THE UNIVERSITY OF AUCKLAND

SECOND SEMESTER, 2015
Campus: City

COMPUTER SCIENCE

Modern Data Communications

(Time allowed: TWO hours)

NOTE:

- Compare the exam version number on the Teleform 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 answer sheet provided.
- 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.
- Answer ALL questions; his exam is marked out of 40 marks and counts for 70% of your final grade.
- 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. When computing the CRC checksum of an Ethernet frame, we perform a modulo-2 division. What do we discard after the division?

   A. The result of the division.
   B. The generator polynomial.
   C. The divisor.
   D. The remainder.
   E. The frame itself.

2. Assume that peer A wants to download a chart-topping song from the Gnutella network. It sends a Query message into the Gnutella network. Which of the following statements is (are) true?
   X: When peer B receives the Query message, it checks to see whether the keyword matches any of the files it is making available for sharing. If there is a match, it sends back a QueryHit message (that includes the file name and file size of the match, among other things) to peer A.
   Y: The QueryHit message from peer B follows the reverse path of the Query message from peer A, thereby using using pre-existing TCP connections in the Gnutella network.
   Z: If peer A chooses to download the file from peer B, peer A will set up a direct TCP connection with peer B and send into the connection an HTTP GET request that includes the specific file name.

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

3. Which of the following statements is (are) true about POP3?
   X: In a POP3 transaction, the client issues commands, and the mail server responds with two possible responses: `+OK` and `-ERR`.
   Y: The mail server deletes a message immediately once the `dele` command is issued by the client.
   Z: POP3 allows users to create remote folders and assign messages to folders.

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

4. How do Ethernet switches learn which port to send packets out through?

   A. Switches build up tables of source MAC addresses for each port from packets arriving on their ports.
   B. Switches build up tables of IP addresses for each port from packets arriving on their ports.
   C. Switches read their forwarding tables from a configuration server on the network.
   D. Switches don't need address tables, they simply forward packets to all their ports.
   E. Switches must be configured 'by hand,' i.e. a new host must be added to a table each time we connect one.

5. Which of the following is NOT needed to implement a Software Defined Network?

   A. Simple packet forwarding hardware in all switches.
   B. A single "Network Operating System" for a whole network.
   C. The Spanning Tree Protocol implemented in each switch to prevent loops.
   D. A single well-defined Application Programming Interface (API) for network-wide Applications.
   E. An Open Interface to forwarding hardware from the network.

6. A radio transmitter using a 1 MHz carrier modulates this carrier with a 100 Hz square wave, i.e., it switches the carrier on and off 100 times per second (amplitude shift keying). If we model the resulting square wave via the Fourier series and include only the fundamental, 3rd and 5th harmonic, what will be the highest frequency component in the resulting spectrum?

   A. 500,000,000 Hz
   B. 1,000,900 Hz
   C. 1 MHz
   D. 999,500 Hz
   E. 1,000,500 Hz

7. Which one of the following measurement locations would most likely provide us with a representative understanding of applications used by the general Internet population?

   A. Tier-1 ISP routers.
   B. Edge routers of Fortune-500 companies.
   C. Using your wireless laptop to sniff packets at several WiFi hotspots.
   D. Edge routers of several residential ISPs.
   E. Tier-2 ISP routers.

8. How many bits could you find between the 01111110 frame delimiter bytes at each end of an Ethernet frame? You may assume that the frame is valid (i.e., does not include any errors)

A. Exactly 1024 bits each time.
B. A multiple of 8 plus 5 zeroes.
C. 48 bytes times 8 bits = 384 bits.
D. Any multiple of 8 bits large enough to include header and CRC checksum.
E. Any number large enough to include header and CRC checksum.

9. Which of the following statements is (are) true about BitTorrent?
X: Although a peer may have fifty concurrent TCP connections with other peers, at any given instant of time it sends data to only four other peers.
Y: At a given instant of time, a peer A may upload to a peer B, even if peer B is not sending anything to A.
Z: Among the chunks that a peer does not have, the peer will request chunks that appear to be relatively rare in the torrent.

