Solution to Midterm Test

Part I Multiple — Choice Problems (30%). Select one correct answer in each problem. If no correct answer is found in (a) - (d), then select “(e) none of above.”

1. Which one of the following is not a function of the data link layer?
   (a) flow control
   (b) error control by doing checksum
   √ (c) breaking a packet into smaller frames with proper framing methods
   (d) providing connection-oriented services to the network layer if requested
   (e) none of above

2. Which one of the following is not true for AMPS (Advanced Mobile Phone System)?
   (a) frequency reuse is not allowed between two neighboring cells
   (b) handoff is initiated by the base station
   (c) registration is initiated by the mobile station
   √ (d) channel allocation decision is made by each base station in a cell
   (e) none of above

3. What is the maximum data rate of a noiseless 4khz bandwidth channel using QAM (Quadrature Amplitude Modulation) encoding?
   (a) 8kbps
   (b) 16kbps
   √ (c) 32kbps
   (d) 64kbps
   (e) none of above.

4. Suppose that we use 01111110 to indicate end of frame and insert a 0 bit after five 1 bits in the payload part. What is the original data part of the following bit-stuffed frame:
   11101111110111110011111110001111111?
   √ (a) 111011111111111101111100
   (b) 111011111111111101111100
   (c) 11101111111111110111100
   (d) 1110111111111111101110011111
   (e) none of above.

5. Which of the following statements is false regarding bandwidth, signaling speed, and data rate?
   (a) frequency bandwidth of a channel limits the data rate
   (b) for a noiseless channel, the data rate is theoretically infinity since in a noiseless channel we can encode and decode as many levels in a signal as we like
   (c) the effective data rate of a channel with 15 Mhz signaling speed based on 8B6T encoding scheme is 20 Mbps
   (d) for a 3khz bandwidth, 30dB noise channel, the maximum data rate is 3000 × log₂(1001) bits per second according to the Shannon theorem.
   √ (e) none of above.

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6. Suppose that a 16-line ATM pipelined switch is designed with a clock cycle of 500 n.s. How many bytes of data will pass through the switch per second?
   (a) $1.36 \times 10^{10}$
   (b) $1.696 \times 10^9$
   (c) $3.2 \times 10^7$
   (d) $1.06 \times 10^8$
   (e) none of above.

7. For an 8 by 8 Batcher-Banyan ATM switch, if the initial configuration is $(7,\ldots,6,\ldots,5,\ldots,4,\ldots)$ then the last step in the Batcher switch is
   (a) $(7,\ldots,4,\ldots,5,\ldots,6,\ldots)$
   (b) $(4,\ldots,7,6,\ldots,5,\ldots,\ldots)$
   (c) $(4,5,6,7,\ldots,\ldots,\ldots)$
   (d) $(4,\ldots,5,\ldots,6,\ldots,7,\ldots)$
   (e) none of above.

8. Which one the following statements is not true for a Hamming code to correct a single-bit error for 24 data bits.
   (a) Hamming distance of the Hamming code is 3
   (b) we can use the same Hamming code to detect a double error if we want; however, this can only be done by giving up the code’s single-bit error correcting capability
   (c) the size of each code word including error-correcting bits is 29 bits
   (d) suppose that all bits of a code word are numbered from left starting at position 1 with power of 2 positions containing error-correcting bits; if only the parity checking bit at position 16 indicates a parity error then it means that bit 16 itself is incorrect.
   (e) none of above.

9. Which one of the following will not be detected by a CRC with a generating polynomial $G(x) = x^{16} + x^2 + 1$?
   (a) all single-bit errors
   (b) all double-bit errors
   (c) all triple-bit errors
   (d) all burst errors of length less than 16
   (e) none of above.

10. Which one of the following is not true for sliding window protocols?
    (a) for stop and wait protocols, 1-bit sequence number is sufficient
    (b) sender’s window size can be different from receiver’s window size
    (c) both the sender’s and receiver’s window size is 1 for go back N protocols
    (d) both the sender’s and receiver’s window size is at most one half the range of the sequence numbers for selective repeat protocols
    (e) none of above.

11. A 3000-km long T1 trunk is used to transmit 64-byte frames using the selective repeat protocol. The propagation delay is 6 $\mu$sec/km. How many bits should the sequence numbers be?
    (a) 5
12. Which one of the following is true for ATM data link protocols?
   √ (a) no flow control
   (b) no framing method
   (c) no error control
   (d) no synchronous medium can be used to transmit ATM cells
   (e) none of above.

13. Which one of the following is not a function of a bridge connecting a source IEEE 802.5 LAN to a destination IEEE 802.3 LAN?
   (a) reformatting the frame and recomputing the checksum
   √ (b) assigning a fictitious priority to the frame
   (c) discarding frames if necessary if the destination 802.3 LAN is too slow
   (d) lying to the sender that the frame is received by the receiver
   (e) none of above.

14. If on the average there is one frame (old and new) to be transmitted per frame time, then the average number of transmissions for a frame to be sent successfully in pure ALOHA is
   (a) $e^{-2}$
   (b) $e^{-1}$
   √ (c) $e^2$
   (d) $e^1$
   (e) none of above.

15. Which one of the following is not true
   (a) in ALOHA, there is no carrier sense, so the sender just transmits at will
   (b) in 1-persistent CSMA, if the channel is sensed free it will send immediately
   (c) in nonpersistent CSMA, if the channel is sensed free it will send immediately
   (d) in $p$-persistent CSMA, if the channel is sensed free it will send with probability $p$
   √ (e) none of above.

