Mid-Semester Test

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Course No./Title :EEE F431/MOBILE TELECOM NETWORKS DATE: Mar. 11^{th}, 2017.

Test duration: 90 Mins. Max. Points: 30

Part-I: Multiple choice questions (8 points)

Note: Each question carries 1 point. Write the right answer in your answer book.

1. Suppose that a mobile terminal is located in a fading dip. On average, the minimum distance the mobile should move to achieve complete decorrelation from the fading dip is approximately ...

A. 0.1λ B. 0.2λ C. 0.3λ D. 0.4λ

2. Suppose that a mobile terminal is operating at 900 MHz and is located in a train moving at 360 Kmph. The maximum Doppler shift is ...

A. 100 Hz B. 200 Hz C. 300 Hz D. 50 Hz

3. A frequency-flat fading channel impulse response is described by $|h[n]|_{\text{dB}} = [0 \ -9.7 \ -19.2 \ -22.8]$. The mean channel power gain (in linear scale) is approximately

A. 0.1 B. 1.1 C. 2.1 D. 3.1

4. Refer to the data in Q. 3. What should be the average transmit SNR so that a receive SNR of 15 dB can be achieved. Assume Rayleigh fading.

A. 14.6 dB B. 11.6 dB C. 8.6 dB D. 18.6 dB

5. Which of the following use spread spectrum modulation?

A. GSM B. CDMA C. AMPS D. OFDM

6. In a mobile cellular system, each hexagonal cell has radius of 1 km. Suppose the minimum distance between cell centers using the same frequency should be 6 km to maintain the required SIR. The number of cells per cluster is equal to ...

A. 9 B. 12 C. 19 D. 11

7. Consider an IEEE 802.11a WLAN system. In it, assume that half the available 48 subcarriers use BPSK with rate $\frac{1}{2}$ and others use 64-QAM with a rate $\frac{3}{4}$. What is its data rate?

A. 7.5 Mbps B. 5 Mbps C. 12.5 Mbps D. 25 Mbps

8. Suppose an OFDM system is operating in a channel with coherence bandwidth of 0.01 MHz. In it, there are 128 subchannels. The system uses raised cosine pulses with roll-off factor of 0.9. If the required additional bandwidth is 10%, then what is the total bandwidth of the system?

A. 128 KHz B. 256 KHz C. 64 KHz D. 512 KHz

Part-II: True or False (2 points)

Note: Each question carries $\frac{1}{2}$ point. Just indicate 'T/F'

('T' for True statement; 'F' for false statement.).

1) Macrodiversity mitigates the detrimental effects of shadow fading. On the other hand, microdiversity techniques mitigate small scale fading.
2) In MIMO, spatial multiplexing technique enables parallel data transmission and achieves multiplexing gain without affecting diversity gain.
3) In OFDM systems, the PAPR of an input signal affects the compatibility of power efficiency and non-linear distortion in a power amplifier.
4) The SIR in a mobile propagation channel limits the frequency reuse factor of a cellular system, which limits the number of channels within the cellular coverage area.

Part III: Solve the following. (20 points)

Q. 1. [On Small Scale Fading]

Suppose that a traffic police uses a radar that detects speed of a vehicle. The police man issues a penalty card to the driver of a vehicle whose speed exceeds 90 Kmph. The policeman's radar radiates sinusoidal signal at a frequency of 900 MHz. The radiated signal propagates through a wireless fading channel to reach Mr. B.'s vehicle and propagates back to the policeman's radar as a signal having frequency 0.9000002 GHz. Note that Doppler effect depends on the relative velocity of the transmitter and the receiver.

Assume that the police man is stationary. Based on the above data, answer the following.

a). Do you think Mr. B. will receive a penalty card? Why? [2+1 points]

b). Figure out whether Mr. B. is driving towards the traffic police or not? Justify your responses. [2 points]

c). Determine approximate coherence time. [2 points]

Q. 2. Suppose that a transmitted signal undergoes shadow fading. Recall that the received power, denoted by $P_{\text{dB}} \sim \mathcal{N}(\overline{P}_R, \sigma^2_{\text{dB}})$. Answer the following.

a). If the threshold power for acceptable performance is P_{th}, derive an expression for the outage probability p_{out} in terms of $Q-$function. [3 points]

b). Assume that the average power remains constant. Let SNR $\triangleq \frac{\overline{P}_R - P_{\text{th}}}{\sigma_{\text{dB}}}$. Express the p_{out} in terms of SNR. What is p_{out} if SNR $= 3$ dB? [1+2 points]

c). Suppose a macrodiversity unit (MDU) employs 'L' antennas which see $i.i.d.$ fading channels, derive an expression for p_{out}. [2 points]

Q. 3. Consider a mobile cellular system with diamond ($\Diamond$)-shaped cells of radius $R = 0.1$ Km. Suppose the minimum distance between cell centers using the same frequency must be $D = 0.6$ Km to maintain the required SIR. Answer the following.

a). Determine the required reuse factor and the number of cells per cluster. Sketch the cluster. [2+1 points]

b) If the total number of channels for the system is 540, determine the number of channels that can be assigned to each cell. [2 points]