Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

SEVENTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION
NOV/DEC 2015
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. Assume that each branch in selection combiner receives an independently Rayleigh- faded signal. The receiver must meet a requirement that the outage probability of the selection combiner for γ_o = 5dB is less than or equal to 10^{-4}. The average SNR of all the branches is 15 dB. (a) Calculate the number of diversity branches required in the receiver to meet this requirement. (b) Calculate the probability that any single branch achieves an SNR greater than 5dB. Derive the formulae used.

1B. A multipath fading channel has a multipath spread of T_m= 1 second and a Doppler spread B_d= 0.01 Hz. The total channel bandwidth at bandpass available for signal transmission is W= 5Hz. To reduce the effects of ISI, the signal designer selects a pulse duration T=10 s. (i) Determine the coherence bandwidth and coherence time. (ii) Is the channel frequency selective? Explain. (iii) Is the channel fading slowly or rapidly? Explain. (iv) Find transmission data rate.

1C. Derive an expression for path gain for 2-ray model.

(5+3+2)

2A. Explain Piecewise linear and simplified path-loss models in detail. Consider a receiver with noise power -160 dBm within the signal bandwidth of interest. Assume a simplified path loss model with d_o = 1 m, K obtained from the free space path loss formula, and f_c = 1GHz, and γ = 4. For a transmit power of P_t = 10 mW, find the maximum distance between the transmitter and receiver such that the received signal-to-noise power ratio is 20 dB.

2B. A fading channel shows an impulse response with peaks at relative power and time having the following values: -15 dB at 1µS, 0 dB at 10 µS, -25 dB at 18 µS and -10 dB at 25 µS. Determine average delay spread and RMS delay spread.

2C. Write Okumura and COST 231 path-loss model equations.

(5+3+2)

3A. Derive an expression for optimal power allocation and Shannon capacity of a block fading channel. Explain with all necessary diagrams

3B. Explain the principle of ZF, MMSE and MLSE equalization techniques

3C. Find 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}. NOTE: for BPSK, the target BER is achieved at SNR of 8.5 dB.

(5+3+2)

4A. 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 .001μW per Hertz, find the optimal power allocation and corresponding Shannon capacity of this channel.

4B. With relevant diagrams, explain the Alamouti scheme of transmitter diversity in the absence of CSI at transmitter.

4C. Consider a communication system, with transmitter and receiver placed 10 m apart, is operating at 1 GHz and has a time varying channel impulse response with N resolvable multipath components. Show that the minimum value of the product of carrier frequency and nth delay time is very much larger than unity. Is it true if the distance is changed to 100 m?

(5+3+2)

5A. Show that for a narrowband fading channel the autocorrelation of in-phase and quadrature components of received signal is same and WSS.

5B. Define, with necessary figures and equations, Power Delay Profile and Coherence Bandwidth. Hence, explain fading channel classifications.

5C. A BFSK system with average SNR of 10.969 dB transmits data over AWGN and Rayleigh fading channel. Find the probability of error for both the cases.

(5+3+2)

6A. For a Rayleigh fading wireless channel, derive an expression for outage probability and average probability of error for BPSK and BFSK modulation

6B. What are the advantages and disadvantages of 2-ray model? If h_t, h_r, and d values are 35m, 3m, and 250m respectively, then whether 2-ray model is applicable and why? Repeat your answer for 30, 1.5m and 450m.

6C. Consider a channel with Rayleigh fading and average received power of 20dBm. Find the probability that the received power is below 10dBm

(5+3+2)