City University of Hong Kong

Course code & title: EE3009 Data Communications and Networking

Session: Semester B 2015/16

Time allowed: Two hours

This paper has 6 pages (including this cover page).

1. This paper consists of 4 questions.
2. Answer **ALL** questions.

*This is a **closed-book** examination.*

Candidates are allowed to use the following materials/aids:

1. Permitted battery operated calculator

Materials/aids other than those stated above are not permitted. Candidates will be subject to disciplinary action if any unauthorized materials or aids are found on them.

Question 1. (25 marks)

a. Besides communication links, provide two other components of Internet?

[2 marks]

b. Name two technologies used for residential access networks?

[2 marks]

c. Name three types of physical media for communication.

[3 marks]

d. Consider the information sequence 1111000000000000, and the generator polynomial $g(x) = x^8 + x^2 + x + 1$.

i. Find the corresponding codeword of this information sequence.

[10 marks]

ii. Can this code detect single-bit errors? Explain your answer.

[3 marks]

iii. Draw the shift register division circuit for this generator polynomial.

[3 marks]

e. If the bit string 0111101111101111110 is bit stuffed, what is the output string?

[2 marks]

Question 2. **(25 marks)**

a. A file of length 10^6 bytes is to be transmitted over a 1 Mbps communication line that has a bit error rate of $p = 10^{-6}$. Assume that bit errors occur independently.

i) What is the probability that the entire file is transmitted without errors? (Note for large n and very small p, $(1-p)^n \approx e^{-np}$.)

[2 marks]

ii) The file is broken up into N equal-sized blocks that are transmitted separately. Write down an expression for the probability that all the blocks arrive without error.

[3 marks]

Stop-and-Wait ARQ is used to transmit the entire file without dividing into blocks.

iii) Let P_f be the probability of frame transmission error, write down an expression in terms of P_f for the probability of taking i transmissions to deliver a frame successfully.

[2 marks]

iv) Let t_f be the transmission time of a frame. Suppose the propagation delay, processing delay and transmission time of ACK is negligible, what is the total time required for a successful frame delivery if i transmissions are required?

[2 marks]

v) On average, how long does it take to deliver the file?
[Useful formulae: $E[X] = \sum x \Pr(X = x)$

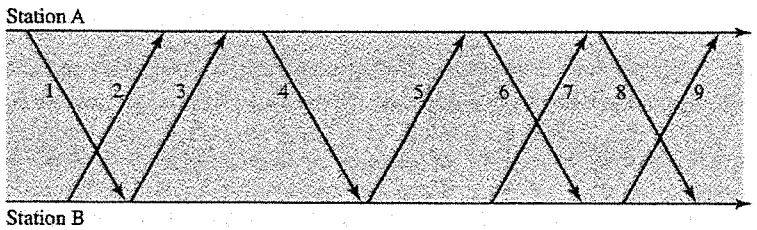
$$\sum_{i=1}^{\infty} i r^{i-1} = \frac{1}{(1-r)^2}$$

]

[6 marks]

b. Figure 1 corresponds to an HDLC ABM frame exchange with no errors. Complete the diagram by completing the labeling of the frame exchanges, and write the sequence of state variables at the two stations as each event takes place.

[10 marks]



1. BI00 2. AI00 3. xIxx 4. xIxx 5. xRRxx 6. xIxx 7. xIxx 8. xRRxx 9. xRRxx

Figure 1.

Question 3.

a. Describe the operation of the *p*-persistent CSMA protocol.

[5 marks]

b. Describe an enhancement that has been made to the CSMA protocol to improve its performance.

[3 marks]

c. Referring to Figure 2 below, *M* terminals are attached by a dedicated pair of lines to a hub in a star topology. The distance from each terminal to the hub is 25 meters, the speed of the transmission lines is 10 Mbps, all frames are of length 12,500 bytes, and the signal propagation on the line at a speed of 2.5×10^8 meters/second. Calculate the maximum network throughput achievable when the hub is implementing CSMA-CD.
[for CSMA-CD:

$$\rho_{\max} = \frac{1}{1+(2e+1)a}$$

]

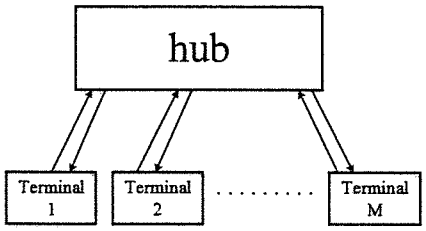


Figure 2.

[6 marks]

d. Consider a token ring network with *M* stations and transmission speed *R*.

i) Let τ be the total propagation delay around the ring, and *b* be the delay in an interface in terms of number of bits. Write down an expression of ring latency τ'.

[2 marks]

ii) In the single-frame operation, the free token is inserted after the transmitting station has received the last bit of its frame. Write down an expression of the cycle time in terms of *M*, τ' and *X*, where *X* is the frame transmission time.

[3 marks]

iii) Let $M = 25$, $R = 25$ Mbps, $\tau = 2.5 \times 10^{-5}$ s, $b = 2$ and frame length be 1250 bytes long. Calculate the maximum throughput.

[6 marks]

Question 4.

a.

i) How many bits does an IPv6 address have?

[1 mark]

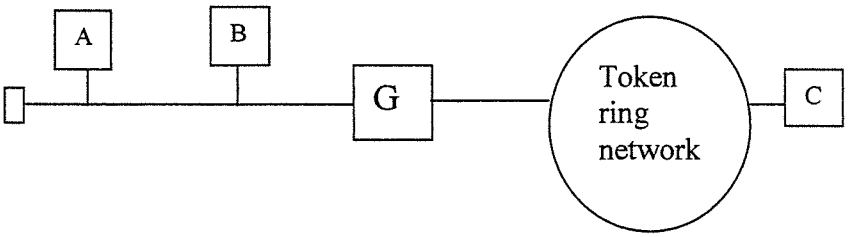
ii) In IPv4 addressing scheme, the first bit of a class A address is 0, what is the maximum number of class A networks that can be supported? And how many hosts can be supported in each class A network?

[2 marks]

iii) A small ISP owns the following networks: 128.56.24.0/24, 128.56.25.0/24, 128.56.26.0/24, 128.56.27.0/24. Perform CIDR aggregation of these networks.

[3 marks]

b. Referring to the following internetwork, when host A is connected to an Ethernet and wishes to send an IP packet to host C, it first forwards the packet to router G.



i) A knows the IP address of G, what else does it need to know in order to forward the IP packet to G?

[1 mark]

ii) If A does not know the information in the above sub-question (4b. i)), what protocol can it use to find the information? Describe how the protocol operates.

[6 marks]

c. A high quality speech signal has a bandwidth of 8 kHz.

i) Suppose that the speech signal is to be quantized and then transmitted over a 28.8 kbps modem. What is the SNR of the received speech signal.

[In dB,

SNR = 6m -7.2

]

[2 marks]

ii) What modem speed is needed if we require an SNR of 45 dB?

[2 marks]

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

i) What bit rate is attainable using 8-level pulses?

[2 marks]

ii) What is the Shannon capacity of this channel if the SNR is 20dB?

[2 marks]

[

$$C = W \log_2(1 + SNR) \text{ b/s}$$

]

e. The nonreturn-to-zero (NRZ) signaling method transmits a 0 with a voltage of +1v for a duration T, and a 1 with a voltage of -1v for duration T. Plot the signal for the sequence of 4 consecutive 1s followed by 4 consecutive 0s. Explain why this code has a synchronization problem.

[4 marks]

-END-