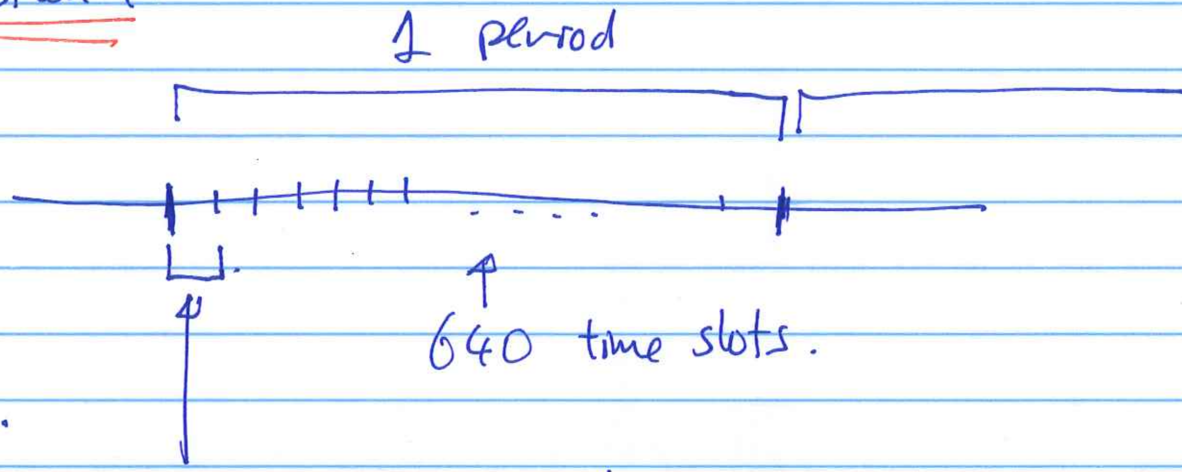
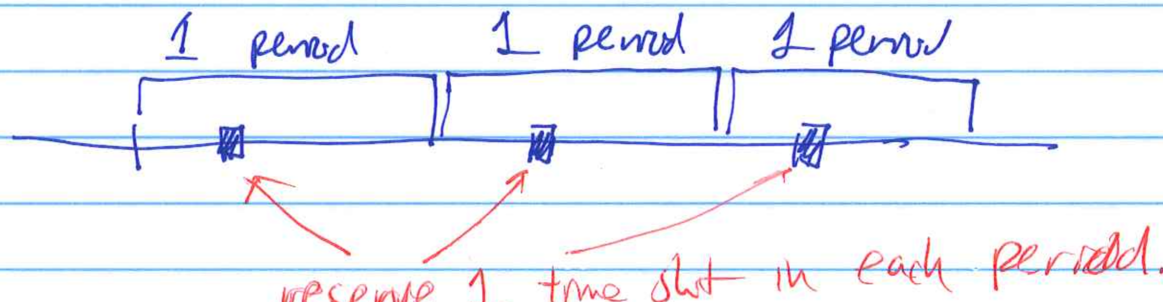
Question 1:



1 time slot = $\frac{1}{640}$ of a period.

- Smallest unit of reservation = 1 time slot.



smallest unit of bandwidth reservation

$$= \frac{1}{640} \cdot 1 \text{ Gbps}$$

$$= 1{,}5625 \text{ Mbps}$$

- To reserve 50 Mbps: $\frac{50}{1.5625} = 32$ slots.

Question 2:

(1) Encode:

1 0 1 0 0 0 0 0
0 1 0 0 1 0 1 1
0 1 0 0 0 1 0 0
1 0 0 1 0 0 1 1
0 0 1 1 1 1 0 0

Transmit bits in serie:

10100000 01001011 01000100
10010011 00111100

(2) Not possible to have 2 bits in error that is undetectable.

(3) Not possible to have 3 bits in error that is undetectable.

(4) Yes. Here is an example:

These 4 bits received in error.

1	0	1	0	0	0	0	0
0	1	~~0~~ 1	~~0~~ 1	1	0	1	1
0	1	~~0~~ 1	~~0~~ 1	0	1	0	0
1	0	0	1	0	0	1	1
0	0	1	1	1	1	0	0

Receiver will not detect these 4 bits errors because:

the parity in each row and column are even

— assumes no error!!!

