

UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF COMPUTER SCIENCE

MAIN EXAMINATION 2014

TITLE OF PAPER: DATA NETWORK AND CODING THEORY I

COURSE NUMBER: CS437

TIME ALLOWED: THREE HOURS

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

EACH QUESTION CARRIES 25 MARKS.

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BY THE INVIGILATOR.**

QUESTION 1 (Compulsory)

- a) List the 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) What is the key difference between a hub, a switch and an IP router? [2]
- d) A certain transmission channel allows for frequencies between 2.4 GHz and 2.4835 GHz and has a signal to noise ratio of 27dB. What is the channel's capacity? [4]
- e) Why is slotted Aloha more efficient than pure Aloha? [2]
- f) With the assistance of an example, describe how character stuffing works. [4]

QUESTION 2

- a) Use clear diagrams to show the encoded signal if the bit string **001110011011** is encoded using:
i) MLT-3
ii) Differential Manchester encoding
Assume that the signal has a negative voltage before the first bit is transmitted [6]
- b) If the bit stream in (a) is first encoded using 4B/5B and then encoded using Non-return to zero inverted, show the transmitted signal. The 4B/5B table is given below.

4-Bit Data Symbol	5-Bit Code
0000	11110
0001	01001
0010	11110
0011	11101
0100	01011
0101	01011
0110	01110
0111	01111
1000	10010
1001	10011
1010	10110
1011	10111
1100	11010
1101	11011
1110	11100
1111	11101

[4]

c) Bits are transmitted from Cairo to Mbabane over an optic fibre link at 5 Mbps. The propagation speed is 200,000 km/s, and the total length of the fibre is 6000 km. Find how many bits have been transmitted and are propagating over the fibre when the first bit reaches Mbabane.

[4]

d) What signal-to-noise ratio (in dB) is needed to put a T1 carrier on a line with a 100 kHz bandwidth?

[4]

e) A digital signal has a bit interval of 10 micro seconds. What is the bit rate?

[3]

f) An analogue signal carries four bits in each signal element. If 2500 signal elements are sent per second, what is the baud rate and the bit rate?

[4]

QUESTION 3

a) Show the encoded analogue signal if the bit string **001110011011** is encoded using:

i) Frequency Shift Keying

ii) Quadrature Phase Shift Keying

[6]

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

[3]

c) Define channel bandwidth.

[2]

d) An image is 1920 x 1080 pixels with 3 bytes per pixel. Assume the image is uncompressed. How long does it take to transmit over a 64 Kbps line? How can the image be transmitted in less time using the same 64 Kbps line?

[3]

e) Describe the operation of the Simplex Stop-and-Wait Protocol for a noisy channel. How does it differ from the Simplex Stop-and-Wait Protocol for a noiseless channel?

[4]

f) A certain transmission channel allows for frequencies between 3.575 GHz and 4.125 GHz and has a signal to noise ratio of 35dB. What is the channel's capacity?

[4]

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

[3]

QUESTION 4

(a) The diagram below shows an Ethernet frame capture.

```
0000 00 10 18 35 36 68 1c 3e 84 c2 28 02 08 00 45 00 ...56h.> ..(...E.
0010 00 28 36 7f 40 00 80 06 d0 a6 ac 10 07 25 c4 0b .(6.@... ..%.
0020 7c 69 d3 d5 0c 38 6b 78 0e 85 61 ee 70 78 50 10 |i...8kx ..a.pxP.
0030 01 00 8e b8 00 00 00 00 .....
```

What is the size of the frame?

[1]

What is the source MAC address?

[2]

What is the destination MAC address?

[2]

What protocol is being carried by the frame?

[1]

b) Describe the **Go back N** sliding window protocol. What is the receiver's window size for Go back N?

[5]

c) What is the Hamming Distance for the codewords **10010101**, **00000000**, **10111001**, **10000001**?

[4]

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

[5]

QUESTION 5

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

[5]

b) Describe the medium access control protocol of the IEEE 802.3, and mention what makes it more efficient than the ALOHA protocol

[6]

c) 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 **10100**. Odd parity is used for the check bits.

[5]

d) With the aid of a diagram, describe the different fields that make up an **Ethernet II** frame.

[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]

f) Consider the use of 8000 byte frames on a 1-Mbps satellite channel with a 240ms delay. What is the maximum link utilization for stop-and-wait flow control?

[5]

End of Question Paper