NATIONAL UNIVERSITY OF SINGAPORE

FINAL ASSESSMENT FOR
CS2105 – INTRODUCTION TO COMPUTER NETWORKS

(Semester 1: AY2017/2018)

Time allowed: 2 hours

INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains **SEVEN** questions and comprises **SIXTEEN** printed pages.
2. This is an **OPEN BOOK** assessment. The maximum possible score is **55 marks.**
3. Calculators are allowed, but not laptops, PDAs, or other electronic devices.
4. Fill in your student number clearly below.

STUDENT NO:

For examiners' use only

Question	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Total
Max	8	6	5	11	8	11	6	55
Score								

Q2. **[6 marks]**

(a) **[3 marks]** Each network interface card has an MAC address. Why not simply use this MAC address for routing of packets on the Internet? Briefly justify your answer.

(b) **[3 marks]** Briefly explain why the Internet is designed as a packet-switching network instead of a circuit-switching network.

For Q3-Q7, write your answers within the space provided in each question. There is no need to show your working.

Q3. **[Total: 5 marks]**

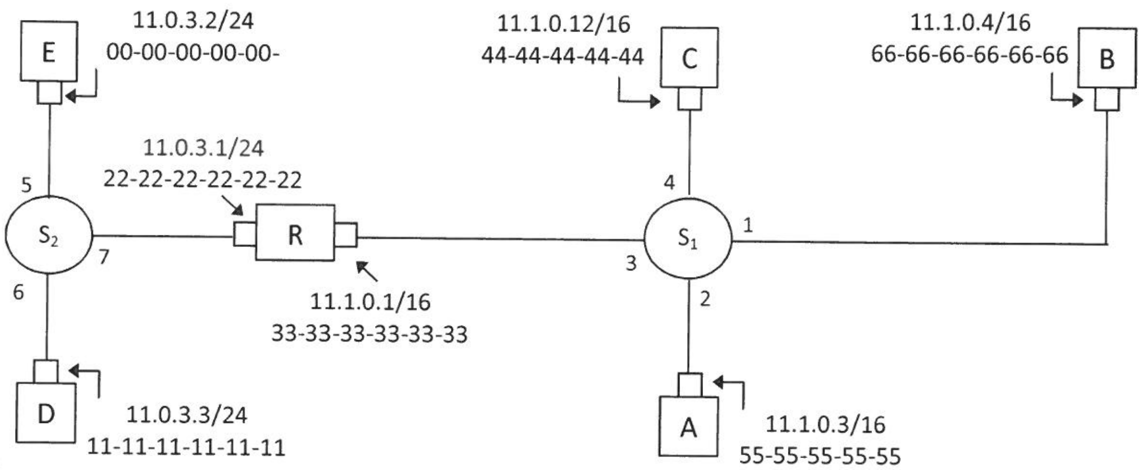
(a) **[1 mark]** The data value to be transmitted is 11100110 and the generator used by the sender and the receiver is 11001. What is the CRC value computed?

(b) **[1 mark]** A device transmits $3 * 10^3$ bits in 10 seconds using 64-QAM. What is the Baud rate of transmission?

(c) **[3 marks]** Three nodes A, B and C are accessing a shared medium using CSMA/CD protocol with binary back-off algorithm as given in lecture 10 notes. At a certain point of time, each of the three nodes attempts to send a frame simultaneously and thus collision happens. Suppose this collision is the first, second and third collisions experienced by A, B and C respectively. What is the probability that *A* successfully transmits a frame in the next attempt?

Q4. **[Total: 11 marks]**

Consider the following network topology in which the IP addresses and MAC addresses of various hosts (A ... E) and router R are given. A runs a DHCP server and B runs a Web server. S_1 and S_2 are two learning switches with their interfaces labelled from 1 till 7.



(a) **[2 marks]** Suppose host D sends an HTTP request to host B. In the packet sent by D, what is the destination MAC address? Which protocol does D use to obtain this MAC address?

