National University of Computer and Emerging Sciences

Assignment 04

Chapter 04 to 06

CS-3001 Computer Networks – Spring 2026

Section: BSE-6B1 **Max Marks: 140**

Instructions:

- **Answer all questions.** Partial credit may be awarded if your reasoning is clear, even if the final answer is incorrect.
- **Academic Integrity:** Students are expected to submit their own original work. Plagiarism, copying from others, or sharing solutions is strictly prohibited and may result in zero marks and disciplinary action.
- **Submission Guidelines:** Submit your assignment by the deadline in the format specified by the instructor. Late submissions may be penalized unless prior permission is granted.

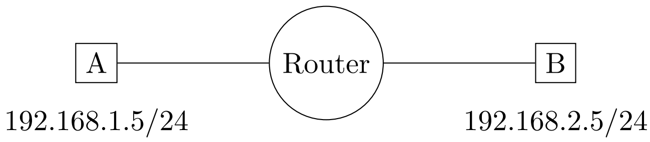
Question	Max Marks	Obtained
1	10	
2	10	
3	10	
4	10	
5	10	
6	10	
7	10	
8	10	
9	10	
10	10	
11	10	
12	10	
13	10	
14	10	
Total	**140**	

Question 1: Subnetting and ARP (10 Marks)

Scenario: Host A (192.168.1.5/24) wants to send a packet to Host B (192.168.2.5/24). They are connected via a Router R. Interface R-left: 192.168.1.1, MAC R-L. Interface R-right: 192.168.2.1, MAC R-R. Host A's MAC: A-MAC. Host A performs a logical AND operation on its IP/Subnet and B's IP.

(a) Mathematically demonstrate why Host A decides **not** to ARP for Host B directly.

(b) Consequently, which IP address will Host A place in the ARP Request target field?

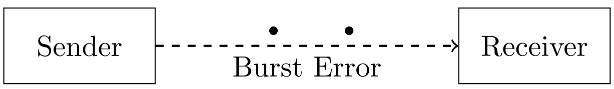


Question 2: Cyclic Redundancy Check (CRC) Analysis (10 Marks)

Scenario: Consider a data transmission system using the CRC polynomial generator $G(x) = x^4 + x^3 + x^2 + x + 1$. The data to be transmitted is $D = 10111101$.

(a) Calculate the actual bit string transmitted by the sender.

(b) Suppose a burst error occurs during transmission such that the received bit string has the 3^{rd} and 4^{th} bits (counting from the left, 1-based index) inverted. Mathematically demonstrate whether the receiver accepts or rejects this frame.



Question 3: Parity Scheme Analysis (10 Marks)

Scenario: Suppose the information content of a packet is the bit pattern 1110 0110 1001 0101 and an even parity scheme is being used. What would the value of the field containing the parity bits be for the case of a two-dimensional parity scheme? Your answer should be such that a minimum-length checksum field is used.

1	1	1	0
0	1	1	0
1	0	0	1
0	1	0	1

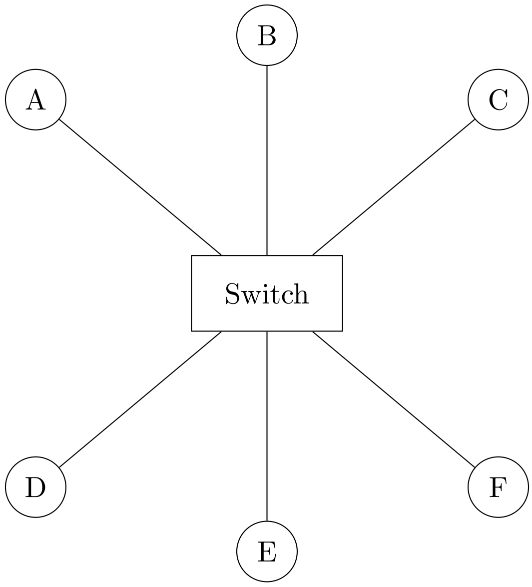
Question 4: Switch Operations (10 Marks)

Scenario: Let's consider the operation of a learning switch in the context of a network in which 6 nodes labeled A through F are star connected into an Ethernet switch. Suppose that

1. B sends a frame to E,
2. E replies with a frame to B,
3. A sends a frame to B,

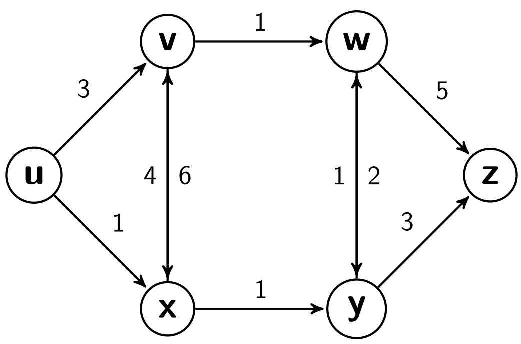
4. B replies with a frame to A.

