Selected Problems from Previous Final Exams

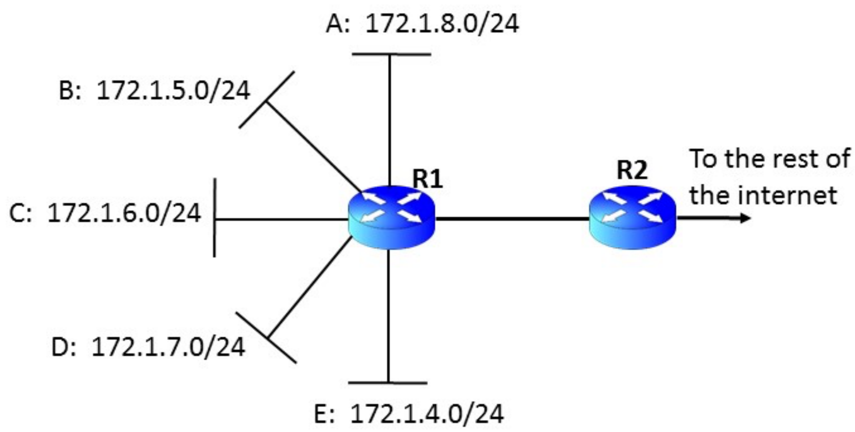
Q1.

Identify the best matching pairs between Column A and Column B. Write your answers in the **Answer** column.

Column A		Answer
A	A solution to routing loops between adjacent routers	7
B	Initial Sequence Number	8
C	Cyclic redundancy check	12
D	Used for intra-AS routing	10
E	Time To Live	11
F	Destination address in an IP packet	3
G	IP address of a DNS server	4
H	Link layer switch	1
I	Binary backoff	6
J		
K		
L		
M		

Column B	
1	Store and forward Ethernet frames
2	This is used by BGP routers to enable an AS to be not used as a transit AS.
3	Routers use it to find the next hop for IP packets.
4	Hosts run the DHCP protocol to get it.
5	It stops duplicate data from being delivered.
6	Helps in avoiding collision between hosts.
7	Poisoned reverse
8	It prevents TCP segments in an old connection from being accepted in a new one.
9	This is used by BGP routers to reject paths to some destination networks.
10	OSPF protocol
11	This changes when an IP packet moves from router to router.
12	Used for error detection at the link layer.
13	This is used to enlarge the receive window size in TCP

Q2.



a) For the given networks (A—E) on this page, what summary address(es) would router R1 forward to router R2?

Summary addresses (Add more rows if there is a need.)
Aggregate B, C, D and E to get 172.1.4.0/22. Forward 172.1.4.0/22 to R2.
The one that cannot be aggregated is 172.1.8.0/24. Forward 172.1.8.0/24 to R2.

b) If a new network, say, 172.1.9.0/24 is connected to router R2, what summary address(es) would R2 forward to its neighboring router (not R1) on the rest of the Internet?

Summary addresses (Add more rows if there is a need.)
Forward 172.1.4.0/22
Aggregate 172.1.8.0/24 and 172.1.9.0/24 to get 172.1.8.0/23. Forward 172.1.8.0/23.

Q3.

Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3.

- Suppose that all of the interfaces in each of these three subnets are required to have the prefix 223.1.17.0/24.
- Suppose that Subnet 1 is required to support at least 60 interfaces, Subnet 2 is to support at least 90 interfaces, and Subnet 3 is to support at least 12 interfaces.
- Suppose that you are required to keep a maximal subset of the remaining addresses in one subnetwork for a future Subnet 4.
- An IP address in each subnet has been given in the following table.

Provide four network addresses of the form a.b.c.d/x that satisfy these constraints. Also, find the network IDs and broadcast addresses of those subnetworks.

If you want to connect a future subnet, called Subnet 5, to the router, what is the largest number of IP addresses that Subnet 5 can have? Count the network ID and broadcast address as well.

Are there IP addresses available for another future subnet, say, Subnet 6? If yes, how many?

