Problem 2

Suppose we begin with the initial two-dimensional parity matrix:

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

With a bit error in row 2, column 3, the parity of row 2 and column 3 is now wrong in the matrix below:

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

Now suppose there is a bit error in row 2, column 2 and column 3. The parity of row 2 is now correct! The parity of columns 2 and 3 is wrong, but we can't detect in which rows the error occurred!

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

The above example shows that a double bit error can be detected (if not corrected).

Problem 5

If we divide 10011 into 1010101010 0000, we get 1011011100, with a remainder of R=0100. Note that, G=10011 is CRC-4-ITU standard.

Problem 8

a)

$$E(p) = Np(1-p)^{N-1}$$
$$E'(p) = N(1-p)^{N-1} - Np(N-1)(1-p)^{N-2}$$
$$= N(1-p)^{N-2}((1-p) - p(N-1))$$

$$E'(p) = 0 \Rightarrow p^* = \frac{1}{N}$$

b)

$$E(p^*) = N\frac{1}{N}(1-\frac{1}{N})^{N-1} = (1-\frac{1}{N})^{N-1} = \frac{(1-\frac{1}{N})^N}{1-\frac{1}{N}}$$

$$\lim_{N\to\infty}(1-\frac{1}{N}) = 1 \qquad \lim_{N\to\infty}(1-\frac{1}{N})^N = \frac{1}{e}$$

Thus

$$\lim_{N\to\infty} E(p^*) = \frac{1}{e}$$

Problem 11

a) $(1 - p(A))^3\, p(A)$

where, p(A) = probability that A succeeds in a slot

p(A) = p(A transmits and B does not and C does not and D does not)

= p(A transmits) p(B does not transmit) p(C does not transmit) p(D does not transmit)

$= p(1 - p)\,(1 - p)(1-p) = p(1 - p)^3$

Hence, p(A succeeds for first time in slot 4)

$= (1 - p(A))^3\, p(A) = (1 - p(1 - p)^3)^3\, p(1 - p)^3$

b) p(A succeeds in slot 5) = $p(1-p)^3$

p(B succeeds in slot 5) = $p(1-p)^3$

p(C succeeds in slot 5) = $p(1-p)^3$

p(D succeeds in slot 5) = $p(1-p)^3$

p(either A or B or C or D succeeds in slot 5) = $4\, p(1-p)^3$

(because these events are mutually exclusive)

c) p(some node succeeds in a slot) = $4\, p(1-p)^3$

p(no node succeeds in a slot) = $1 - 4\, p(1-p)^3$

Hence, p(first success occurs in slot 4) = p(no node succeeds in first 3 slots) p(some node succeeds in 4rd slot) = $(1 - 4\, p(1-p)^3)^3\, 4\, p(1-p)3$

d) efficiency = p(success in a slot) =$4\, p(1-p)^3$

Problem 13

The length of a polling round is

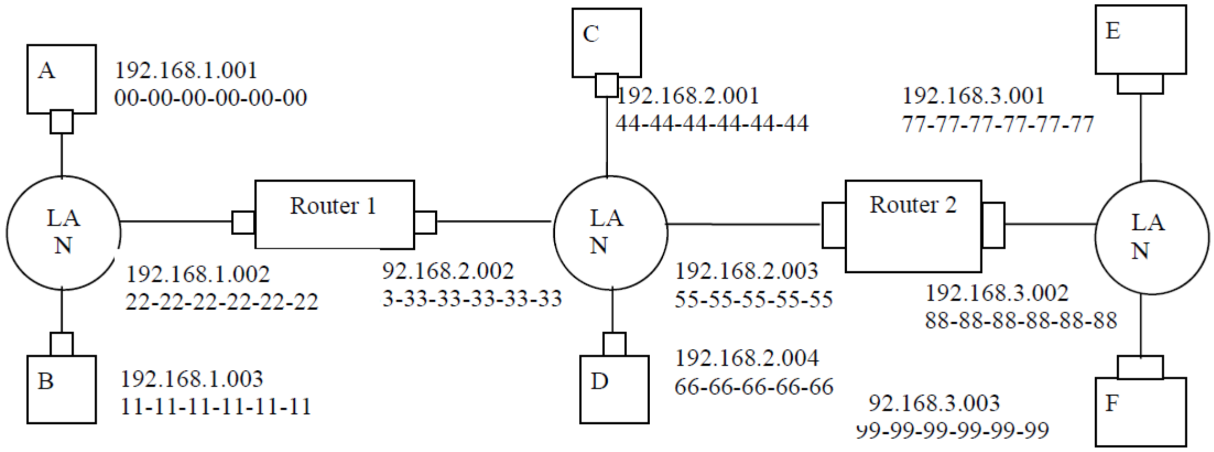
$$N(Q/R + d_{poll})$$

The number of bits transmitted in a polling round is NQ. The maximum throughput therefore is

$$\frac{NQ}{N(Q/R + d_{poll})} = \frac{R}{1 + \frac{d_{poll} R}{Q}}$$

Problem 14

a), b) See figure below.



