American University of Beirut
Department of Electrical and Computer Engineering
EECE 350 – Computer Networks
Spring 2014
Midterm – March 28, 2014
Closed Book / Notes – No Programmable Calculators – 90 minutes

NAME:_____ **ID Number:** _____

- All questions are equally graded
- **PENALTY** is four-to-one (four wrong answers cancel one correct answer, one to three wrong answers have no effect)
- Grading is based on the answers marked on the SCANTRON computer sheet only.
- There are **50** questions and **7** pages in this exam.

1. Network protocols define the:

I. format and order of messages sent and received
II. actions taken on message transmission, receipt, or other event

a) I only
b) II only
c) I and II
d) Neither I nor II
e) None of the above

2. Which of the following is/are true?

I. PAN is professional-area network
II. Bluetooth is an example of PAN

a) I only
b) II only
c) I and II
d) Neither I nor II
e) None of the above

3. The Internet Architecture includes X layers, while the OSI Architecture includes Y layers.
a) X = 7, Y = 4 b) X = 5, Y = 7 c) X = 7, Y = 5 d) X = 4, Y = 7

4. Which of the following is/are true?
I. The network layer sends packets over multiple links
II. The presentation layer manages synchronization
III. The application layer provides end-to-end delivery of segments

a) I only
b) II only
c) III only
d) II and III only
e) I and III only

5. In the Internet Architecture, the following two OSI layers are missing:
a) Physical and Session
b) Data Link and Transport
c) Presentation and Application
d) Transport and Session
e) None of the above

6. The lower X layers in OSI are implemented in all network devices. X =
a) 1 b) 2 c) 3 d) 4 e) none of the above

7. Which of the following bodies does *not* deal with network standardization?
a) ISO b) ITT c) IETF d) IEEE e) ITU

8. In a 5-layer network architecture, an application generates a 100-Byte message. Layers 4, 3, and 2 add a 20-Byte header *each*. Layer 2 also adds a 4-Byte trailer. Layer 1 uses 4B/5B encoding. How many bits are actually transmitted as a result of the message, as seen "on the wire"?
a) 1600 b) 1800 c) 1312 d) 1640 e) 1472

9. In a circuit-switching system, how many users can be supported on a 150 Mbps link if each user requires a 5 Mbps bitrate when active?
a) 50 b) 45 c) 40 d) 35 e) 30

10. A circuit-switched link uses TDM to support 48 simultaneous users. Each user is allowed to transmit 200 bits during a timeframe of 100 μs. What is the overall bitrate of the link in Mbps?
a) 2 b) 24 c) 48 d) 96 e) 12

11. An Ethernet frame includes 1000 Bytes of Payload, 22 Bytes of header, and 4 Bytes of trailer. Find the transmission time (in μs) of this frame over a 100 Mbps interface.
a) 82.1 b) 80.0 c) 85.6 d) 93.4 e) none of the above

12. The frame in the previous problem is sent over a cable 100 meters long. Find the propagation delay (in μs) over this cable if the signal propagation speed is 2×10^8 m/s.
a) 0.3 b) 0.4 c) 0.5 d) 0.6 e) none of the above

13. Find the total time (in ms) needed to send a 1-million-Byte file from host A to host B, over a 1 Gbps, 200 km fiber link. The total time includes a setup time (one RTT) and the time to continuously transmit 1 million Bytes. The signal propagation speed is 2×10^8 m/s.
a) 7 b) 8 c) 9 d) 10 e) none of the above

14. Assuming infinite link bitrate, and infinite signal propagation speed, delays would still be observed in packet switching networks due to:
a) processing and queuing delays
b) transmission and propagation delays
c) processing and transmission delays
d) queuing and propagation delays
e) processing and propagation delays

15. When using packet switching with 32 users, what is the probability that more than 10 users are active at the same time instant, if each user is independently active 18% of the time?
a) 0.01 b) 0.03 c) 0.02 d) 0.05 e) 0.04

16. The code below refers to a connection-oriented client written in Python.

```
import socket
server = "myserver.mycompany.com"
port = 80
request_string = "GET /d/q?s=MyRequest HTTP/1.1\r\n\r\n"
receive_buffer_size = 4096
mysocket = socket.AAA( )
mysocket.BBB( ( server, port ) )
mysocket.send( request_string )
response_string = mysocket.recv( receive_buffer_size )
mysocket.close
print response_string
```

In the code above, **AAA** should be:
a) socket b) send c) recv d) close e) connect

17. In the code of the previous question, **BBB** should be
a) socket b) send c) recv d) close e) connect

18.
I. Satellite broadcast is an example of full-duplex communication
II. Error rates over fiber links are similar to those over copper links
III. Bitrates that are obtained over fiber links are much higher than those over copper links

a) All statements are true
b) All statements are false
c) Only statement II is false
d) Only statement III is false
e) Statements I and II are false

