

SCHOOL OF ENGINEERING AND TECHNOLOGY

EXAMINATION FOR THE BSC (HONS) INFORMATION TECHNOLOGY (BIT) & BSC (HONS) COMPUTER NETWORKING AND SECURITY (BCNS) & BSC (HONS) COMPUTER SCIENCE (BCS) & BSC (HONS) SOFTWARE ENGINEERING (BSE); YEAR 2

ACADEMIC SESSION : APRIL 2024 SEMESTER

SUBJECT : NET2201 – COMPUTER NETWORKS

EXAMINATION : AUGUST 2024

TIME ALLOWED : 2 HOURS + 10 MINUTES READING TIME

INSTRUCTIONS TO CANDIDATES

- This question booklet contains **two sections**.
- **Section A:** Answer the two compulsory questions.
- **Section B:** Answer two questions out of three questions.
- All answers must be written in the answer booklets provided using blue or black INK.

IMPORTANT NOTES TO CANDIDATES

Materials Allowed

Standard Items: Pen, Pencil, Eraser or Correction Fluid, Ruler

Special Items : Non Programmable Calculators

It is your responsibility to ensure that you do NOT have in your possession any unauthorised notes or any other means that would improperly help you in your work. If you have any unauthorised materials with you, hand it to the invigilator BEFORE reading any further.

DO NOT REMOVE THIS QUESTION PAPER FROM THE EXAMINATION HALL

[This paper contains FIVE questions printed on SEVEN pages, including cover page]

Section A <i>Compulsory section</i>

Question 1 (25 marks)

- a) Briefly describe the following: (4 marks)
- i. An application-layer message?
 - ii. A transport-layer segment?
 - iii. A network-layer datagram?
 - iv. A link-layer frame?
- b) Consider sending a packet from a source host to a destination host over a fixed route. List the delay components in the end-to-end delay. Which of these delays are constant and which are variable? (3 marks)
- c) Describe why an application developer might choose to run an application over UDP rather than TCP. (3 marks)
- d) Describe how Web caching can reduce the delay in receiving a requested object. Will Web caching reduce the delay for all objects requested by a user or for only some of the objects? Why? (5 marks)
- e) What is the role of the forwarding table within a router? (3 marks)
- f) Suppose a process in Host C has a UDP socket with port number 6789. Suppose both Host A and Host B each send a UDP segment to Host C with destination port number 6789. Will both of these segments be directed to the same socket at Host C? If so, how will the process at Host C know that these two segments originated from two different hosts? (3 marks)
- g) Suppose end system A wants to send a large file to end system B. At a very high level, describe how end system A creates packets from the file. When one of these packets arrives to a router, what information in the packet does the router use to determine the link onto which the packet is forwarded? (4 marks)

Question 2 (25 marks)

- a) How long does it take a packet of length 1,000 bytes to propagate over a link of distance 2,500 km, propagation speed 2.5×10^8 m/s, and transmission rate 2 Mbps? Does this delay depend on packet length? Does this delay depend on transmission rate? (5 marks)
- b) Suppose you would like to urgently deliver 50 terabytes data from Ipoh to Georg Town, Penang. You have available a 100 Mbps dedicated link for data transfer. Would you prefer to transmit the data via this link or instead use FedEx overnight delivery? Explain. (5 marks)
- c) Suppose there is exactly one packet switch between a sending host and a receiving host. The transmission rates between the sending host and the switch and between the switch and the receiving host are R_1 and R_2 , respectively. Assuming that the switch uses store-and-forward packet switching, what is the total end-to-end delay to send a packet of length L ? (Ignore queuing, propagation delay, and processing delay.) (5 marks)
- d) Suppose Host A wants to send a large file to Host B. The path from Host A to Host B has three links, of rates $R_1 = 500$ kbps, $R_2 = 2$ Mbps, and $R_3 = 1$ Mbps.
- i. Assuming no other traffic in the network, what is the throughput for the file transfer? (5 marks)
- ii. Suppose the file is 4 million bytes. Dividing the file size by the throughput, roughly how long will it take to transfer the file to Host B? (5 marks)

Section B

Answer any TWO questions from this section.

