GLASGOW COLLEGE UESTC

Exam paper

Advanced Digital Communication (UESTC4028)

Date: 29th, December
Time: 9:30-11:30

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) Explain the operation of a regenerative repeater. [5]

(b) Show mathematically why a low pass filter is needed in a Quadrature Amplitude Modulation (QAM) receiver. [7]

(c) With the aid of a diagram, describe a Quadrature Phase Shift Keying (QPSK) generator. [5]

(d) A user, User A, has Code Division Multiple Access (CDMA) code (1, -1) and data (0, 0, 1, 1). [8]

i. What is the transmitted CDMA signal by User A?

ii. Assuming there is another user, User B, with code (1,1) and the receiver receives the signal (1, -1, -1, 1, -1, 1, 1, -1). Determine if User B transmitted any data.

Q2 (a) Describe the operation of Stop and Wait Automatic Repeat reQuest. [5]

(b) Consider a linear block code with codeword defined by $U = m1 + m2 + m4 + m5$, $m1 + m3 + m4 + m5$, $m1 + m2 + m3 + m5$, $m1 + m2 + m3 + m4$, $m1$, $m2$, $m3$, $m4$, $m5$ and minimum distance of 3. [8]

i. Show the generator matrix.

ii. Show the parity check matrix.

iii. What is the error-correcting capability of the code?

iv. What is the error-detecting capability of the code?

(c) Compare and contrast Frequency Division Duplexing (FDD) and Time Division Duplexing (TDD). [6]

(d) Give 2 scenarios where using digital communication would not be ideal. [6]

Q3 (a) Explain what is Additive White Gaussian Noise (AWGN) channel? [4]

(b) Assume a communication is composed of coding, modulation, OFDM, RF and antenna, draw a figure to show the processing chain of the components at the transmitter side. [8]

(c) Draw a figure to show the receiver processing chain to detect the signal sent by the system in Q3-(b), channel equalisation should be considered. [4]

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(d) Design a 3-tap Zero Forcing (ZF) equalizer for input x(n) = {0, 0.1, 0.15, -0.87, 0.12, -0.2, 0} in which x(0) = -0.87. [9]

Q4 Assume a communication system consists of coding, modulation and Cyclic Prefix – Orthogonal Frequency Division Multiplexing (CP-OFDM) modules. The coding rate is 0.5, modulation scheme is QPSK, OFDM subcarrier spacing is 10 kHz.

(a) List three advantages and two disadvantages of OFDM system? [5]

(b) Calculate the OFDM symbol duration in seconds. [5]

(c) Assuming the guard-band is 12.5% at each side, calculate the minimum communication bandwidth to achieve the data rate of 4000 bits per OFDM symbol. [5]

(d) Based on the result of Q4-(c), assume the communication channel has a duration of 45 μs, calculate the minimum CP-OFDM symbol duration in samples. [5]

(e) Calculate the overall overhead (in percentage) by considering both time and frequency domains. [5]

End of question paper