Y/K/TX

Reg. No: 21BEC0765

VIT
Vellore Institute of Technology

Final Assessment Test – November 2024

Course: **BECE307L - Wireless and Mobile Communications**

Class NBR(s): **2746/ 2749 / 2753 / 2758 / 2760 / 2763 / 2765 / 2767 / 2770 / 2775**

Slot: **A1**

Time: **Three Hours**

Max. Marks: **100**

- **KEEPING MOBILE PHONE/ANY ELECTRONIC GADGETS, EVEN IN 'OFF' POSITION IS TREATED AS EXAM MALPRACTICE**
- **DON'T WRITE ANYTHING ON THE QUESTION PAPER**

General Instructions : Erlang B, Erlang C, Q Tables, and Okumura charts are permitted

Answer ALL Questions

(10 X 10 = 100 Marks)

1. i) Distinguish the different types of channel assignment strategies. **[5]**

   ii) Describe the concept of cell splitting. Determine the transmitted power of the smaller cell's base station when the transmitted power of the larger cell's base station is 20 watts, the path loss exponent is 4, and the received powers of both base stations are equal. Comment on the result. **[5]**

2.(a) Employing the Okumura Model, compute the median path loss at the cell edge of cellular system with a cell radius of 10 km, $f_c = 2\ GHz$, $h_{te} = 40\ m$ and $h_{re} = 2\ m$. Assume a large city environment.

OR

2.(b) I) A company with 100 employees was provided with wireless public phone service with four lines. Each employee on an average makes a three-minute telephone call every two hours. Calculate **[4]**

   i) the traffic load

   ii) the blocking probability

   II) A cellular phone owns 100 cell sites and 20 is the traffic intensity per cell with a bandwidth of 30 kHz. Assuming each user makes three calls per hour and the average holding time per call is 4 minutes, determine the number of channel per cell and total number of subscribers that the service provider can support with a GoS of 2%. **[6]**

3. Assume that extensive measurements have been done in an area and a multipath channel model is constructed whose power-delay profile consists of 4 paths arriving 0.1 μs apart. First path arrives and assumed to have unit power (0 dB), and, subsequent paths have 3 dB reductions in power as compared to

the previous one. What is the largest transmitted signal bandwidth of this channel without frequency selective fading, if the channel correlation is 90%?

4. i) What is carrier aggregation in LTE-A, and how does it enhance network performance? [5]

ii) Explain the basic architecture of LTE with a brief description of its key components. [5]

5.(a) Consider an OFDM system that operates with a transmission bandwidth of 4 MHz. The channel coherence bandwidth is 200 kHz. The subcarrier bandwidth is fixed to be 10% of the coherence bandwidth to avoid the effects of frequency selective fading i.e., $B_{sc} = 0.1B_c$. Determine the following

i) number of subcarriers [5]

ii) symbol time without cyclic prefix (CP) [2]

iii) number of samples in the CP (given that CP occupies 20% of the raw symbol time). [3]

OR

5.(b) i) Calculate the BER of an OFDM system with N = 256 subcarriers and L= 16 channel taps. The transmit Signal-to noise ratio (SNR) of the system is 35 dB. Compare this BER performance with a system that does not employ multi-carrier modulation. [5]

ii) How the PAPR problem is addressed through SC-FDMA? Explain with the help SC-FDMA transmitter schematic. [5]

6. For a wired communication system that uses BPSK modulation, find the following:

i) What is the allowed SNR for achieving the BER as 5.375×10^{-5}.

ii) What would be the transmit power if the noise variance is -30 dBm?

iii) For a Rayleigh faded SISO communication system, what may the BER be for the same transmitting SNR?

iv) Find the probability of deep fading for the same Rayleigh faded SISO communication environment. Describe the causes of the deep fading.

7. Consider a wireless communication system with $L = 3$ receive antennas. The complex fading channel coefficients are given by $h_1 = 0.5 + j\,0.5$, $h_2 = 0.3 + j\,0.4$, and $h_3 = 0.7 - j\,0.2$. The transmitted signal, $x(t)$, is BPSK modulated, where $x(t)$ can take values $+1$ volt or -1 volt. The received signals at the different antennas are $y_1(t), y_2(t)$, and $y_3(t)$ is given by $y_i = h_i x(t) + n_i(t); i = 1,2,3$, where $n_i(t); i = 1,2,3$ are Gaussian distributed independent random variables with variance $\sigma_n^2 = 1$.

a) If Maximal Ratio Combining (MRC) technique is employed at the receiver, then find the MRC weights that would result in minimum BER. [4]

b) Find the maximum SNR that can be obtained with MRC applied to this system. [3]

c) Calculate the BER for the system under consideration. [3]

8. Consider a channel matrix given below:

$$H = \begin{bmatrix} 1 & 2 \\ 1 & -2 \\ 1 & -2 \\ 1 & 2 \end{bmatrix}$$

If noise power $\sigma^2 = 16\text{W}$ and total power $P_0 = 5\text{W}$. Determine the optimal power allocation for this system.

9. Describe the methods used by NOMA for simultaneous user access and illustrate its operation in a downlink scenario with two users.

10. a) List the differences between Device-to-Device (D2D) communication and conventional Bluetooth technology. [5]

b) What specific performance targets does 6G aim to achieve regarding peak data rate, user experience data rate, spectral efficiency, energy efficiency, latency, connection density, and reliability? [5]

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