Question 3 (25 marks)

- a) Suppose you can access the caches in the local DNS servers of your department. Can you propose a way to roughly determine the Web servers (outside your department) that are most popular among the users in your department? Explain. (5 marks)
- b) Consider the following string of ASCII characters that were captured by Wireshark when the browser sent an HTTP GET message (i.e., this is the actual content of an HTTP GET message). The characters `<cr><lf>` are carriage return and line-feed characters (that is, the italicized character string `<cr>` in the text below represents the single carriage-return character that was contained at that point in the HTTP header). Answer the following

questions, indicating where in the HTTP GET message below you find the answer.

```
<cr><lf>Accept-Language: en-us,en;q=0.5<cr><lf>Accept-
Encoding: zip,deflate<cr><lf>Accept-Charset: ISO
-8859-1,utf-8;q=0.7,*;q=0.7<cr><lf>Keep-Alive: 300<cr>
<lf>Connection:keep-alive<cr><lf><cr><lf>
GET /cs453/index.html HTTP/1.1<cr><lf>Host: gai
a.cs.umass.edu<cr><lf>User-Agent: Mozilla/5.0 (
Windows;U; Windows NT 5.1; en-US; rv:1.7.2) Gec
ko/20040804 Netscape/7.2 (ax) <cr><lf>Accept:ex
t/xml, application/xml, application/xhtml+xml, text
/html;q=0.9, text/plain;q=0.8,image/png,*/*;q=0.5
```

- i. What is the URL of the document requested by the browser? (2 marks)
 - ii. What version of HTTP is the browser running? (2 marks)
 - iii. Does the browser request a non-persistent or a persistent connection? (3 marks)
 - iv. What is the IP address of the host on which the browser is running? (2 marks)
 - v. What type of browser initiates this message? Why is the browser type needed in an HTTP request message? (3 marks)
- c) The text below shows the reply sent from the server in response to the HTTP GET message in the question above. Answer the following questions, indicating where in the message below you find the answer.

```
HTTP/1.1 200 OK<cr><lf>Date: Tue, 07 Mar 2008
12:39:45GMT<cr><lf>Server: Apache/2.0.52 (Fedora)
<cr><lf>Last-Modified: Sat, 10 Dec2005 18:27:46
GMT<cr><lf>ETag: "526c3-f22-a88a4c80"<cr><lf>Accept-
Ranges: bytes<cr><lf>Content-Length: 3874<cr><lf>
Keep-Alive: timeout=max=100<cr><lf>Connection:
Keep-Alive<cr><lf>Content-Type: text/html; charset=
ISO-8859-1<cr><lf><cr><lf><!doctype html public "-
//w3c//dtd html 4.0transitional//en"><lf><html><lf>
<head><lf> <meta http-equiv="Content-Type"
content="text/html; charset=iso-8859-1"><lf> <meta
name="GENERATOR" content="Mozilla/4.79 [en] (Windows NT
5.0; U) Netscape]"><lf> <title>CMPSCI 453 / 591 /
NTU-ST550ASpring 2005 homepage</title><lf></head><lf>
<much more document text following here (not shown)>
```

- i. Was the server able to successfully find the document or not? (2 marks)
- ii. What time was the document reply provided? (2 marks)
- iii. When was the document last modified? (2 marks)
- iv. How many bytes are there in the document being returned? (2 marks)

Question 4 (25 marks)

- a) Is it possible for an application to enjoy reliable data transfer even when the application runs over UDP? If so, how? (4 marks)
- b) Suppose Host A sends two TCP segments back-to-back to Host B over a TCP connection. The first segment has sequence number 90; the second has sequence number 110.
- i. How much data is in the first segment? (3 marks)
 - ii. Suppose that the first segment is lost but the second segment arrives at B. In the acknowledgment that Host B sends to Host A, what will be the acknowledgment number? (3 marks)
- c) Consider Figure 4-1. Now we replace the router between subnets 1 and 2 with a switch S1, and label the router between subnets 2 and 3 as R1.

