

# THE UNIVERSITY OF AUCKLAND

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**SECOND SEMESTER, 2016**  
**Campus: City**

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## COMPUTER SCIENCE

### Modern Data Communications

**(Time allowed: TWO hours)**

**NOTE:**

- Compare the exam version number on the Teleform answer sheet supplied with the version number above. If they do not match, ask the exam supervisor for a new sheet.
- Enter your name and student ID on the Teleform sheet. Your name should be entered left aligned. If your name is longer than the number of boxes provided, truncate it.
- Answer ALL multiple-choice questions on the Teleform sheet; all questions have equal mark value.
- This exam is marked out of 40 marks and counts for 70% of your final grade.
- Use a dark pencil to mark your answers in the multiple choice answer boxes on the Teleform sheet. Check that the question number on the sheet corresponds to the question number in this question/answer book. If you spoil your sheet, ask the supervisor for a replacement.
- Each question is expected to have exactly 1 (one) correct answer. If you believe that a question has either NO or MULTIPLE correct answers, select the ONE you believe is most likely to be the intended answer.
- Keep your question book (this exam script). Writing on the question book will not be marked.
- Use of calculators is NOT permitted.
- Good luck!

1. Match measurement tasks (M1, M2, M3 and M4) with measurement approaches (Active and Passive):

Measurement Task	Description
M1	Delay of a network path
M2	Capacity of an end-to-end path
M3	Number of packets and bytes traversing a link
M4	BGP protocol exchange

Choose the correct option.

- A. M1: Active or Passive, M2: Active only, M3: Passive only, M4: Passive only  
 B. M1: Active only, M2: Active only, M3: Passive only, M4: Active only  
 C. M1: Passive only, M2: Active or Passive, M3: Active or Passive, M4: Active or Passive  
 D. M1: Passive only, M2: Passive only, M3: Active only, M4: Active only  
 E. M1: Active only, M2: Active or Passive, M3: Active or Passive, M4: Passive only

2. Which of the following statement(s) is (are) true about client-side Web measurement (page tagging)?

X: Client-side Web measurement is able to record page errors.

Y: Client-side Web measurement can track Web pages, but cannot record hits to the individual resources (e.g., images, documents) that are linked or embedded in the pages.

Z: Client-side Web measurement can measure the traffic volume to a site.

- A. Y and Z only  
 B. All of X, Y, Z  
 C. Y only  
 D. X and Y only  
 E. X only

3. Consider the minimum time for P2P file distribution as discussed in class. Suppose the upload rate of the server is 10 Megabits per second (Mb/s), the upload rate of each peer is 1 Mb/s, and the download rate of each peer is 10 Mb/s. There are 50 peers, and the size of the file to be distributed is 50 Mb. What is the minimum distribution time (i.e., the minimum time it takes to get a copy of the file to all 50 peers)?

- A. Approximately 38 seconds  
 B. Approximately 8 seconds  
 C. Approximately 42 seconds  
 D. Approximately 17 minutes  
 E. Approximately 12 seconds

4. Consider the following statements about BitTorrent:

X: A peer will give priority to neighbours that are supplying data to the peer at the highest rate.

Y: Every 30 seconds, a peer randomly picks one additional neighbour and sends chunks to that neighbour. This neighbour is referred to as being *optimistically unchoked*.

Z: Except for the five *unchoked* neighbours and the one *optimistically unchoked* neighbour, all other neighbours are *choked* and do not receive any chunks from the peer.

Which option is true?

- A. Y and Z only
- B. Y only
- C. All of X, Y, Z
- D. X only
- E. X and Y only

5. Consider the following POP3 session using Telnet between client and server:

```
S: +OK POP3 server ready <aa@aaa.com>
C: APOP aa
S: +OK aa's mailbox has 2 messages
C: STAT
S: +OK 2 320
C: LIST
S: +OK 2 messages
S: 1 120
S: 2 200
S: .
C: RETR 1
S: +OK 120 octets
S:
S: .
C: DELE 1
S: +OK message 1 deleted
C: Client abruptly ends the session by closing the Telnet terminal
```

Which of the following statement(s) is (are) true?

