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MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SECOND SEMESTER M. Tech. (DEAC) DEGREE END SEMESTER EXAMINATION
April/May 2017
SUBJECT: WIRELESS COMMUNICATION (ECE - 5201)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates
- Answer **ANY FIVE** full questions.
- Missing data may be suitably assumed.

1A. Given a set of empirical path-loss measurements as: (d (m), P_r/P_t (dB)) = (5, -60), (25, -80), (65, -105), (110, -115), (400, -135), (1000, -150). (i) Find the parameters of a simplified path loss model (take $d_o = 1$ m). (ii) Estimate the path loss at 2 Km based on this model. Let f = 706 MHz.

1B. A baseband binary message is modulated by an RF carrier using BPSK and transmitted at the rate of 100 Kbps. (i) Find the range of RMS delay spread of the channel such that signal is flat fading signal (ii) If carrier frequency is 5.8 GHz and receiver is moving with speed of 30 miles/hour, find coherence time. (iii) Whether the channel of part (ii) is fast or slow fading (iv) If channel is static, how many bits are sent for the channel of part (ii)?

(5+5)

2A. A wideband channel has multipath intensity profile given by $\exp\left(-10^5\tau\right)$ in the range $0 \le \tau \le 20\ \mu s$.

(a) Find the coherence bandwidth, if channel's frequency transfer function has correlation exceeds 0.9 (b) Repeat your calculation if correlation is at least 0.5 (c) If symbol rate is 20 kilo symbols per second, whether the signalling will be frequency selective fading and why? (d) What is the value of RMS delay spread?

2B. Determine the required average bit energy to noise density ratio for BPSK modulation in slow Rayleigh fading such that, in 95% of the locations probability of bit error is less than or equal to 10^{-4}. Derive the formula used.

(5+5)

3A. Derive an expression for optimal power allocation and Shannon capacity of a wireless channel when CSI is available at both transmitter and receiver.

3B. Consider a flat fading channel of bandwidth 20MHz and where, for a fixed transmit power $\bar{P}$, the received SNR is one of three values: γ_1 = 20dB, γ_2 = 10dB, γ_3 = -5dB. The probabilities associated with each state are $p_1 = 0.25$, $p_2 = 0.4$ and $p_3 = 0.35$. Assume that only the receiver has CSI. (a) Find the Shannon capacity of this channel. (b) Plot the capacity versus outage for $0 \le P_{out} \le 1$ and find the maximum average rate that can be correctly received (maximum C_{out}).

(5+5)

4A. Using Hata model for urban and rural area, find the path loss if $f_c = 900\,\text{MHz}$, $h_t = 20\,\text{m}$, $h_r = 5\,\text{m}, d = 100\,\text{m}$

4B. If X and Y are independent zero mean Gaussian random variables with variance σ^2, show that the distribution $Z = \sqrt{X^2 + Y^2}$ is Rayleigh distributed and Z^2 is exponentially distributed.

(5+5)

5A. Find the coverage area for a microcellular system where path loss follows the simplified model (with $\gamma = 3$, $d_0 = 1$ m, and $K = 0$ dB) and there is also log-normal shadowing with $\sigma = 4$ dB. Assume a cell radius of 100 m, a transmit power of 80 mw, and a minimum received power requirement of $P_{min} = -100$ dBm.

5B. Write descriptive note on Diversity. With relevant diagrams, explain the Alamouti scheme of transmitter diversity in the absence of CSI at transmitter.

(5+5)