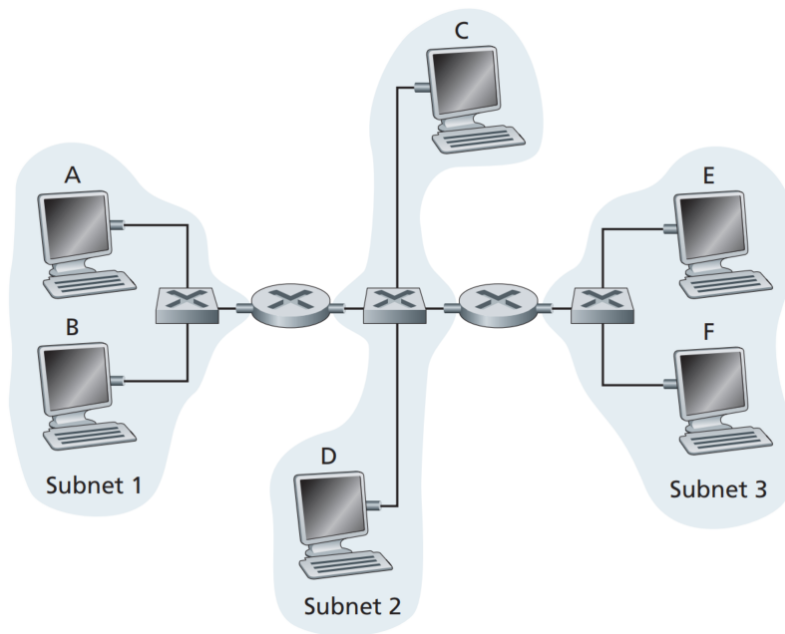


Figure 4-1.

- i. Consider sending an IP datagram from Host E to Host F. Will Host E ask router R1 to help forward the datagram? Why? In the Ethernet frame containing the IP datagram, what are the source and destination IP and MAC addresses? (5 marks)
- ii. Suppose E would like to send an IP datagram to B, and assume that E's ARP cache does not contain B's MAC address. Will E perform an ARP query to find B's MAC address? Why? In the Ethernet frame (containing the IP datagram destined to B) that is delivered to router R1, what are the source and destination IP and MAC addresses? (5 marks)

- iii. Suppose Host A would like to send an IP datagram to Host B, and neither A's ARP cache contains B's MAC address nor does B's ARP cache contain A's MAC address. Further suppose that the switch S1's forwarding table contains entries for Host B and router R1 only. Thus, A will broadcast an ARP request message. What actions will switch S1 perform once it receives the ARP request message? Will router R1 also receive this ARP request message? If so, will R1 forward the message to Subnet 3? (5 marks)

Question 5 (25 marks)

- a) Describe how packet loss can occur at input ports. Describe how packet loss at input ports can be eliminated (without using infinite buffers). (5 marks)
- b) Describe how packet loss can occur at output ports. Can this loss be prevented by increasing the switch fabric speed? (5 marks)
- c) Suppose you purchase a wireless router and connect it to your cable modem. Also suppose that your ISP dynamically assigns your connected device (that is, your wireless router) one IP address. Also suppose that you have five PCs at home that use 802.11 to wirelessly connect to your wireless router. How are IP addresses assigned to the five PCs? Does the wireless router use NAT? Why or why not? (7 marks)
- d) Consider the network shown in Figure 5-1. Suppose AS3 and AS2 are running OSPF for their intra-AS routing protocol. Suppose AS1 and AS4 are running RIP for their intra-AS routing protocol. Suppose eBGP and iBGP are used for the inter-AS routing protocol. Initially suppose there is no physical link between AS2 and AS4.

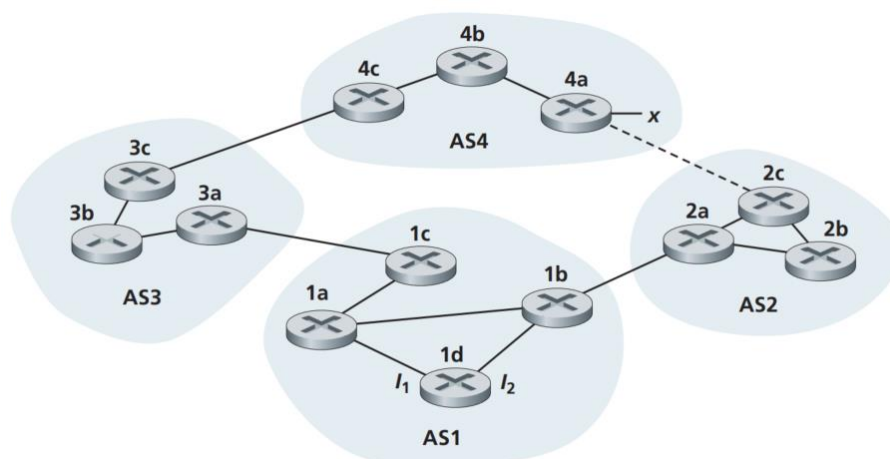


Figure 5-1

- i. Router 3c learns about prefix x from which routing protocol: (2 marks)
OSPF, RIP, eBGP, or iBGP?
- ii. Router 3a learns about x from which routing protocol? (2 marks)
- iii. Router 1c learns about x from which routing protocol? (2 marks)
- iv. Router 1d learns about x from which routing protocol? (2 marks)

~ END OF PAPER ~