

NATIONAL UNIVERSITY OF SINGAPORE

CS2105 – INTRODUCTION TO COMPUTER NETWORKS

Mock Exam Paper 2

Please DO NOT upload questions and answers onto the Internet.

Time allowed: 2 hours

INSTRUCTIONS TO CANDIDATES

1. This assessment paper contains **EIGHT** questions and comprises **SEVEN** printed pages, including this page.
2. This is an **OPEN BOOK** assessment.
3. Calculators are allowed, but not laptops, PDAs, or other electronic devices.
4. There is no need to show your working for each question.

Q1. Multiple Choice Questions (MCQs)

1.1 Ethernet provides an unreliable service and _____.

- A. CRC is not used for error checking
- B. Ethernet sends a negative acknowledgement to the sender to indicate packet loss
- ☒ C. Ethernet drops a frame that fails error checking without retransmission
- D. Ethernet does not function correctly when bit errors in frames are detected
- E. Applications that require reliable delivery cannot run over Ethernet

1.2 Consider a noisy channel with a Shannon capacity of 100 kbps and a bandwidth of 10 kHz. The signal-to-noise ratio of this channel is

- A. 3.3
- B. 5
- C. 9
- D. 10
- ☒ E. 1023

$$\begin{array}{ccccccc} 0 & 1 & 1 & 0 & 0 & 0 & 0 \\ 128 & 64 & 32 & 16 & 8 & 4 & 2 \end{array}$$

1.3 Which of the following IP addresses belong to the subnet 137.132.96/20?

- ☒ i. 137.132.96.96
- ii. 137.132.104.104
- iii. 137.132.112.112
- iv. 137.132.120.120

$$96 + 15 = 104$$

- A. (i) only
- ☒ B. (i) and (ii) only
- C. (i), (ii) and (iii) only
- D. (iii) and (iv) only
- E. (i), (ii), (iii) and (iv) only

1.4 Which of the following statements about 2-dimensional parity bits is FALSE?

- ☒ A. It can detect any one-bit error.
- ☒ B. It can correct any one-bit error.
- ☒ C. It can detect any two-bit error.
- ☒ D. It can correct any two-bit error.
- E. It may not be able to detect a four-bit error.

1.5 Two hosts are communicating using CRC as an error detection scheme, with a generator of 110. Every byte sent consists of six bits of data and two bits of the CRC value. Suppose the following four bytes are received. Which bytes would pass the CRC test and considered as containing no bit error?

(i) 11011000

~~(ii) 11011101~~

(iii) 10010110

~~(iv) 11111100~~

~~A. (i) and (ii) only~~

B. (i) and (iv) only

C. (i), (iii) and (iv) only

~~D. (iii) and (iv) only~~

~~E. (i), (ii) and (iii) only~~

$$\begin{array}{r} 10010110 \\ 110 \overline{) 11011000} \\ \underline{-110} \\ 000100 \\ \underline{-110} \\ 000000 \end{array}$$

$$\begin{array}{r} 10010111 \\ 110 \overline{) 11011101} \\ \underline{-110} \\ 011100 \\ \underline{-110} \\ 001000 \\ \underline{-110} \\ 010000 \\ \underline{-110} \\ 100000 \\ \underline{-110} \\ 010000 \\ \underline{-110} \\ 000000 \end{array}$$

$$\begin{array}{r} 111001 \\ 110 \overline{) 11001011} \\ \underline{-110} \\ 001010 \\ \underline{-110} \\ 000000 \end{array}$$

$$\begin{array}{r} 111001 \\ 110 \overline{) 11100100} \\ \underline{-110} \\ 000000 \end{array}$$

1.6 Which of the following statements about IP header is TRUE?

~~A. The source and destination port numbers in the IP header determine which port — application on the receiving host will process the datagram.~~

B. The TTL field in the IP header determines the time period within which the source IP address is valid. hop?

C. The 16-bit identifier field in the IP header is not changed during IP fragmentation.

~~D. The checksum field in the IP header allows the receiver to check if the IP header or payload is corrupted.~~

~~E. The protocol field in the IP header determines which link layer protocol should be used to transmit the datagram.~~ transport.