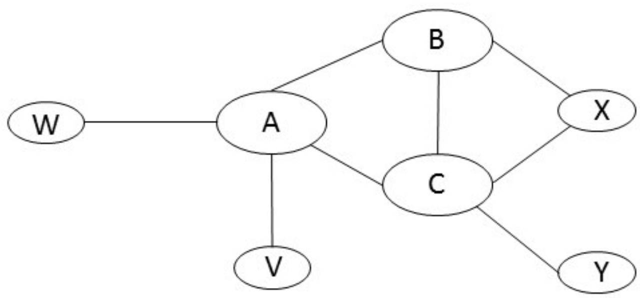
Subnets	**Block size (# of bits)**	**One IP address**	**Network ID**	**Prefix Length**	**Broadcast address**
Subnet 1 (60 interfaces)	64 (6 bits)	223.1.17.140	223.1.17.128	/26	223.1.17.191
Subnet 2 (90 interfaces)	128 (7 bits)	223.1.17.75	223.1.17.0	/25	223.1.17.127
Subnet 3 (12 interfaces)	16 (4 bits)	223.1.17.97	223.1.17.192	/28	223.1.17.207
Future Subnet 4	Remaining int. = 256 – (64 + 128 + 16) = 48 Largest block size = 32	223.1.17.230	223.1.17.224	/27	223.1.17.255
Future Subnet 5	16	xxxxxx	xxxxxx	xxxxxx	xxxxxx
Future Subnet 6	0	xxxxxx	xxxxxx	xxxxxx	xxxxxx

Q4.

The following figure shows the interconnection of seven autonomous systems, A, B, C, V, W, X, and Y. The solid lines represent physical links.

Suppose that B and C have a peering relationship, and A is a customer of both B and C.

Suppose that A would like to have the traffic destined to W to come from B only, and the traffic destined to V from either B or C.



i. How should A advertise its routes to B and C?

A should advise to B two routes, AS-paths A-W and A-V.
A should advise to C only one route, A-V.

ii. What AS paths does C receive in this context?

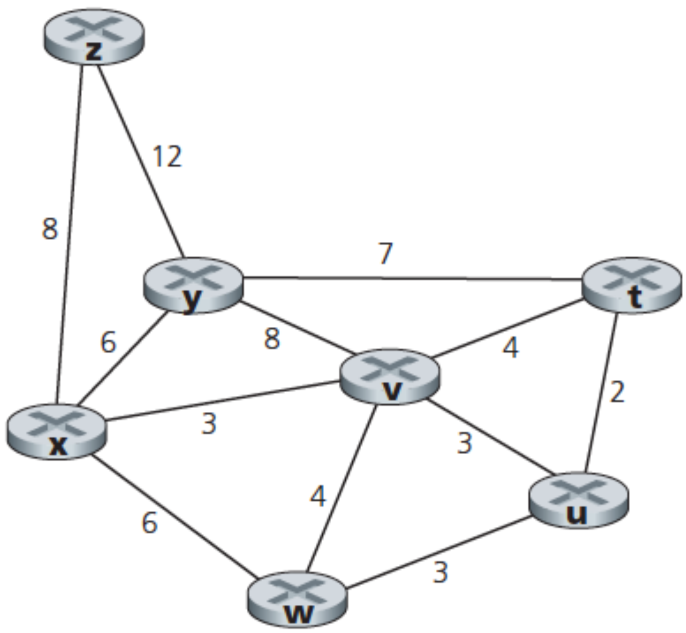
C receives AS paths: B-A-W, B-A-V, A-V.

iii. What should A do to prevent X and Y from using A as a transit AS in case links B-C and X-C fail?

If A receives an AS-PATH B-X, it does not advertise a path A-B-X to C.
Similarly, if A receives an AS-PATH C-Y, it does not advertise A-C-X to B.

Q5.

Consider the network shown in the figure below. The cost of each link is indicated in the figure. Use Dijkstra's shortest-path algorithm to compute the shortest path from x to all network nodes. Show the forwarding table at node x. You need to show your work.



