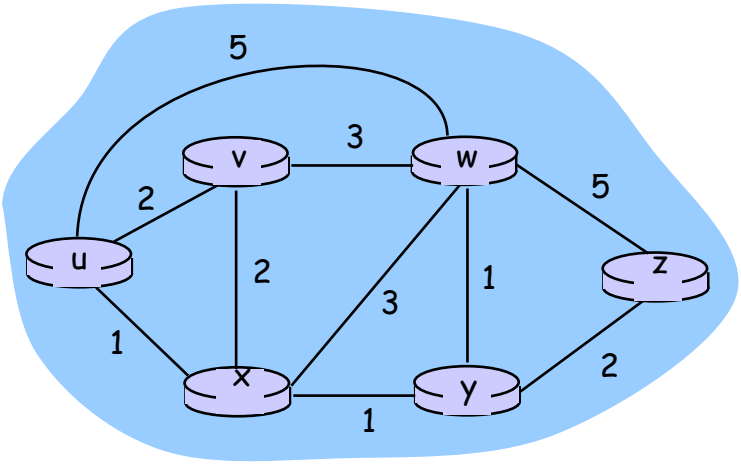
Computer Networks midterm (100/4)

只寫答案而沒有解釋說明，扣一半分數

1. Explain the following.
   (a) Explain how TCP Fast Retransmit works. (4%)
   (b) How TCP does its flow control? (4%)
   (c) Consider the TCP procedure for estimating RTT ($EstimatedRTT^{n} = \alpha \times SampleRTT^{n-1} + (1-\alpha) \times EstimatedRTT^{n-1}$). Why TCP uses this function? (4%)
2. Draw the flow of the TCP three way handshake to explain its operations. Suppose the initial sequence numbers of the client and the server are 99 and 1, respectively. 必須在圖上分別清楚標示出 TCP 必要的 flag, sequence number, and ACK number. (8%)
3. (a) What is the purpose of the DHCP protocol? (b) Draw a figure to show the four messages exchanged between the DHCP client and server. (10%)
4. Draw a figure to show (a) the router architecture (4%) (b) three types of switching fabrics (6%) (10% total)
5. (a) How are routing algorithms classified by global and decentralized information? (b) What are these two routing algorithms? (10%)
6. Use Dijkstra's shortest-path algorithm to compute the shortest path from the source node to all other network nodes. (6%) (a) Show how the algorithm works by computing a table. (b) Show the forwarding table of the source node. (5%) (note: the source node 選法：學號最後一位除以 5 的餘數：0=>z, 1=>y, 2=>x, 3=>w, 4=>v, cost 數值相同時，優先選字母順序較前者)



7. 針對 IPv4 Class B 網路（以十進位表示，要寫完整過程） (23%)
   a. 求出第一個 Class B 網路的網路表示法為何？(2%) 可用 IP 範圍？ (4%) 共有幾個 IP 可用？(2%) mask 的值為何？(2%)
   b. 將第一個 Class B 網路分成 15 個 subnet，subnet mask 的值為何？(2%) 請列出第一個 subnet 的網路表示法 (2%) 可用 IP 範圍？(4%) 共有幾個 IP 可用？(2%)

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c.手動設定電腦的網路時，至少要設定哪三個項目的資訊，才可以上網？(3%)

8. What are the two key network-layer functions in a datagram network? (名稱 2%, 說明 2%, 8% total) What is the additional network-layer function in a virtual-circuit network? (2%)
9. Consider sending a 3000-byte datagram into a link that has an MTU of 980 bytes, including 20-byte IP header. Suppose the original datagram is stamped with the identification number 100. List these segments in a table with their data lengths, IDs, flags and offsets. (表格中 data length, offset, flag 每列一分，ID 全部一分。沒有解釋或不清楚，視狀況扣分，8%)

fragment	data lengths	ID	offset	flag
1				
…..				

10. Describe how TCP does its congestion control. (8%)

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只寫答案而沒有解釋說明，扣一半分數

1.