X: There are two messages in the mailbox.

Y: The user will not be able to retrieve message 1 next time user connects to the mail server.

Z: The server can respond with a +OK and -ERR response to commands issued by the client.

- A. X only
- B. X and Y only
- C. All of X, Y, Z
- D. X and Z only
- E. Y only

6. Given an alphabet with letters E, X, A, M, and S and the probabilities  $E=0.13$ ,  $S=0.09$ ,  $A=0.08$ ,  $M=0.03$  and  $X=0.01$ , derive the associated Huffman code.

Note: we always assign the respective (*higher-weight*) child node or subtree to the 0 branch in a Huffman Tree.

- A. E=1, X=001, A=000, M=0001, S=0000
- B. E=1, X=0010, A=000, M=10, S=01
- C. E=1, X=0011, A=01, M=0010, S=000
- D. E=0, X=0010, A=000, M=0001, S=0011
- E. E=1, X=0011, A=000, M=0010, S=01

7. Which of the following is NOT a BGP (Border Gateway Protocol) message type?

- A. OPEN
- B. KEEPALIVE
- C. NOTIFICATION
- D. DELETE
- E. UPDATE

8. Consider the following statements about active and passive measurements:  
X: Active measurement may overload the network.  
Y: Passive measurements are ideal when tapping traffic is not possible.  
Z: Active measurements refer to measurements based on observing existing traffic.  
Which option is true?

- A. Y and Z only
- B. X only
- C. Y only
- D. All of X, Y, Z
- E. X and Y only

9. A 16-QAM constellation diagram whose constellation points are in a quadratic 4x4 array arrangement (as shown in the lecture slides) has:

- A. 4 amplitude levels and 4 possible phase angles
- B. 16 possible amplitudes
- C. 4 amplitude levels and 4 frequencies
- D. 3 amplitude levels and 12 possible phase angles
- E. 4 power levels and 4 phase levels

10. If the signal-to-noise ratio at the receiver of a digital radio link with bandwidth  $B$  Hz rises from 92 dB to 101 dB, approximately by which amount does the theoretical channel capacity rise?

- A. By  $3B$  bits/s
- B. By a factor of 8
- C. By  $8B$  bits/s
- D. By a factor of 9
- E. By a factor of 3

11. Which of the following is the proper definition of a signals bandwidth?

- A. The difference between the highest and the lowest frequency component in the signal
- B. The time it takes for the signal to reach the receiver
- C. The maximum distance between two constellation points
- D. The number of bits that the signal communicates per second
- E. The width of the white space between constellation points

12. A power ratio of 62 dB corresponds to a voltage ratio of... ?

- A. 124 dB
- B. 65 dB
- C. 68 dB
- D. 56 dB
- E. 62 dB

13. Which of the following sequences could be Manchester-coded (where H stands for “high level” and L for “low level”)? You may assume that the sequence starts at the beginning of a bit.

- A. HLLHHLHLHL
- B. LHLLHLLHL
- C. HLLHLHHHLH
- D. HLHLHLHHHL
- E. LLHLLHLHHL

14. You receive a Hamming-encoded codeword with 8 data bits  $m_1$  to  $m_8$  and 4 parity bits  $p_1$  to  $p_4$ . The parity check matrix is:

	$m_1$	$m_2$	$m_3$	$m_4$	$m_5$	$m_6$	$m_7$	$m_8$
$p_1$	1	1	0	1	1	0	1	0
$p_2$	1	0	1	1	0	1	1	0
$p_3$	0	1	1	1	0	0	0	1
$p_4$	0	0	0	0	1	1	1	1

After computing your own parity checks on the received codeword, you find that your values for  $p_2$  and  $p_4$  differ from those in the codeword you received. Which bit is in error with the highest probability?