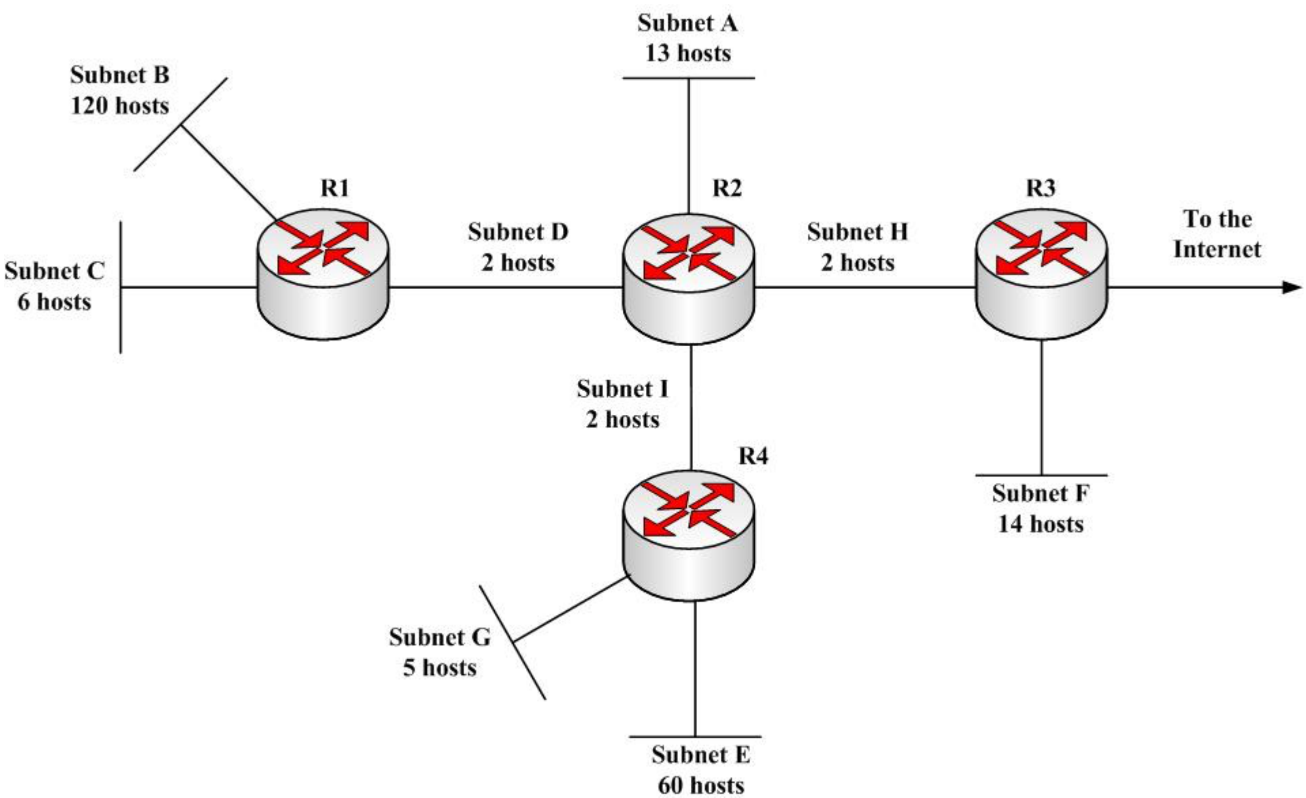
Step	*N'*	*D(t),p(t)*	*D(u),p(u)*	*D(v),p(v)*	*D(w),p(w)*	*D(y),p(y)*	*D(z),p(z)*
0	x	∞	∞	3,x	6,x	6,x	8,x
1	xv	7,v	6,v	3,x	6,x	6,x	8,x
2	xvu	7,v	6,v	3, x	6,x	6,x	8,x
3	xvuw	7,v	6,v	3,x	6,x	6,x	8,x
4	xvuwy	7,v	6,v	3,x	6,x	6,x	8,x
5	xvuwyt	7,v	6,v	3,x	6,x	6,x	8,x
6	xvuwytz	7,v	6,v	3,x	6,x	6,x	8,x

Q6.