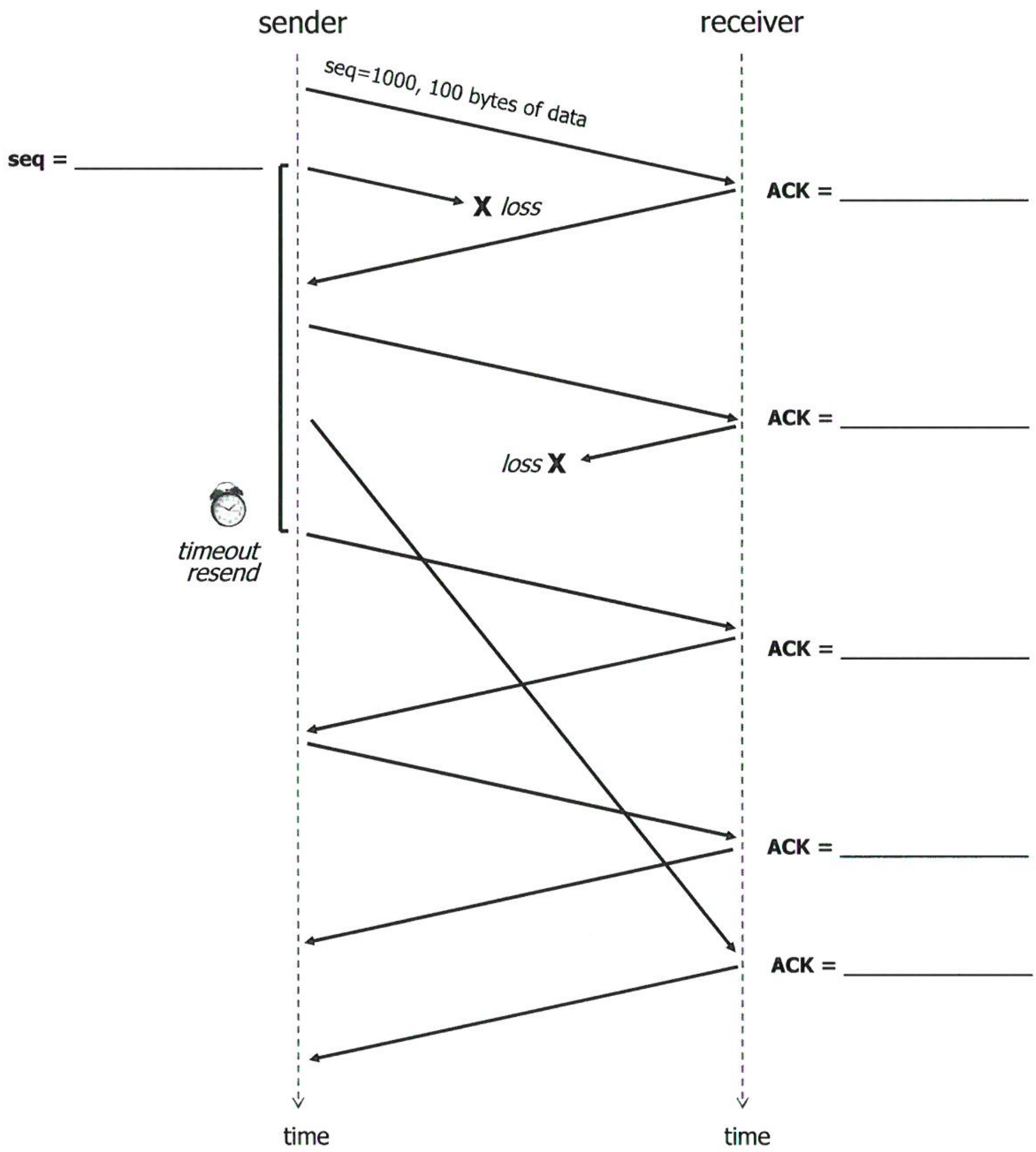
(b) **[2 marks]** After receiving an HTTP request from host D, host B replies with an HTTP response. In the packet that carries this HTTP response message, what is the destination IP address? How can B know this IP address?

(c) **[4 marks]** Suppose host C just joins the network. Outline the main steps and sequence of events/actions for C to obtain the IP address 11.1.0.12 from DHCP server A. For every packet sent by A and C, note down its source and destination port numbers, IP addresses and MAC addresses.

(d) **[3 marks]** Explain why host B will receive the DHCP messages exchanged between hosts A and C as in part (c). Will host B respond to these messages? Why?

Q5. **[Total: 8 marks]**

(a) **[3 marks]** Consider the TCP communication between a sender and a receiver as shown in the following diagram. The receiver has already received from the sender all bytes up to byte 999. Now the sender sends five more TCP segments to the receiver with each segment carries 100 bytes of data. The second segment is lost and re-transmitted upon timeout; the fourth segment is reordered. Assuming no packet is corrupted during transmission and receiver buffers out-of-order packets for eventual delivery to the application. Write down the sequence number of the second TCP segment sent by the sender and the acknowledgement number in every ACK segment sent by the receiver.



(b) **[5 marks]** Suppose we want to design a stop-and-wait, reliable protocol for communication between a sender S and a receiver R, over a channel with the following characteristics.

