Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SEVENTH SEMESTER B. TECH (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2016
SUBJECT: WIRELESS COMMUNICATION (ECE - 405)

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

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

1A. For a Rayleigh fading wireless channel, derive an expression for outage probability and average probability of error for BFSK modulation.

1B. The scattering function for a fading channel is nonzero for the range $0 \le \tau \le 1$ ms and $-0.1 \le \rho \le 0.1$ Hz. Determine (a) Multipath spread (b) Doppler spread (c) Coherence time (d) Coherence bandwidth (e) Whether channel fading is frequency selective and why? (f) Whether channel signal is slowly fading and why?

1C. Consider an indoor wireless LAN with f_c = 1 GHz, cells of radius 100 m, and omnidirectional antennas. For free space path loss model, what should be the transmitted power if all receivers within the cell are to receive a minimum power of -40 dBm? Repeat your calculation for 500 m.

(5+3+2)

2A. A wideband channel has multipath intensity profile given by $\exp\left(-10^5\tau\right)$ in the range $0 \le \tau \le 20$ μs. (a) Determine 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. Calculate the outage probability of BPSK modulation at $P_b = 10^{-3}$ for a Rayleigh fading channel with SC diversity for the values of M equal to 1, 2 and 3, if each branch SNR value $\bar{\gamma}$ is 15 dB.

2C. Derive an expression for path gain for 2-ray model.

(5+3+2)

3A. For a cellular system operating at 900 MHz, the measured value of the received signal power has log-normal distribution given by $P_r\left(d\right) \propto d^{-3.3}$ for a transmitted power of 10 mW. At a reference distance of 1 m, the received power is 1 mW. At a distance of 10 m, it is found to be 11.5% more than the threshold value -28 dBm. Determine (a) the standard deviation at 10 m distance. (b) Repeat your calculation, if the distribution is $P_r\left(d\right) \propto d^{-3.8}$ with 14.5% more than threshold value of -35 dBm.

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) Determine the Shannon capacity of this channel. (b) Plot the capacity versus outage for $0 \le P_{out} \le 1$ and calculate the maximum average rate that can be correctly received (maximum C_{out}).

(6+4)

4A. 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.

4B. Consider a time-invariant block fading channel with frequency response

$$H(f) = \begin{cases} 1 & f_c - 20\text{MHz} \le f < f_c - 10\text{MHz} \\ .5 & f_c - 10\text{MHz} \le f < f_c \\ 2 & f_c \le f < f_c + 10\text{MHz} \\ .25 & f_c + 10\text{MHz} \le f < f_c + 20\text{MHz} \\ 0 & \text{else} \end{cases}$$

For a transmit power of 10mW and a noise power spectral density of 0.001μW per Hertz, calculate the optimal power allocation and corresponding Shannon capacity of this channel.

(5+5)

5A. Determine 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. Explain the principle of Threshold combining diversity technique and hence derive for average probability of bit error with DPSK modulation employed.

(5+5)

6A. Using Hata model for urban and rural area, determine the path loss if $f_c = 900\,\text{MHz}$, $h_t = 20\,\text{m}$, $h_r = 5\,\text{m}, d = 100\,\text{m}$.

6B. For a Rayleigh fading channel with $\sigma = 3\text{mV}$, calculate the probability that the received voltage will exceed threshold of 6 mV and 0.1 mV.

6C. How Doppler spread and ISI affects symbol error probability in fading channels? Explain.

(5+3+2)