19.
I. DSL uses frequency-division multiplexing
II. Omnidirectional wireless transmission requires careful antenna alignment
III. Geostationary satellites orbit at an altitude of 36000 km.

a) All statements are true
b) All statements are false
c) Only statement II is false
d) Only statement III is false
e) Statements I and II are false

20. What bandwidth (in kHz) is needed to transmit at 2 Mbps over a channel with a signal-to-noise ratio of 33 dB?
a) 91.2 b) 182.4 c) 606.0 d) 362.8 e) none of the above

21. What is the minimum number of signal levels that are needed in the previous problem?
a) 8 b) 16 c) 32 d) 64 e) 128

In the following problems, assume that all signals are initially LOW. Consider the following sequence of data bits that should be transmitted
0 0 0 1 1 0 1 0 0 1 0 1 0 1 1 1 0 0 0 0 1 0
Count *the number of LOW-TO-HIGH* transitions when using the encoding scheme:

22. NRZ
a) 3 b) 4 c) 5 d) 6 e) none of the above

23. NRZI
a) 3 b) 4 c) 5 d) 6 e) none of the above

24. Manchester
a) 3 b) 4 c) 5 d) 6 e) none of the above

25. The payload of an HDLC frame consists of 500 bits, with all bits being "1". After bit stuffing, how many bits are transmitted as payload?
a) 600 b) 500 c) 560 d) 640 e) 400

26. The bit-error-rate over a wireless link is 10^{-4}. What is the expected number of bits in error out of 1 million bits that are received by a wireless station?
a) 1000 b) 100 c) 10 d) 500 e) 5000

27. In the previous problem, the 1 million bits are received as a sequence of frames, each with *M* Bytes. What is the maximum value of *M* in order to limit the frame error rate to 0.13?
a) 144 b) 214 c) 174 d) 84 e) 324

28. How many additional Forward-Error-Correction bits are needed to *correct* single-bit errors in 8000-bit frames? Assume Hamming code is used.
a) 13 b) 12 c) 14 d) 15 e) none of the above

29. In the previous problem, how many additional bits (to be sent with the data bits) are needed to *detect* single-bit errors in an 8000-bit frame?
a) 10 b) 1 c) 3 d) 5 e) none of the above

30. In a 2D even parity scheme, the following sequence of bits are taken 7 at a time, with a parity bit added at the end of the seven bits to create a Byte.
`1000011 1010001 0111101`
The three resulting Bytes are then followed by a vertical parity Byte, which should be:
a) `10000110` b) `01011111` c) `01111111` d) `00000110` e) none of the above

31. Find the internet checksum of the following message:
`1000001111010001 1011111011010011`
a) `1010100101011010`
b) `1011111101111010`
c) `1011110101011010`
d) `1011111101011011`
e) none of the above

32. The 3-bit CRC of the message `11000011` using the generator polynomial x^3+x+1 is:
a) `010` b) `110` c) `001` d) `111` e) none of the above

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33. A Stop-and-Wait scheme uses data frames of length 6000 bits and ACK frames of negligible size, over a symmetrical link with bitrate 500 kbps, and an RTT of 30 ms. What is the cycle time (in ms) for this scheme?
a) 12 b) 22 c) 32 d) 42 e) 52

34. What is the throughput in the previous problem (in kbps)?
a) 234 b) 462 c) 311 d) 78 e) 143

35. If the frames in the previous problem arrive with an error rate of 0.111, and the error is always detected by the receiver, and assuming the minimum timeout value for correct operation at the sender, find the throughput (in kbps).
a) 208 b) 127 c) 276 d) 350 e) 88

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36. Over a 250 kbps satellite link, the RTT between two hosts is 500 ms. Data frames are 6000 bits, and ACK frames are negligible in size. What is the minimum window size in a sliding-windows scheme for *maximum* utilization of this satellite link?
a) 22 b) 18 c) 16 d) 24 e) 26

37. Assume in the previous problem that Go-Back-N is used, how many bits are needed in the header to store the sequence number of a frame?
a) 3 b) 4 c) 5 d) 6 e) 7

38. Repeat the previous question if Selective Repeat is used.
a) 3 b) 4 c) 5 d) 6 e) 7

Station A wants to send 1000-Byte frames to station B over an 802.11 wireless LAN. Assume that the distance from A to B is 15 meters, the bitrate is 117 Mbps, DIFS is 50 μs, SIFS is 10 μs. RTS and CTS frames are 20 Bytes and 16 Bytes, respectively, and ACK frames are 64 Bytes. The propagation speed is 3×10^8 m/sec, and processing delays are negligible.