(a) If sender receives 3 ACKs for the same data, it supposes that segment after ACKed data was lost (2%): resend segment before timer expires (2%)

(b) Rcvr advertises spare room by including value of **RcvWindow** in segments. (2%) Sender limits unACKed data to **RcvWindow** for guaranteeing receive buffer doesn't overflow (2%)

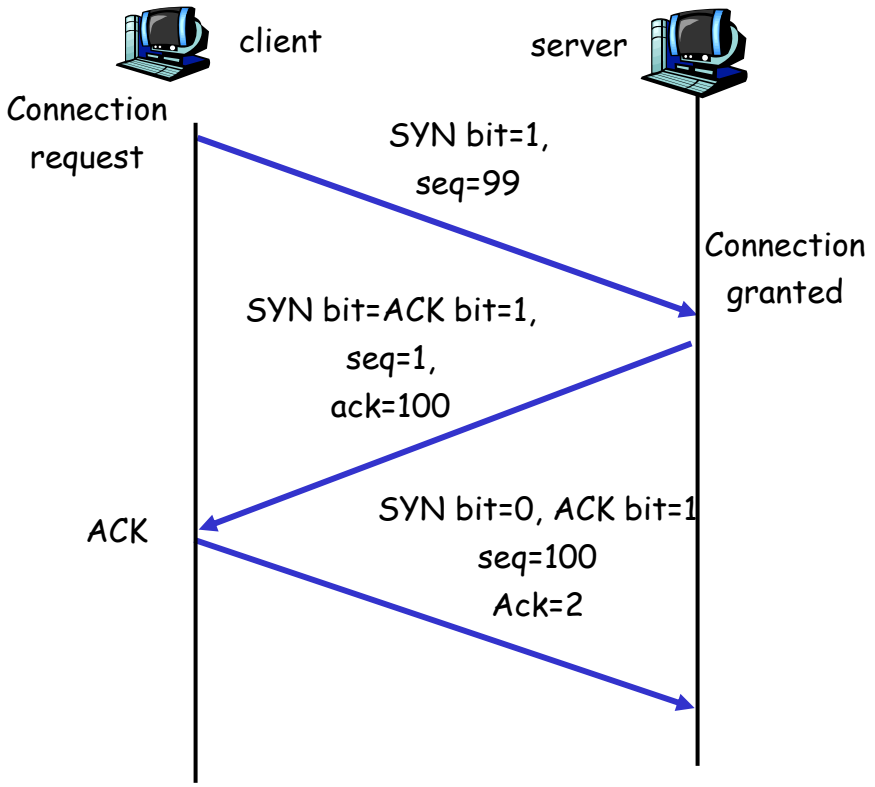
(c) 根據測量出來的 SampleRTT，使用 Exponential weighted moving average 公式，估計下一次的 EstimatedRTT，用來設定下一次的 Timeout 時間(4%)

2. Three way handshake:

Step 1: client host sends TCP SYN segment to server (搭配圖要正確 2%)

Step 2: server host receives SYN, replies with SYNACK segment (3%)

Step 3: client receives SYNACK, replies with ACK segment, which may contain data (3%)



上圖每個符號含內容 1 分，標示不全者，視狀況扣分，共 8 分

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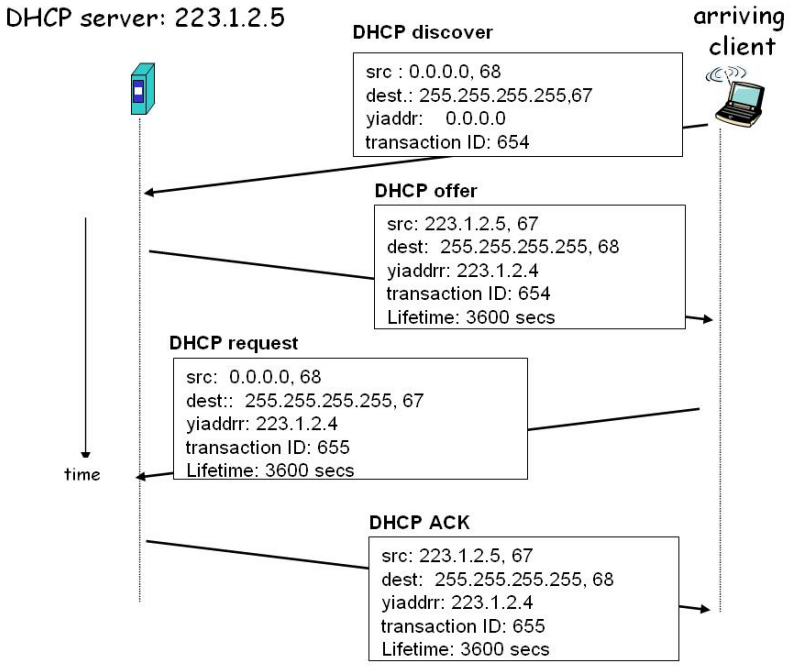
3. DHCP: (10%)