c)
1. Forwarding table in E determines that the datagram should be routed to interface 192.168.3.002.
2. The adapter in E creates and Ethernet packet with Ethernet destination address 88- 88-88-88-88-88.
3. Router 2 receives the packet and extracts the datagram. The forwarding table in this router indicates that the datagram is to be routed to 198.162.2.002.
4. Router 2 then sends the Ethernet packet with the destination address of 33-33-33- 33-33-33 and source address of 55-55-55-55-55-55 via its interface with IP address of 198.162.2.003.
5. The process continues until the packet has reached Host B.

d) ARP in E must now determine the MAC address of 198.162.3.002. Host E sends out an ARP query packet within a broadcast Ethernet frame. Router 2 receives the query packet and sends to Host E an ARP response packet. This ARP response packet is carried by an Ethernet frame with Ethernet destination address 77-77-77-77-77-77.

Problem 17

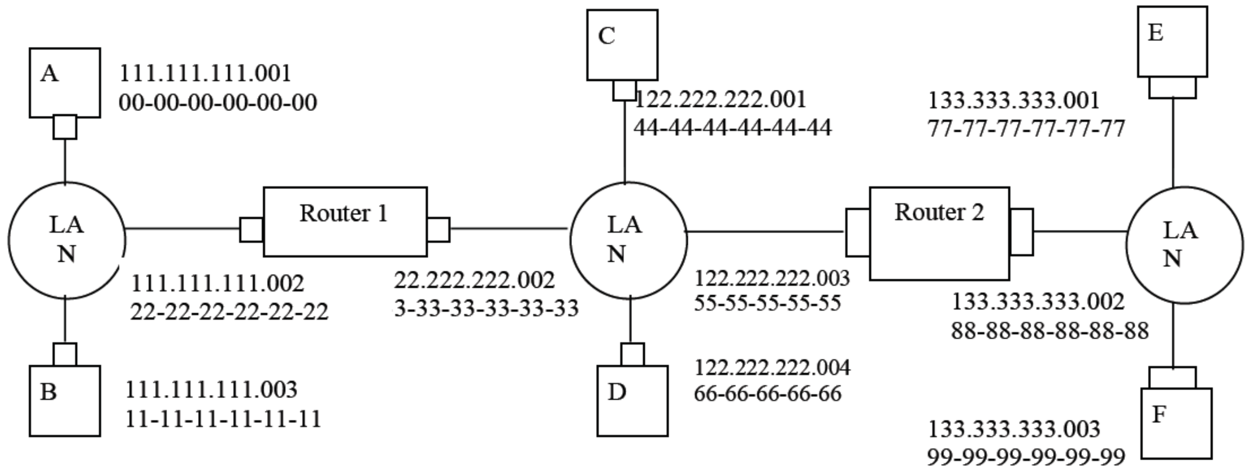
Wait for 51,200 bit times. For 100 Mbps, this wait is $\frac{51.2\times10^3 bits}{100\times10^6 bps} = 0.512 msec.$

For 1 Gbps, the wait is 0.0512 sec.

Problem 18

At $t = 0$, A transmits. At $t = 576$, A would finish transmitting. In the worst case, B begins transmitting at time t=324, which is the time right before the first bit of A’s frame arrives at B. At time t=324+325=649, B's first bit arrives at A. Because 649> 576, A finishes transmitting before it detects that B has transmitted. So A incorrectly thinks that its frame was successfully transmitted without a collision.

Problem 21



i) from A to left router: Source MAC address: 00-00-00-00-00-00
Destination MAC address: 22-22-22-22-22-22
Source IP: 111.111.111.001
Destination IP: 133.333.333.003

ii) from the left router to the right router: Source MAC address: 33-33-33-33-33-33
Destination MAC address: 55-55-55-55-55-55
Source IP: 111.111.111.001
Destination IP: 133.333.333.003

iii) from the right router to F: Source MAC address: 88-88-88-88-88-88
Destination MAC address: 99-99-99-99-99-99
Source IP: 111.111.111.001
Destination IP: 133.333.333.003