University of KwaZulu-Natal

Electrical, Electronic and Computer Engineering

Examinations: **June 2014**
Subject & course code: **Data Communications: ENEL4DT**

Duration: Two Hours **Total Marks: 80**

Examiner/s: Mr Mr P N Zulu (Internal)
Dr. Olabisi Falowo (External)

Instructions:
1. This paper consists of **four** questions. ***Answer all four questions.***
2. All questions must be answered in full. All relevant assumptions must be documented clearly. Use diagrams where possible.
3. Programmable calculators may be used – all memory must be cleared out.
4. No notes of any kind are allowed. Useful data is attached at the back of the question paper

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Question 1 **[22]**

A. Which OSI layer is responsible for the following?

   i. The particular choice of system parameters such as voltage levels and signal durations as well as the procedures to set up actual connections. [1]

   ii. The insertion of control and address information in the header and check bits to enable recovery from transmission errors, as well as flow control. [1]

   iii. The conversion of machine-dependent information into machine-independent information and vice-versa. [1]

B. How does the network layer in a connection-oriented packet-switching network differ from the network layer in a connectionless packet-switching network? [6]

C. How long does it take to send an *L*-byte file and to receive a 10-byte acknowledgement back for *L* = 5 Mbytes traversing a 200 km network at a transmission speed of 10 megabits/second? Speed of light in a cable (2.3×10^8 meters/second). [3]

D. Ethernet is a LAN so it placed in the data link layer of the OSI reference model.

   i. Does Ethernet provide connection-oriented or connectionless service? [1]

   ii. How is the transfer of frames in Ethernet similar to the transfer of frames [3] across a wire, and how is it different?

iii. How is the transfer of frames in Ethernet similar to the transfer of frames in a packet switching network? [2]

E. Define "channel capacity". Give three key factors that can affect channel capacity. [4]

Question 2 **[20]**

A. Give three advantages and three disadvantages of *Fibre Optic* cables, with a brief explanation of each. [6]

B. Design a three stage switch using the *Clos Nonblocking* criteria. Assume the value of *N* is 200.

i. Calculate the values of *n* and *k* and draw the three stage switch. [5]

ii. Calculate the total number of crosspoints. [2]

C. Consider the network in Figure 1. Use the *Bellman-Ford* algorithm to find the set of shortest paths from all nodes to destination node 2. [7]

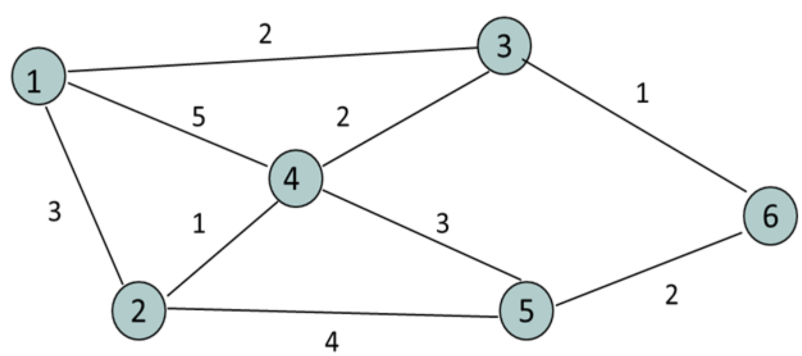

Figure 1

Question 3 **[20]**

A. A satellite is stationed approximately 36,000 km above the equator. What is the attenuation in dB due to distance for the microwave radio signal? Assume a path loss exponent of 2 for free space. [2]

B. Suppose that a speech signal is Analog-to-Digital and Digital-to-Analog converted four times in traversing a telephone network that contains analog and digital switches. Assuming SNR = 38 dB for each A/D and D/A conversion in the telephone system and that the noise level in all conversions is the same. What is the signal-to-noise (SNR) of the speech signal after the fourth Digital-to-analog conversion? [4]

C. Suppose that a low-pass communications system has a 1 MHz bandwidth.

i. What bit rate is attainable using 8-level pulses? [4]

ii. What is the Shannon capacity of this channel if the SNR is 20 dB? [2]

D. Suppose that the two end systems *A* and *B* in Figure 2 communicate over a connection oriented packet network. Suppose that station *A* sends a 10-kilobyte message to station *B* and that all packets are restricted to 1000 bytes (neglect headers). Assume that each packet can be accommodated in a data link frame. For each of the links, let *p* be the probability that a frame incurs errors during transmission.

