# Solutions for Sample Questions

# (Mid-term)

### ECE 591 Wireless Networks and Mobile Computing

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## (For question# 2-18, please refer to lecture slides; please ignore question#16)

1. (10 points) Consider a frame consisting of three characters of 4 bits each. Assume that the probability of a bit error is $10^{-3}$, and the bit errors are independent of each other.
   a. What is the probability that this received frame contains at least one error?
   b. Now add even parity bit to each character, what is the probability?
   c. Does adding parity bits reduce the error probability? Why?

Answer:

By definition:

- $P_b$ : Probability of single bit error (BER)
- $P_1$ : Probability that a frame arrives with no bit errors
- $P_2$ : While using error detection, the probability that a frame arrives with one or more undetected errors

With no error detection:

$$P_1 = (1 - P_b)^F,$$

$$P_2 = 1 - P_1$$

Where, F = Number of bits per frame

Here, $P_b = 10^{-3}$, F = 12

**a. The probability that received frame contains at least one error is**

**$1-( 1-P_b)^F = 1-(1-10^{-3})^{12}$**

**b. After added even parity bit to each character, the probability that received frame contains at least one error is**

**F= 12+3 = 15**

**$P_2 = 1 - P_1 = 1 – (1 – P_b)^{15} = 1 – (1 – 10^{-3})^{15}$**

**c. No, adding parity bit doesn't reduce the error probability because it just does error detection does (no error corrections).**

2. (10 points) For P=11101 and M=111100111, find CRC.

3. (5 points) What is the hidden terminal problem? What is the exposed terminal problem? How does IEEE 802.11 (MACA variant) solve these two problems?

4. (5 points) Given bandwidth = 2.0 GHz and S/N (signal noise ratio) = 20dB, what is the transmission capacity according to Shannon's Theorem?

5. (5 points) Given data 0101010, what is the data frame after adding parity (even) check? If we use the divisor 3 (11), what is the CRC check we should add?

6. (5 points) How does ARQ work? What are the disadvantages of go-back-N ARQ?

7. (5 points) Calculate the Hamming distance among the following codewords:
   a. 101011, 010100
   b. 0000110,1111001

8. (5 points) Calculate the attenuation if $P_{in}$ =500 mw and $P_{out}$=50 mw

9. (5 points) Describe the characteristics of signal propagation in wireless environments

10. (5 points) How do the mobility and multiple-path affect the signal propagation?

11. (5 points) What is multiplexing? Describe at least 3 multiplex techniques

12. (5 points) Describe Sliding-window flow control mechanism.

13. (10 points) What are the differences between Ad-hoc mode and Infrastructure mode in 802.11? Describe how the 802.11 DFWMAC scheme works?

14. (10 points) How does the synchronization work in 802.11 infrastructure mode and ad-hoc mode, respectively?

15. (5 points) Describe the security attack model.

16. (5 points) Assume a fixed internet connection with a round trip time of 30ms and an error rate of $10^{-9}$. Calculate the upper bound on TCP's bandwidth for a maximum segment size of 1,000 bytes.

Please ignore this question (which is not covered in the lecture)

17. (5 points) Why is routing in ad-hoc networks complicated? What are the special challenges? How does TTDD routing work in wireless sensor network?

18. (5 points) List the entities of mobile IP and describe the data transfer from a mobile phone to a fixed node and vice versa. Why and where is encapsulation needed?

19. *(5 points)* the length of a frame is L bit, and the bit error rate is $P_b$. If maximum ARQ retransmission count is 3, what is the probability that the receiver can receive this frame correctly using the ARQ mechanism?

Answers:

The success probability for the first time: $(1-Pb)^L$

The success probability for the second time: $(1-(1-Pb)^L)(1-Pb)^L$

The success probability for the third time: $(1-(1-Pb)^L)\ (1-(1-Pb)^L)\ (1-Pb)^L$

Then the probability that the receiver can receive this frame correctly using the ARQ mechanism:

$(1-Pb)^L+(1-(1-Pb)^L)(1-Pb)^L+(1-(1-Pb)^L)\ (1-(1-Pb)^L)\ (1-Pb)^L$