THE HONG KONG POLYTECHNIC UNIVERSITY
HONG KONG COMMUNITY COLLEGE

Subject Title	: Computer Networking	**Subject Code**	: CCN2238
Session	: Semester Two, 2014/15	**Time**	: 09:30 – 12:30
Date	: 5 May 2015	**Time Allowed**	: 3 hours
Subject Examiner(s)	: Dr Joseph SO		

This question paper has a total of **SIXTEEN** pages (including this covering page).

Instructions to Candidates:

1. There are THREE sections in this paper.
   Section A (30%) – Multiple-choice Questions. Answer ALL questions in this section on the multiple-choice answer sheet provided. Each question carries 1 mark.
   Section B (40%) – Short Questions. Answer any FIVE out of the SIX questions from this section in the answer book provided. Each question carries 8 marks.
   Section C (30%) – Long Questions. Answer any TWO out of the THREE questions from this section in the answer book provided. Each question carries 15 marks.
2. Appendix 1 shows the list of selected well - known TCP and UDP port numbers.
3. Unless specified in a question, you may assume 1k = 10^3 and 1M = 10^6.
4. Candidates are required to pay special attention to neatness and clarity of expression in their answers. Marks will be deducted for untidy work.

Authorised Materials:

	YES	NO
CALCULATOR	[✓]	[ ]
SPECIFICALLY PERMITTED ITEMS	[ ]	[✓]

DO NOT TURN OVER THE PAGE UNTIL YOU ARE TOLD TO DO SO

Section B (40%) – Short Questions

Answer any FIVE out of the SIX questions from this section in the answer book provided. Each question carries 8 marks.

Question B1

(a) Explain briefly how the piggybacking techniques improve the link utilization in sliding window ARQ protocols. (2 marks)

(b) HDLC uses bit stuffing to achieve data transparency. Assume messages in HDLC contain frame delimiters and data only. If the original data is 0110 1011 1111 1111 0110 0111 111, what is the message to be transmitted? (2 marks)

(c) For a circuit with a signal power of 4 W and a thermal noise power of 18 mW, determine SNR_{dB}. (2 marks)

(d) For a telephone circuit with a signal-to-noise ratio of 12 dB in power and a bandwidth of 5 kHz, what is the Shannon limit of information bit rate? (2 marks)

Question B2

Two stations are sending messages to each other through a dedicated channel in stop-and-wait mode with piggybacking. Both stations have messages of length of 864000 bytes to send out and the processing delay of 40ms. It is known that the channel has the propagation delay of 15ms and the bandwidth of 500kbps. The frame format is defined in Figure B.2:

Flag $(01111110)_2$	Header and ACK <4 bytes>	Data <80 bytes>	Flag $(01111110)_2$

Figure B.2

Assuming that all frames transmitted are received properly, find the time required for both stations to receive the entire messages sent out by another station. (8 marks)

Question B3

There are three stations A, B, and C in a bus network adopting the 1-persistent CSMA / CD protocol. The data packets may have different lengths in term of transmission time. When the channel is sensed to be busy or when a packet is collided, the same fixed back-off time will be used for a particular station. However the back-off times of individual stations are different and are indicated as below. Suppose 6 data packets indicated below are ready to be transmitted.

Station	Packet ID	Packet Length	Ready time (at)	Backoff Time
A	A1	5 minutes	4:00 pm	5 minutes
B	B1	5 minutes	4:02 pm	9 minutes
C	C1	5 minutes	4:03 pm	7 minutes
A	A2	10 minutes	4:06 pm	5 minutes
B	B2	3 minutes	4:07 pm	9 minutes
A	A3	7 minutes	4:18 pm	5 minutes

Assume the propagation delay is negligible and the source station can receive the acknowledgement from the destination station immediately after the packet transmission and it takes 1 minute to detect the occurrence of a collision. One station will attempt sending a new packet only after the previous packet is successful received for 1 minute.

(a) Between 4:00 pm and 4:30 pm, how many times will packet collisions occur? You should write down which packets are collided at what time. (3 marks)

(b) At what time will packets A1, A2, A3, B2 and C1 successfully finish their transmissions? You should write down individual finish time for each packet. (5 marks)

Question B4

The following is the first parts of the content (including the header) of two IP packets in hexadecimal format received in a station:

PACKET 1: `4400 0104 D003 0A00 0B08 453B ...`
PACKET 2: `4800 0208 2304 0A00 0B08 475C ...`

Figure B.4 shows the conceptual diagram of an IP format and it may not be in scale of the field length.

