CSC 478/678
Principles of Wireless Networks (Spring 2021)
Exam 1

Note:
• This is an open-book, open-note exam, though you must work on it yourself. Please do not request help from any others or experts from any website.
• There are five questions. Good luck!

1. True or False, explain briefly if false. (8 points, 2 points each)

(a) The QPSK modulation technique encodes 4 bits in each symbol for transmission.

FALSE, QPSK codes 2 bits into one phase shift.

(b) Short-term signal fading is mainly because of the changes in static noise.

FALSE, short-term signal fading is caused by quick changes in the received power as the receiver moves.

(c) Radio wave propagation demonstrates characteristics of both regular particle propagation and that of waves.

FALSE, wave propagation is similar to that of water waves.

(d) FDMA requires accurate time synchronization for its successful operation.

FALSE, F(requency)DMA divides the allotted bandwidth into multiple sub frequency bands and senders use this band continuously.

2. Answer the following questions briefly: (40 points, 10 points each)

(a) Briefly explain what multi-path fading is.

The receiver may receive multiple copies of the same signal due to the differing paths of travel as signal is reflected, refracted, scattered, etc. The delay spread of these multiple signals will result in receiver getting weaker copies with phase shift. This may result in distortion as the energy intended for one symbol spills over into the adjacent symbol (ISI).

(b) Give one example of digital data, analog signal and one example for analog data, digital signal.

Digital data/analog signal example would be satellite communications
Analog data/digital signal example would be digital signal transmission via switching equipment between ADC and DAC

(c) What is the relationship of transmission range, detection range, and interference range in wireless transmission?

Transmission range is the area where accurate communication between the sender and receiver is possible with minimal errors.
Detection range is the range beyond transmission range where the signal is detectable (can differentiate from background noise) by the receiver, but no communication is possible.
Interference range is the area where the signal is not even detectable, but adds to the background noise.

(d) Name two problems for the RI-BTMA scheme that makes it hard to implement.

First bandwidth must be divided into data channel and busy tone channel, which is more difficult to implement.

Also, the busy tone signal and data channel must have exactly the same range to prevent incorrect use by the nodes (equal opportunity to use).

3. (27 points) Poisson distribution gives us a closed-form equation for finding chances of different events happening. Assuming the average number of arrivals is G per unit time, the chance of n arrivals in T unit times is:

$$Pr(n) = ((GT)^n / n!)\, e^{-GT}$$

(a) In a wireless network where an average of G arrivals occur in each unit time, what is the chance of exactly 3 arrivals in a period of 3 unit times?

$$\Pr(3) = \left(\frac{(3G)^3}{3!}\right) * e^{-3G}$$

$$\Pr(3) = \left(\frac{9G^3}{2}\right) * e^{-3G}$$

(b) In a wireless network where an average of G arrivals occur in each unit time, what is the chance of an idle channel in a period of 3 unit times?

$Pr(0) = e^{-3G}$

(c) In a wireless network where an average of G arrivals occur in each unit time, what is the chance of more than 2 arrivals (excluding 2) in a period of 2 unit time?

$Pr(2) = ((2G)^2/2!) * e^{-2G} = 2G^2 * e^{-2G}$

$Pr(1) = G * e^{-2G}$

$Pr(0) = e^{-2G}$

$Pr(>2) = 1 – Pr(2) – Pr(1) – Pr(0)$

$Pr(>2) = 1 – 2G^2 * e^{-2G} – G * e^{-2G} – e^{-2G}$

4. The following figure illustrates node S sending to node D. Node H is the hidden terminal and node E is the exposed terminal. The RTS/CTS/DATA/ACK sequence is for the MACAW scheme. Explain the reason for the following in the MACAW scheme: (15 points, hint: there might be other nodes around.)

a) E cannot send any transmission.

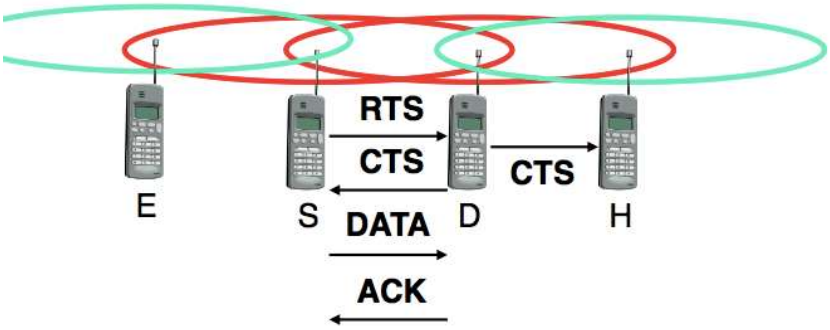
Exposed terminal is within range of D and cannot send because S still needs to receive ACKnowledge

b) H may miss the CTS packet.

CTS packet may collide with other control packets and hidden terminal may not overhear the CTS and begin to transmit data.

c) H may start a new transmission of RTS or DATA packet.

Hidden terminal (H) is within the range of D, and since D has sent ACK to S, then H is free to start new transmission.



5. We never got to find out what frequency Marconi used to send human's first-ever transatlantic radio message. Suppose the antenna was 50 meters tall and it represented a quarter of the wavelength for the signal that was used. What was the frequency? ($c=3x10^8$ m/s). (10 points)

$\lambda = (4) * 50m = 200m$

$c = \lambda f$
$f = c/\lambda$
$f = (3*10^8 \text{ m/s}) / 200m$
$f = 1{,}500{,}000$ oscillations per sec

$f = 66.67\ \mu Hz$