1. A satellite serving 100 stations can receive a maximum of 10,000 packets per second. If the channel is being utilized optimally (5 points)
   I. What is the average number of packets sent by every station? (for plain and slotted ALOHA)
   II. How many packets (per second) suffer collisions? (for plain and slotted ALOHA)

Plain ALOHA:
All stations together send 5000 packets per second - 50 packets per station on an average
Satellite receives 1860 packets per second (efficiency = 1/e) without collision. 5000-1860 = 3140 packets per second suffer collision

Slotted ALOHA:
All stations together send 10000 packets per second - 100 packets per station on an average
Satellite receives 3720 packets per second (efficiency = 2/e) without collision. 10000-3720 = 6280 packets per second suffer collision

2. Assume that you are designing a CSMA-CD protocol which permits (9 points)
   ● maximum bit-rate of 1 Mbps
   ● maximum distance of 1250 m between any two stations (no repeaters are used)
   ● maximum packet size of 1000 bits

The velocity of propagation of electromagnetic waves in the medium is 250 million m/s. Determine other parameters of the system like minimum packet size, minimum packet duration, maximum round trip time. What is the efficiency when the maximum allowed packet size is used for all packets? What is the efficiency if we use packet size of 500 bits?

Propagation delay = distance/speed = 1250/250,000,000 = 5 micro seconds
round trip time = 10 micro seconds
minimum packet duration = round trip time (RTT) = 10 micro seconds
minimum packet size = 5 bits; (packet duration = packet size / bit rate)
Efficiency = P/(P+RTT*e) = P/(P+2.7183*RTT)
If packet size is 1000 bits P = 1000 micro seconds
Efficiency = 1000/(1000+27.183) = 97.35%
If packet size is 500 bits P = 500 micro seconds
Efficiency = 500/(500+27.183) = 94.84%

3. Explain the hidden station and the exposed station problems in CSMA-CA. Is exposed station problem handled in 802.11? Why? (3 points)

A               B                C                 D
A and C are out of range
B and D are out of range

Hidden station problem:
When A is transmitting to B, C cannot sense A's transmission. If C transmits to D (as the channel as seen by C is clear) then collision occurs at B

Exposed station problem:
B is transmitting to A. C can simultaneously transmit to D. However, C will not transmit as C does not sense the channel to be clear (as C can hear B)
Exposed station problem is not handled in 802.11 as if C transmits then B will not be able to hear the ACK from A.

4. Briefly explain the concept of backward learning in bridges. (3 points)

Bridges inspect from (MAC) addresses in received MAC frames and learn which MAC addresses correspond to which lines. They maintain a table of MAC addresses for each line. The table is periodically flushed clear and the learning process begins all over again.