Problem 3

```
      01001100    01101001
+     01101110    01101011
       ------------------------------
      10111010    11010100
+     00100000    01001100
      ------------------------------
      11011011    00100000
+     01100001    01111001
      -----------------------------
      00111100    10011010
      (overflow, then wrap around)
 +    01100101    01110010
      ------------------------------
      10100010    00001100
```

The one's complement of the sum is 01011101   11110011

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 6

a) we get 1000110000, with a remainder of R=0000.
b) we get 0101010101, with a remainder of R=1111.
c) we get 1011010111, with a remainder of R=1001.

Problem 10

a) A's average throughput is given by pA(1-pB).   Total efficiency is pA(1-pB) + pB(1-pA).
b) A's throughput is pA(1-pB)=2pB(1-pB)=2pB-2(pB)2.

B's throughput is pB(1-pA)=pB(1-2pB)= pB- 2(pB)2. Clearly, A's throughput is not twice as large as B's. In order to make pA(1-pB)= 2 pB(1-pA), we need that pA= 2 - (pA / pB).

c) A's throughput is 2p(1-p)N-1, and any other node has throughput p(1-p)N-2(1-2p).

Problem 11

a) (1- p(A))4 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 5)

= (1 -p(A))4 p(A) = (1 -p(1 -p)3)4 p(1 -p)3

b) p(A succeeds in slot 4)

= p(1-p)3 p(B succeeds in slot 4)

= p(1-p)3 p(C succeeds in slot 4)

= p(1-p)3 p(D succeeds in slot 4)

= p(1-p)3

p(either A or B or C or D succeeds in slot 4)

= 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 3)

= p(no node succeeds in first 2 slots) p(some node succeeds in 3rd slot)

= (1 - 4 p(1-p)3)2 4 p(1-p)3

d) efficiency = p(success in a slot) =4 p(1-p)3