NATIONAL UNIVERSITY OF SINGAPORE

FINAL ASSESSMENT FOR
CS2105 – INTRODUCTION TO COMPUTER NETWORKS

(Semester 1: AY2016/2017)

Time allowed: 2 hours

INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains **SEVEN** questions and comprises **TWELVE** printed pages.
2. This is an **OPEN BOOK** assessment. The maximum possible score is **60 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	**20**	**5**	**4**	**7**	**6**	**7**	**11**	**60**
Score								

Q2. **[Total: 5 marks]**

(a) **[1 mark]** If generator is k-bit long, CRC will be _____ bits long.

(b) **[2 marks]** If every person in a group of 5 needs to communicate with every other person in another group of 10 people secretly, the number of secret keys required is _____ if symmetric key cryptography is used and _____ if public key cryptography is used.

(c) **[2 marks]** A host has just been plugged into the network. It has no information about the network it joins and is trying to get an IP address. List down two protocols that are involved in this process.

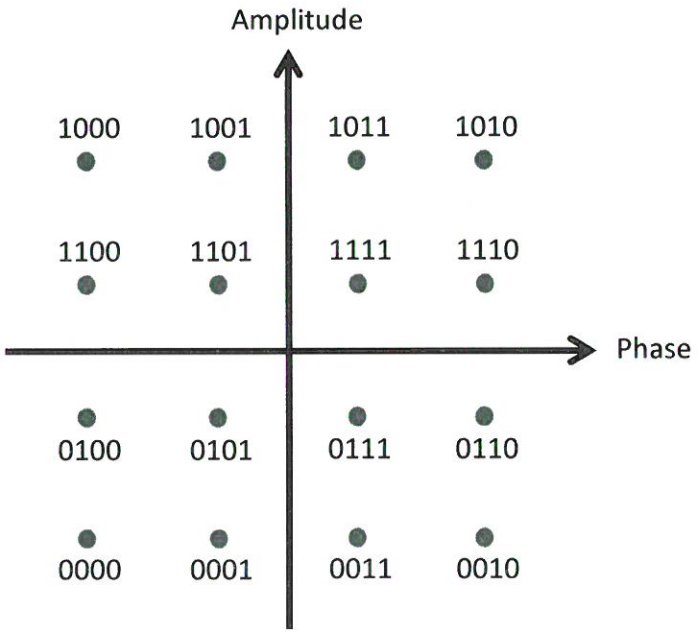
Q3. **[Total: 4 marks]**

A webpage contains a base HTML file and two images referenced by the base HTML file. The HTML file is 728 bytes and the two images are 413 bytes and 1719 bytes respectively. Assume link rate is 1 Mbps, propagation delay between the Web server and the client is 46 milliseconds and the Web server has only one output queue.

A client downloads the webpage from the Web server over an existing TCP connection. HTTP/1.1 (persistent HTTP with pipelining) is used. HTTP/TCP headers and ACK packets are of negligible size. How long (in milliseconds) will it take for the client to download the webpage? Briefly show how you work out the answer.

Q4. **[Total: 7 marks]**

Consider the following constellation diagram.



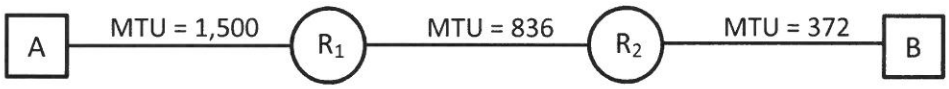
(a) **[2 marks]** What modulation scheme is represented in the above diagram?

(b) **[2 marks]** If baud rate of the above modulation scheme is 8,000 baud, what is the bit rate of transmission?

(c) **[3 marks]** In the above diagram, neighbouring signals differ by one bit only. In no more than 60 words, explain the advantage of such a design.

Q5. **[Total: 6 marks]**

Two hosts A and B are separated by two routers R_1 and R_2. Different links have different MTUs as illustrated in the following diagram. Suppose host A sends an IP datagram of 1,500 bytes (inclusive of 20 bytes of IP header) to host B. This datagram is not a fragment.



(a) **[2 marks]** Fill in the following table for the missing information of the IP fragments send by router R_1.

(List fragments in the increasing order of offset; use as many rows as necessary)

Fragments	Length of fragment	Offset	Flag
1			
2			
3			

(b) **[3 marks]** Fill in the following table for the missing information of the IP fragments send by router R_2.

(List fragments in the increasing order of offset; use as many rows as necessary)

Fragments	Length of fragment	Offset	Flag
1			
2			
3			

(c) **[1 mark]** Suppose one of the IP fragments received by router R_2 is corrupted, will R_2 signal R_1 for retransmission? Answer "yes" or "no".

Q6. **[Total: 7 marks]**

Nodes A and B are accessing a shared medium with propagation delay of 300 bit times between them (i.e., propagation delay equals to the amount of time to transmit 300 bits onto the link). A and B each have a frame of 1,000 bits (including all headers and preambles) to send to each other.

(a) **[3 marks]** In the worst case, how many bits would A have sent out when it detects collision? Briefly show how you work out the answer.

(b) **[4 marks]** Suppose both A and B attempt to transmit at time $t = 0$. CSMA/CD protocol with back-off intervals of multiples of 512 bits is used. After the first collision, A draws $K = 0$ and B draws $K = 1$ in the exponential back-off protocol. Ignore the jam signal and other unmentioned delays. At what bit time will A's packet be successfully received by B? Briefly show how you work out the answer. If the information given in the question is insufficient to derive the answer, explain why it is so.

Q7. **[Total: 11 marks]**

(a) A source and a destination are separated by 20,000 kilometers and are connected by a direct link of 2 Mbps. The propagation speed over the link is $2.5*10^8$ meters/s. The source sends a file of 3,000,000 bytes using protocol rdt 2.2. Assume MSS is 2,000 bytes, no packet header and ACKs are of negligible size.

i. **[2 marks]** If no packet is corrupted during transmission, how long (in seconds) does it take for the source to receive the 20^{th} ACK? Briefly show how you work out the answer.

ii. **[2 marks]** If 10% of the packets are corrupted, how long (in seconds) will it take, on average, for the source to know the file is successfully delivered to the destination, assuming retransmission is always successful? Briefly show how you work out the answer.

(b) m packets are sent from a source to a destination using Selective Repeat protocol with window size set to n ($n << m$). Assume the source sends data as fast as possible, no packet header and ACK packets are of negligible size.

i. **[3 marks]** Given that propagation delay is d, all packets are l bits long and link transmission rate is r bps, express throughput with given parameters.

ii. **[4 marks]** Suppose the source just receives an ACK packet with sequence number k. What are the smallest and largest possible values of the source's $send\_base$ just before this ACK packet is received? Briefly describe the scenarios that lead to such smallest and largest values.

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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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