Goal: allow host to *dynamically* obtain its IP address from network server when it joins network (2%)

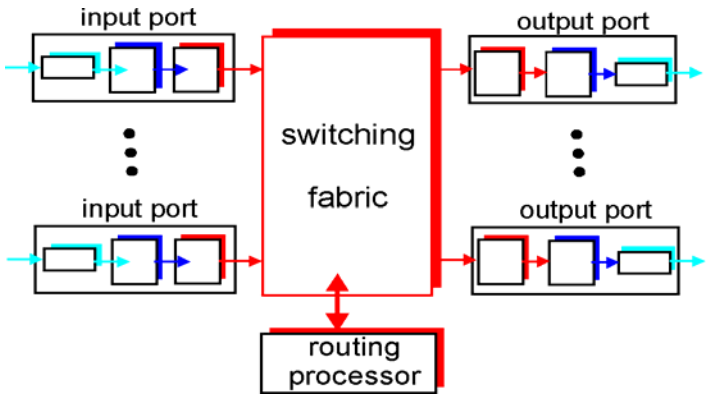
Flow: (8%)

- host broadcasts "DHCP discover" msg
- DHCP server responds with "DHCP offer" msg
- host requests IP address: "DHCP request" msg
- DHCP server sends address: "DHCP ack" msg



4. (10%)

(a) (4%)



(b) (6%)

List the three types of switching fabrics. (2% each, 6% total)

switching via memory; (2%)

switching via a bus; (2%)

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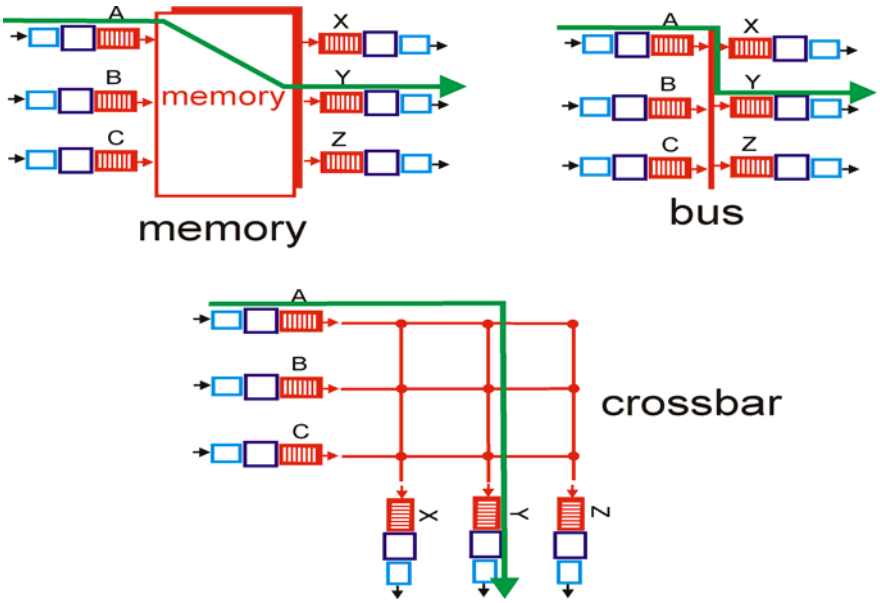
switching via an interconnection network (2%)



5. (10%)

(a) Global:

all routers have complete topology, link cost info (2%)