- A.  $m_6$
- B.  $m_5$
- C.  $p_4$
- D.  $p_2$
- E. There is more than one bit error in the codeword, and it is not possible to tell which bits are affected.

15. Which of the following statements is FALSE?

- A. A fibre cable has at least one pair of individual fibres, and may have many more fibre pairs
- B. Light can travel in a fibre for 40 km or more without repeaters
- C. Signals propagate faster in fibre cables than they do in copper cables
- D. An individual fibre has an inner core and an outer core; light travels faster in the outer core
- E. A fibre can carry many signals if each signal is carried by light of a different wavelength

16. Given even parity on 1-bits, which of the following sequences of 8 data bits and 1 parity bit is in error?

- A. 110100010
- B. 000100010
- C. 101110011
- D. 011100011
- E. 111001110

17. Which of the following statement is FALSE about TCP?

- A. TCP is connection-oriented
- B. TCP provides in-order delivery
- C. TCP implements flow control
- D. TCP implements congestion control
- E. TCP lacks error detection

18. What is FALSE about SDN (Software Defined Networking)?

- A. SDN can be configured programmatically
- B. SDN is vendor-independent
- C. SDN has no security issues
- D. SDN enables central management
- E. SDN is based on open standards

19. Which of the following statement(s) is (are) true about DASH?

X: Server-side scalability is improved due to client keeping intelligence about which video chunk to request.

Y: The manifest file contains all the URLs corresponding to the different video qualities encoded at various bit rates.

Z: Video chunks are requested using HTTP byte-range header.

- A. X and Y only
- B. X only
- C. Z only
- D. All of X, Y, Z
- E. X and Z only

20. Which of the following statement(s) is (are) true about SMTP?

X: SMTP is an example of a pull protocol.

Y: SMTP requires each message to be in ASCII format.

Z: SMTP places all of the message's objects into one message.

- A. X and Z only
- B. Z only
- C. All of X, Y, Z
- D. X and Y only
- E. Y and Z only

21. Consider the following statements about Internet traffic measurement vantage points:  
X: The measurement vantage point is the point where the measurement host connects to the network.  
Y: Results of measurements are independent of the vantage point.  
Z: An end system connected to the Internet is a good vantage point for launching active measurements of end-to-end paths.  
Which option is true?

- A. Z only
- B. All of X, Y, Z
- C. X and Y only
- D. X only
- E. X and Z only

22. A transmitter radiates a signal whose power is 10 Watts. A distant receiver receives  $1/100,000,000$  of this power, then a receiving antenna increases the signal power by a factor of 20 dB. How much power is delivered to the receiver?

- A. 0.000100 W
- B. 0.000002 W
- C. 0.001000 W
- D. 0.000020 W
- E. 0.000010 W

23. Imagine there are 14 active peers in a P2P network, which are distributed across multiple geographic locations. Each pair of peers has an active (bidirectional) TCP connection. Suppose that each of the TCP connections passes through a total of 6 routers and 10 middleboxes (A middlebox is an intermediary networking device that transforms, inspects, filters, or manipulates traffic, however, it performs no IP routing functions between the source and the destination hosts.). How many edges are there in the corresponding overlay network?

- A. 91
- B. 84
- C. 840
- D. 140
- E. 60



24. Which of the following key exchange method in SSL/TLS does not require a certificate from a Certificate Authority (CA)?

A. RSA  
B. Ephemeral DH  
C. Fixed DH  
D. Anonymous Diffie-Hellman (DH)  
E. All key exchange methods require a certificate from a CA

25. Which of the following approaches can NOT be used to carry many signals over a channel? (The channel's physical media are shown in parentheses for each method).

