Chapter 3: Sample Questions, Problems and Solutions
Bölüm 3: Örnek Sorular, Problemler ve Çözümleri

Örnek Sorular (Sample Questions):

- What is an unacknowledged connectionless service?
- What is an acknowledged connectionless service?
- What is an acknowledged connection-oriented service?
- Draw a placement of the data link protocol?
- What is a framing?
- What is a character count framing method?
- What are flag bytes with byte stuffing framing method?
- What is starting and ending flags, with bit stuffing framing method?
- What is Physical layer coding violations framing method?
- What is an error control?
- What is error detection?
- What is an error correction?
- What is an error control?
- What is a feedback-based flow control?
- What is a rate-based flow control?
- What is a codeword?
- What is a Hamming distance?
- What is a (even or odd) parity bit?
- What is CRC (Cyclic Redundancy Check)?
- What is a packet?
- What is a frame?
- What is an unrestricted simplex protocol?
- What is a simplex stop-and-wait protocol?
- What is a simplex protocol for a noisy channel?
- What is a piggybacking?
- What is a sliding window?
- What is a one-bit sliding window protocol?
- What is a protocol using go back N?
- What is a protocol using selective repeat?
- What is a HDLC – High Level Data Link Control?
- What is a PPP – The Point-to-Point Protocol?

Örnek Problemler ve Çözümleri (Sample Problems and Solutions):

(Chapter 3, Problem 2-1)

The following character encoding is used in a data link protocol:
A: 01000111; B: 11100011; FLAG: 01111110; ESC: 11100000
Show the bit sequence transmitted (in binary) for the four-character frame:
A B ESC FLAG when each of the following framing methods are used:
(a) Character count
(b) Flag bytes with byte stuffing.
(c) Starting and ending flag bytes, with bit stuffing.

ANS:

a) **00000100 01000111 11100011 11100000 01111110**
b) **01111110 01000111 11100011 11100000 11100000 11100000 01111110 01111110**
c) **01111110 01000111 110100011 11100000 011111010 0111110**

(Chapter 3, Problem 2-2)

The following character encoding is used in a data link protocol:
A: 11010101; B: 10101001; FLAG: 01111110; ESC: 10100011
Show the bit sequence transmitted (in binary) for the five-character frame:
A ESC B ESC FLAG when each of the following framing methods are used:
(a) Flag bytes with byte stuffing.
(b) Starting and ending flag bytes, with bit stuffing.

ANS:

d) **01111110 11010101 10100011 10100011 10101001 10100011 10100011 10100011 01111110 01111110**
e) **01111110 11010101 10100011 10101001 10100011 011111010 0111110**

(Chapter 3, Problem 3)

Given the output after byte-stuffing: FLAG A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D F FLAG. What is the original data?

ANS:
A B ESC C ESC FLAG FLAG D F

(Chapter 3)

Given the output after byte-stuffing: FLAG A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D FLAG. What is the original data?

ANS:
A B ESC C ESC FLAG FLAG D

(Chapter 3)

A B ESC C ESC FLAG FLAG D is given. This data fragment occurs in the middle of a data stream for which the byte-stuffing algorithm described in the text is used. What is the output after stuffing?

ANS:
After stuffing, we get
A B ESC ESC C ESC ESC ESC FLAG ESC FLAG D

(Chapter 3)

A bit string, 0111101111101111110, needs to be transmitted at the data link layer. What is the string actually transmitted after bit stuffing?

ANS:
The output is 011110111110011111010

(Chapter 3, Problem 9)

Eight bit messages are transmitted using a Hamming code. How many check bits are needed to ensure that receiver can detect and correct single bit errors? Show the bit pattern transmitted for the message 11001010. Assume that odd parity is used in the Hamming code.

ANS:
$m+r+1 \le 2^r$, m=8
$8+r+1 \le 2^r$, r=4
n=m+r=8+4=12

1	2	3	4	5	6	7	8	9	10	11	12
2^0	2^1		2^2				2^3				
?	?	1	?	1	0	0	?	1	0	1	0

$3=2^0+2^1=1+2$
$5=2^0+2^2=1+4$
$6=2^1+2^2=2+4$
$7=2^0+2^1+2^2=1+2+4$
$9=2^0+2^3=1+8$
$10=2^1+2^3=2+8$
$11=2^0+2^1+2^3=1+2+8$
$12=2^2+2^3=4+8$

Check bit 2^0 is used for data in positions 3, 5, 7, 9, 11 so its value is 1 because of 110111
Check bit 2^1 is used for data in positions 3, 6, 7, 10, 11 so its value is 1 because of 100011
Check bit 2^2 is used for data in positions 5, 6, 7, 12 so its value is 0 because of 10000
Check bit 2^3 is used for data in positions 9, 10, 11, 12 so its value is 1 because of 10101

So the bit pattern transmitted for the message 11001010 is 1 1 1 0 1 0 0 1 1 0 1 0

(Chapter 3, Problem 10)

An 8-bit byte with binary value 10101111 is to be encoded using an even-parity Hamming code. What is the binary value after encoding?

