Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.Tech. (E & C) DEGREE END SEMESTER EXAMINATION
APRIL 2018
SUBJECT: WIRELESS COMMUNICATION (ECE - 5201)

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

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. 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}).

1B. The channel impulse response of an indoor free space channel is

$h(\tau,t) = 0.5\cos(2\pi f_1 t)\delta(\tau-20) + 0.3\cos(20\pi f_1 t)\delta(\tau-90) + 0.2\cos(40\pi f_1 t)\delta(\tau-170)$ where τ is in nsec and f_1 = 50Hz. (i) Find the maximum delay spread (ii) Find the maximum Doppler spread (iii) Find the coherence BW and coherence time (iv) Is this channel slow or fast fading, if the transmission is at 10kbps.

(5+5)

2A. Derive expressions for Autocorrelation, Cross Correlation and Power Spectral Density of Narrow band fading model.

2B. Find 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 branch SNRs value $\bar{\gamma}$ is 15 dB. Repeat your calculation for $P_b = 10^{-5}$

(5+5)

3A. 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)?

3B. Derive an expression for optimal power allocation and Shannon capacity of a block fading channel.

(5+5)

4A. For a cellular system operating at 900 MHz, the measured value of the received signal power has log-normal distribution given by $P_r(d) \propto d^{-3.3}$ 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. Find (a) the standard deviation at 10 m distance. (b) Repeat your calculation, if the distribution is $P_r(d) \propto d^{-3.8}$ with 14.5% more than threshold value of -35 dBm.

4B. Why an equalizer is required? Explain the principle of working of decision feedback equalizer.

(5+5)

5A. If the received power at a distance of 1 km is $1\,\mu W$, find the received power in dBm at distances of 2 km, 4 km and 8 km using 2-ray reflection model. Let h_t = 40 m, h_r = 3 m, $G_t = G_r$ = 0 dB, f = 1800 MHz. Also find and compare the received power obtained using simplified model in each of the above cases.

5B. For a Rayleigh fading wireless channel, derive an expression for outage probability and average probability of error for BPSK and QPSK modulation.

(5+5)