1.7 A subnet contains two hosts with IP addresses 137.132.80.16 and 137.132.67.94 respectively. Which of the following is/are possible address block assigned to the subnet?

(i) 137.132.64.0/18

(ii) 137.132.64.0/19

~~(iii) 137.132.64.0/20~~

(iv) 137.132.0.0/17

$$\begin{array}{r} 128 \ 64 \ 32 \ 16 \ 8 \ 4 \ 2 \ 1 \\ 0 \ 1 \ 0 \ 0 \\ \hline 17 \ 18 \ 19 \ 20 \end{array}$$

$$80 - 64 = 16$$

A. (i) only

B. (i) and (ii) only

C. (i), (ii) and (iii) only

D. (iii) and (iv) only

E. (i), (ii) and (iv) only

- 1.8 A Web server supports both HTTP/1.0 and HTTP/1.1. So far 100 clients have downloaded a web page from the server, which contains 1 HTML file and 2 images. Half of the clients run HTTP/1.0 and the other half run HTTP/1.1.

How many sockets has the Web server ever created since it starts running?

☒ A. 201

B. 200

C. 100

D. 101

E. None of the above

welcome 1.0 1.1
 1 socket + 3 sockets + 1 sockets
 150 50

- ~~2.9~~ Which of the following digital-to-analogy modulation scheme can support the highest data rate?

A. PSK at 8000 baud

☒ B. QPSK at 8000 baud

C. 4-QAM at 6000 baud

D. 8-QAM at 4000 baud

E. 16-QAM at 2000 baud

- ~~1.10~~ Knowing that you have taken CS2105, a friend comes to you for help with his laptop. He says that he cannot access the Web page hosted at **www.example.com**. Using the tools you have learned in CS2105, you run the following commands on his laptop to troubleshoot what could be the reason.

Which of the following is NOT the correct use of the corresponding tool?

☒ A. You run **telnet** to check if **www.example.com** is listening on port 80. ?

☒ B. You run **traceroute** to check if there is a route from the laptop to **www.example.com**.

☒ C. You run **dig** to check if his DNS server is able to resolve the IP address of host name **www.example.com**.

☒ D. You run **ping** to check if you can establish a TCP connection to **www.example.com**.

☒ E. You run **curl** to check if **www.example.com** is responding to a HTTP request correctly.

transfer data

Connects
to or
remote
host.

→ test if IP destination exist, not establishing a TCP connection

Q2.

Two hosts A and B are communicating over a wireless channel with a signal to noise ratio of 15 and a bandwidth of 100 MHz. The nodes are 300 meters apart. The signal propagation speed over the air is the 3×10^8 m/s.

- What is the maximum data rate that can be supported by the wireless channel?
- Suppose that A transmits at 20 MBaud using 64-QAM as the modulation scheme. What is the transmission rate of A in Mbps?
- Suppose that A transmits a frame of size 1000 bytes at 100 Mbps, starting at time $t = 0$. At what time will the frame reach B completely? Give your answer in the unit of μs (Note: $1 \mu s = 1 \times 10^{-6}$ s).

Q3.

Two hosts A and B are 2,000 km apart and are connected directly using a link with propagation delay of 800 bit times and propagation speed of 2.5×10^8 m/s. A is sending a sequence of packets, each is 100 bytes in size, to B.

- How long does it take for B to receive a packet?

$$\frac{2000 \times 10^3}{2.5 \times 10^8}$$

$$\frac{2000 \times 10^3}{2.5 \times 10^8} = 16$$

- A is using a sliding window protocol to communicate with B. What is the minimum window size A should use for the link to be fully utilized?

find bps

3.

$$\text{delay} = 100 \text{ bytes} + 100 \text{ bytes size.}$$

$$\therefore \text{min frame / window size} = 101 \text{ bytes.}$$

Q4.

To preserve message confidentiality and integrity, the following information is contained in a secured message sent from Alice to Bob.

- Encrypted hash of the message
- Encrypted message
- Encrypted session key

Authentication

sess key.

To preserve message integrity by sending $H(M+S)$ and m , so can detect if the message has been tampered with.