The switch table is initially empty. Show the state of the switch table before and after each of these events. For each of these events, identify the link(s) on which the transmitted frame will be forwarded, and briefly justify your answers.



Question 5: Directed Dijkstra's Algorithm (10 Marks)

Scenario: Consider the network below. Note that the links are **directed** and costs are asymmetric (e.g., $c(u, v) \neq c(v, u)$).

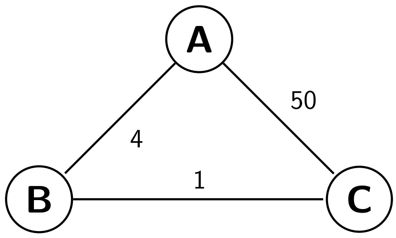


1. Run Dijkstra's algorithm for source node **u**. Show the table state (N', D(v), p(v), etc.) for every step until convergence. If there is a tie in costs, choose the node alphabetically (e.g., choose v over x).

2. Based on the final tree, construct the **Forwarding Table** for router **u**.

Question 6: Asymmetric Link State Routing (10 Marks)

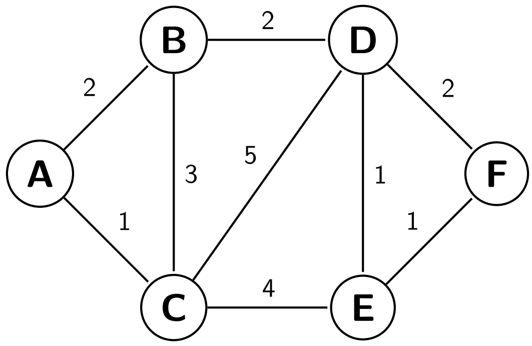
Scenario: Consider the triangular network below. The Bellman-Ford equation is used. Assume synchronous updates: all nodes compute their distance vectors at time t, then exchange messages, then compute for $t + 1$.



At time $t = 0$, the link costs are as shown above ($c(A, C) = 50$). The network has converged. Suddenly, at $t = 1$, the link cost $c(B, C)$ changes from **1 to 60**. Determine the distance $D_B(C)$ (cost from B to C) at $t = 1$, at $t = 2$ and at $t = 3$.

Question 7: Undirected Dijkstra's Algorithm (10 Marks)

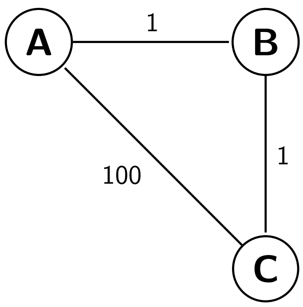
Scenario: Consider the undirected network shown below. The numbers on the links represent the cost.



1. Run Dijkstra's algorithm for source node **A**. Show the table state (N', $D(v)$, $p(v)$) for every step.
2. Tie-breaking rule: If two nodes have the same cost, choose the one that is alphabetically first (e.g., choose B over C).
3. Identify the shortest path from A to F and its total cost.

Question 8: Poison Reverse Rule (10 Marks)

Scenario: We often say Poison Reverse fixes Count-to-Infinity for 2-node loops. Consider the 3-node loop below. $c(A, B) = 1, c(B, C) = 1, c(C, A) = 100$.



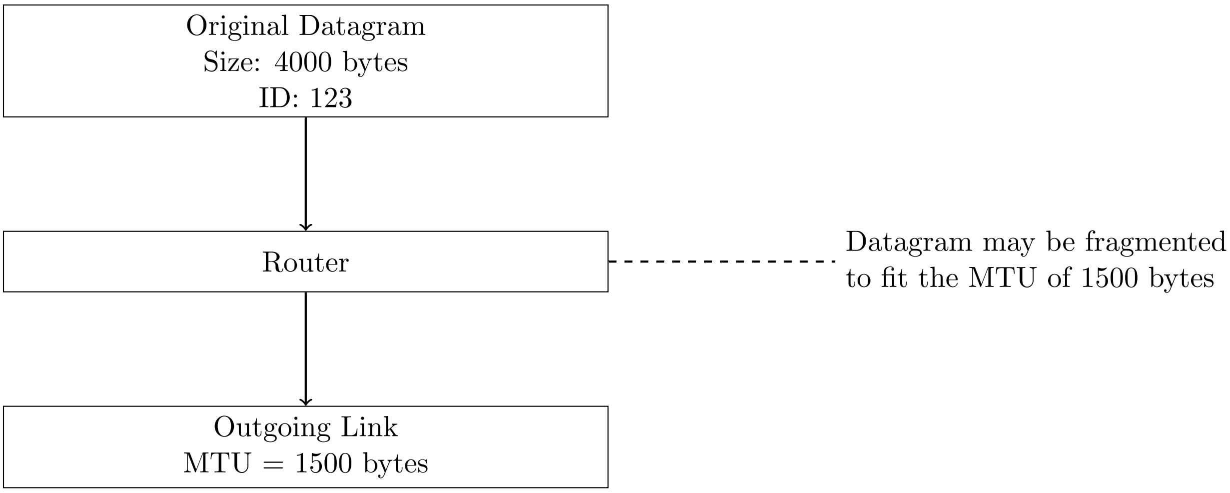
Suppose link (C, A) fails (cost becomes ∞). At the moment of failure, the tables are: A: Dist to A=0. NextHop - B: Dist to A=1. NextHop A. C: Dist to A=2. NextHop B.

