UNIVERSITY OF SWAZILAND

Faculty of Science

Department of Computer Science

MAIN EXAMINATION December 2012

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.

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QUESTION 1

a) i) What is the open systems concept as applied to network models? [2]

ii) State any 3 reasons why we use the layered structure for computer networks? [3]

iii) What is the difference between a protocol and an interface? [2]

b) The Data Link layer, Network layer and Transport layer are layers in the OSI reference model. Describe the key functions of these three (3) layers. [9]

c) Operations of similar functionality can be performed at different layers of a protocol stack. With reference to the OSI reference model which layer, layers, or sub layer is associated with each of the following terms, functions,
   i) Routing
   ii) Encryption
   iii) Error detection and correction
   iv) Flow control and framing
   v) Signaling/ Data Encoding [5]

d) Describe the fundamental difference between cross over and straight through twisted pair cables? [4]

QUESTION 2

a) Given that the speed of light is 3×10^8m/s. A satellite is at geosynchronous orbit. How long would it take for a signal to go from the earth station to the satellite (minimum time)? Assume that the distance of the satellite from the earth (ground) is 35 863km. [6]

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? [4]

c) The binary string 10111010111 represents a 7-bit ASCII character encoded using Hamming coding and assuming **ODD** parity. Given that the bit string has been subjected to a single bit error. Which bit is in error? Show all your working. What **ASCII** character is being transmitted? [8]

d) What is multiplexing and why is it commonly carried out in communications networks? Describe frequency division multiplexing and time division multiplexing indicating what type of signal use each type of multiplexing. [7]

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 generator polynomial, G(x), used is: $x^5 + x^4 + x^2 + 1$ and the data to be transmitted ,M(x), is **1001101100**, Determine the frame, T(x), that will be transmitted.
[6]

c) With the aid of clear diagrams, show the encoded signal if the bit stream **11001101001** is encoded using:
   i)   Manchester encoding
   ii)   NRZ-I
   iii)   Differential Manchester encoding
   Assume the first bit starts at a high voltage level. [9]

d) Describe character stuffing and bit stuffing. Why are they needed? [4]

QUESTION 4

a) Explain the principle and 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". [9]
   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.

c) The serial ports on two computers which use binary signaling are connected by a twisted pair cable. The cable has a flat frequency response up to **12 kHz**, with negligible group delay distortion.

   i. What is the maximum information transfer rate that can be accommodated by the cable, assuming a noise-free environment?
   ii. If the noise introduced by the cable is **-40 dB** with respect to the signal power, what is the resulting maximum information transfer rate?

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 1-persistent, and p-persistent versions of the algorithm. [6]

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? [5]

c) Briefly describe the following techniques:
   i. Amplitude Shift Keying (ASK)
   ii. Pulse code modulation (PCM) [6]

d) 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) Determine the height of an antenna for a TV station that must be able to reach customers up to 80km away. [5]

b) Why is **Modulo2** arithmetic used in calculating CRCs? [2]

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 and 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. [4]

f) Give 2 reasons why networks might use error correcting codes instead of error detection and retransmission. [4]

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