NATIONAL UNIVERSITY OF SINGAPORE

FINAL ASSESSMENT FOR
CS2105 – INTRODUCTION TO COMPUTER NETWORKS

(Semester 2: AY2017/2018)

Time allowed: 2 hours

INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains **FIVE** questions and comprises **FOURTEEN** printed pages.
2. This is a **CLOSED BOOK** assessment. You may bring in one piece A4 size help sheet.
3. Calculators are allowed, but not laptops, PDAs, or other electronic devices.
4. Fill in your student number clearly below. Do not write your name.

STUDENT NO: | | | | | | | | | |

For examiners' use only						
Question	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**	**Total**
Max	**20**	**10**	**5**	**11**	**9**	**55**
Score						

Q2. Keep your answers for each question succinct. **[Total: 10 marks]**

(a) **[2 marks]** Name two reasons that may cause packet loss in a packet-switching network.

(b) **[2 marks]** List any two advantages of packet-switching network over circuit-switching network.

(c) **[2 marks]** UDP provides a connection-less, unreliable service just like the Internet Protocol. Would it not have been enough to just let application processes send raw IP datagram? Justify your answer in no more than 100 words.

(d) **[2 marks]** Give a reason Wi-Fi uses CSMA/CA instead of CSMA/CD. Show a simple example.

(e) **[2 marks]** Cryptographic hash function is commonly used to ensure message integrity, which provides a basis to verify message authenticity. On the other hand, CRC is used by link layer to detect bit errors. Can we use CRC to ensure message integrity instead? Justify your answer in no more than 50 words.

For Q3-Q5, 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 **11001** and the CRC generator is **1101**. What is the CRC value computed?

(b) **[1 mark]** Find the bandwidth needed for a system that has 310 W of signal power, to transmit data at the speed of 10,000 bps over a channel with noise of 10 W.

(c) **[1 mark]** Consider a wired Ethernet that spans 500 meters and employs CSMA/CD protocol. Assume that data transmission rate is 100 Mbps and speed of light is $2 * 10^8$ m/s. In the worst case, after transmitting how many bits would a station detect that a collision has happened?

(d) **[2 marks]** There are three active stations in a slotted Aloha network, namely A, B and C. Each station decides to send a frame in a time slot independently with the probability $P_A = 0.2$, $P_B = 0.3$ and $P_C = 0.4$ respectively. What is the probability no collision happens in a time slot?

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

(a) **[4 marks]** Consider sending 50,000 bytes of application data over an existing TCP connection (i.e. 3-way handshake is already done). The connection is still open after the transmission. Suppose TCP header and IP header are 20 bytes each. Link MTU is 500 bytes. An IP datagram in turn is encapsulated in an Ethernet frame that adds another 144 bits of header and trailer.

i. **[1 mark]** How many Ethernet frames are needed to transmit data?

ii. **[1 mark]** What is the total number of overhead bytes (i.e. all packet headers and trailers) in each frame?

iii. **[1 mark]** Calculate the percentage overhead (with respect to the total number of application data) incurred from segmenting the data into Ethernet frames.

iv. **[1 mark]** Using the results above to explain the drawback of the layered approach to network architectures and protocols. Keep your answer succinct.

(b) **[1 mark]** A technique called _____ is used to improve the efficiency of the bidirectional protocols. When a packet is carrying data from host A to host B, it can also carry control information about the packets A received from B; when a packet is carrying data from B to A, it can also carry control information about the packets B received from A.

(c) **[4 marks]**

i. **[2 marks]** Older versions of Microsoft Windows fix the maximum TCP window size to a constant. For example, Windows 95's maximum window size is 8,192 bytes. What is the maximum throughput (in Mbps) achievable over a 10 Mbps channel that has a one-way delay of 5 milliseconds? Correct your answer to two decimal places.

ii. **[2 marks]** Do you think it is a good idea for Windows 95 to fix the TCP window size to 8,192 bytes? Why or why not?

(d) **[2 marks]** A series of 1000-bit frames is to be transmitted over a cable of 10 Mbps using a stop-and-wait protocol. The propagation speed over the cable is 200 meters per microseconds. Determine the length (in meters) of the cable if the maximum link utilization is to be maintained at 80%.

Q5. **[Total: 9 marks]**

(a) **[2 marks]** A host with IP address `137.132.92.18/21` sends an IP datagram to another host with IP address `137.132.88.17/21`. Should this IP datagram cross one or more routers to reach the destination? Justify your answer in no more than 50 words.

(b) **[3 marks]** Consider sending a 2,000-byte IP datagram over a link that has an MTU of 100 bytes. Suppose this datagram is not a fragment and IP header is 20 bytes.

iii. **[1 mark]** How many fragments will be generated?

iv. **[2 marks]** What is the offset value in the 10th fragment?

(c) **[4 marks]** A university has four IP subnets A, B, C and D, with 240, 12, 60 and 100 hosts respectively. From the address space 102.10.0.0/22, assign IP addresses to these four subnets such that you use the minimum number of consecutive addresses, starting from 102.10.0.0. Write down the IP addresses of each subnet in CIDR format.

subnet A:

subnet B:

subnet C:

subnet D:

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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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