Question 3:

6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1

Data: 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1

Encode:

1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1

0 1 0 0 0 $\boxed{}$ 0 0 0 1 . 0 0 0 $\boxed{}$ 0 0 0 $\boxed{}$ 1 $\boxed{}$ $\boxed{}$

↑ ↑ ↑

Compute code bits:

$$
\begin{array}{rcl}
20 & = & 10100 \\
12 & = & 01100 \\
3 & = & 00011 \quad \text{XOR.} \\
\hline
 & & 11011
\end{array}
$$

Construct Hamming code:

1 0 9 8 7 6 5 4 3 2 1 0 9 8 7 6 5 4 3 2 1

0 1 0 0 0 $\boxed{1}$ 0 0 0 0 1 0 0 0 $\boxed{1}$ 0 0 0 $\boxed{0}$ 1 $\boxed{1}$ $\boxed{1}$

This is the transmitted bit pattern

Question 4

(1) Received code word:

6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1
	15							8							1
0	$\boxed{1}$	0	0	0	0	0	0	$\boxed{1}$	0	0	0	0	0	0	$\boxed{1}$

Recode check:

$$\begin{aligned} 15 &= 1111 \\ 8 &= 1000 \\ 1 &= 0001 \end{aligned} \quad \text{XOR}$$

$$0110 = 6 \Rightarrow \text{bit 6 is in error}$$

Assume:

(2) To find the original data:

(A) Correct the received code word:

6	5	4	3	2	1	0	9	8	7	6	5	4	3	2	1
$\boxed{0}$	1	0	0	0	0	0	0	$\boxed{1}$	0	1	0	$\boxed{0}$	0	$\boxed{0}$	$\boxed{1}$

Data bits

(B) Extract the data bits:

1000000 010 0

original data.

(3) The bit pattern :

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	1	0	0	0	0	0	1	0	0	0	0	0	0	1

has the error signature :

$$\begin{array}{rl} 15 & = 1111 \\ 8 & = 1000 \\ 1 & = 0001 \quad \text{XOR} \\ \hline & 0110 \quad = 6. \end{array}$$

A 2-bit errors that produces the same error signature is:

$$0100 = 4$$
$$0010 = 2.$$

So the following can be the original Hamming code word (with bits 2 and 4 in error) to produce the recei'd pattern:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
0	1	0	0	0	0	0	1	0	0	0	1	0	1	1

if bit 2 and bit 4 are recv'd in error, we get this

Question 5:

(1).

10101011

101 / 1000000100

101

100

101

100

101

110

101

110

101

11

add 2 0's.

CRC code.

Transmitted bit pattern by sender:

1000000111

(2) CRC check:

```
          10101
     ___________
101 / 10000001
      101
      ---
        100
        101
        ---
          100
          101
          ---
           11
```

Not Zero.

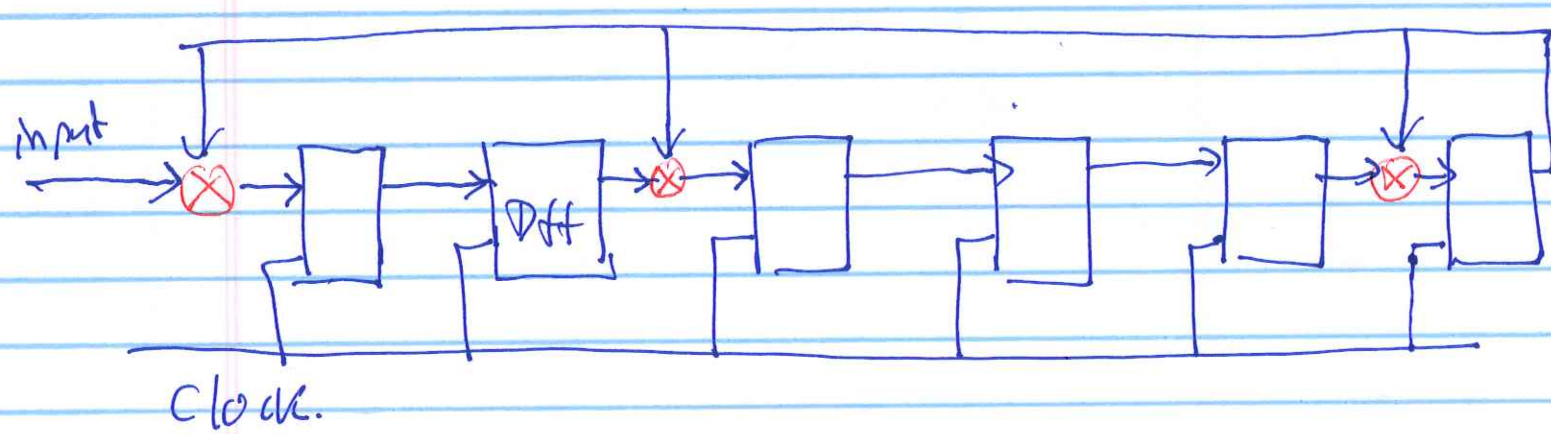
$\Rightarrow$ error

Question 6

CRC polynomial: 1100101

∴ we need 6 Dff's.

Reverse: 101001 (ignore first bit)



Answer.