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NWC203c Practical Exam

Answer sheet

Q1.

Consider the three-way handshake in TCP connection setup.
(a) Suppose that an old SYN segment from station A arrives at station B, requesting a TCP connection. Explain how the three-way handshake procedure ensures that the connection is rejected.
(b) Now suppose that an old SYN segment from station A arrives at station B, followed a bit later by an old ACK segment from A to a SYN segment from B. Is this connection request also rejected?

Solution:

a)
In a three-way handshake procedure, one must ensure the selection of the initial sequence number is always unique.
If station B receives an old SYN segment from A, B will acknowledge the request based on the old sequence number.
When A receives the acknowledge segment from B, A will find out that B received a wrong sequence number.
A will discard the acknowledgement packet and reset the connection.

b)
If an old SYN segment from A arrives at B, followed by an old ACK segment from A to a SYN segment from B, the connection will also be rejected.

Initially, when B receives an old SYN segment, B will send a SYN segment with its own distinct sequence number set by itself.
If B receives the old ACK from A, B will notify A that the connection is invalid since the old ACK sequence number does not match the sequence number previously defined by B. Therefore, the connection request is rejected.

Q2.

A bit stream 10011101 is transmitted using the CRC method. The generator polynominal is $x^3 + 1$. Show the actual bit string transmitted. Suppose the third bit from the left is inverted during transmission. Show that this error is detected at the receivers end.

<u>Solution:</u>

The generator polynomial: $x^3 + 1 \longrightarrow$ Encoded as 1001 (consists of 4 bits)
So the string of 3 zeros is appended to the original bit stream 10011101, and the result bit stream is: 10011101000
Calculate the CRC at sender:

```
            10001100
      ______________________
1001 | 10011101000
       1001
       ----
       00001
        0000
        ----
        00011
         0000
         ----
         00110
          0000
          ----
          01101
           1001
           ----
           01000
            1001
            ----
            00010
             0000
             ----
             00100
              0000
              ----
              0100 ⟶ CRC = 100
```

Hence, the actual transmitted message to the receiver is: 10011101100

The 3rd bit from the left is inverted during transmission, the receivers end is received the bit stream as: 10111101100
Calculate the CRC at receiver:

```
            10101000
      ______________________
1001 | 10111101100
       1001
       ----
       00101
        0000
        ----
        01011
         1001
         ----
         00100
          0000
          ----
          01001
           1001
           ----
           00001
            0001
            ----
            00010
             0000
             ----
             00100
              0000
              ----
              0100 ⟶ Remainder = 100
```

The remainder obtained on division is a **non-zero value.** This indicates to the receiver that an error occurred in the data during the transmission. Therefore, receiver rejects the data and asks the sender for retransmission.

Q3.

A router has the following CIDR entries in its routing table:

Address/mask	Next hop
135.46.56.0/22	Interface 0
135.46.60.0/22	Interface 1
192.53.40.0/23	Router 1
default	Router 2

a) What does the router do if a packet with an IP address 135.46.63.10 arrives?
b) What does the router do if a packet with an IP address 135.46.57.14 arrives?

Solution:

a) The bit pattern of 135.46.63.10 is 10000111.00101110.00111111.00001010.
Take the first 22 bits as net address.
bitmask pattern: 11111111.11111111.11111100.00000000

Take AND operation:

10000111.00101110.00111111.00001010
11111111.11111111.11111100.00000000

10000111.00101110.00111100.00000000 → 135.46.60.0

Thus, network address is 135.46.60.0

Match with network address in the routing table. The 2nd row matches.
The router will forward the packet to **Interface 1** if a packet with an IP address 135.46.63.10 arrives.

b)
The bit pattern of 135.46.57.14 is 10000111.00101110.00111001.00001110.
Take the first 22 bits as net address.
bitmask pattern: 11111111.11111111.11111100.00000000

Take AND operation:

10000111.00101110.00111001.00001110
11111111.11111111.11111100.00000000

10000111.00101110.00111000.00000000 → 135.46.56.0

Thus, network address is 135.46.56.0

Match with network address in the routing table. The 1st row matches.
The router will forward the packet to **Interface 0** if a packet with an IP address 135.46.57.14 arrives.

Q4.

Let g1(x) = x + 1 and let g2(x) = $x^3 + x^2 + 1$. Consider the information bits (1,1,0,1,1,0).

a. Find the codeword corresponding to these information bits if g1(x) is used as the generating polynomial.

b. Find the codeword corresponding to these information bits if g2(x) is used as the generating polynomial.

<u>Solution:</u>

a) The generator polynomial: x + 1 ⟶ Encoded as 11 (consists of 2 bits)
So the string of 1 zeros is appended to the information bits, and the result is: 1101100
Calculate the FCS:

```
        10010
     ___________
 11 | 1101100
      11
      000
       00
       001
        00
        011
         11
         000
          00
          000
           00
           00  ⟶ FCS = 0
```

Hence, the corresponding codeword is: **1101100**

b) The generator polynomial: $x^3 + x^2 + 1$ ⟶ Encoded as 1101 (consists of 4 bits)
So the string of 3 zeros is appended to the information bits, and the result is: 110110000
Calculate the FCS:

```
          100011
       ____________
 1101 | 110110000
        1101
        00001
         0000
         00010
          0000
          00100
           0000
           01000
            1101
            01010
             1101
             0111 ⟶ FCS = 111
```

Hence, the corresponding codeword is: **110110111**

Q5.

Suppose an application layer entity wants to send an L-byte message to its peer process, using an existing TCP connection. The TCP segment consists of the message plus 20 bytes of header. The segment is encapsulated into an IP packet that has an additional 20 bytes of header. The IP packet in turn goes inside an Ethernet frame that has 18 bytes of header and trailer.
What percentage of the transmitted bits in the physical layer correspond to message information, if L = 100 bytes, 500 bytes, 1000 bytes?

Solution:

The MTU of normal Ethernet is 1500, subtract bytes for the IP and TCP headers (20 bytes each) leaving 1460 bytes available to the application. Thus, we have:

TCP / IP over Ethenet allows data frames with a payload size up to 1460 bytes.
Therefore, L = 100, 500, 1000 are within this limit.

The message overhead includes:
+ TCP: 20 bytes of header
+ IP: 20 bytes of header
+ Ethernet: 18 bytes of header and trailer

Therefore:
L = 100 bytes ⟶ 100 / (100 + 20 + 20 + 18) = 63,29% efficiency

L = 500 bytes ⟶ 500 / (500 + 20 + 20 + 18) = 89,61% efficiency

L = 1000 bytes ⟶ 1000 / (1000 + 20 + 20 + 18) = 94,52% efficiency