Wireless Communications

Monsoon 2025

Exam: Mid Semester
Total Marks: 40

Date: 23 September 2025
Time: 4:30 PM to 06:00 PM

Instructions:

- All questions are compulsory.
- Clearly state the assumptions (*if any*) made that are not specified in the question.

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1. Assuming perfect Channel State Information at the Transmitter (CSIT), derive the expression for the maximum achievable capacity. Clearly explain the corresponding capacity-achieving system model. Also, provide your interpretation for the considered constraints and the obtained solutions. [10]

2. Explain the Maximum Ratio Combining (MRC) technique. Derive its array gain and diversity order for the Rayleigh fading channels. [8]

3. A wireless communication system operates over a frequency-selective fading channel with 4 parallel subchannels. Each subchannel experiences independent and time-invariant fading, and the channel gains are given as: [8]

$$|h_1|^2 = 0.5, \quad |h_2|^2 = 2, \quad |h_3|^2 = 1.5, \quad |h_4|^2 = 0.2$$

The total transmit power budget is $P = 10$ units, and the noise power per subchannel is $N_0 = 1$. Assuming CSIT, answer the following:

   (a) Compute the power allocated to each subchannel.

   (b) Calculate the maximum capacity achievable by the channel.

4. Derive the average bit error probability for BPSK and BFSK over a Rayleigh fading channel. Then, determine the required bit duration T_b to achieve an average bit error probability of 10^{-3}, given that the ratio of the fading gain to the noise variance is 10. [8]

5. State and explain the key performance indicators (KPIs) used to measure the impact of fading in wireless communication systems. [6]

ALL THE BEST!