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

10. Consider the following FTP session:

```
user@login01:~$ ftp 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> rstatus
---> STAT
211-FTP server status:
     Connected to 130.216.34.40
     Logged in as ftp
     TYPE: ASCII
     No session bandwidth limit
     Session timeout in seconds is 300
     Control connection is plain text
     Data connections will be plain text
     At session startup, client count was 2
     vsFTPd 2.0.5 - secure, fast, stable
211 End of status
ftp> passive
Passive mode on.
ftp> ls
ftp: setsockopt (ignored): Permission denied
---> PASV
227 Entering Passive Mode (130,216,191,48,100,54)
---> 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> quit
---> QUIT
221 Goodbye.
```

What is the server port number on which the FTP client makes the TCP data connection?

A. 21.
B. 154.
C. 226.
D. 48000.
E. 25654.

11. 36 dB correspond to a voltage ratio of approximately

A. 400:1
B. 6:1
C. 36:1
D. 4000:1
E. 64:1

12. A radio receiver receives a signal at a signal-to-noise ratio (SNR) of 32 dB. If the transmitter doubles its transmit power, the received signal will have an SNR of approximately

A. 35 dB
B. 29 dB
C. 64 dB
D. 26 dB
E. 38 dB

13. Which of the following is not a method of splitting a communication channel into several simplex or duplex channels?

A. Using separate cables or fibres for different channels.
B. Using different frequency hopping or code spread patterns for different channels (in spread-spectrum radio).
C. Using different colours / frequencies for different channels.
D. Using different time slots for different channels.
E. Using different transmit powers for different channels.

14. How does an Ethernet sender behave when it detects a collision on a shared-bus cable?

A. It sends a long ‘jamming’ signal, so as to make all stations aware of the collision, then resends.
B. It sends a short ‘jamming’ signal, so as to minimise the time the medium is occupied, then resends.
C. It discards the frame it was trying to send, and reports the collision to its network layer.
D. It stops sending, waits for the medium to be quiet, then resends.
E. It stops sending, waits for a random time, then resends.

15. Which of the following statements is (are) true about SMTP?
X: SMTP is used to define the format of message headers.
Y: SMTP is used to transfer messages from a mail server to a user agent.
Z: SMTP is used to transfer messages from one mail server to another.

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

16. Increasing the number of constellation points in a QAM scheme

A. Increases the symbol rate (Baud rate).
B. Decreases the robustness of the scheme against noise.
C. Increases the bandwidth of the signal.
D. Increases the received power density.
E. Decreases the bit rate for a given symbol rate.

17. Consider a sliding window system that uses w frames as its window size and acknowledgements for each packet. If s is the sequence number of the first frame in the window, when can the system move the window on to frame $s + 1$?

A. When it receives a NAK for frame s.
B. When it receives an ACK for a frame with sequence number greater than s.
C. When the receiver has space available to receive more frames.
D. When it has sent all of the w frames currently in the window.
E. When it receives an ACK for frame s from the receiver.

18. Consider the minimum time for P2P file distribution as discussed in class. Suppose the upload rate of the server is 10 Megabits per second, the upload rate of each peer is 1 Megabits per second, and the download rate of each peer is 10 Megabits per second. There are 100 peers, and the size of the file to be distributed is 100 million bits. What is the minimum distribution time (i.e, the minimum time it takes to get a copy of the file to all 100 peers)?

A. Approximately 40 minutes.
B. Approximately 15 minutes.
C. Approximately 1000 seconds.
D. Approximately 10 seconds.
E. Approximately 100 seconds.

19. Imagine there are 8 active peers in the Gnutella network. These peers are distributed all over the globe. Each pair of peers has an active (bidirectional) TCP connection. Suppose that each of the TCP connections passes through a total of 3 routers. How many edges are there in the corresponding overlay network?

A. 28.
B. 8.
C. 21.
D. 24.
E. 11.

20. Consider a DASH system to play a blockbuster movie on-demand. There are 20 video versions and 20 audio versions for this movie. These versions represent different bit rates and audio/video qualities for that particular movie. To adjust to varying network conditions, the player (at any moment in time) can choose any of the 20 video versions and any of the 20 audio versions. If you create files so that audio is mixed in with the video, so server sends only one media stream at a given time, how many unique files will the server need to store?