ANS:
The encoded value is 101001001111

(Chapter 3, Problem 14)

What is the remainder obtained by dividing $X^7 + X^5 + 1$ **by the generator polynomial** $X^3 + 1$**?**

ANS:

$X^7 + X^5 + 1$ $\qquad$ $X^3 + 1$

$X^7 + X^4$ $\qquad$ $X^4 + X^2 + X$

$X^5 + X^4 + 1$
$X^5 + X^2 + 0$

$X^4 + X^2 + 1$
$X^4 + X$

$X^2 + X + 1$ **is remainder**

(Chapter 3, Problem 15)

A bit stream 10101010 is transmitted using the standard CRC method. The generator polynomial is x^3+x^2+1. Show the actual bit string transmitted. Suppose the second bit from the left is inverted during transmission. Show that this error is detected at the receiver's end.

ANS:
The frame is 10101010
The generator is 1101= x^3+x^2+1
So we must append 3 zeros to the message: 10101010000

```
10101010000       1101
1101              11011110
01111
 1101
    1001
    1101
    01000
      1101
      01010
        1101
```

01110
1101
110 is remainder

So actual bit string transmitted is 10101010110
The received bit stream with an error in the second bit from the left is 11101010110

```
11101010110      1101
1101             10101010
001110
  1101
  001110
    1101
    001111
      1101
      00100 is a remainder
```

As we see the remainder is different from zero.
Thus, the receiver detects the error and can ask for a retransmission.

(Chapter 3, Problem 17)

A channel has a bit rate of 4 Kbps and a propagation delay of 20 msec. For what range of frame sizes does stop-and-wait give an efficiency of at least 50 percent?

ANS:
Efficiency will be 50% when the time to transmit the frame equals the round-trip propagation delay. At a transmission rate of 4 bits/ms, 160 bits takes 40 ms. For frame sizes above 160 bits, stop-and-wait is reasonably efficient.

(Chapter 3, Problem 29-1)

Frames of 1000 bits are sent over a 1-Mbps channel using a geostationary satellite whose propagation time from the earth is 270 msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used. What is the maximum achievable channel utilization for
a) Stop-and-wait.
b) Protocol 5.
c) Protocol 6.

ANS:
Let *t=0* denote the start of transmission. At *t=1 msec*, the first frame has been fully transmitted. At *t=271 msec*, the first frame has fully arrived. At *t=272 msec*, the frame acknowledging the first one has been fully sent. At *t=542 msec*, the acknowledement-bearing frame has fully arrived. Thus, the cycle is *542 msec*. A total of *k* frames are sent in *542 msec*, for an efficiency of *k/542*. Hence

a) **k=1, efficiency=1/542=0,18%**
b) **k=7, efficiency=7/542=1,29%**
c) **k=4, efficiency=4/542=0,74%**

(Chapter 3, Problem 29-2)

Frames of 10000 bits are sent over a 1-Mbps channel using a geostationary satellite whose propagation time from the earth is 270 msec. Acknowledgements are always piggybacked onto data frames. The headers are very short. Three-bit sequence numbers are used. What is the maximum achievable channel utilization for
a) Stop-and-wait.
b) Protocol 5.
c) Protocol 6.

ANS:
Let *t=0* denote the start of transmission. At *t=10 msec*, the first frame has been fully transmitted. At *t=280 msec*, the first frame has fully arrived. At *t=290 msec*, the frame acknowledging the first one has been fully sent. At *t=580 msec*, the acknowlededement-bearing frame has fully arrived. Thus, the cycle is *580 msec*. A total of *k* frames are sent in *542 msec*, for an efficiency of *k/542*. Hence

d) **k=1, efficiency=1/580=0,17%**
e) **k=7, efficiency=7/580=1,21%**
f) **k=4, efficiency=4/580=0,69%**

(Chapter 3, Problem 32-1)

A 100-km-long cable runs at the T1 data rate. The propagation speed in the cable is 2/3 the speed of light in vacuum. How many bits fit in the cable?

ANS:
The propagation speed in the cable is 200,000 km/sec, or 200 km/msec, so a 100-km cable will be filled in 500 microsec. Each T1 frame is 193 bits sent in 125 microsec. This corresponds to four frames, or 772 bits on the cable.

(Chapter 3, Problem 32-2)

A 50-km long cable run at the T1 data rate. The propagation speed in the cable is 2/3 the speed of light in vacuum. How many bits fit in the cable?

ANS:
The propagation speed in the cable is 200,000 km/sec, or 200 km/msec.
So a 50 km cable will be filled in 250 µsec.
Each T1 frame is 193 bits sent in 125 µsec.
This corresponds to two frames, or 386 bits on the cable.