Nine LANs (A - I) have been interconnected by means of four routers (R1 - R4) as shown in the figure shown below. LANs A, B, C, G, E and F have been implemented with **six** link layer switches, whereas LANs D, H and I have been implemented with direct connections between three pairs of routers. For example, LAN D has been formed by directly connecting R1 and R2 with an Ethernet cable.

You have been given a single block of IPv4 addresses: **192.168.10.0/24**. To configure the routers, you need to compute the ID and prefix length of each of the 9 networks.

In the Table given on the following page, show the **network ID** in the dotted decimal notation for each of the **nine** networks. Also, identify the prefix length and broadcast addresses for Networks A - D on the same table in the dotted decimal notation.

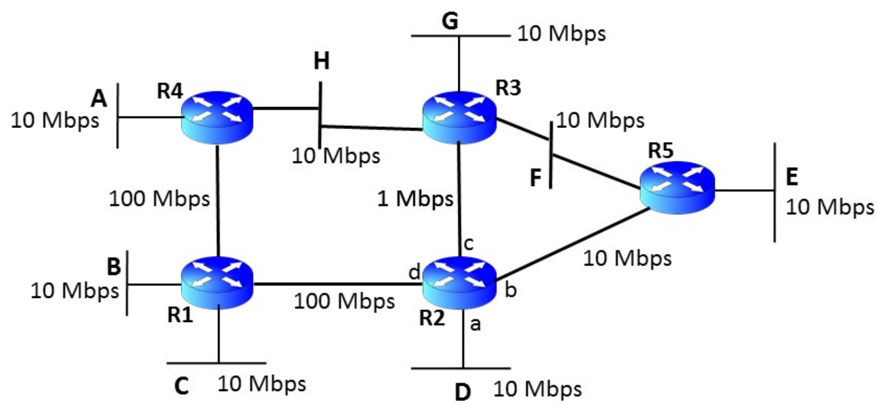


The following is one of the many possible solutions.

Subnet	# of Hosts	Block size (# bits for the host)	Network ID	Prefix length	Broadcast address
A	13	4	192.168.10.160	28	192.168.10.175
B	120	7	192.168.10.0	25	192.168.10.127
C	6	3	192.168.10.152	29	192.168.10.159
D	2	2	192.168.10.128	30	192.168.10.131
E	60	6	192.168.10.192	xxx	xxxxxxxxxxxxxx
F	14	4	192.168.10.176	xxx	xxxxxxxxxxxxxx
G	5	3	192.168.10.144	xxx	xxxxxxxxxxxxxx
H	2	2	192.168.10.132	xxx	xxxxxxxxxxxxxx
I	2	2	192.168.10.136	xxx	xxxxxxxxxxxxxx

Q7.

Consider the network in the figure shown below. There are five routers, R1—R5, and eight LANs, A—H. The speed of each LAN and each point-to-pint link has been given in the figure. Assume that the OSPF protocol computes the cost of a link as: *cost = 100 Mbps/link speed*. The four physical interfaces of router R2 have been labeled as a—d.