(a) It is known that one of the packets is corrupted. Which one? Why? (2 marks)

(b) For the one not corrupted,

(i) What is the header size? (1 mark)

(ii) Are there any options in the packet header? (1 mark)

(iii) What is the size of the data? (1 mark)

(iv) Is the packet fragmented? (1 mark)

(v) How many more routers can the packet travel to? (1 mark)

(vi) What is the identification number of the packet? (1 mark)

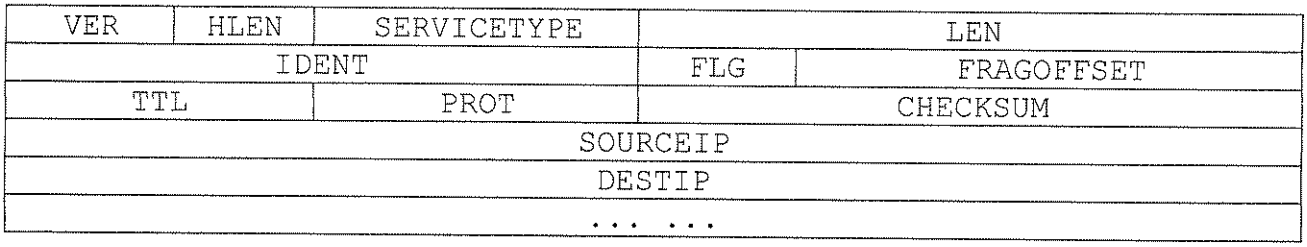


Figure B.4 Conceptual Diagram of an IP Format

Question B5

The following is the first part of the content (including the header) of a TCP segment in hexadecimal format

```
3DB8 027C 5634 0103 0450 2A45 914F 3C32 5294 9D52 329D .....
```

(a) What is the source port number in decimal number? (1 mark)

(b) What is the destination port number in decimal number? (1 mark)

(c) What is the length of the header in decimal number? (1 mark)

(d) What is the sequence number in hexadecimal number of the latest byte of data that the sender has successfully received? (1 mark)

(e) Is the packet directed from a client to a server or vice versa? (1 mark)

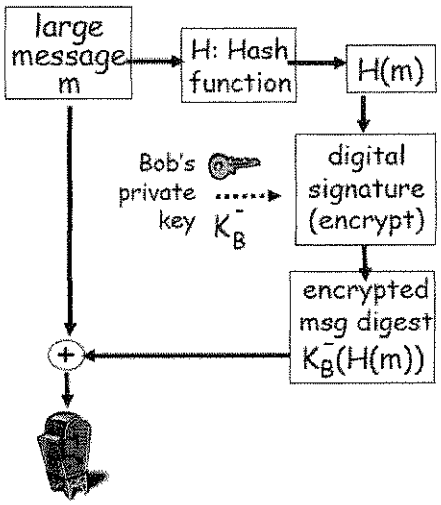
(f) What is the application-layer protocol? (1 mark)

(g) Briefly describe the Three-way handshaking in the TCP connection establishment. (2 marks)

Question B6

(a) What is a message digest? Explain the main reason why message digests are used in digital signature applications. (3 marks)

(b) Suppose the user Bob wants to sign a message m in a public-key encryption system. Below is a diagram showing the main steps in forming the digital signature using a message digest.



Draw a diagram in a similar format to show the main steps of verifying the digital signature at the receiving side. (5 marks)

- End of Section B -

Section C (30%) – Long Questions

Answer any TWO out of the THREE questions from this section in the answer book provided. Each question carries 15 marks.

Question C1

A transmission system uses an encoding scheme to send video signal. It encodes a pixel colour into 12-bit codeword. The video is captured in 24 frames per second with resolution of 768 x 512. Each colour (red, green and blue) has the signal strength from 0 to 6V and is converted linearly into a 4-bit binary number by rounding down (For example, 1μV is represented by 0000). In the codeword, from leftmost to rightmost, bit 0 to bit 3 is a binary value representing the intensity of red, bit 4 to bit 7 is a binary value representing the intensity of green, and bit 8 to bit 11 is a binary value representing the intensity of blue, where bit 0 is the leftmost bit. The system uses a CRC for bit error detection. The CRC generator polynomial is X^4+X^2+X+1.

(a) A sender is sending a codeword of 1110 1010 0110 to a receiver. What is the message being sent? (5 marks)

(b) The receiver gets a message of 1011 0110 0101 1101. Show with steps whether this message is regarded as an error free message? (3 marks)

(c) The receiver gets another message of 1011 1010 1100 1001. What is the strength of the signal for blue? (3 marks)

(d) What is the bit rate required in the transmission link? (2 marks)

(e) Comment on whether the video be suitable for transmitting in the mobile network. (2 marks)

Question C2

A sender, A, wants to send an IP datagram to a receiver D as shown in Figure C.2. The link from A to router has an MTU of 1700 bytes. The receiver is connected to the router in the Ethernet LAN. The length of the original datagram (including the header) is 5080 bytes. Suppose this datagram is stamped with the identification number (ID) 355 and there is no optional information in the header.

