HW2_written

Sunday, October 16, 2022 2:03 PM

1. Hamming (7,4).

$C_1 \oplus C_2 \oplus C_3 \oplus C_5 = 0$

$C_1 \oplus C_3 \oplus C_4 \oplus C_6 = 0$.

$C_1 \oplus C_2 \oplus C_4 \oplus C_7 = 0$.

(a)

C1	C2	C3	C4	C5	C6	C7
0	0	0	0	0	0	0
0	0	0	1	0	1	1
0	0	1	0	1	1	0
0	0	1	1	1	0	1
0	1	0	0	1	0	1
0	1	0	1	1	1	0
0	1	1	0	0	1	1
0	1	1	1	0	0	0
1	0	0	0	1	1	1
1	0	0	1	1	0	0
1	0	1	0	0	0	1
1	0	1	1	0	1	0
1	1	0	0	0	1	0
1	1	0	1	0	0	1
1	1	1	0	1	0	0
1	1	1	1	0	0	0

(b) $1001100 \oplus 1011010$.

$$\begin{array}{r} 1001100 \\ \oplus\ 1011010 \\ \hline 0010110 \end{array}$$

0010110 is a codeword from the Hamming (7.4) code.

(c) 1010010

$R_1 \oplus R_2 \oplus R_3 \oplus R_5 = S_1$

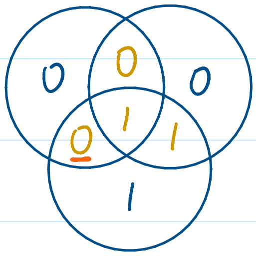
$\Rightarrow 1 \oplus 0 \oplus 1 \oplus 0 = 0$. no error in right circle.

$R_1 \oplus R_3 \oplus R_4 \oplus R_6 = S_2$

$\Rightarrow 1 \oplus 1 \oplus 0 \oplus 1 = 1$ error in bottom circle

$R_1 \oplus R_2 \oplus R_4 \oplus R_7 = S_3$

$\Rightarrow 1 \oplus 0 \oplus 0 \oplus 0 = 1$ error in left circle.



Based on that, we know the error bit is R_4, and the original message should be 1011010.

(d) $d_{min} = 3$.

Hamming(7,4) code can correct $(d_{min} - 1)/2 = 1$ bit error.

(e) $\because$ Hamming(7,4) code can detect all one-bit and two-bits errors.

$$\therefore P_{error} = \binom{1}{7}(1-p)^6 p + \binom{2}{7}(1-p)^5 p^2$$

$$= 7(1-p)^6 p + 21(1-p)^5 p^2$$

Let $p = 0.9$.

$$\therefore P_{error} = 7(0.1)^6(0.9) + 21(0.1)^5(0.9)^2$$

$$= 0.0001764$$

2. ① CRC: D: 1110011

G: 101

```
         1101001
101 / 111001100
      101
      ---
       100
```

```
  1 0 1
  -----
   0 1 0
   0 0 0
   -----
    1 0 1
    1 0 1
    -----
     0 0 1
     0 0 0
     -----
      0 1 0
      0 0 0
      -----
       1 0 0
       1 0 1
       -----
         0 1
```

A: 1110011 01.

② Checksum: with blocks of size 3   A: 111 001 101.

```
Carry:   1 1 1
          1 1 1
         0 0 1
         1 0 1
        -------
         1 0 1
             1
        -------
         1 1 0
        -------
```

complement: 0 0 1

∴ message: 111 001 101 001.

3. (a)

- Host 2 sends a frame to Switch 2 via its interface;
- Switch 2 records the incoming frame and MAC address of

Host 2 in its switch table;

- If Switch 2 found the entry for the destination using the MAC destination address, Switch 2 forwards the frame on interface indicated by the entry (i.e. Switch 1 in this case);
- If Switch 2 could not find the entry, it floods to forward on all interfaces expect Host 2;
- After Switch 1 receives the frame, it follows the same logic as Switch 2 does to forward the frame on interface indicated by the entry of flood;
- After Switch 4 receives the frame, it repeat the same steps like the two switches did above;
- At the end, Host 8 receives the frame and matches its MAC address with the destination address of the frame. Then it responses to Switch 4 to record it in the table;
- Then Switch 4 responses to Switch 1 to update the table of Switch 1;
- Then Switch 1 responses to Switch 2 to update the table of Switch 2;
- Finally Switch 2 updates its table;

(b) Switch 2.

MAC	Linterface.	TTL.
Host 2	H2.	a.
switch 1.	S1→S2.	a.

switch 1.

MAC	Inter.	TTL.
Switch 2	S2→S1	a.
Switch 4	S4→S1.	a.

switch 4.

MAC	Inter.	TTL.
Switch 1	S1→S4.	a.
Host 8	H8.	a.

4. (a) Only 3 packets in total has been transmitted successfully after slot 8 completed.

Node A transmitted a packet in time slot 3 successfully.

Node B transmitted a packet in time slot 7 successfully.

Node C transmitted a packet in time slot 5 successfully.

(b) In slot 1, a collision happened.

$\therefore N = \min\{1, 10\} = 1.$

$X \in \text{unif}\{0, 1\}. \Rightarrow P(X=0) = P(X=1) = \frac{1}{2}.$

$\therefore P(\text{no collision}) = 3(\frac{1}{2})(1-\frac{1}{2})^2.$

$= \frac{3}{8}.$

$\therefore P(\text{collision}) = 1 - P(\text{no collision})$

$= \frac{5}{8}.$

(c) After time slot 8 complete, 5 collision happened.

$\therefore N = 5$

$X \in \text{unif}\{0, 1, 2, \cdots, 31\}$.

$\therefore P(X=0) = \frac{1}{32}$.

$\therefore P(\text{no transmission}) = 1 - P(\text{at least one node transmits})$

$\therefore P(\text{at least one node transmit}) = P(\text{all nodes transmit}) + P(\text{two nodes transmit}) + P(\text{only one node transmits})$.

$$= \left(\frac{1}{32}\right)^3 + \binom{2}{3}\left(\frac{1}{32}\right)^2\left(1-\frac{1}{32}\right) + \binom{1}{3}\left(\frac{1}{32}\right)\left(1-\frac{1}{32}\right)^2$$

$$= \frac{1 + 3(31) + 3(31)^2}{32^3}$$

$$= 0.09085$$

$\therefore P(\text{no transmission}) = 0.90915$