GLASGOW COLLEGE UESTC

Exam paper

Mobile Communications (UESTC 4017)

Date: Jan. 6th 2020
Time: 14:30-16:30

Attempt all PARTS. Total 100 marks

Use one answer sheet for each of the questions in this exam.
Show all work on the answer sheet.

Make sure that your University of Glasgow and UESTC Student Identification Numbers are on all answer sheets.

An electronic calculator may be used provided that it does not allow text storage or display, or graphical display.

All graphs should be clearly labelled and sufficiently large so that all elements are easy to read.

The numbers in square brackets in the right-hand margin indicate the marks allotted to the part of the question against which the mark is shown. These marks are for guidance only.

Continued overleaf

Q1 (a) Describe the concept of FDD and TDD mode. [4]

(b) Describe the concept of the multiple access methods. [3]

(c) Write down 4 basic multiple access methods in modern mobile communication system and describe their corresponding concepts. [8]

(d) Why the direct sequence spreading spectrum (DS-SS) technology can effectively suppress narrowband interference. Please explain the reason using the diagrams to describe the spectra of i) the original information signal before spreading, ii) the transmitting information signal after spreading, iii) the received spread signal (with narrowband interference) before dispreading, iv) and the signal after dispreading, and v)the dispread signal after bandpass filter. [10]

Q2 (a) There is mobile system, the coverage distance for its cell is d=200m. The carrier frequency is 900MHz and $G_t = G_r = 1$, where G_t and G_r denote the transmit antenna gain and the receive antenna gain respectively. If the minimal acceptable power of the received signal is 10uW, please calculate the minimal transmit power with free space loss model. [7]

(b) If the measured received power is 10^{-5} mW when the distance between the transmitter and the receiver is 1m, and the measured received power is 10^{-6} mW when the distance between the transmitter and the receiver is 10m. Please calculate the path loss exponent n for log-distance pass loss model. [8]

(c) If the bandwidth of the wireless channel is 50KHz, the power spectrum density of the addictive white Gaussian noise (AWGN) is $N_0 = 10^{-9}$ W/Hz. Utilizing the result in (a) to calculate the channel capacity if the distance between the transmitter and the receiver is 1km. [10]

Q3 (a) Assume a single pulse signal is applied to the input of the multi-path wireless channel, the received single passing through the wireless channel is $\{x_n\} = \{..., x_{-2}, x_{-1}, x_0, x_1, x_2, ...\} = \left\{..., 0, \frac{1}{3}, 1, \frac{1}{4}, 0, ...\right\}$. Please design a 3-tap time domain equalizer, and find out

(i) 3 weighting factors of the 3-tap time domain equalizer to mitigate the multi-path interference. [10]

(ii) the output signal after the above 3-tap equalizer. [10]

(iii) the inter-symbol interference before the equalizer and after the equalizer, respectively. [5]

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Q4 (a) The local average power delay profile in a particular environment is found to be $P(\tau)=\sum_{n=0}^{2}\frac{10^{-2}}{2^{n}}\delta(\tau-5n\times10^{-6})$, draw the power delay profile of the channel in dBm ($\log_{10}2=0.3$). [6]

(b) Calculate the mean excess delay and the root mean square (RMS) delay of the given channel. [8]

(c) If 256-QAM modulation having a bit rate of 4 Mbit /s is applied to the channel, will the modulation undergo flat or frequency selective fading? Explain your answer. (Channel is considered to be constant when the correlation exceed 0.9) [6]

(d) If OFDM signal using BPSK modulation is transmitted over this RF channel, the bandwidth of OFDM symbol is B_{OFDM} =400KHz , find the minimum number of subcarriers $N_{\min}$ and the minimum length of cyclic prefix N_{CP} so as to avoid inter symbol interference. [5]

End of question paper