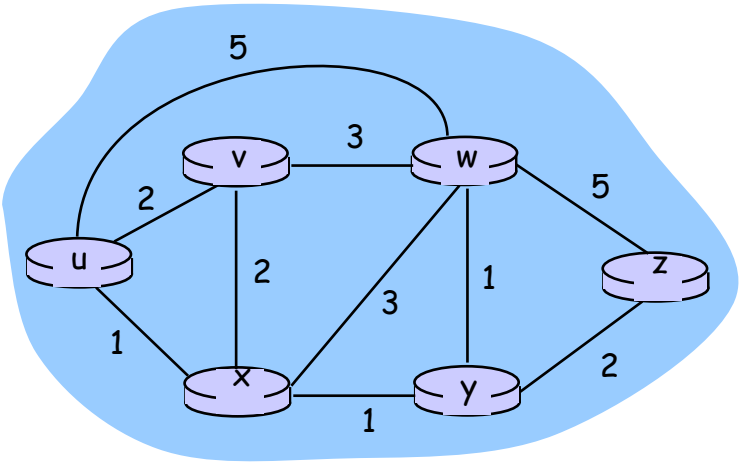
Decentralized:

router knows physically-connected neighbors, link costs to neighbors (2%)

iterative process of computation, exchange of info with neighbors (2%)

(b) "link state" algorithms and "distance vector" algorithms (4%)

6. Ans: (除 step 之外，一欄 1 分)



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以 v 為起點

Step	N'	D(u), p(u)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(z), p(z)
0	v	2, v	3, v	2, v	∞	∞
1	vu		3, v	2, v	∞	∞
2	vux		3, v		3, x #1	∞
3	vuxw				3, x	8, w #2
4	vuxwy					5, y #3
5	vuxwyz					

#1.D(y)=min(D(y),D(x)+c(x,y))=min(∞, 2+1)=3
#2.D(z)=min(D(z),D(w)+c(w,z))=min(∞, 3+5)=8
#3.D(z)=min(D(z),D(y)+c(y,z))=min(∞, 3+2)=5

Forwarding table （一列 1 分）

Destination	Next hop (output link)
u	u
w	w
x	x
y	x
z	x

以 w 為起點

Step	N'	D(u), p(u)	D(v), p(v)	D(x), p(x)	D(y), p(y)	D(z), p(z)
0	w	5, w	3, w	3, w	1, w	5, w
1	wy	5, w	3, w	2, y #1		3, y #2
2	wyx	3, x #3	3, w			3, y
3	wyxu		3, w			3, y
4	wyxuv					3, y
5	wyxuvz					

#1.D(x)=min(D(x),D(y)+c(y,x))=min(3, 1+1)=2
#2.D(z)=min(D(z),D(y)+c(y,z))=min(5, 1+2)=3
#3.D(u)=min(D(u),D(x)+c(x,u))=min(5, 2+1)=3

Forwarding table

Destination	Next hop (output link)
u	y
v	v
x	y
y	y
z	y

Computer Networks midterm (100/4)

以 x 為起點

Step	N'	D(u), p(u)	D(v), p(v)	D(w), p(w)	D(y), p(y)	D(z), p(z)
0	x	1, x	2, x	3, x	1, x	∞
1	xu		2, x	3, x	1, x	∞
2	xuy		2, x	2, y #1		3, y #2
3	xuyv			2, y		3, y
4	xuyvw					3, y
5	xuyvwz					

#1.D(w)=min(D(w),D(y)+c(y,w))=min(3, 1+1)=2
#2.D(z)=min(D(z),D(y)+c(y,z))=min(∞, 1+2)=3

Forwarding table

Destination	Next hop (output link)
u	u
v	v
w	y
y	y
z	y

以 y 為起點

Step	N'	D(u), p(u)	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(z), p(z)
0	y	∞	∞	1, y	1, y	2, y
1	yw	6, w #1	4, w #2		1, y	2, y
2	ywx	2, x #3	3, x #4			2, y
3	ywxu		3, x			2, y
4	ywxuz		3, x			
5	ywxuzv					

#1.D(u)=min(D(u),D(w)+c(w,u))=min(∞, 1+5)=6
#2.D(v)=min(D(v),D(w)+c(w,v))=min(∞, 1+3)=4
#3.D(u)=min(D(u),D(x)+c(x,u))=min(∞, 1+1)=2
#4.D(v)=min(D(v),D(x)+c(x,v))=min(∞, 1+2)=3

Forwarding table

Destination	Next hop (output link)
u	x
v	x
w	w
x	x
z	z

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以 z 為起點

Step	N'	D(u), p(u)	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)
0	z	∞	∞	5, z	∞	2, z
1	zy	∞	∞	3, y #1	3, y #2	
2	zyw	8, w #3	6, w #4		3, y	
3	zywx	4, x #5	5, x #6			
4	zywxu		5, x			
5	zywxuv					