A. 100.
B. 200.
C. 20.
D. 400.
E. 40.

21. Consider the following lines from a Web server log:

```
260.216.169.164 - - [26/Oct/2015:09:26:34 +1200]
        "GET /login/ HTTP/1.1" 302 0 "https://you.university.nz/profile/
            SAML2/Redirect/SSO"
         "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2) AppleWebKit/537.36
            (KHTML, like Gecko) Chrome/34.0.1847.131 Safari/537.36"
260.216.169.164 - - [26/Oct/2015:09:26:35 +1200]
         "GET / HTTP/1.1" 200 1943 "https://you.university.nz/profile/
            SAML2/Redirect/SSO"
         "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2) AppleWebKit/537.36
            (KHTML, like Gecko) Chrome/34.0.1847.131 Safari/537.36"
260.216.169.164 - - [26/Oct/2015:09:26:35 +1200]
         "GET /test_ui/gwt/chrome/1BEB1F98F392A12232A754A0784B49A8.cache.
            css HTTP/1.1" 200 3858 "https://it.university.nz/"
         "Mozilla/5.0 (Macintosh; Intel Mac OS X 10_9_2) AppleWebKit/537.36
            (KHTML, like Gecko) Chrome/34.0.1847.131 Safari/537.36"
```

Which of the following statements is (are) true?
X: The log is in the Common Access Log format.
Y: The host with IP address `260.216.169.164` made two successful requests to the Web server for two unique objects.
Z: The host with IP address `260.216.169.164` was probably using the Chrome browser to make requests to the Web server.

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

22. Suppose we have a received signal power 512 times that of the noise power, giving us a theoretical channel capacity of C bits/second in a bandwidth of B Hz. Doubling the bandwidth of the system from B to B' results in a theoretical channel capacity of

A. $10B'$
B. $7B$
C. $16B$
D. $15B$
E. $2C$

23. Time Division Multiplexing (TDM) and Statistical Multiplexing (SM) are two methods to carry several bit streams through a channel. Which of the following statements is FALSE?

A. TDM may introduce delay into the the transmitted bit stream.
B. TDM uses fixed time slots, so each bit stream gets a well-defined share of the channel.
C. TDM doesn't require data frames to carry a stream identifier.
D. SM data frames do not carry a stream identifier.
E. SM makes better use of the channel if traffic in the bit streams is bursty.

24. Assume a receiver whose clock produces 1,000,000 ticks per second. The corresponding transmitter's clock produces 999,990 ticks per second. The transmitter sends (going by its own clock) a symbol at each clock tick. At the receiver, you would expect:

A. A symbol insertion error every 10 symbols.
B. A symbol deletion error every 0.1 seconds.
C. A symbol insertion error every 0.1 seconds.
D. A symbol deletion error every 10 symbols.
E. A symbol insertion error every 0.01 milliseconds.

25. Which of the following statements is (are) true about FTP?
X: FTP sends its control information in-band.
Y: FTP command and replies are sent in 7-bit ASCII format.
Z: Throughout an FTP session, the FTP server maintains state about the client (user).

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

26. Point A and point B are 20 m apart. The power received at point B from a wireless transmitter at point A is -68 dBm. What is the power at point C 40 m away from the transmitter? You may assume that A, B, and C are on the same straight line.

A. -65 dBm
B. -74 dBm
C. -88 dBm
D. -62 dBm
E. -80 dBm

27. Which of the following statements about IPv4 and IPv6 addresses is FALSE?

A. A host's network interface may only have a single IPv4 and a single IPv6 address.
B. For routing to scale, IP addresses must be related to topology.
C. IP addresses are assigned to interfaces, not to host computers.
D. Application-layer software should treat IP addresses as meaningless bit strings.
E. To make routing possible, IP addresses must be unique.

28. 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_1 and p_3 differ from those in the codeword you received. Which bit is in error with the highest probability?

A. p_2
B. There is more than one bit error in the codeword, and it is not possible to tell which bits are affected.
C. m_6.
D. p_3
E. m_2

29. Which of the following statements is (are) true about CDNs?
X: The *enter deep* CDN placement philosophy involves deploying server clusters in Tier-1 ISPs all over the world.
Y: The *bring the ISPs home* CDN placement philosophy involves building large clusters at a smaller number of key locations (e.g., near Point of Presences of several Tier-1 ISPs), and connecting these clusters using a private high-speed network.
Z: Load on clusters and ISP delivery costs are the only factors when designing CDN cluster selection strategies.

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

30. Which of the following aspects of BGP has contributed most to its scalability and therefore to the Internet's growth over past 20 years?

A. BGP *aggregates* adjacent address prefixes in a binary tree.

B. A BGP router sends Update messages when any of its links (to other BGP routers) fails or is re-connected.

C. BGP *communities* act as a label for a group of destination address prefixes.

D. BGP routing is a Path Vector protocol.

E. BGP supports routing *policies,* allowing Internet Service Providers to specify paths to particular destination address prefixes.

