Assignment # 4 (For BS-CS: All Sections)
(CS-3001 Computer Networks – Fall-2024)

Due Date and Time: 01 December, 11:59 pm **Marks: 50**

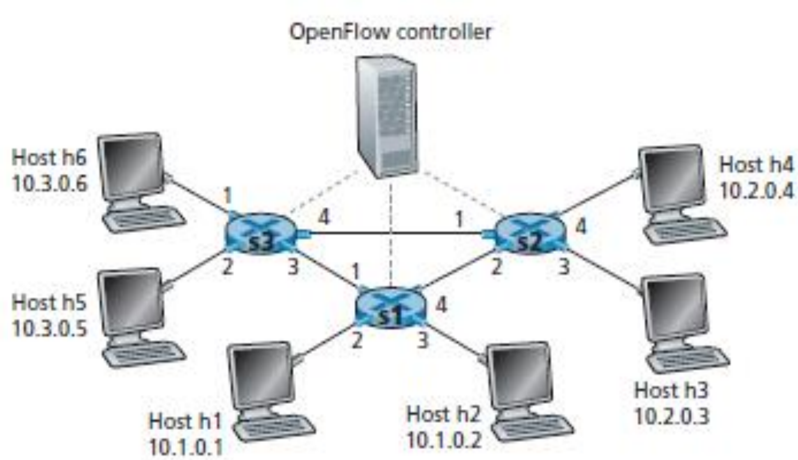
Instructions:

- *Late assignment will not be accepted*
- *Only handwritten attempt will be graded, i.e., printed attempts will not be graded*
- *There will be no credit if the given requirements are changed*
- *Your solution will be evaluated in comparison with the best solution*
- *Whenever a calculation is involved, your solution should show complete steps and a final answer. There will be significant marks for the correct final answer (as far as assignments are concerned).*
- *You must write your roll number, name, and section (Computer Networks Course section) on your submitted attempt.*
- *Submit scan copy of your written assignment on GCR before deadline.*

Question 1: [10 Marks]

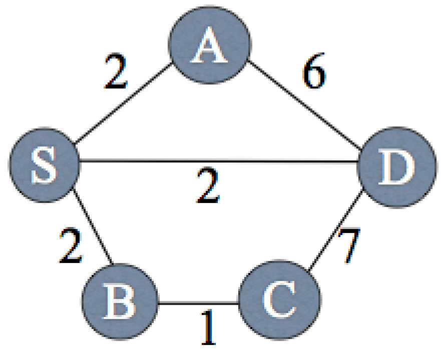
Using the SDN OpenFlow network depicted in the figure below, configure switch s2 to act as a firewall. Design a separate flow table for each of the following firewall behaviors, ensuring they govern the delivery of datagrams to hosts h3 and h4. You do not need to address the forwarding rules for traffic destined for other routers.

1. Allow only traffic originating from hosts h1 and h6 to reach hosts h3 or h4. Block traffic arriving from hosts h2 and h5.
2. Permit only TCP traffic to be delivered to hosts h3 or h4, while blocking all UDP traffic.
3. Allow traffic to be delivered exclusively to host h3, blocking all traffic destined for h4.
4. Deliver only UDP traffic from host h1 to host h3. Block all other traffic.



Question 2: [5 Marks]

Suppose a distance-vector protocol is implemented on the network shown below. Each node has its own local clock, which may not be synchronized with any other node's clock. Each node sends its distance-vector advertisement every 100 seconds. When a node receives an advertisement, it immediately integrates it. The time to send a message on a link and to integrate advertisements is negligible. No advertisements are lost. There is no HELLO protocol in this network.



a) At time 0, all the nodes except D are up and running. At time 10 seconds, node D turns on and immediately sends a route advertisement for itself to all its neighbors. What is the minimum time at which each of the other nodes is guaranteed to have a correct routing table entry corresponding to a minimum-cost path to reach D? Justify your answers.

b) If every node sends packets to destination D, and to no other destination, which link would carry the most traffic?