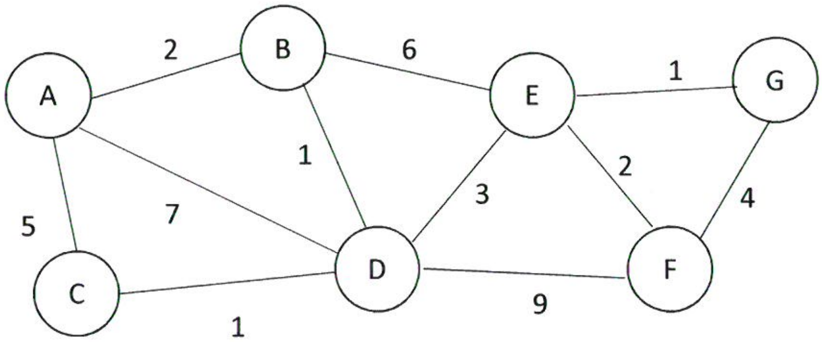
- From S to R, packets may be lost but will not be corrupted.
- From R to S, packets will not be lost or corrupted.
- Neither direction of transmission will reorder packets.
- The delay in each direction of transmission is unknown and variable.

Show your design of the protocol by drawing the FSM diagram for S and R. You may follow the pseudo-code notation shown in the lecture 4 notes to describe the events and actions in your FSM.

Note that your FSM must not use more mechanisms than necessary.

Q6. **[Total: 11 marks]**

(a) **[5 marks]** Consider the network topology shown below. Routers A ... G each runs distance vector algorithm. Initially every router only knows the distances to its immediate neighbours. Every t seconds, routers will exchange distance vectors with immediate neighbours.



i. **[1 mark]** Show the initial distance vector table of router A (i.e. before the distance vectors are exchanged). If A is unaware of another router, write '-' in the corresponding slot.

	cost to A	cost to B	cost to C	cost to D	cost to E	cost to F	cost to G
from A							

ii. **[2 marks]** Show the distance vector table of router A at t seconds (i.e. after one round of information exchange and update). If A is unaware of another router, write '-' in the corresponding slot.

	cost to A	cost to B	cost to C	cost to D	cost to E	cost to F	cost to G
from A							

iii. **[2 marks]** Suppose the distance vector algorithm has terminated and each router knows the cost of the least cost path to every other router. Fill in the distance vector table for the final distance vectors of router A.

	cost to A	cost to B	cost to C	cost to D	cost to E	cost to F	cost to G
from A							

(b) **[4 marks]** The format of the header of IP datagram is shown below.

VER 4 bits	HLEN 4 bits	DS 8 bits	Total length 16 bits		
Identification 16 bits			Flags 3 bits	Fragmentation offset 13 bits	
Time to live 8 bits		Protocol 8 bits	Header checksum 16 bits		
Source IP address					
Destination IP address					

An IP datagram received by a router has the following information in the IP header.

```
45 00 00 9e
b8 bc 00 00
3f 11 76 57
89 84 57 02
ac 1a bf 99
```

(Note: A ... F in hexadecimal correspond to 10 ... 15 in decimal.)

Will router discard this IP datagram? Why or why not?

(c) **[2 marks]** An organization is granted the IP address block 211.80.180.0/24. The administrator wants to create 15 equal size subnets. How many more bits will be used for the subnet prefix?

Q7. **[Total: 6 marks]**

A client is connected to a file server via an error-free link of L meters. Signal propagation speed on the link is C m/s and link bandwidth is B b/s. To retrieve a file, the client first sends a short request of R bytes to the server. The server locates the file and then reads data byte-by-byte from the hard-disk to form data packets. Assuming the disk access delay is d seconds per byte, file size is F bytes, which is multiple of the data packet of P bytes (i.e. $F = nP$, where n is a positive integer). A stop-and-wait protocol is used for transmission whereby the client sends a short ACK (of negligible size) for every packet it receives. Assume that packetization delay is smaller than the transmission delay of a packet and the file server sends out packets continuously.

(a) **[1 mark]** What is the time lapsed from the moment the first bit of the short request starts leaving the client to the moment the last bit of the request arrives at the server?

(b) **[1 mark]** What is the time taken for the server to form a data packet (i.e. the packetization delay)?

(c) **[2 marks]** What is the total time taken from the moment the first packet is ready for transmission at the server until the moment the file server is sure that the whole file is completely transferred to the client?

(d) **[2 marks]** What is the throughput of file transfer over the observed time from the moment the first bit of the short request is sent until the moment the file server is sure that the whole file is completely transferred to the client?

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Do **NOT** use it for your rough work.
Use it ONLY if you need extra space for your answer, in which case please indicate the **question number clearly**.

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