1. (a) Transport
(b) DataLink
(c) Data Link
(d) Network

2. (a) Amplitude Modulation (ASK)
Frequency Modulation (FSK)
Phase Modulation (PSK)
Quadratic Amplitude Modulation (QAM)

(b) geostationary medium-earth orbit low-earth orbit

(c) twisted pair coaxial cable fiber optic cable

(d) space Division Multiplexing (SDM)
Frequency Division Multiplexing (FDM)
Wavelength Division Multiplexing
Time Division Multiplexing (TDM)
Time and Frequency Multiplexing
Code Division Multiplexing (CDM & CDMA)

3. The answer is no.

Packets can face delays due to buffering, routing decisions and potential congestion at network nodes. This can result in variable and potentially higher end-to-end delay.

In situations with ~~higher~~ high congestion or strict real-time requirements, ~~it~~ circuit switching may provide more consistent and lower end-to-end delay.

4. (a) $\frac{6\text{Mbps}}{500\text{kbps}} = 12$

Circuit switching can host a maximum of 12 users

(b) $p = 1 - P(A \le 12)$

$= 1 - \left(C(30,0) \times 0.7^{30} + C(30,1) \times 0.3 \times 0.7^{29} + \cdots + C(30,12) \times 0.3^{12} \times 0.7^{18} \right)$.

(c) According to Shannon Formula:

Capacity = bandwidth $\times \log_2(1+SNR)$.

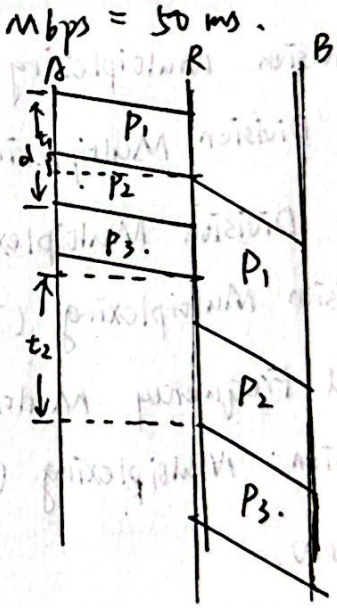
$\Rightarrow SNR = 2^{0.2} - 1 \approx 0.148$

5. Transmission time for A-R: 50kb / 10Mbps = 5ms.

Transmission time for R-B: 50kb / 1Mbps = 50 ms.

Propagation time for A-R = 10 ms.

Propagation time for R-B = 100 ms.



Queuing delay = t_2 =

$(5+10+50\times2) - (5\times3+10)$

$= 90$ ms

6. $A \cdot S = \frac{1}{8}\sum_{i=1}^{8} AS = \frac{1}{8}\left((-1)\times(-1)+1-1\times1+(-1)\times(-1)+1\times1+(-1)\times(-1)+1\times(-3)+1+1\right)$

$= 1$

$B \cdot S = \frac{1}{8}\sum_{i=1}^{8} BS = \frac{1}{8}(1-1-3-1-1-3+1-1) = -1$

$C \cdot S = \frac{1}{8}\sum_{i=1}^{8} CS = \frac{1}{8}(1+1+3+1-1-3-1-1) = 0$

$D \cdot S = \frac{1}{8}\sum_{i=1}^{8} DS = \frac{1}{8}(1+1+3-1+1+3+1-1) = 1$

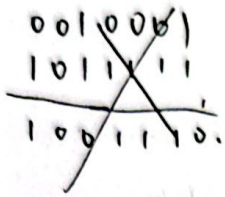
∴ A transmits 1, B transmits 0, D transmits 1

C didn't transmit any bit.

1.

~~horizontal check bits: 10001~~

~~vertical check bits: 1011111~~



~~So the~~ hamming distance is 4
The.

According to the detection and correction capability,

it can detect ~~most~~ most. 3 errors and correct @ 1 error most.

~~Take white for the 7×7 block in class, there are more than 3 errors in some cases.~~

As ~~for~~ So the block discussed in class:

① 1 error. We can not only detect but also correct the error, since the vertical and horizontal ~~parti~~ parity code both have one incorrect bit.

② 2 errors. We can detect errors by checking vertical or horizontal parity code. But we can not localize or correct the errors.

③ 3 errors. We can also detect errors by checking vertical or horizontal parity code, but we can not localize or correct the errors.

④ 4 errors. We can neither detect nor correct error.

As a result, we can detect max. 3 errors and correct max. 1 error

So the answer is right.

1\. ~~7. hamming distance is 4~~
~~can detect max. 3 errors.~~
~~can correct max. 1 error.~~

8\. (a) $9 + k \le 2^k - 1 \Rightarrow k = 4$

(b)

1	2	3	4	5	6	7	8	9	10	11	12	13
P_1	P_2	1	P_3	0	0	1	P_4	0	1	0	1	1

P_1: 3, 5, 7, 9, 11, 13 $\therefore P_1 = 1 \oplus 0 \oplus 1 \oplus 0 \oplus 0 \oplus 1 = 1$

P_2: 3, 6, 7, 10, 11 $\therefore P_2 = 1 \oplus 0 \oplus 1 \oplus 1 \oplus 0 = 1$

P_3: 5, 6, 7, 12, 13 $\therefore P_3 = 0 \oplus 0 \oplus 1 \oplus 1 \oplus 1 = 1$

P_4: 9, 10, 11, 12, 13 $\therefore P_4 = 0 \oplus 1 \oplus 0 \oplus 1 \oplus 1 = 1$

$\therefore$ Hemming code is ~~1111 0011 01011~~ ~~1001 0010 1110~~
1111 0011 01011

9\. (a) r = 3. $G(x) = x^3 + 1 \Rightarrow 1001$

```
       1 0000 0111 1
1001 ) 1001 0011 101000
       1001
       ----------
          11 10
          10 01
          -------
          01 1110
           1 001
          -------
            1 100
            1 001
          -------
             1 010
             1 001
          -------
               110
```

1001 0011 101110
$x^{13} + x^{10} + x^7 + x^6 + x^5 + x^3 + x^2 + x$.

(b) 0111 0011 101110. remainder is not 0

$\therefore$ can be detected

```
       0 1111 10000 1
1001 ) 0111 0011 101110
        100 1
        -------
         11 10
         10 01
        -------
          1 111
          1 001
        -------
            1101
            1001
        -------
            1001
            1001
        -------
               1110
               1001
               ----
                110.
```