1. B and C exchange vectors. With Poison Reverse, what does C advertise to B regarding destination A?
2. If C detects the failure of (C,A), it updates its table. It calculates route to A via B. What is the new cost?

Question 9: Datagram Fragmentation (10 Marks)

Scenario: A datagram of 4,000 bytes arrives at a router and must be forwarded to a link with an MTU of 1,500 bytes. The datagram has an Identification field value of 123.

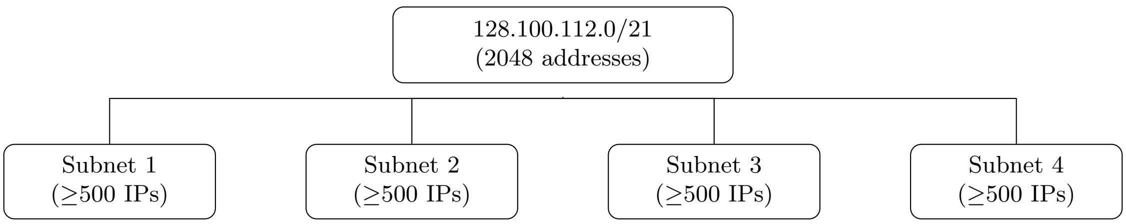
1. Determine into how many fragments the datagram will be divided.
2. For each fraagment give it's **Total length, Data size** and **Offset value** (assume an IPv4 header size of 20 bytes).



Question 10: IPv4 Subnetting Analysis (10 Marks)

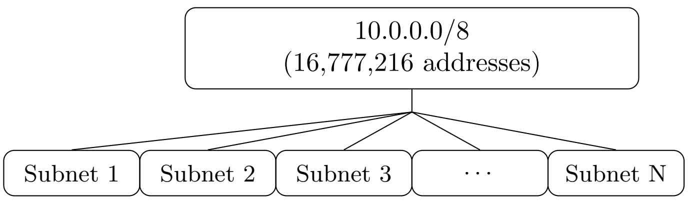
Scenario: Consider the 128.100.112.0/21 block of IP addresses. This block of addresses must be divided into four subnetworks that have each at least 500 IP addresses.

1. Give the subnet mask of the four new subnets.
2. Specify the network address and the network prefix for each subnet.
3. Specify the broadcast IP address for each subnet.



Question 11: IPv4 Subnetting Estimate (10 Marks)

Scenario: Select a subnet mask for 10.0.0.0/8 so that there will be at least 16,000 subnets with at least 700 host addressed on each subnet.



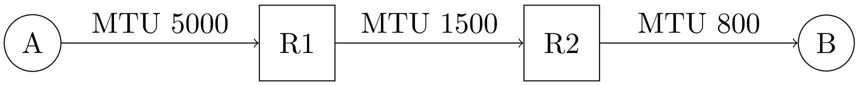
Requirements:
- At least $\geq$ 16,000 subnets
- Each subnet $\geq$ 700 hosts

Question 12: Nested Fragmentation (10 Marks)

Scenario: Host A sends a UDP datagram with **4000 bytes of payload** to Host B. The path MTUs are:

1. Link 1 (A to R1): MTU = 5000 bytes
2. Link 2 (R1 to R2): MTU = 1500 bytes
3. Link 3 (R2 to B): MTU = 800 bytes

Assume the IPv4 header is always **20 bytes**. Calculate the fragment fields (Total Length, Data Size and Offset) for the packets arriving at Host B after passing through Router R2. Note that R2 fragments the fragments received from R1.



Question 13: Routing Algorithms Analysis (10 Marks)

Scenario: Compare and contrast the properties of a centralized and a distributed routing algorithm. Give an example of a routing protocol that takes a centralized and a decentralized approach

Question 14: BGP Policy Analysis (10 Marks)

Scenario: True or false: When a BGP router receives an advertised path from its neighbor, it must add its own identity to the received path and then send that new path on to all of its neighbors. Also explain it?