Ensures confidentiality, only sender and receiver can decrypt message

Briefly describe the purpose of each piece of information and the key used in generating that information.

A symmetric key that is shared between sender and receiver, ensures confidentiality as it enables receiver and sender to decrypt message.

Video streaming - fast / (stable thought)

Online banking - reliable

Q5. Keep your answers for each question accurate and succinct.

(a) Name an application that uses UDP service and another application that uses TCP service. Describe the reason they choose the respective transport services.

(b) List and compare two major differences between switches and routers. invisibility - packet modification,

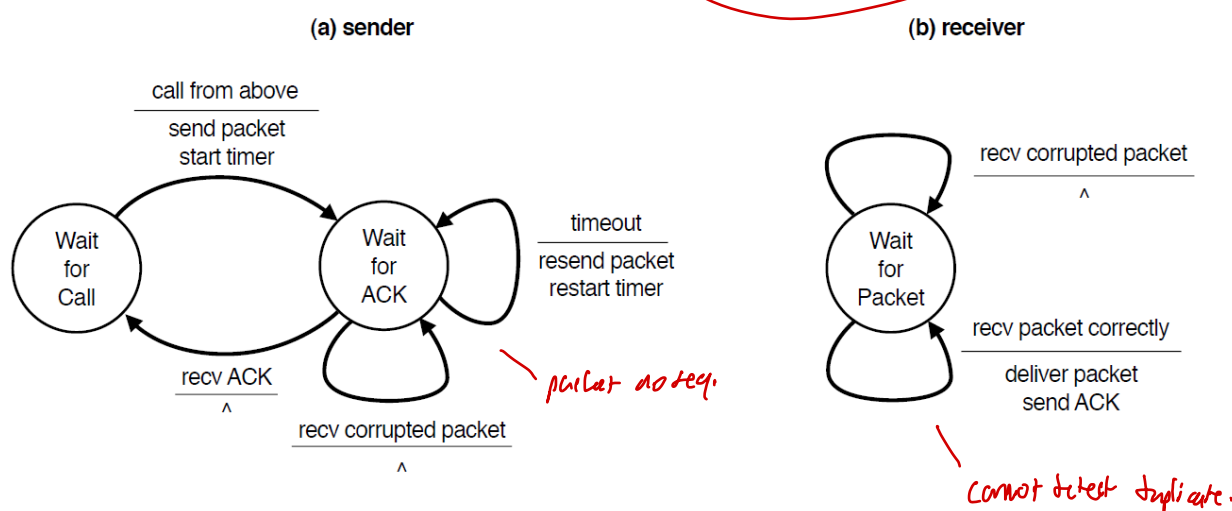
(c) Each network interface card has a MAC address. Why not simply use this MAC address for routing of packets on the Internet?

MAC vs IP address checking

Does not have a range, need to search every host in the world ...

Q6.

Figure 1 shows the finite state machine of a protocol designed to run over a channel with the following properties: (P₁) can corrupt packet, (P₂) can lose packets, and (P₃) has an unknown round trip time.



(a) Is it possible for this protocol to deliver the same packet twice to the application? Either give an example where the same packet is delivered twice by drawing a timing diagram, or argue why every packet will only be delivered once. Yes. On timeout.

(b) Is it possible for this protocol to not detect a lost data packet? Either give an example where a lost packet is not detected by drawing a timing diagram or argue why a packet loss is always detected. No. Timeout. Yes! ACK has no seq. no, duplicate ACK.

(c) Can we remove only one of the network properties P₁, P₂, P₃ so that the protocol works as intended without modification? Justify your answer. Yes. Timeout can handle all 3 properties if they are removed.

According to these properties

No.