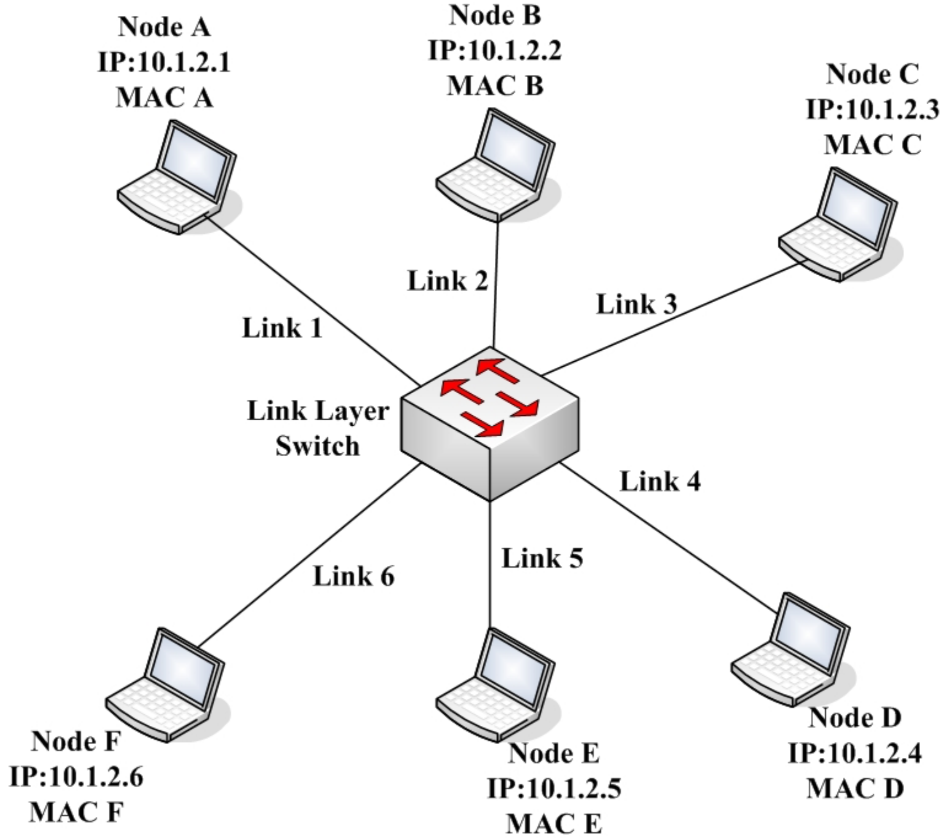


You are going to create a routing table on **R2**. Using the following table, for each destination LAN, provide the **Next Hop** and **Cost** values to reach the network for both the OSPF. Assume that cost is the only metric used to choose paths to destination networks.

Destination Network	OSPF Protocol	
	Next Hop	Cost
A	d	12
B	d	11
C	d	11
D	a	10
E	b	20
F	b	20
G	d	22
H	d	12

Q8.

Consider the operation of a learning switch in the context of the network shown in the figure below in which 6 nodes labeled A through F are star connected into a link layer switch. Suppose that (i) B sends a frame to E, (ii) E replies with a frame to B, (iii) A sends a frame to B, (iv) B replies with a frame to A. The switch table is initially empty. Show the state of the switch table 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**. **Ignore the TTL entries in the switch table.**



<table>
<tr><th>Action</th><th>Switch Table State</th><th>Link(s) packet is forwarded to</th><th>Explanation</th></tr>
<tr><td>B sends a frame to E</td><td>Switch learns interface corresponding to MAC address of B<table><tr><td>MAC</td><td>Link</td></tr><tr><td>MAC B</td><td>2</td></tr><tr><td></td><td></td></tr></table></td><td>A, C, D, E, and F

Links 1, 3, 4, 5, 6</td><td>Since switch table is empty, so switch does not know the interface corresponding to MAC address of E</td></tr>
<tr><td>E replies with a frame to B</td><td>Switch learns interface corresponding to MAC address of E<table><tr><td>MAC</td><td>Link</td></tr><tr><td>MAC B</td><td>2</td></tr><tr><td>MAC E</td><td>5</td></tr><tr><td></td><td></td></tr></table></td><td>B

Link 2</td><td>Since switch already knows interface corresponding to MAC address of B</td></tr>
<tr><td>A sends a frame to B</td><td>Switch learns the interface corresponding to MAC address of A<table><tr><td>MAC</td><td>Link</td></tr><tr><td>MAC B</td><td>2</td></tr><tr><td>MAC E</td><td>5</td></tr><tr><td>MAC A</td><td>1</td></tr></table></td><td>B

Link 2</td><td>Since switch already knows the interface corresponding to MAC address of B</td></tr>
<tr><td>B replies with a frame to A</td><td>Switch table state remains the same as before<table><tr><td>MAC</td><td>Link</td></tr><tr><td>MAC B</td><td>2</td></tr><tr><td>MAC E</td><td>5</td></tr><tr><td>MAC A</td><td>1</td></tr></table></td><td>A

Link 1</td><td>Since switch already knows the interface corresponding to MAC address of A</td></tr>
</table>

Q9.