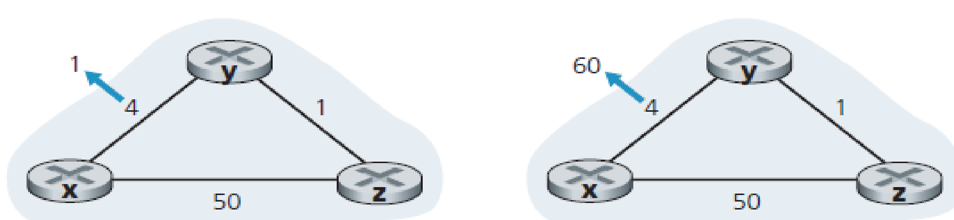
Question 3: [10 Marks]

Consider the following Figure. Suppose there is another router *w*, connected to router *y* and *z*. The costs of all links are given as follows: $c(x,y) = 4$, $c(x,z) = 50$, $c(y,w) = 1$, $c(z,w) = 1$, $c(y,z) = 3$. Suppose that poisoned reverse is used in the distance-vector routing algorithm.

a) When the distance vector routing is stabilized, router *w*, *y*, and *z* inform their distances to *x* to each other. What distance values do they tell each other?

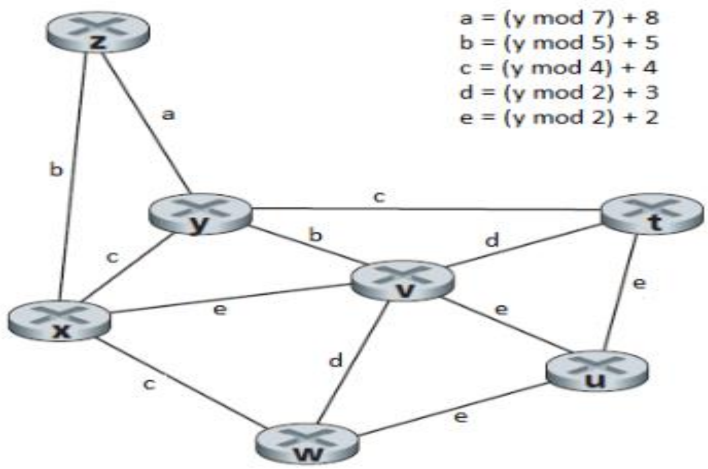
b) Now suppose that the link cost between *x* and *y* increases to 60. Will there be a count-to-infinity problem even if poisoned reverse is used? Why or why not? If there is a count-to-infinity problem, then how many iterations are needed for the distance-vector routing to reach a stable state again? Justify your answer.

c) How do you modify $c(y,z)$ such that there is no count-to-infinity problem at all if $c(y,x)$ changes from 4 to 60?



Question 4: [10 Marks]

Consider the given network with the specified link costs. Apply Dijkstra's shortest-path algorithm to determine the shortest paths from node X to all other nodes in the network. Illustrate the algorithm's process by constructing a table and presenting the resulting graph. Show all steps.



Question 5: [10 Marks]

Suppose the internal network at FAST, NUCES operates using link-state routing. The network administrators are interested in experimenting with several routing strategies. Each strategy determines how a node selects a path to a destination to create a routing table entry. Below are the proposed strategies, along with a description of how each works:
MinCost: Each node selects the path with the lowest total link cost along the route. (This corresponds to the minimum-cost routing implemented in the lab.)
MinHop: Each node selects the path with the fewest hops, regardless of the link costs.
SecondMinCost: Each node selects the path with the second-lowest total link cost, effectively choosing the second-best path in terms of cost.
MinCostSquared: Each node selects the path with the smallest sum of the squares of the link costs along the route.
Assume that link-state advertisements exchange sufficient information (e.g., costs, delays, bandwidths, and loss probabilities for all links) so that every node has a complete view of the network and can correctly implement these strategies. Additionally, assume that link properties remain constant and no failures occur.

a) Help the network administrators at FAST NUCES determine which of the following routing strategies will work correctly and which could lead to routing loops. For strategies that result in routing loops, provide an example network topology illustrating the loop to demonstrate why it occurs.
b) How would you implement MinCostSquared in a distance-vector protocol?

Question 6: [5 Marks]

Consider the following network. ISP B serves as the national backbone provider for regional ISP A, while ISP C provides national backbone service to regional ISP D. Each ISP operates as a single AS (Autonomous System). ISPs B and C establish peering connections at two locations using BGP. Now, consider traffic flowing from ISP A to ISP D. ISP B prefers to hand over this traffic to ISP C at the West Coast peering point, shifting the cost of cross-country transit to ISP C. Conversely, ISP C prefers to receive the traffic at the East Coast peering point, so ISP B would bear the cost of cross-country transit. What BGP mechanism could ISP C employ to encourage ISP B to hand over the A-to-D traffic at the East Coast peering point and why?