City University of Hong Kong
Department of Electrical Engineering

EE3009 Data Communications & Networking

Solution to Test 2

1. Following are the steps involved:
   a. Since Host F has an empty ARP table, it first needs to operate the ARP protocol as follows. It sends out an ARP query packet within a broadcast Ethernet frame. Router 2 receives the query packet and sends to Host F an ARP response packet. This response packet is carried by an Ethernet frame with MAC destination address 99-99-99-99-99-99.
   b. Forwarding table in Host F determines that the datagram should be routed to interface 192.168.3.002. The adapter in Host F creates and Ethernet packet with MAC destination address 88-88-88-88-88-88.
   c. Router 2 receives the packet and extracts the datagram.
   d. The forwarding table in Router 2 indicates that the datagram is to be routed to 198.162.2.002. Router 2 then encapsulates the datagram in an Ethernet packet with the destination MAC address of 33-33-33-33-33-33 and sends the Ethernet packet via its interface with IP address of 198.162.2.003.
   e. Router 1 receives the packet and extracts the datagram. Then, Router 1 encapsulates the datagram in an Ethernet packet with the destination MAC address of 00-00-00-00-00-00, and sends the Ethernet packet via its interface with IP address of 198.162.1.002.
   f. Host A receives the frame and extracts the datagram.
2.

Event	Change(s) to the switch table	Link(s) packet is forwarded to	Explanation
B sends a frame to E	An entry is added, with MAC address of B and the corresponding interface	A,C,D,E,F	Since switch table is empty, so switch does not know the interface corresponding to MAC address of E
A sends a frame to B	An entry is added, with MAC address of A and the corresponding interface	B	Since switch already knows the interface corresponding to MAC address of B
B replies a frame to A	No change	A	Since switch already knows the interface corresponding to MAC address of A

3. With pure ALOHA, the maximum throughput is 0.184x56 kbps = 10.3 kbps. Each station requires 10 bps, so N=10300/10 = 1030 stations.

4. Pure ALOHA.
   This is because with pure ALOHA, transmission can start instantly. With slotted ALOHA, it has to wait for the next slot.

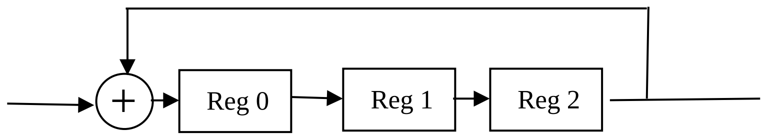
5.
   a. A's average throughput = $p_A(1-p_B)$
   b. Total efficiency = $p_A(1-p_B) + p_B(1-p_A)$
   c. We need $p_A(1-p_B) = 3\,p_B(1-p_A)$
      $p_A + 2p_Ap_B = 3p_B$
      $p_A = \frac{3p_B}{1+2p_B}$

6. It is possible. Suppose that the original information bits contain the bit sequence 01111110. After bit stuffing, this sequence will be modified as 011111010. If the second 0 is lost during transmission, then the sequence 01111110 is received, which is regarded as the end of frame by the receiver. The receiver then looks for the frame check sequence (FCS) before this mis-interpreted end of frame. If the FCS is 16 bits, there is 1 chance in 2^{16} that it will accidentally be the correct checksum, leading to an undetected error.

7. 011110111110011111010

8. a. 01011001
   b. $\binom{8}{2} p^2(1-p)^6$

9. a.



b.

```
              10110111
1001 | 10100001000
       1001
         1100
         1001
          1010
          1001
            1110
            1001
             1110
             1001
              1110
              1001
               111 <- Remainder
```

Since there is remainder, there is error in the received code word.

10. The sum of the numbers 1 through 6 is 21, its binary representation is
00000000 00010101
Taking 1's complement, the internet check sum is
11111111 11101010

11. In CHAP, the password is encrypted, and the authenticator can reissue challenge during the session.

12. First, we have the following:

$$n_f = 512 \times 8 = 4096$$

$$P_f = 1 - (1 - 10^{-4})^{4096} = 0.3361$$

$$\eta = (1 - \frac{n_0}{n_f})(1 - p_f) = (1 - \frac{32}{4096})(1 - 0.3361) = 0.6587$$

13. $$X = \frac{12500 \times 8}{10 \times 10^6} = 10^{-2} s$$

$$\tau' = M(\frac{2d}{v} + \frac{b}{R}) = 25(\frac{5000}{2.5 \times 10^8} + \frac{8}{10 \times 10^6}) = 5.2 \times 10^{-4} s$$

$$\rho_{\max} = \frac{1}{1 + a'(1 + \frac{1}{M})} = \frac{1}{1 + \frac{5.2 \times 10^{-4}}{10^{-2}}(1 + \frac{1}{25})} = 94.87\%$$

14.