THE HONG KONG POLYTECHNIC UNIVERSITY
HONG KONG COMMUNITY COLLEGE

Subject Title	: Computer Networking	**Subject Code**	: CCN2238
Session	: Semester Two, 2017/18	**Time**	: 14:00 – 17:00
Date	: 13 May 2018	**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 in 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 in 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 in 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 signal containing components: one 5 kHz with maximum amplitude of 5 V, one 10 kHz with maximum amplitude of 3 V and one 25 kHz with maximum amplitude of 6 V with phase of 90^{o}.

(a) Sketch the frequency domain graph. (2 marks)

(b) What is the bandwidth of the signal? (2 marks)

(c) What is the minimum sampling frequency is needed to capture the signal? (2 marks)

(d) What is the signal distortion and what is the main cause? (2 marks)

Question B2

In a wide area network the stations are partially connected by point-to-point links and the data rate is 5120 bps on all links. Data are transmitted via intermediate nodes. The network uses store-and-forward datagram packet switching.

There are two stations P and Q which are 5 links apart and the propagation delay per link is 0.3 second. The packet size is fixed at 1024 bits and this size includes the length of the packet header of 48 bits. Assume there is no nodal processing delay and only one message is to be transmitted in the network. No acknowledgement is needed as it is handled by upper layers.

A 7500-bit message is sent from P to Q. Calculate the time needed for the transmission.
(8 marks)

Question B3

There are three stations P, Q and R in a bus network adopting 1-persistent CSMA protocol. When a packet is collided, the backoff time of station P, Q and R will always be 4 minutes, 6 minutes and 9 minutes respectively.

Suppose each station has some packets to be sent as the following

- Packets p_1 (length = 6 minutes) and p_2 (length = 3 minutes) of station P are ready to be sent at 2:06 pm and 2:19 pm respectively.
- Packets q_1 (length = 5 minutes) and q_2 (length = 4 minutes) of station Q are ready to be sent at 2:07 pm and 2:41 pm respectively;
- Packets r_1 (length = 5 minutes) and r_2 (length = 7 minutes) of station R are ready to be sent at 2:01 pm and 2:09 pm respectively.

Assume the propagation delay is negligible and the source station can receive the acknowledgement from the destination station immediately after the packet transmission. One station will attempt sending a new packet only after the previous packet of this station is successfully received for 1 minute.

(a) Between 2:00 pm and 2:15 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 p_1, q_2, r_1 and r_2 successfully finish their transmissions? You should write down individual finish time for each packet. (4 marks)

Question B4

(a) What is the key difference of feedback error control and forward error control in data links? (2 marks)

(b) Why is feedback error control used more frequently than forward error control? In what situation should forward error control be used? (3 marks)

(c) In a transmission system with noise power of 3.4 mW, the average signal power is 4.2 W and its bandwidth is 30 MHz.

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

(ii) What is the Shannon limit of information bit rate? (2 marks)

Question B5

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

D4B0 0073 00A8 0203 0110 2324 8921 .....

(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 total length of the user datagram in decimal number? (1 mark)

(d) What is the length of the data in decimal number? (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 UDP and what transport protocol should be used for this type of service. (2 marks)

Question B6

(a) Given the classful IP address 158.218.210.152, find the following information of the network.

(i) the class (1 mark)

(ii) the network mask (1 mark)

(iii) the network address (1 mark)

(iv) the broadcast address (1 mark)

(b) Given the classless IP address 195.234.132.34/28, find the network address and the broadcast address of the network. Explain how to derive your answer. (4 marks)

- End of Section B -

Section C (30%) – Long Questions

Answer any TWO out of the THREE questions in 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 transmission system is designed to encode and send video signal. It encodes a pixel colour into 12-bit codeword. Each colour (red, green and blue) has the signal strength from 0 to 4V 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.

(a) The system uses a CRC for bit error detection. The CRC generator polynomial is X^4+X^3+1.

(i) A sender is sending a codeword of 1011 0110 1110 to a receiver. What is the final bit stream being sent? (5 marks)

(ii) The receiver gets a bit stream of 0111 0101 1011 1101. Show with steps whether this message is regarded as an error free message. (3 marks)

(iii) The receiver gets another message, in which the first 12 bits are 1011 1010 1100. What is the strength of the signal for green? (3 marks)

(b) The following block of data units is to be sent over a line using two dimensional even parity check. Each data block consists of 12 bits and 1 parity bit added at the end of each block. The fifth block consists of the parity bits for the previous 4 blocks.

A sender is sending a set of codewords of 1110 1010 0110, 1001 0010 0011, 0001 0110 1001 and 0110 1010 0110, to a receiver. What is the final bit stream being sent? (2 marks)

(c) Comment on the efficiency of the use of error detection methods in the two above mentioned mechinism. (2 marks)

Question C2

A system uses the Stop-and-Wait ARQ Protocol. The protocol has a time-out of 80 ms. Each packet carries 1600 bits of data. The distance between the sender and receiver is 600 km and the propagation speed is 2×10^8 ms^{-1}. The channel data rate is 800 kbps and the processing time at the receiver is 4 ms per packet. The overhead due to the header and trailer and ACK transmission time are ignored. The sender will send the next packet once the ACK is received.

(a) Assume that no data or control frame is lost or damaged, how long does it take to send 3.2 M bits of data? (6 marks)

(b) It is known that for every 4 packet, there will be a packet loss and all resent packets are successfully received. No control frame is lost or damaged. How long does it take to transmit 4.8 M bits? (7 marks)

(c) Explain how GBN can improve the system performance. (2 marks)

Question C3

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

```
4700 04B3 4D91 2080 0B08 475C C82D 2341 A24C 0D03 ...
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(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)

(vii) How many bytes of data were already sent before this packet? (2 marks)

(b) It is known that the addresses are classful,

(i) What is the class of the destination address? (1 marks)

(ii) What is the IP address of the destination in dotted decimal number? (1 marks)

(iii) What are the network mask and the network address of the destination in dotted decimal number? (2 marks)

(c) This IP network is providing an unreliable, connectionless datagram best-effort delivery service. What are its main characteristics? (3 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	-

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 ratio due to quantitation

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

Conceptual Diagram of an IP Packet Format

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

Conceptual Diagram of an UDP Segment Format

SOURCEPORT	DESTPORT
LEN	CHECKSUM
... ...	

Conceptual Diagram of an TCP Segment Format

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

- END OF PAPER -