Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

SEVENTH SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2020/JANUARY 2021
SUBJECT: WIRELESS COMMUNICATION (ECE - 4101)

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

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

1A. Derive an expression for optimal power allocation and Shannon capacity of a block fading channel. Explain with all necessary diagrams.

1B. For a cellular system the reference distance for the antenna far field is 100 m and the path-loss exponent is a random variable taking on values 2, 2.5, 3 and 4 with probabilities 0.4, 0.3, 0.2 and 0.1 respectively. Assume a receiver at a distance of 1000 m from the transmitter with average transmit power constraint of 100 mW and a receiver noise power of 1mW. (i) Assuming that both transmitter and receiver have CSI, find the distribution of the received SNR (ii) Assuming only receiver CSI, determine the ergodic capacity per unit bandwidth for this channel (iii) Assuming both receiver and transmitter CSI, derive the optimal power adaptation policy for this channel and its corresponding Shannon capacity per unit bandwidth (iv) Assuming both receiver and transmitter CSI, determine the zero outage capacity per unit bandwidth of this channel.

(5+5)

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

2B. Consider a cellular system operating at 900 MHz where propagation follows free space path loss with variations from log normal shadowing with $\sigma = 4$ dB. Suppose that for acceptable voice quality a signal-to-noise power ratio of 10 dB is required at the mobile. Assume the base station transmits at 1 W and its antenna has a 3 dB gain. There is no antenna gain at the mobile and the receiver noise in the bandwidth of interest is -40dBm. Find the maximum cell size so that a mobile on the cell boundary will have acceptable voice quality 90% of the time.

(5+5)

3A. With usual notations, derive an expression for cell coverage area in detail. Obtain its simplified form also.

3B. Consider a receiver with noise power -120dBm within the signal bandwidth of interest. Assume a simplified path loss model with $d_0 = 1$ m, K obtained from the free space path loss formula with omnidirectional antennas and fc = 2 GHz, and $\gamma = 4$. 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. (Assume noise power is 10^{-19} W/Hz)

3C What is the distribution of channel fading coefficient of a Rayleigh fading channel? Calculate the probability that the attenuation of the channel is worse than -30dB.

(5+2+3)

4A. 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 and why? (f) Whether channel signal is slowly fading and why?

4B. 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 1 m and 100 m?

4C Comment on the Practical limitations related to the Implementation of Diversity schemes.

(4+3+3)

5A. Explain the Alamouti scheme when no CSI is available at the Transmitter. Show that how Alamouti Scheme Achieves a diversity order of two for a 2×2 (MIMO) system.

5B. Compare the average probability of bit error of BPSK under MRC and EGC two-branch diversity with i.i.d. Rayleigh fading with average SNR of 10 dB on each branch. Comment on the Probability of error.

5C What do you mean by "Parallel decomposition of a MIMO Channel"? Show that $\tilde{y} = \Sigma\tilde{x} + \tilde{n}$.

(4+3+3)