

UNIVERSITY OF SWAZILAND

Faculty of Science

Department of Computer Science

MAIN EXAMINATION December 2009

Title of Paper: NETWORKS AND CODING THEORY – I

Course Number: CS437

Time Allowed: 3 hours

Instructions to candidates:

*This question paper consists of **SIX (6)** questions. Answer any **FOUR (4)** questions.*

Marks are indicated in square brackets.

All questions carry equal marks.

**THIS EXAMINATION PAPER SHOULD NOT BE OPENED UNTIL PERMISSION HAS BEEN
GRANTED BY THE INVIGILATOR**

QUESTION 1

- a) Computer networks are divided into several layers, for instance, ISO's OSI has seven layers, the Internet's TCP/IP has only 4 layers. In our lecture we used 5 layers. What is the open systems concept (in the context of the OSI model)? State any 4 reasons why we need the layered structure for computer networks? [6]
- b) What are the five layers discussed in this course? What is a network "protocol"? What are the main disadvantage(s) of using a layered network architecture? [6]
- c) Describe the fundamental difference between cross over and straight through twisted pair cables? [3]
- d) Operations of similar functionality can be performed at different layers of a protocol stack. At which layers are the following done?
i) Routing
ii) Multiplexing
iii) Error detection and correction
iv) Flow control and framing
v) Signaling/ Data Encoding [10]

QUESTION 2

- a) Suppose you have a channel from 10 000Hz to 22 000Hz, with an SNR of 18dB. Assuming that you can achieve about 1/3 of the Shannon's limit,
i) What is the data rate of your channel and
ii) How many signal elements/levels should you use? [7]
- b) One way of detecting errors is to transmit data as a block of n rows of k bits per row and adding parity bits to each row and each column. Will this scheme detect all single errors? Double errors? Triple errors? [6]
- c) The binary string 10111010111 represents a 7-bit ASCII character using Hamming coding and odd parity. Given that the bit string has been subjected to a single bit error. Which bit is in error? Show all your working. [6]
- d) Describe frequency division multiplexing and time division multiplexing indicating what type of signal use each type of multiplexing [6]

QUESTION 3

- a) Explain the concept of bandwidth and how it limits the baud rate. Explain how the baud rate and the bit rate relate. What will limit the maximum bit rate you can achieve? [6]
- b) Cyclic Redundancy Checks (CRC) are used to detect errors in longer messages. If the polynomial used is : $x^5 + x^3 + 1$ [6]
- i) What is the binary representation of this polynomial?
 - ii) The sequence 001001100011011111110110011100001 is a message followed by a CRC generated using the polynomial above. Write down the message and the CRC.
- c) With the aid of clear diagrams, show the encoded signal if the bit stream 1100111010010110 is encoded using:
i) Manchester encoding
ii) NRZ-L
iii) Differential Manchester encoding
Assume the first bit starts at a high voltage level. [7]
- d) Describe character stuffing and bit stuffing. Why are they needed? [6]

QUESTION 4

- a) Explain the principle of operations of an ADSL modem and cable modem. [6]
- b) "Packet-switching provides more efficient communication of data between computers than is possible with circuit-switching".
i. Explain the terms circuit-switching and packet switching used in this statement. Provide arguments to justify the statement.
ii. Packet-switched networks may operate using either virtual circuits (VC) or datagrams; explain the differences between these two approaches and their advantages and disadvantages. [10]
- c) Describe the advantages and the disadvantages of fiber optics cable compared to copper cables for computer communications? [6]
- d) What happens in CSMA/CD when a node detects that its data has suffered a collision? [3]

QUESTION 5

- a) Explain the operation of the Carrier-Sense, Multiple Access (CSMA) channel allocation algorithm. Distinguish between the persistent, non-persistent and p-persistent versions of the algorithm. [7]
- b) State any 4 factors that can be used to compare encoding/signaling techniques. Under what circumstances do we need to encode digital data to analogue signals? Briefly describe the following techniques:
i. Amplitude Shift Keying (ASK)
ii. Pulse code modulation (PCM) [10]
- c) Automatic Repeat Request (ARQ) protocols aim to provide a Connection Oriented style service based on simple services providing only framing. "Go-back-N" and "Selective Retransmissions" are two such ARQ protocols.
i) Give illustrated examples of how Go-back-N and selective re-transmissions work.
ii) Briefly discuss the relationship between sequence numbers and window sizes in ARQ protocols.
iii) Explain the concept of Piggybacking. [8]

QUESTION 6

- a) Is packet switching always more efficient than circuit switching? Briefly explain your answer. [4]
- b) Why is **Modulo2** arithmetic used in calculating CRCs? [3]
- c) What is the difference in functionality of an ISDN connection compared to a normal voice line? [6]
- d) List two ways in which the OSI reference model and the TCP/IP reference model are the same. Now, list the two ways in which they differ. [4]
- e) In an Ethernet using CSMA/CD protocol, when two nodes transmit at the same time, a collision happens. Can you explain how they resolve this collision? Please justify your answer. [8]

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