39. Since the frame size is small, the stations do *not* use RTS/CTS. Station A starts its DIFS timer at time $t = 0$. Estimate the time at which the ACK frame is completely received by A (in microseconds).
a) 132.9 b) 128.5 c) 122.8 d) 172.8 e) none of the above

40. If the RTS/CTS scheme is used, at what time (in microseconds) does station A start transmitting its data frame bits?
a) 55.6 b) 62.6 c) 32.6 d) 72.6 e) none of the above

41. When the RTS/CTS scheme is *not* used, what is effective useful throughput of the network (in Mbps)? The useful bits are those of the data frames only.
a) 49.7 b) 60.2 c) 93.1 d) 75.6 e) none of the above

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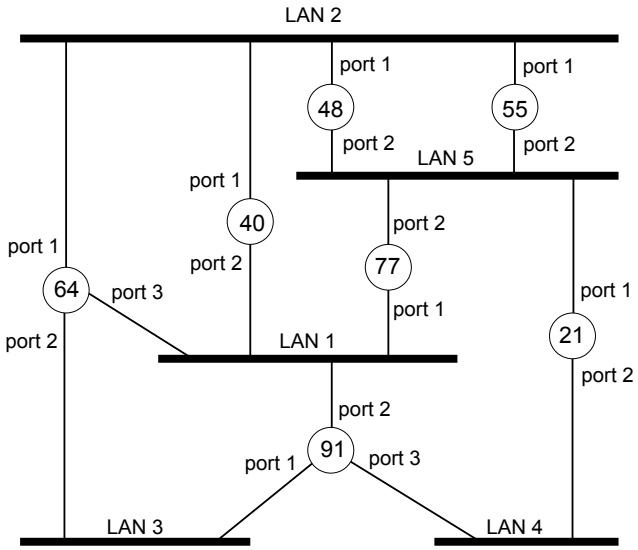
42. Given two stations A and B connected to one Ethernet network cable, with no other stations on the network. Both stations attempt to transmit at time $t = 0$. As a result, a collision occurs. After the first collision, the stations try to transmit again, but collide a second time. What is the probability that the two stations will collide the third time they try to transmit?
a) 0.25 b) 0.125 c) 0.75 d) 0.005 e) none of the above

43.
I. A MAC address consists of 48 bits
II. A station can have only one MAC address
III. Sending a frame with a source address equal to FF:FF:FF:FF:FF:FF results in a broadcast

a) All statements are true
b) All statements are false
c) Only statement I is true
d) Only statement II is false
e) None of the above

The circles in the network diagram below depict LAN bridges. The bridge ID is the number inside the circle. The thick lines depict LAN segments (LAN 1 to LAN 5).



44. For the Spanning Tree, the root bridge is bridge number:
a) 40 b) 48 c) 91 d) 21 e) none of the above

45. Assume that the Spanning Tree is *not formed yet*. A station on LAN 5 transmits a broadcast frame. How many frame transmissions occur (including the initial transmission by the station on LAN 5)?
a) 3 b) 5 c) 7 d) 9 e) none of the above

46. Assume that the Spanning Tree is formed. A station on LAN 5 transmits a broadcast frame. How many frame transmissions occur (including the initial transmission by the station on LAN 5)?
a) 3 b) 5 c) 7 d) 9 e) none of the above

47. Which of the following ports changes state in the Spanning Tree (from blocking to forwarding or vice-versa) when port 3 of Bridge 91 gets completely disconnected (i.e. erased from figure)?
a) port 2 of bridge 40
b) port 3 of bridge 64
c) port 1 of bridge 64
d) port 2 of bridge 91
e) none of the above

Consider a network that uses roll-call polling: A central station interrogates N other stations to check if they have data frames to send. A station has a data frame to send *with probability* p. Assume that the round-trip delay in interrogating a station is R seconds, the medium has a bitrate of b bps, a poll (and poll reply) message is of length l bits, and the data frame length is L bits.

48. How long does it take to complete the poll of a station that has no data frame to send?
a) $R+L/b$ b) $R+2l/b$ c) $R+l/b$ d) $R + 2L/b$ e) none of the above

49. How long does it take to complete the poll of a station that *has* a data frame to send?
a) $R+L/b$ b) $R+l/b$ c) $R+2L/b$ d) $R + (L+l)/b$ e) none of the above

50. How long does it take to complete a cycle over all of the N stations in the network?
a) $N (p (R + l/b) + (1 – p)(R + (L+l)/b))$
b) $N ((1 – p)(R + l/b) + p (R + 2L/b))$
c) $N (p (R + L/b) + (1 – p)(R + 2l/b))$
d) $N ((1 – p)(R + 2l/b) + p (R + (L+l)/b))$
e) none of the above
