UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

MAIN EXAMINATION 2013

TITLE OF PAPER: NETWORKS AND CODING THEORY I

COURSE NUMBER: CS437

TIME ALLOWED: THREE HOURS

INSTRUCTIONS: ANSWER **ANY FOUR QUESTIONS.**

EACH QUESTION CARRIES **25 MARKS.**

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QUESTION 1

a) List four bottom layers of the ISO Open Systems Interconnection architecture and briefly describe what each layer does.

[8]

b) What differentiates LANs, MANs and WANs?

[5]

c) Differentiate between guided media and unguided media.

[3]

d) What is the function of the twists in twisted pair wire?

[2]

e) Describe how data is transmitted using fibre optic cable.

[3]

f) Define channel bandwidth and channel capacity.

[4]

QUESTION 2

a) What is the key difference between a hub, a switch and an IP router?

[3]

b) Use clear diagrams to show the encoded signal if the bit string **001110011011** is encoded using:

i) Non-return to Zero Inverted
ii) Differential Manchester encoding

Assume that the signal has a negative voltage before the first bit is transmitted

[6]

c) Show the encoded analogue signal if the bit string in b) is encoded using:

i) Amplitude Shift Keying
ii) Quadrature Phase Shift Keying

[6]

d) Wireless LANs operate at frequencies between 902MHz and 928MHz and 2.4 GHz and 2.4835GHz. yet the data speeds supported by wireless are less than those supported by category 5 UTP which operates at frequencies from 0 to 100 MHz. Explain why this is the case.

[3]

e) A certain transmission channel allows for frequencies between 902MHz and 928MHz and has a signal to noise ratio of 27dB. What is the channel's capacity?

[4]

f) Given a **5 Mbps** satellite link connecting two ground stations, find the bit length of the link. The bit length is defined as a frame whose size is such that when the first bit of the frame reaches the receiver, the last bit of the frame is leaving the sender. The satellite is located **36, 000 km** above the earth's surface, and electromagnetic waves travel at **300, 000 km/s** in air and vacuum.

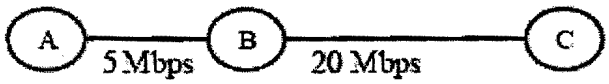
[3]

QUESTION 3

a) Describe how PCM works.

[4]

b) A message of **5500 bytes** is being sent using packet switching from node A to node C, via node B, as shown by the diagram below. The link between nodes A and B is a 100 Km fibre optic link, while the nodes B and C are connected by a satellite link, where the satellite is located 36, 000 km above the earth's surface. The propagation speed for fibre optic is 250, 000 Km/s, while the propagation speed over air or vacuum is 300, 000 Km/s. Given that the maximum packet size is **1500 bytes**, find the time it takes for the message to be sent from A to B.



[6]

c) Using phase shift modulation, show how **3 bits** per baud can be transmitted.

[3]

d) With the assistance of an example, describe how character stuffing works.

[4]

e) What is Hamming Distance? Find the Hamming Distance for the codewords **10010101, 00000000, 10111001, 10000001.**

[4]

f) Determine the transmitted codeword for the message word given by the data string **1001011110**, using the generator polynomial $x^3 + x + 1$.

[4]

QUESTION 4

a) Describe each of the following ARQ protocols making sure to highlight the differences between them

(i) Stop-and-wait ARQ
(ii) Go back N ARQ
(iii) Selective repeat

[8]

b) Describe the operation of the pure Aloha protocol. Why is slotted Aloha more efficient than pure Aloha?

[5]

c) For sliding window protocols, what is:
the Sender Window?
the Sender Window size?
the Receiver Window?

[4]

d) Consider the use of 512 bytes frames on a 1 Mbps satellite channel with a 270ms delay. What is the maximum link utilization for stop-and-wait flow control? Acknowledgement frames are 40 bytes.

[4]

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

[4]

QUESTION 5

a) A person on a bicycle travelling at 50 Km/hr can carry 5 DVDs, each DVD containing **4.7 GB** (1GB = 2^{30} bytes) of data. For what range of distances would it be faster to use the person on the bicycle to transfer the information on 5 DVDs, than to use a **25 Mbps** (1Mbps = 10^6 bps) data line to transfer the data?

[5]

b) The Hamming Code computes the codeword that uses the least number of check bits to correct single bit errors. Give the formula that gives the relation between the number of check bits used for a given data word. Find the Hamming Code for the bit string **10100111**. Odd parity is used for the check bits.

[4]

(c) Describe the MAC protocol of the IEEE 802.3 LAN, and mention what makes it more efficient than the ALOHA protocol.

[6]

d) A 1 Km long, 10 Mbps CSMA/CD LAN has a propagation speed of 2 x 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?

[3]

e) Suppose nodes A and B are on the same 10 Mbps Ethernet segment and the propagation delay between the two nodes is 290 bit times. Suppose node A transmits a 72 byte frame and before it finishes, node B begins transmitting a frame. Show that A will transmit the entire frame before it detects a collision and discuss the consequences.

[3]

f) Draw a diagram for the **IEEE 802.3** frame. If the total length of the frame is 1000 bytes, show the actual values of the fields that can be deduced from this information. Explain your answer.

[4]