A. Separate by frequency (radio, fibre and electrical cable)  
B. Separate by power level (radio)  
C. Lay separate cables or fibres (electrical cables)  
D. Separate by mode or color (fibre)  
E. Separate geographically (radio)

26. Which statement is FALSE about IPv6?

A. There is built-in IPSec support in IPv6  
B. In IPv6, a sending host cannot do fragmentation  
C. Checksum field is not included in IPv6 header  
D. In IPv6, header length is fixed  
E. IPv6 supports a chain of headers

27. Consider a circular DHT, where the key and peer identifiers are defined in the same range  $[0, 2^4 - 1]$ . In this circular DHT, each peer only keeps track of its immediate successor and immediate predecessor. The peer identifiers in the circular DHT are as follows: 0001, 0011, 0100, 0101, 1000, 1010, 1100, and 1111. The key 1101 is stored in the DHT. A key is assigned to a peer with an identifier that is the immediate successor of the key. How many messages are sent in the circular DHT, when peer identifier 0100 wants to determine which peer is responsible for key 1101?

A. 10  
B. 8  
C. 5  
D. 7  
E. 12

28. Which of the following statement(s) is (are) true about KaZaA?

X: KaZaA resembles Gnutella in the sense that it does not use a dedicated server for tracking and locating content.

Y: Unlike Gnutella, in KaZaA not all peers are equal, where powerful peers are designated as group leaders.

Z: When a peer launches the KaZaA application, the peer establishes a TCP connection with one of the group leaders.

- A. X only
- B. X and Y only
- C. Y only
- D. X and Z only
- E. All of X, Y, Z

29. Consider the following FTP session:

```
ftp> open ftp.auckland.ac.nz
Connected to ftp.its.auckland.ac.nz.
220 Welcome to UOA FTP service.
Name (ftp.auckland.ac.nz:user): anonymous
331 Please specify the password.
Password:
230 Login successful.
Remote system type is UNIX.
Using binary mode to transfer files.
ftp> debug
Debugging on (debug=1).
ftp> ls
ftp: setsockopt (ignored): Permission denied
---> PORT 130,216,34,40,227,157
200 PORT command successful. Consider using PASV.
---> LIST
150 Here comes the directory listing.
lrwxrwxrwx   1 0      0          18 Mar 05  2010 debian -> linux/dists/debian
drwxr-x---   3 30016  30016      20480 Aug 05  2010 ironport
drwxr-xr-x   3 0      0          4096 Mar 05  2006 linux
drwxr-xr-x   2 0      0          16384 Jan 11  2007 lost+found
dr-xr-xr-x  20 0      0          4096 Jun 13  2010 pub
226 Directory send OK.
ftp> passive
Passive mode on.
ftp> ls
ftp: setsockopt (ignored): Permission denied
---> PASV
227 Entering Passive Mode (130,216,191,48,132,162)
---> LIST
150 Here comes the directory listing.
lrwxrwxrwx   1 0      0          18 Mar 05  2010 debian -> linux/dists/debian
drwxr-x---   3 30016  30016      20480 Aug 05  2010 ironport
drwxr-xr-x   3 0      0          4096 Mar 05  2006 linux
drwxr-xr-x   2 0      0          16384 Jan 11  2007 lost+found
dr-xr-xr-x  20 0      0          4096 Jun 13  2010 pub
226 Directory send OK.
ftp> exit
---> QUIT
221 Goodbye.
```

What is the IP address of the FTP client making the control connection to the FTP server?

- A. 130.216.227.157
- B. 130.216.34.40
- C. 130.216.191.48
- D. 130.216.132.162
- E. Cannot determine from given information

30. Consider the simple model for HTTP streaming as discussed in class. Assume the HTTP video server sends bits at a constant rate of 1 Megabits per second. Let the size of the client application buffer be 1000 Kilobits. The client buffer must have 500 Kilobits buffered before client application can begin playout. Ignore TCP buffers. The video being sent by the server has a frame rate of 30 frames/second. The size of each frame is 100,000 bits. What is the *continuous playout period* of the video stream?