31. Which of the following statements is (are) true about KaZaA?

X: The peers in KaZaA are organized into a two-tier hierarchy of group-leader peers and ordinary peers.

Y: KaZaA encrypts all control and data traffic.

Z: The KaZaA hierarchical design allows for significantly more peers to be checked for a match (in response to a query), without creating an excessive quantity of query traffic.

A. X and Z only.

B. All of X, Y, and Z.

C. Y and Z only.

D. X only.

E. X and Y only.

32. A ground station for a continous service medium earth orbit satellite system needs:

A. A device to compensate for the additional latency between ground station and MEO satellite compared to GEO satellite

B. An antenna that is larger than for a GEO satellite

C. A clear view to the sky above the North Pole

D. At least two dish antennas to track the satellites.

E. A more powerful transmitter than for a GEO satellite

33. Which of the following statements is (are) true about the *page tagging* client-side Web measurement method?
    X: Page tagging can measure (byte) traffic volume to a Web site.
    Y: Page tagging can provide details about client and server errors.
    Z: Page tagging can track Web pages, but cannot record hits to the individual resources (e.g., images, documents) that are linked or embedded in the pages.

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

34. Which of the following best explains why fragmentation is needed less often in IPv6 than it was in IPv4?

    A. Before sending packets to a destination IPv6 host, an IPv6 sender must determine the shortest MTU (Maximum Transmission Unit) size for all links in the packets' path.
    B. For IPv6 the fragment Identifier is a 32-bit field, in IPv4 it is only 16 bits.
    C. IPv6 requires that every link in the Internet has an MTU of 1280 bytes or greater.
    D. In IPv4 fragmentation was done by routers; in IPv6 fragmentation is never done by routers.
    E. In IPv6 information about a fragment is carried in a Fragmentation Subheader; IPv4 carried it in the IPv4 header.

35. 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 identifier that is the immediate successor of the key. How many messages are sent in the circular DHT, when peer identifier 0011 wants to determine which peer is responsible for key 1101?

    A. 6.
    B. 7.
    C. 10.
    D. 8.
    E. 12.

36. Which of the following is an example (are examples) of active network measurement?
    X: Using `traceroute` to understand the network path to top-100 international Web sites.
    Y: Automating a Web browser to load the top-10 New Zealand Web sites and record average page load times.
    Z: Using Web server logs to characterize usage behaviour of your company's Web site.

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

37. Assume that a fibre from Auckland to New Plymouth is 360 km long, and is used to provide a 10 Mb/s link. Approximately how long does it take for a 1,000-byte frame to be sent out and acknowledged? (Hints: light travels at 2×10^8 m/s in optical fibre; you may ignore the time needed to transmit the short ACK frame).

    A. 3.6 ms
    B. 1.6 ms
    C. 4.4 ms
    D. 5.2 ms
    E. 1.8 ms

38. A TCP connection is being used to transfer a steady stream of 1000-byte data segments with 40-byte headers, through a 10 Mbit/s link with a 10.4 ms one-way delay. Assume that its receiving host uses incoming data at the rate it arrives. How big should the sending host's TCP transmit buffer be if the transfer is to run at its maximum possible rate? (You may ignore the time taken to send the short Ack segments).

    A. 24 kB
    B. 12.5 kB
    C. 25 kByte
    D. 13 kB
    E. 26 kB

39. Which of the following statements about OSPF routing is FALSE?

A. OSPF routing is a Link State protocol, each router in an OSPF network maintains a Link State database.
B. OSPF distinguishes *routers* from *networks*, networks are either *stub* or *transit* networks.
C. OSPF can be used for routing between Autonomous Systems (AS).
D. OSPF allows administrators to divide their network into *Areas*.
E. OSPF transit networks contain at least rone outer that is connected to more than one other network.

40. During a TCP connection between hosts A and B, A send five data segments 1000 bytes long to B, starting with Sequence number 11000. The path between A and B reorders the packets so that they arrive at B with sequence numbers 11000, 14000, 12000, 15000, 13000. Assuming that B acknowledges every incoming packet, what will the Acknowledgement number be in B's fourth packet?

A. 14000
B. 12000
C. 15000
D. 13000
E. 16000

SPARE PAGE FOR ROUGH WORKING

SPARE PAGE FOR ROUGH WORKING