Suppose nodes A, B, C and D are competing for access to a channel using slotted ALOHA. Assume each node has an infinite number of packets to send. Each node attempts to transmit in each slot with probability $p = 0.6$. The first slot is numbered slot 1, the second slot is numbered slot 2, and so on.

a) What is the probability that node A succeeds for the first time in slot 5?

b) What is the probability that some node (either A, B, C or D) succeeds in slot 4?

c) What is the probability that the first success occurs in slot 3?

d) What is the efficiency of this four-node system?

<u>Answer:</u>

a) $(1 - p(A))^4\, p(A)$

where, $p(A)$ = probability that A succeeds in a slot

$p(A)$ = p(A transmits and B does not and C does not and D does not)

= p(A transmits) p(B does not transmit) p(C does not transmit) p(D does not transmit)

$= p(1 - p)\,(1 - p)(1-p) = p(1 - p)^3 = 0.0384$

Hence, p(A succeeds for first time in slot 5)

$= (1 - p(A))^4\, p(A) = (1 - p(1 - p)^3)^4\, p(1 - p)^3 = 0.03264$

b) p(A succeeds in slot 4) $= p(1-p)^3$

p(B succeeds in slot 4) $= p(1-p)^3$

p(C succeeds in slot 4) $= p(1-p)^3$

p(D succeeds in slot 4) $= p(1-p)^3$

p(either A or B or C or D succeeds in slot 4) $= 4\, p(1-p)^3 = 0.1536$

(because these events are mutually exclusive)

c) p(some node succeeds in a slot) $= 4\, p(1-p)^3$

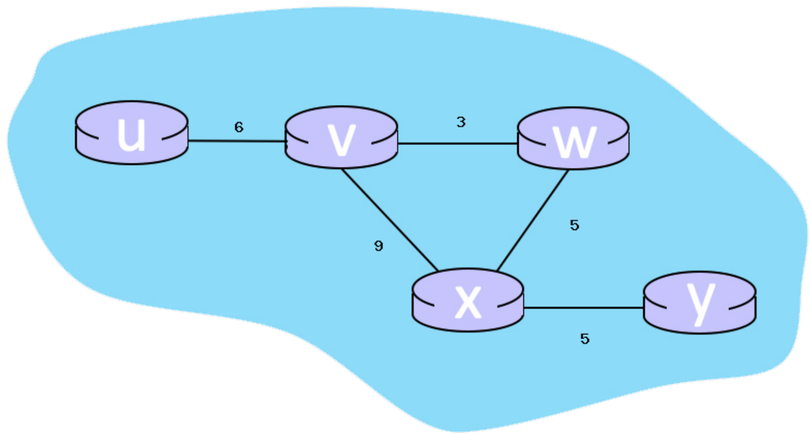
p(no node succeeds in a slot) $= 1 - 4\, p(1-p)^3$

Hence, p(first success occurs in slot 3) = p(no node succeeds in first 2 slots) p(some node succeeds in 3rd slot) $= (1 - 4\, p(1-p)^3)^2\, 4\, p(1-p)^3 = 0.11$

d) efficiency = p(success in a slot) $= 4\, p(1-p)^3 = 0.1536$

Q10.

BELLMAN FORD DISTANCE VECTOR ALGORITHM



1. When the algorithm converges, what are the distance vectors from router 'V' to all routers?

2. What are the initial distance vectors for router 'W'?

3. The phrase 'Good news travels fast' is very applicable to distance vector routing when link costs decrease; what is the name of the problem that can occur when link costs increase?

4. What will be the distance vector for router 'W' after the first round? The first round is the round following the initial round.