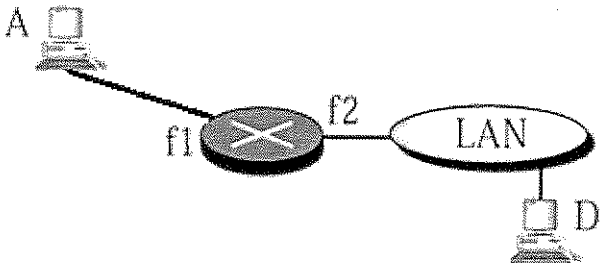


Figure C.2

(a) Derive the number of fragments needed in sending the datagram through the link from A towards f1. (3 marks)

(b) What are the values of ID, Flag (the M-bit) and Fragment Offset in the corresponding headers of the first, second and the last fragments in (a)? (5 marks)

(c) Derive the number of fragments needed in sending the datagram through the link from f2 to D. (4 marks)

(d) What are the values of Fragment Offset in the IP and size of the Ethernet frames in the corresponding headers of the first, second and the last fragments? (3 marks)

Question C3

(a) A company is granted a block of addresses with an address of 124.135.67.15/21. The organization needs to have 4 subblocks of addresses to use in its four subnets: one subblock of 12 addresses, two subblocks of 50 addresses, and one subblock of 220 addresses. Design the subblocks and determine the first address, and the last address of each subblock. (9 marks)

(b) In TCP, the round trip time is estimated by the following formula:

$$\texttt{EstimatedRTT} = (1- \alpha) * \texttt{EstimatedRTT} + \alpha * \texttt{SampleRTT}$$

Consider a host is sending TCP segments. Suppose now α = 0.25 and the values of `EstimatedRTT` and `SampleRTT` at 4:20:00 pm are 14 seconds and 18 seconds respectively. The host sends a segment at 4:20:00 pm and receives its corresponding ACK at 4:20:32 pm. The host then sends another segment at 4:20:38 pm and receives its corresponding ACK at 4:20:55 pm. What are the updated values of `EstimatedRTT` after re-computation at 4:20:32 pm and 4:20:55 pm respectively? (6 marks)

- End of Section C -

Appendix 1: List of selected well-known TCP and UDP port numbers

Port in Decimal	TCP or UDP	Service or Protocol Name	RFC
7	TCP/UDP	Echo	792
20	TCP	File Transport Protocol (FTP)	959
21	TCP	FTP control	959
22	TCP	Secure Shell (SSH)	4253
23	TCP	Telnet	854
25	TCP	Simple Mail Transfer Protocol (SMTP)	5321
53	TCP/UDP	Domain Name System (DNS)	1034
67	UDP	Bootstrap Protocol Server (BootP, bootps)	951
68	UDP	Bootstrap Protocol Client (bootpc)	951
69	UDP	Trivial File Transfer Protocol (TFTP)	1350
79	TCP	Finger	1288
80	TCP	Hypertext Transfer Protocol (HTTP)	2616
88	TCP	Kerberos	4120
106	TCP	Password Server(Unregistered Use)	-
110	TCP	Post Office Protocol (POP3) Authenticated Post Office Protocol (APOP)	1939
115	TCP	Simple File Transfer Protocol (SFTP)	913
119	TCP	Network News Transfer Protocol (NNTP)	3977
123	TCP/UDP	Network Time Protocol (NTP)	1305
137	UDP	Windows Internet Naming Service (WINS)	-
143	TCP	Internet Message Access Protocol (IMAP)	3501
161	UDP	Simple Network Management Protocol (SNMP)	1157
192	UDP	OSU Network Monitoring System	-
311	TCP	Secure server administration	-
427	TCP/UDP	Service Location Protocol (SLP)	2608
443	TCP	Secure Sockets Layer (SSL, or "HTTPS")	2818
445	TCP	Microsoft SMB Domain Server	-
464	TCP/UDP	kpasswd	3244
500	UDP	ISAKMP/IKE	2408
514	TCP	shell	-
514	UDP	Syslog	-
548	TCP	Apple Filing Protocol (AFP) over TCP	-
554	TCP/UDP	Real Time Streaming Protocol (RTSP)	2326
587	TCP	Message Submission for Mail (Authenticated SMTP)	4409
600-1023	TCP/UDP	Mac OS X RPC-based services	-
626	TCP	AppleShare Imap Admin (ASIA)	-
626	UDP	serialnumberd (Unregistered Use)	-
631	TCP	Internet Printing Protocol (IPP)	2910
636	TCP	Secure LDAP	-
660	TCP	Server administration	-
687	TCP	Server administration	-
749	TCP/UDP	Kerberos 5 admin/changepw	-
985	TCP	NetInfo Static Port	-
1085	TCP/UDP	WebObjects	-
1099 & 8043	TCP	Remote RMI and IIOP Acess to JBOSS	-

- END OF PAPER -