16. Suppose initially stations A, B, C, D, E, F, G, H, I are assigned with a priority order (8, 5, 6, 1, 4, 7, 0, 2, 3) based on Mok and Ward’s binary countdown protocol. Suppose three stations E, F and H each want to transmit one frame at the same time. What is the final priority order associated with stations A, B, C, D, E, F, G, H, I after all three eventually finish transmitting their frames?
   √ (a) (8, 6, 7, 4, 1, 2, 3, 0, 5)
   (b) (8, 5, 6, 1, 0, 2, 3, 4, 7)
   (c) (8, 6, 7, 4, 2, 1, 3, 0, 5)
   (d) (8, 6, 7, 2, 0, 1, 3, 4, 5)
   (e) none of above.
Part II True — False Problems (20%). Circle “true” or “false” for each of the following statements. No need to give reasons.

(F) Flow control in the transport layer concerns the regulation of the flow of information between routers.

(F) All WANs use point-to-point links.

(T) The difference between a bridge and a router is that a bridge works at the data link layer and thus does not know whether the frame contains an IP or IPX packet.

(F) Nyquist’s theorem is true only for copper wires, not for fibers.

(T) When a CDMA receiver gets a sum of bipolar chip sequences filled with all 0’s, it means that in the last bit period, all senders were silent.

(T) In CSMA/CD, it needs $2\tau$ time to detect collisions where $\tau$ is the one-way propagation time through the shared channel. This is implemented in 802.3 by requiring a minimum frame size.

(F) In 802.3 Ethernet, increasing the channel data rate while keeping other parameters unchanged will increase the channel efficiency.

(T) Token ring has a known worst case transmission time only if the token holding time is bounded.

(T) If a protocol uses 4-bit sequence number and fixes the sender’s window at 15 frames, it is impossible for the receiver to use a window size greater than 1 without causing any flow control errors.

(F) We cannot put parallel transparent bridges between two LANs in order to avoid forwarding the same frame in a loop.
Part III Quantitative Problems (50%).

1. An error-free 128kbps satellite channel is used to send 512-byte frames in one direction, with very short ACKs coming back the other way. What is the maximum throughput if selective repeat is being used for flow control with 5-bit sequence numbers?

   Ans: the sender’s window size is \( \frac{32}{2}=16 \), therefore the max. throughput is
   \[
   \frac{16 \times 512 \times 8}{(32 + 540)ms} = 114.6 kbps
   \]

2. Suppose that the chip sequences of stations A, B, and C under CDMA are assigned as follows:

   A: 0 1 0 1 1 1 0 0
   B: 0 0 0 1 1 0 1 1
   C: 0 0 1 0 1 1 1 0

   If a CDMA receiver gets the following chips (in bipolar notation):
   \((-1 +1 -3 +3 +1 -1 -1 +1)\)
   which stations transmitted and which bits did each one send?

   \[
   S \cdot A = \frac{1}{8}(1 + 1 + 3 + 3 + 1 - 1 + 1 - 1) = 1
   \]
   \[
   S \cdot B = \frac{1}{8}(1 - 1 + 3 + 3 + 1 + 1 - 1 + 1) = 1
   \]
   \[
   S \cdot C = \frac{1}{8}(1 - 1 - 3 - 3 + 1 - 1 - 1 - 1) = -1
   \]

   Therefore A and B each transmitted a 1 bit and C transmitted a 0 bit.

3. A large 100 Mbps FDDI ring has 1000 stations and a token rotation time of 400 msec. The token holding time is 10 msec. What is the maximum achievable data rate of the network?

   \[
   100Mbps \times \frac{10}{10 + \frac{400}{1000}} = 96.15Mbps
   \]

4. Compute the CRC for 10010001000 using the generating polynomial \( x^4 + x + 1 \). Express the result in binary form. Ans: 1100.
5. A 2.5-km-long, 10-Mbps IEEE 802.3 Ethernet has a propagation speed of 200 m/μsec. The minimum frame size is 64 bytes. Assume that stop-and-wait protocol is being used for flow control. What is the maximum achievable data rate, excluding overhead, under the conditions that there are no collisions and that the sender and the receiver are one-half cable length apart? Assume that the sender’s data frames are 1024 bytes long including the overhead.

Ans: under IEEE 802.3, there is no channel-seize time if there are no collisions because the sender will just send and detect if there is a collision in 2τ time as long as each frame’s transmission time is greater than 2τ, which is the case for IEEE 802.3. Also, under stop and wait, the sender needs to wait for the ACK to come back before it can send another frame. Each data frame sent by the sender is 1024-byte long which takes 819.2 μs to transmit. This data frame takes 6.25 μs propagation time to reach the receiver. At the receiver end, the ACK frame takes the minimum frame size, that is, 64 bytes, so the transmission time of the ACK frame is 51.2 μs. Finally, the ACK frame takes another 6.25 μs to propagate back to the sender. This cycle then repeats. In 802.3, there are 26 overhead bytes in each frame (page 281, text). Therefore with a total of (819.2 + 6.25 + 51.2 + 6.25) μs, only (1024-26) × 8 = 7984 useful data bits are transmitted, giving the effective data rate of 9.04 Mbps.