

UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

MAIN EXAMINATION 2005

TITLE OF PAPER: DATA NETWORK AND CODING THEORY (I)

COURSE NUMBER: CS440 (I)

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: ANSWER QUESTION 1 AND ANY **THREE** OF THE
OTHER FOUR QUESTIONS.

EACH QUESTION CARRIES **25 MARKS**.

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GIVEN
BY THE INVIGILATOR.

QUESTION 1 (Compulsory)

- a) What is the OSI Model? Describe the function of each layer of the OSI Model. [15]
- b) Describe three different types of data network topologies, using diagrams to illustrate each type. [6]
- c) What differentiates LANs, MANs and WANs? [4]

QUESTION 2

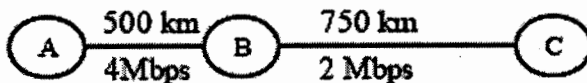
- a) Describe how fibre optic is used to transmit data. [5]
- b) Given the binary information **01011001001001**, show how it can be transmitted over an analogue transmission medium using
 (i) Frequency modulation
 (ii) Phase shift modulation. [6]
- c) Using phase shift modulation, show how 2 bits per baud can be transmitted. [4]
- d) A person on a bicycle travelling at 30 Km/hr can carry 10 CDs, each CD containing **650 MB** ($1\text{MB} = 2^{20}$ bytes) of data. For what range of distances would it be faster to use the person on the bicycle to transfer the information on 10 CDs, than to use a **2 Mbps** ($1\text{Mbps} = 10^6$ bps) data line to transfer the data? [5]
- e) Describe Frequency Division Multiplexing and Time Division Multiplexing, indicating what type of signal use each type of multiplexing. [5]

QUESTION 3

a) A **9600 baud** modem uses a constellation diagram with data points at the following coordinates: (1,0), (3,0), (1,1), (2,2), (3,3), (-1,0), (-3,0), (-1,1), (-2,2), (-3,3), (-1,-1), (-2,-2), (-3,-3), (1,-1), (2,-2), (3,-3). How many amplitude levels and phase levels are employed? What is the data rate in Kbps of the modem?

[8]

b) A message of **5000 bytes** is being sent using packet switching from node A to node C, via node B, as shown by the diagram below. Determine the time between the first bit leaving node A and the last bit reaching node C. Ignore the processing delay at each node. The propagation speed for the links connecting any two nodes is 2.5×10^8 m/s.



[5]

c) A certain transmission channel allows for frequencies between 3.725 GHz and 4.175 GHz and has a signal to noise ratio of 24dB. What is the channel's capacity?

[4]

d) A link is to be operated at a bandwidth efficiency of $B=15$, i.e. at a rate of 15 bps for each Hz of bandwidth. Obtain the minimum signal to noise ratio required at the receiver to allow in theory the error-free transmission with this bandwidth efficiency. Express your answer in dB.

[3]

e) Explain in detail the operation of an Ethernet bridge when used to connect two Ethernet LAN segment. Your description should include reasons why a bridge is introduced in a LAN.

[5]

QUESTION 4

a) Determine the transmitted codeword for the message word given by the polynomial $x^7 + x^4 + x^3 + x$, using the generator polynomial $x^3 + x^2 + 1$.

[5]

b) Provide a description of the key differences between a hub, a switch, a bridge and an IP router.

[5]

c) Show the encoded signal if the bit stream 1100111010010110 is encoded using
(i) Manchester encoding
(ii) MLT-3 encoding.

[5]

d) Draw a diagram for the **IEEE 802.3** frame and the **Ethernet II** frame. What are the minimum and maximum frame sizes of the two frame types?

[7]

e) If the bit string 011110111110111110 is subjected to bit-stuffing, what is the output string?

[3]

QUESTION 5

a) What is the Medium Access Control (MAC) protocol? Describe the operation of the CSMA/CD medium access (MAC) protocol.

[5]

b) Ethernet supports broadcast, unicast and multicast transmission modes. Explain what is meant by each term, and provide examples of MAC addresses of each type.

[6]

c) Sixteen stations are contending for the use of a shared channel using the adaptive tree walk protocol. If all the stations whose addresses are prime numbers suddenly become ready at once, how many bit slots are required to resolve the contention?

[5]

d) A group of N stations share a 64 kbps pure ALOHA channel. Each station outputs a 1000 bit frame on an average of once every 100 sec, even if the previous one has not yet been sent (e.g. stations are buffered). What is the maximum value of N ?

[5]

e) A 1 Km long, 10 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]