#1.D(w)=min(D(w),D(y)+c(y,w))=min(5, 2+1)=3
#2.D(x)=min(D(x),D(y)+c(y,x))=min(∞, 2+1)=3
#3.D(u)=min(D(u),D(w)+c(w,u))=min(∞, 3+5)=8
#4.D(v)=min(D(v),D(w)+c(w,v))=min(∞, 3+3)=6
#5.D(u)=min(D(u),D(x)+c(x,u))=min(∞, 3+1)=4
#6.D(v)=min(D(v),D(x)+c(x,v))=min(∞, 3+2)=5

Forwarding table

Destination	Next hop (output link)
u	y
v	y
w	y
x	y
y	y

7.

a.

第一個 class B 的 Network ID 表示為 10000000. 00000001. XXXXXXXX. XXXXXXXX，十進位為為 128.1.0.0 (2%)
所有 16 個 bit 的 X 不可以全為 0 或 1，
因此第一個可用 Host ID 為 10000000. 00000001. 00000000. 00000001 = 128.1.0.1 (2%)
最後一個可用 Host ID 為 10000000. 00000001. 11111111. 11111110 = 128.1.255.254 (2%)
->共有 2^{16}-2=65534 個可用 Host ID (2%)
Mask: 255.255.0.0 (2%)

b.

將第一個 Class B 網路分成 15 個 subnet，加上全為 0 與全為 1 的兩個不能用的 subnet ID，最少需要 15+2=17 subnet mask 的值 => 需要 Host ID 的前 5 個 bits 當作 subnet ID。所以新的 subnet mask 是由原本 Class B 的 default subnet mask 255.255.0.0 來改，改成 11111111. 11111111. 11111000.00000000 => 255.255.248.0 (2%)

subnet 的 ID 要從第一個 Class B Network ID 10000000. 00000001. 00000000.00000000 來改，需要 Host ID 的前 5 個 bits 當作 subnet

ID，不可全為 0 或 1。因此第一個 subnet ID 為 10000000. 00000001. 00001000.00000000 => 128.1.8.0 (2%)
因此第一個可用 Host ID 為 10000000. 00000001. 00001000. 00000001 = 128.1.8.1 (2%)
最後一個可用 Host ID 為 10000000. 00000001. 00001111. 11111110 = 128.1.15.254 (2%)
->共有 2^{11}-2=2046 個可用 Host ID (2%)

c.
IP address, subnet mask, default gateway (3%)

8. What are the two key network-layer functions in a datagram network? (8%) What is the additional network-layer function in a virtual-circuit network? (2%)
Ans: forwarding: move packets from router's input to appropriate router output
routing: determine route taken by packets from source to dest. (名稱 2%, 說明 2%, 8% total)
Additional function of VC-based network layer: call setup. (2%)

9. Consider sending a 3000-byte datagram into a link that has an MTU of 980 bytes, including 20-byte IP header. Suppose the original datagram is stamped with the identification number 100. List these segments in a table with their data lengths, IDs, flags and offsets. (表格中 data length, offset, flag 每列一分，ID 全部一分。沒有解釋或不清楚，視狀況扣分，8%)

fragment	data lengths	ID	offset	flag
1				
…..				

Ans:
IP data=980–20=960Bytes. 980 Bytes 內 IP data=960Bytes, 3000 byte-20 byte datagram IP data=3000–20=2980Bytes,分為 960, 960, 960, 100 共 4 個 fragments, 加上 20bytes IP header 後，data length 為 980, 980, 980, 120.

fragment	data lengths	ID	offset	flag
1st	980	100	0	1
2nd	980	100	960/8=120	1
3rd	980	100	120*2=240	1
4th	120	100	120*3=360	0

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(表格中 data length, offset, flag, ID 每格 0.5 分。沒有解釋或不清楚，視狀況扣分，8%)

10.(8%)

When **CongWin** is below **Threshold (1%)**, sender in slow-start phase, window grows exponentially **(1%)**.

When **CongWin** is above **Threshold (1%)**, sender is in congestion-avoidance phase, window grows linearly **(1%)**.

When a triple duplicate ACK occurs **(1%)**, **Threshold** set to **CongWin/2** and **CongWin** set to **Threshold (1%)**.

When timeout occurs **(1%)**, **Threshold** set to **CongWin/2** and **CongWin** is set to 1 MSS **(1%)**.