THE HONG KONG POLYTECHNIC UNIVERSITY
HONG KONG COMMUNITY COLLEGE

Subject Title	: Computer Networking	**Subject Code**	: CCN2238
Session	: Semester Two, 2016/17	**Time**	: 14:00 – 17:00
Date	: 11 May 2017	**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. Select the most appropriate option for each question. 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. If you answer more than five questions, only the first five attempted questions will be marked. Indicate in your answer book clearly which five questions you are attempting.
   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. If you answer more than two questions, only the first two attempted questions will be marked. Indicate in your answer book clearly which two questions you are attempting.
2. Appendix 1 shows the list of selected well-known TCP and UDP port numbers.
   Appendix 2 shows the 7-bit ASCII Table.
   Appendix 3 shows the list of selected well-known formulae and conceptual diagram of some protocols (Not in scale).
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.
5. Electronic calculators, including programmable calculators, may be used provided that the calculators are battery powered, silent in operation, with neither printout nor graphic / word display facilities and do not use dot-matrix technology in the main display. All programmes stored in the calculator should have been cleared. Other electronic devices with graphic / word-display facilities (such as databank watches) are not permitted.

Authorised Materials:

	YES	NO
CALCULATOR	[✓]	[ ]
(All programmes stored should be cleared.)		
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. If you answer more than five questions, only the first five attempted questions will be marked. Indicate in your answer book clearly which five questions you are attempting.

Question B1

A system transmits data between two sites. Each character is stored as a 7-bit ASCII (the conversion table is shown in Appendix 2.). At the end of the resulting 14-bit data, the system adds a FCS using a polynomial generator $x^4 + x^3 + 1$. The first sent bit in an ASCII code is the leftmost bit.

(a) The sender sends the word "PC" in a transmission system.

(i) Find the CRC. (4 marks)

(ii) What is the final bit stream? (1 mark)

(b) The receiver now receives a bitstream 1001 0001 0101 11 0001. Is the bitstream regarded as a correct message? If no, why? If yes, what are the original characters? (3 marks)

Question B2

(a) Kanny is using his email cilent on his mobile phone sending an email to Corel. Explain the interaction of the UA and the mail server in the sending process. (3 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
1111 1101 1111 1111 0110 0111 110, what is the message to be transmitted? (2 marks)

(c) In a transmission system, the signal power is 3.5 W and its bandwidth is 108 kHz. It is measured that the noise power is 24 mW

(i) Determine SNR_{dB}. (1 mark)

(ii) What is the Shannon limit of information bit rate? (2 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 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	11:00 pm	5 minutes
B	B1	6 minutes	11:03 pm	8 minutes
C	C1	5 minutes	11:04 pm	6 minutes
A	A2	8 minutes	11:14 pm	5 minutes
B	B2	3 minutes	11:28 pm	8 minutes
C	C2	7 minutes	11:24 pm	6 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 of this station is successfully received for 1 minute.

(a) Between 11:00 pm and 11:25 pm, how many times will packet collisions occur? You should write down which packets are collided at what time. (4 marks)

(b) At what time will packets A1, A2, B1 and B2 successfully finish their transmissions? You should write down individual finish time for each packet. (4 marks)

Question B4

Two given end nodes in a network are separated by 4 links and the propagation delay per link is 0.01 second. The call setup time between the two nodes is 1.5 second and the data rate is 160 kbps on all links. For datagram operation, the packet size is fixed 2048 bits which includes the length of the packet header of 40 bits, and Stop-and-wait operation is used among the nodes with the size of an acknowledgement being negligible, and a node will send the next packet immediately when an acknowledgement is received and it will send a packet to the next node immediately when a packet is received completely. There is no nodal processing delay, no data loss, negligible teardown time and no other data traffic.

Calculate the end-to-end delay of transmitting a message of 200 kbits

(a) if the network adopts circuit switching. (3 marks)

(b) if the network adopts datagram packet switching. (5 marks)

Question B5

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

```
0077 45BE 4B20 1436 0012 A985 814F C02F 99E4 D2D3 91DA .....
```

(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) Suggest what type of service is not suitable to use TCP and what transport protocol should be used for this type of service. (2 marks)

Question B6

David and Sarah are communicating with public key system.

(a) Describe how the message confidentiality can be implemented when David sends an email to Sarah. (3 marks)

(b) Describe how the message authenticity can be both implemented when Sarah replies an email to David. (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. If you answer more than two questions, only the first two attempted questions will be marked. Indicate in your answer book clearly which two questions you are attempting.

Question C1

A network system has the limit in the end-to-end length of 3000 km and propagation speed is 2×10^8m/s. The initial sequence number for both the sender and the receiver is 0. The data rate of the network is 500 kbps. The timeout period is the 3 times of the longest propagation time of the network. The frame size is fixed to be 800 bits. The size of headers and trailer and the size of acknowledgement can be negligible.

(a) What is the timeout period of the network? (3 marks)

(b) Two stations are using Stop-and-wait algorithm. A station, P, is sending a message of 8000 bits to another station R. and the distance between them is 500km. It is noted that the third frame is lost. The retransmission and the other frames are successfully received.

What is the total delay when P can be confirmed that the whole message is received? (7 marks)

(c) Suppose that a GBN ARQ is used where the window size=4. Show, by example, that at least 3-bit sequence number is needed. (5 marks)

Question C2

As shown in Figure 1, the four routers (RA, RB, RC and RD) in a network are connected by links with MTU of 2400 bytes in each link.

