starlink by POTRAZ to provide advanced internet and related digital processing services in Zimbabwe through its sole and exclusive local partner, IMC Communications (Pvt) Ltd. Starlink is a Low Earth Orbit (LEO) Satellite operator wholly owned by global conglomerate Space X led by prominent multi-billionaire ElonMusk."

Extracted from a post by the President of Zimbabwe @edmnangagwa on X (Twitter)

Analyse the impact of Low Earth Orbit (LEO) Satellite on digital telecommunications space in Zimbabwe. In your answer, include the definition of Low Earth Orbit (LEO) Satellite transmission, and explain any 2 advantages and 1 disadvantage for data communications in rural areas. [7]

c) Explain the purpose of the IP address 127.0.0.1 in computer networking. [2]

d) Consider a 6 node network described below, with the given link costs. Using Dijkstra's routing algorithm, find the path with the least cost from source node A to all other destinations. [8]

Vertices: A, B, C, D, E, F

Edges   [A – B, 5], [A –C, 2], [B – C, 1], [B – D, 4], [B – E, 2], [C – E, 7], [D – E, 6], [D – F, 3], [E –F, 1]

Hint
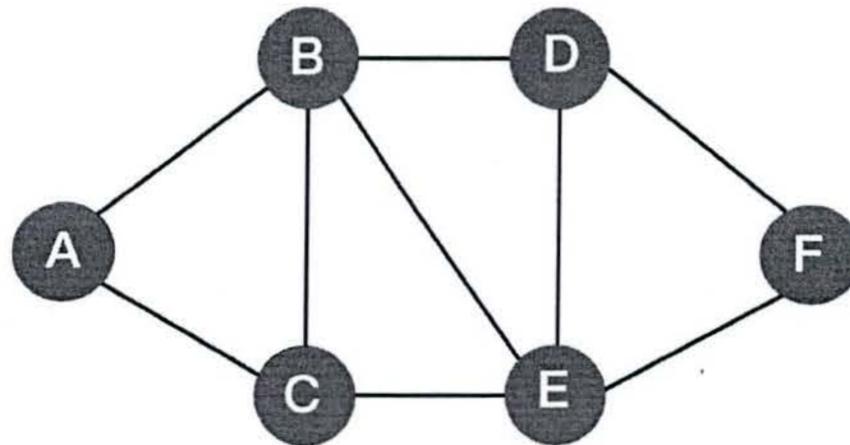
QUESTION FOUR

a) Explain the following terms as they are used in network security

    i.   Virtual Private Network (VPN)

    ii.   Firewall

    iii.   Public Key Encryption

    iv.   Digital Certificates

    v.   Eavesdropping   [10]

b) Explain the difference between passive attacks and active attacks   [5]

c) "You are designing a network for a medium sized company with 200 employees. The company has a main office and two remote branches. The main office has 150 employees, and each remote branch has 25 employees. The company wants to ensure that all employees can communicate with each other and access shared resources. The network requirements are high availability and reliability, secure data transmission, ability to support video conferencing and streaming and scalability to accommodate future growth"

You are required to design a network for the company. In your design, include the type of network topology, the IP addressing scheme, and the devices needed to ensure efficient and secure communication across the network. [10]

QUESTION FIVE

a) With the aid of a diagram, illustrate the structure of a fibre optic cable. [3]

b) List any three reasons why Internet Service Providers (ISPs) prefer to install fibre optic cables for long distance data communication [3]

c) Given the IP address 192.168.1.100 with a subnet mask of 255.255.255.0
   i.   Identify the class of the IP address [1]
   ii.   Identify the network address and broadcast address for this network. [2]
   iii. How many usable host addresses are available on this network? [2]
   iv.   What is the purpose of a default gateway? [2]

d) Discuss the differences between IPv4 and IPv6 [6]

e) Compare and contrast the Transmission Control Protocol (TCP) and the User Data Protocol (UDP) in terms of their connection establishment, reliability, error checking, flow control and applications where each protocol is most suitable [6]