COMPREHENSIVE EXAMINATION

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Course Name & Number: Mobile Telecom Networks/EEE F431

DATE: May 15^{th} 2017 (FN) MAX. TIME: 3 hrs. MAX. SCORE: 40 Marks

Important: Provide key steps in all your solutions. Final answers must be highlighted in a rectangular box. Since this test is open book, no credit will be given for writing just formula.

Q. 1. Suppose that a vehicle is moving at a speed of 180 Kmph. It has a transceiver that operates at 1 GHz carrier frequency. Let v denote speed of the vehicle. Let f_c denote carrier frequency, λ_c denotes wavelength, and, c denotes the speed of electromagnetic (EM) wave.

a). If the proportionality constant is $k = 0.423$, express coherence time T_c in terms of the maximum Doppler shift $D_{s,\max}$. [2 marks]

b). Compute the maximum Doppler shift in Hz and coherence time in millisecond. [2 marks]

c). Suppose that the duration of an IS-95 (a CDMA standard) frame T_f is 0.02 second, express the integer number of fades 'n'(number of times the channel will vary) within a frame in terms of coherence time. Determine number of fades. [1 + 1 marks]

d). Assuming all other parameters fixed, sketch the variation of n as a function v in Kmph. [1 mark]

Q. 2. Suppose that security officer in BITS Pilani campus uses a radar that detects speed of a vehicle. The officer issues a penalty card if vehicle speed exceeds 108 Kmph. The security officer's radar radiates sinusoidal signal at a frequency of 1 GHz. The electromagnetic (EM) wave propagates through a wireless fading channel to reach a vehicle moving at a speed v and propagates back to the security officer's radar as an EM wave having frequency 1.0000001 GHz. Note that Doppler effect depends on the relative velocity of the transmitter and the receiver. Assume the following: i). The security officer is stationary. ii). The transmitted signal undergoes Rayleigh fading. iii). Average received power of -30 dBm. iv). Received signal envelop crosses level at -10 dB.

Based on the above information, compute the following.

a). Speed of the vehicle in Kmph. [2 marks] b). Level crossing rate (LCR). [2 marks]

c). Average fade duration (AFD) in millisecond. [2 marks]

d). Determine the speed of the vehicle in order to achieve AFD of 1 microsecond. [2 marks]

Q. 3. Let $\mathcal{P}_h(\tau)$ denote the power delay profile (PDP) of a wireless fading channel. Let the PDP is given by $\mathcal{P}_h(\tau) = P_0 \exp(-\mu\tau), \tau > 0$.

a). Determine the average delay spread and RMS delay spread in terms of μ. [2 marks]

b). Solve them for $\mu = 10^6$ sec^{-1}. [1 mark]

c). Give the relationship between delay spread and coherence bandwidth W_c. If the proportionality constant is 0.2, compute W_c. [1 mark]

d). If the symbol duration is 0.9 times to the RMS delay spread, compute the symbol rate. Furthermore, if 512-QAM is used, determine the bit rate. [1 + 1 marks]

Q. 4. a). An unbiased coin is tossed four times. If head is mapped '1' and tail is mapped to '-1', write all possible outcomes in the form of finite length (N = 4) sequences. [1 mark]

b). Compute Peak power-to-Average Power Ratio (PAPR) of all sequences in dB. [8 marks].

c). How many sequences have PAPR of 0 dB? [1 mark]

Q. 5. Each question carries 1.0 mark. Indicate 'TRUE' for true statement and 'FALSE' for false statement. Justify your answer in ONE sentence.

a). Consider the link budget analysis for a mobile cellular system. In it, uplink (UL) budget is the same as downlink (DL) budget.

b). Assume digital wireless communication over Rayleigh fading channel and Rician fading channel. The outage probability of Rayleigh fading channel is lower than Rician fading channel.

c). The frame rate of GSM frame is 216.6 frames per second (fps).

d). The IS-41 standard and the capability application part (CAP) are same standards used in mobile cellular networks.

e). The GSM cellular system uses TDMA along with frequency division duplexing (FDD).

f). Consider the architecture of mobile cellular communication network. In it, intelligent network (IN) is part of core network.

Q. 6. In the Figure shown below, identify multiple access schemes (from the left to the right) and give their application in mobile telecommunication networks. [3 points]