A sender, A, wants to send an IP datagram to a receiver D. The link from A to router RB has an MTU of 2000 bytes. The receiver is connected to the router in the Ethernet LAN. The length of the original datagram (including the header) is 9200 bytes. Suppose this datagram is stamped with the identification number (ID) 532 and there is no optional information in the header.

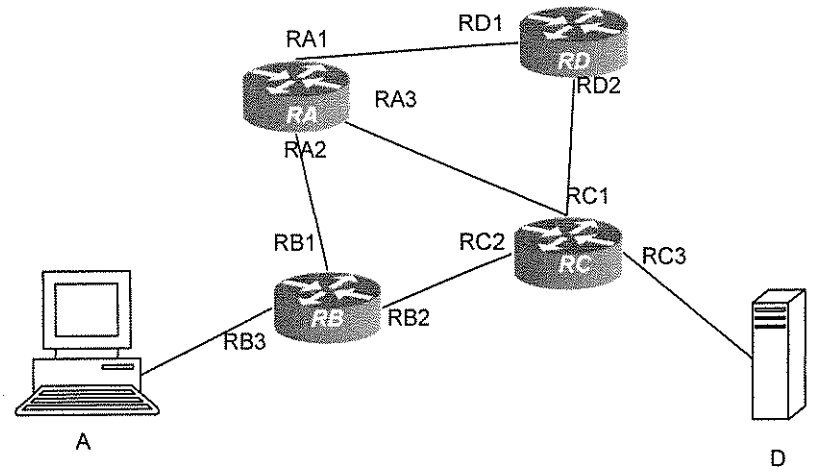

Figure 1

(a) Derive the number of fragments needed in sending the datagram through the link from A towards RB3. (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 RC3 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 117.151.71.15/23. The organization needs to have 4 subblocks of addresses to use in its four subnets: one subblock of 20 addresses, one subblock of 60 addresses, and one subblock of 230 addresses. Design the subblocks and determine the first address, and the last address of each subblock.
(9 marks)

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

```
4700 04C8 4D9E 0A00 0D08 475C ...
```

(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 payload? (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)

- 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	-

Appendix 2: 7-bit ASCII Table

Decimal	Octal	Hex	Binary	Value	
048	060	030	0110000	0	
049	061	031	0110001	1	
050	062	032	0110010	2	
051	063	033	0110011	3	
052	064	034	0110100	4	
053	065	035	0110101	5	
054	066	036	0110110	6	
055	067	037	0110111	7	
056	070	038	0111000	8	
057	071	039	0111001	9	
058	072	03A	0111010	:	(colon)
059	073	03B	0111011	;	(semi-colon)
060	074	03C	0111100	<	(less than)
061	075	03D	0111101	=	(equal sign)
062	076	03E	0111110	>	(greater than)
063	077	03F	0111111	?	(question mark)
064	100	040	1000000	@	(AT symbol)
065	101	041	1000001	A	
066	102	042	1000010	B	
067	103	043	1000011	C	
068	104	044	1000100	D	
069	105	045	1000101	E	
070	106	046	1000110	F	
071	107	047	1000111	G	
072	110	048	1001000	H	
073	111	049	1001001	I	
074	112	04A	1001010	J	
075	113	04B	1001011	K	
076	114	04C	1001100	L	
077	115	04D	1001101	M	
078	116	04E	1001110	N	
079	117	04F	1001111	O	
080	120	050	1010000	P	
081	121	051	1010001	Q	
082	122	052	1010010	R	
083	123	053	1010011	S	
084	124	054	1010100	T	
085	125	055	1010101	U	
086	126	056	1010110	V	
087	127	057	1010111	W	
088	130	058	1011000	X	
089	131	059	1011001	Y	
090	132	05A	1011010	Z	
091	133	05B	1011011	[	
092	134	05C	1011100	\	(back slash)
093	135	05D	1011101	]	
094	136	05E	1011110	^	
095	137	05F	1011111	_	(underscore)
096	140	060	1100000	`	

Decimal	Octal	Hex	Binary	Value
097	141	061	1100001	a
098	142	062	1100010	b
099	143	063	1100011	c
100	144	064	1100100	d
101	145	065	1100101	e
102	146	066	1100110	f
103	147	067	1100111	g
104	150	068	1101000	h
105	151	069	1101001	i
106	152	06A	1101010	j
107	153	06B	1101011	k
108	154	06C	1101100	l
109	155	06D	1101101	m
110	156	06E	1101110	n
111	157	06F	1101111	o
112	160	070	1110000	p
113	161	071	1110001	q
114	162	072	1110010	r
115	163	073	1110011	s
116	164	074	1110100	t
117	165	075	1110101	u
118	166	076	1110110	v
119	167	077	1110111	w
120	170	078	1111000	x
121	171	079	1111001	y
122	172	07A	1111010	z

Appendix 3

Nyquist Bit Rate

$$\text{BitRate} = 2 \times \text{BW} \times \log_2 L$$

Shannon Capacity

$$C = B \log_2 (1 + \text{SNR})$$

Signal-to-noise due to quantitation

$$\text{SNR}_{\text{dB}} = 6.02 n_b + 1.76 \text{ dB}$$

Conceptual Diagram of an IP Format

VER	HLEN	SERVICETYPE	LEN
IDENT		FLG	FRAGOFFSET
TTL	PROT	CHECKSUM	
SOURCEIP			
DESTIP			
... ...			

Conceptual Diagram of an UDP Format

SOURCEPORT	DESTPORT
LEN	CHECKSUM
... ...	

Conceptual Diagram of an TCP Format

SOURCEPORT			DESTPORT
SEQNO			
ACKNO			
HLEN	RESERVED	FLAGS	WINSIZE
CHECKSUM			URGPT
... ...			

- END OF PAPER -