- A. 500 milliseconds
- B. 200 milliseconds
- C. 100 milliseconds
- D. 50 milliseconds
- E. 250 milliseconds

31. Consider the following statements about CDNs:

X: Most CDNs take advantage of DNS to intercept and redirect requests.

Y: The cluster selection strategy using *IP anycast* has the advantage of finding the cluster that is closest to the client rather than the cluster that is closest to the client's local DNS.

Z: The *enter deep* philosophy of CDN server placement involves building large clusters at a small number of key locations and connecting those clusters using a private high-speed network.

Which option is true?

- A. X and Z only
- B. Y and Z only
- C. Z only
- D. X and Y only
- E. All of X, Y, Z

32. Which of the following data links has the lowest latency?

- A. A 320 km coaxial cable
- B. A geostationary satellite link
- C. A 300 km twisted pair cable
- D. A 310 km fibre optic cable
- E. A 350 km microwave radio link

33. Which of the following statement(s) is (are) true about Gnutella?

X: Unlike Napster, Gnutella does not use a centralised server for tracking content in the peers.

Y: In earlier versions of the Gnutella network, all neighbours of a peer would forward a Query message to all their neighbours, which in turn forward the message to all of their neighbours and so on.

Z: If peer A wants to download a file from peer B in the Gnutella network, then peer A issues an HTTP GET request that travels through the overlay network.

- A. Y only
- B. Y and Z only
- C. X and Y only
- D. X only
- E. All of X, Y, Z

34. Imagine we have an IP datagram of size 4000 bytes, but the Maximum Transfer Unit (MTU) is 1500 bytes. Assuming 20-byte IP headers, how many IP fragments will be generated and what will be their offsets (in octet)?

- A. 2 fragments with offsets 0 and 2000
- B. 3 fragments with offsets 0, 1500 and 3000
- C. 2 fragments with offsets 0 and 250
- D. 3 fragments with offsets 0, 185 and 370
- E. Only 1 fragment with offset 0

35. Given the target bit rate of a communication channel, the signal strength at the receiver, and the noise power per unit (Hertz) of bandwidth, which of the following does the Shannon-Hartley capacity theorem let us compute?

- A. The signal-to-noise ratio (SNR)
- B. The theoretical minimum bandwidth required to achieve the target bit rate
- C. The baud rate
- D. The required transmit power
- E. The bit error rate

36. A transmitter sends a bit sequence using NRZ (Non-Return-to-Zero) encoding. If the receiver clock is faster than the transmitter clock, what would you expect?

- A. Bit deletion errors (receiver misses bits)
- B. Bit inversion errors (receiver detects bit values that are the opposite of what was transmitted)
- C. Bit insertion errors (receiver detects additional bits that were not transmitted)
- D. Parity bits might occur
- E. Bit reordering errors (receiver detects bits in different order)

37. If we send the bit sequence ...1010101010... through a coaxial cable, we expect to observe a square wave on the cable's central conductor. Which of the following best explains why we would not see a perfect square wave?

- A. The lowest-frequency component of a square wave is its *fundamental frequency*
- B. The more frequencies our cable can carry, the more bits we can transmit each second
- C. The frequencies of a square wave's components are integer multiples of its fundamental frequency
- D. Any periodic signal can be regarded as the sum of sinusoidal signals
- E. A coaxial cable does not have an infinite bandwidth

38. Each entry in an ARP (Address Resolution Protocol) table includes:

- A. IP address only
- B. TTL only
- C. MAC address only
- D. IP address, MAC (Media Access Control) address and TTL (Time to Live)
- E. IP address and TTL

39. Which security service is NOT provided by IPSec?

- A. Availability
- B. Authentication
- C. Confidentiality
- D. Integrity
- E. Access control

40. Which value should the maximum noise amplitude in 256 QAM not exceed?

- A. 1/256th of the maximum signal amplitude
- B. The noise power
- C. 256 times the bandwidth
- D. 1/16th of the maximum signal amplitude
- E. 16 times the channel capacity

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