UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

MAIN EXAMINATION 2006

TITLE OF PAPER: DATA NETWORK AND CODING THEORY I

COURSE NUMBER: CS437

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: ANSWER QUESTION 1 AND **ANY THREE** OF THE

OTHER FOUR QUESTIONS.

EACH QUESTION CARRIES **25 MARKS**.

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QUESTION 1 (Compulsory)

a) Name and briefly describe the layers of the OSI model. Include in your description the process of how data is encapsulated and decapsulated.

[15]

b) Describe three different types of data network topologies, using diagrams to illustrate each type.

[6]

c) A 12 bit Hamming code whose hexadecimal value is 111001001111 arrives at a receiver. What was the original value that left the transmitter in hexadecimal? Assume that not more than 1 bit is in error, and even parity is used.

[4]

QUESTION 2

a) Describe two different types of guided transmission media, indicating when it would be appropriate to use one over the other.

[6]

b) Describe the bandwidth of a signal and bandwidth of a transmission medium.

[5]

c) A signal is made up of four (4) simple signals, with the following amplitudes and frequencies: 10 and 600Hz; 12 and 5.6 KHz; 8 and 3.8 KHz; 5 and 1.2 KHz. Draw a frequency domain diagram of the signal; what is the bandwidth of the signal?

[5]

d) Describe two (2) multiplexing techniques, indicating what type of signals use each type of multiplexing.

[5]

e) Why can voice and data transmission be done simultaneously on ADSL lines? Why are the lines called **Asymmetric** (Digital Subscriber Lines)?

[4]

QUESTION 3

a) A certain transmission channel allows for frequencies between 25 MHz and 135 MHz and has a signal to noise ratio of 32 dB. What is the channel's capacity?

[4]

b) Given the binary information **0101 1001 0010**, show how it can be transmitted over an analogue transmission medium using
    (i) Frequency modulation
    (ii) Amplitude modulation.

[5]

c) Using phase shift modulation, describe how the information in **(b)** can be transmitted using 2 bits per baud.

[3]

d) Does the CSMA/CD MAC protocol eliminate the possibility of collisions? Explain your answer.

[3]

e) Does an Ethernet switch modify Ethernet headers?

[2]

f) A 1 Km fibre optic link between nodes A and B has a bandwidth of 1 Mbps. Information on the link travels at the speed of light, which is 3×10^8 m/s. A sends a 1 KB packet to B. Give an expression for the propagation delay.

[2]

g) A message of **5000 bytes** is to be sent from node A to node C, via node B, as shown by the diagram below. Message and packet switching are used for the transfer, where packets can be a maximum of **2000 bytes**. Determine the time between the first bit leaving node A and the last bit reaching node C for both the message switching and packet switching. Ignore the processing delay at each node. The propagation speed for the links connecting any two nodes is 2×10^8 m/s.
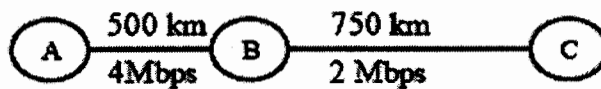
[6]

QUESTION 4

a) Show the encoded signal if the bit stream **110011101001** is encoded using
  (i) NZRL encoding
  (ii) Differential Manchester encoding
  (ii) MLT-3 encoding.

[8]

b) You are tasked with designing an error control strategy for sending 4-bit messages.
(i) What is the minimum number of redundant bits required for the receiver to be able to detect all 1-bit errors? Describe how the redundant bits are generated.
(ii) What is the minimum number of redundant bits required for the receiver to be able to correct all 1-bit errors? Show how you determine this.

[4]

c) What is Hamming Distance? Find the Hamming Distance for the codewords **101101, 000000, 110011, 100001.**

[4]

d) Determine the transmitted codeword for the message word given by the polynomial $x^5 + x^4 + x^2 + x$, using the generator polynomial $x^3 + 1$.

[4]

e) Describe the Simplex Stop-and-Wait protocol for both an error free channel, and a noisy channel.

[5]

QUESTION 5

a) What is the difference between a hub and a switch? At what layer of the OSI model do they operate?

[3]

b) Describe Pulse Code Modulation. Why is it necessary in telecommunication networks?

[4]

c) Consider the use of 10000 bit frames on a 1 Mbps satellite channel, where the satellite relay station is located 35000 Km above the earth's surface. The propagation speed of electromagnetic waves in air/vacuum is 3×10^8 m/s. What is the maximum link utilization for:
   a) Stop-and-wait flow control protocol
   b) Sliding window flow control protocol, with a window size of 7
Assume that acknowledgement frames are of negligible size.

[5]

d) What differentiates LANs, MANs and WANs?

[4]

e) A 1 Km long, 4 Mbps CSMA/CD LAN has a propagation speed of 2×10^8 m/s. Data frames are 256 bits long, including 32 bits of header, checksum, and overhead. The first bit slot after a successful transmission is reserved for the receiver to capture the channel to send a 32 bit acknowledgement frame. What is the effective data rate, excluding overhead, assuming that there are no collisions?

[4]

f) With the assistance of a diagram, describe the functions of each field of an HDLC frame.

[5]

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