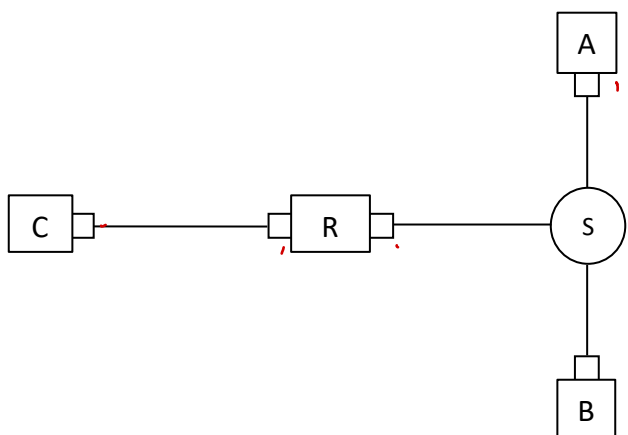
P1 - ACK

P2 - RTT

P3 - packet duplication

Q7.

The diagram below shows a small network with five entities: hosts A and B are connected to a router R through a switch S. Host C connects to R directly. There is no other host, switch, or router in the network.

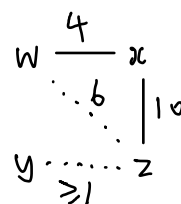


- (a) What is the maximum number of entries that could be in the switching table of S? 3 ✓
- (b) What is the maximum number of entries that could be in the ARP table of A? 2 ✓
- (c) What is the maximum number of entries that could be in the ARP table of C? 1 ✓
- (d) How many IP addresses need to be assigned to this network? 5 ✓
- ~ sockets.
- ARP excludes own -

Q8. ???

A node x is part of a network running distance vector routing protocol. x has three entries in its forwarding table:

Destination	Cost	Next Hop
w	4	w
y	α	z
z	β	w



α and β are two unknown values (unknown to you, but known to x). Assume that the distance vector routing protocol has converged and the minimum cost from x to every other node has been found. We denote $c(x, y)$ as the link cost between x and y , and $d_x(y)$ as the cost of the minimum cost path from x to y . The link cost is a positive integer.

We know that $c(x, w)$ is 4, and $c(x, z)$ is 10.

- (a) What is the minimum possible value for α ? 1 ✓
- (b) What is the maximum possible value for $d_w(z)$? 6 ✓
- ~ can be equal in weight.

=== END OF PAPER ===

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1.1	C	1.2	E	1.3	B	1.4	D	1.5	C
1.6	C	1.7	E	1.8	A	1.9	B	1.10	D

2.

- (a) 400 Mbps
- (b) 120 Mbps
- (c) 81 μs

3.

- (a) 16 ms
- (b) 3

4.

(Multiple possible answers. Below is one example)

Encrypted hash of the message: digital signature of Alice used to prove her identity to Bob. Alice's private key is used.

Encrypted message: message encrypted with the session key to ensure confidentiality of the message. Session key is a symmetric key.

Encrypted session key: session key encrypted with Bob's public key. The purpose is to share the session key with Bob.

5.

(a)

FTP runs over TCP – need to ensure files are uploaded/downloaded intact;

Live video streaming often runs over UDP – fast; relatively stable throughput.

(b)

Switch	Router
Layer-2 device	Layer-3 device
Self-learning	Need manual configuration
Forward link layer frames	Forward IP datagrams
Used in a subnet	Used to connect subnets

(c)

An IP address logically comprises two parts: network prefix and host ID. This is designed to facilitate routing: routers check prefix and deliver a packet to an aggregated destination network. If MAC address is used instead, hierarchical routing cannot be achieved. For example, MAC address is burnt in ROM and usually cannot be changed. When people carry their laptops around the world, devices in a subnet won't have common prefix in MAC addresses. This makes routing difficult as routers have to remember routing for every single MAC address.

6.

- (a) Yes. Premature timeout and retransmitted packet delivered to application.
- (b) Yes. Premature timeout and retransmission. The next new packet is lost but undetected because the sender treats the duplicate ACK as the acknowledgement for the next packet.
- (c) No

7.

- (a) 3
- (b) 2
- (c) 1
- (d) 5

8.

- (a) $\alpha \geq 11$, since $d_z(y) \geq 1$, $c(x, z) = 10$, and $\alpha = d_x(y) = c(x, z) + d_z(y)$.
- (b) $d_w(z) \leq 6$, since $d_x(z) \leq c(x, z)$, and therefore $c(x, w) + d_w(z) \leq 10$.