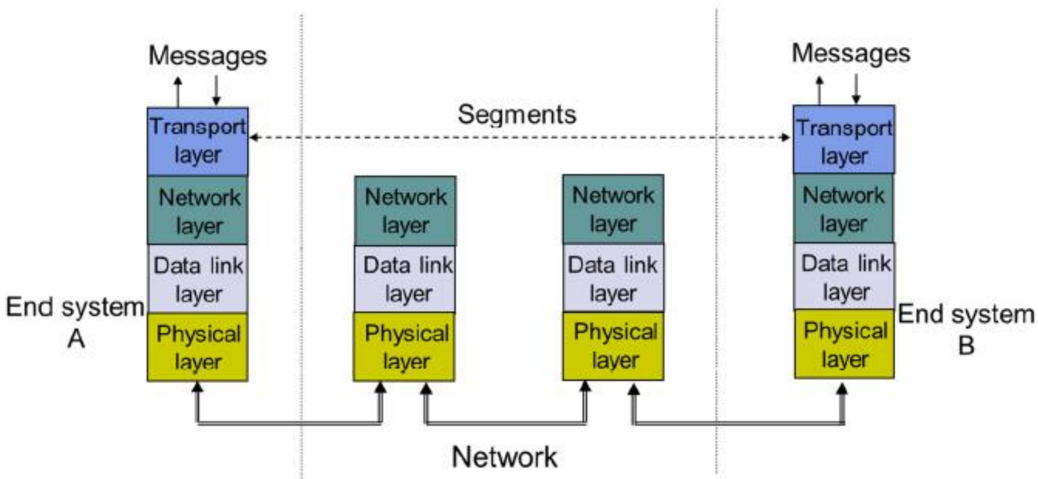

Figure 2

i. Suppose that the data link control just transfers frames and does not implement error control. Derive an expression for the probability that the message arrives without errors at station *B*. [3]

ii. Suppose that error recovery is carried out end to end and that if there are any errors, the entire message is retransmitted. How many times does the message have to be retransmitted on average? [1]

iii. Suppose that the error recovery is carried out end to end on a packet basis. What is the total number of packet transmissions required to transfer the entire message? [2]

E. Suppose we wish to transmit at a rate of 64 kbps over a 3 kHz telephone channel. What is the minimum SNR required to accomplish this? [2]

Question 4 **[20]**

A. For circuit switching networks, draw the network structure that represents 1 to 1 Linear Automatic Protection Switching and explain how it works. [4]

B. Given the generator polynomial $g(x) = x^4 + x^2 + x + 1$, and the information sequence 1010011110. Calculate the CRC codeword that should be transmitted. [4]

C. Consider an application layer protocol that uses the Stop-and-Wait ARQ protocol. Suppose that the frames are 1250 bytes long including 25 bytes of overhead. Also assume that ACK frames are 25 bytes long. Calculate the efficiency of the ARQ system that transmits at a rate of $R = 1\ Mbps$ and with a reaction time, $2(t_{prop} + t_{proc}) = 1ms$, and a bit error rate of 10^{-3}. [5]

D. The Trivial File Transfer Protocol is an application layer protocol that uses the Stop-and-Wait protocol. To transfer a file from a server to a client, the server breaks the file into blocks of 512 bytes and sends these blocks to the client using Stop-and-Wait ARQ. Find the efficiency in transmitting a 1 megabyte file over a 10 Mbps Ethernet LAN that has a diameter of 300 meters. Assume the transmissions are error free and that each packet has 60 bytes of header attached. [5]

DATASHEET

$t_{total} = L_{message}/R + L_{ack}/R + 2 * t_{prop}$

$k > 2n - 1$

Cross points $\geq 4N\,[(2N)^{1/2} - 1]$

Total $delay = L\tau + LP + (k-1)P$

Transmission Efficiency = $\eta_0 = \dfrac{R_{eff}}{R} = \dfrac{\dfrac{n_f - n_o}{t_0}}{R} = \dfrac{1 - \dfrac{n_o}{n_f}}{1 + \dfrac{n_a}{n_f} + \dfrac{2(t_{prop} + t_{proc})R}{n_f}}.$