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

(5+5)

2A. In terrestrial microwave link, LOS limits the separation of transmitter and receiver about 40km. If 100mW transmitter is used at 4GHz, find receiver power in dBm if (a) isotropic antennas are used (b) non-isotropic antennas with gains 30.5dB are used. Also find the induced voltage at the receiving antenna terminals, if matching impedance is 50ohms.

2B. Show that for a narrowband fading channel the autocorrelation of in-phase and quadrature components of received signal is same and WSS.

(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. If minimum SNR required for an acceptable performance is 7dB and average SNR is 15dB, find the outage probability of BPSK modulation for 2-branch SSC i.i.d. Rayleigh fading channel with threshold SNR values of 5dB and 10dB.

(5+5)

4A. Write descriptive note on Diversity. With relevant diagrams, explain the Alamouti scheme of transmitter diversity in the absence of CSI at transmitter.

4B. 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)

5A. 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.

5B. 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. Find (a) Multipath spread (b) Doppler spread (c) Coherence time (d) Coherence bandwidth (e) Whether channel fading is frequency selective or not? (f) Whether channel signal is slowly fading or not? Give reasons.

5C. 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)

6A. 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) 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 experience frequency selective fading? Give reasons. (d) What is the value of RMS delay spread?

6B. 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.

(5+5)