# MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
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**SIXTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION**
**MAY/JUNE 2023**
**SUBJECT: WIRELESS COMMUNICATION (ECE 3252)**

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

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

| Q. No. | Questions | M* | C* | A* | B* |
|---|---|---|---|---|---|
| 1A. | From fundamentals, obtain an expression for coverage area, assuming a circular cell. Give its simplified form also. | 5 | 2 | C3 | 3 |
| 1B. | A Wireless communication base station transmits 10 watts of power at a carrier frequency of 1GHz.If the receiver station is at a distance of 1.6km from the base station, then determine<br>(i) The propagation path loss (in dB) in a free space environment<br>(ii) The received signal power in dBm<br>(iii) The transmission delay in ns.<br>Assume that the transmitter and receiver antenna gains are 1.6 each. | 3 | 1 | C2 | 4 |
| 1C. | For the ten-ray model, assume that the transmitter and receiver are at the same height in the middle of a street of width 20m. The transmitter-receiver separation is 500m. Find the delay spread for this model. | 2 | 1 | C2 | 4 |
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| 2A. | Derive an expression for autocorrelation of in-phase and quadrature components and show that both are WSS random processes. | 5 | 2 | C3 | 3 |
| 2B. | Explain the power delay profile, Doppler power spectrum, and channel coherence time. | 3 | 2 | C3 | 3 |
| 2C. | Consider a channel with Rayleigh fading and average received power of 20dBm. Find the probability that the received power is below 10dBm | 2 | 2 | C3 | 4 |
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| 3A. | Derive an expression for optimal power allocation and Shannon's capacity of a time variant wireless channel. | 5 | 3 | C2 | 3 |
| 3B. | For a Rayleigh fading wireless channel, derive an expression for average probability of error in BFSK modulation | 3 | 4 | C2 | 3 |
| 3C. | Obtain the expression for outage probability and hence fade margin in Rayleigh fading channel. | 2 | 4 | C2 | 3 |
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| 4A. | Consider a time invariant frequency selective block fading channel that has four sub-channels of bandwidth B=10MHz. The frequency responses associated with each sub-channel are $H_1$=1, $H_2$=0.5, $H_3$=2 and $H_4$=0.25 respectively. The transmit power constraint is P= 10mW and noise PSD of $N_0/2$ with$N_0$=0.001μW/Hz. Find the Shannon's capacity of this channel and the optimal power allocation that achieves this capacity | 5 | 3 | C2 | 4 |

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|---|---|---|---|---|---|
| 4B. | Consider BPSK modulation in a channel with both log-normal shadowing of 8dB and Rayleigh fading. The desired maximum average error probability is $\overline{P_{bo}} = 10^{-4}$ . Determine the value of $\bar{\bar{\gamma}}_b$ that will ensure $\overline{P_b} \leq 10^{-4}$ with probability 1-$P_{out} = 0.95$ | 3 | 4 | C2 | 4 |
| 4C. | With neat diagrams, explain the principle of decision feedback equalizer | 2 | 1 | C2 | 3 |
| | | | | | |
| 5A. | With relevant diagrams, explain the Alamouti scheme of transmitter diversity in the absence of CSI at transmitter and derive necessary equations. | 5 | 5 | C2 | 3 |
| 5B. | Derive an expression for maximum SNR achieving condition in Maximal Ratio Combining (MRC) technique | 3 | 5 | C2 | 3 |
| 5C. | Find the outage probability of BPSK modulation at $P_b \leq 10^{-3}$ for a Rayleigh fading channel with Selection Combining (SC) diversity for M=1 (no diversity), M = 2 and M = 3. Assume equal branch SNR of 15 dB. | 2 | 5 | C2 | 4 |

**M*--Marks, C*--CLO, A*--AHEP LO, B* Blooms Taxonomy Level**