1) (2 Points) A data-link channel employs bit-stuffing for framing. If the frame consists of the following sequence of bits indicate the positions where a zero-bit will be stuffed - the frame to be sent is

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

2) A DL channel employs a CRC with generator 11011. The following sequence of bits have to be sent over the channel

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

a) (1 point) How many redundant bits will be added?

b) (3 points) What are the values of the redundant bits?

c) (1 point) What is the efficiency?

d) (2 points) What type of errors will escape detection? Provide an example.

3) A DL channel employs a Hamming Error correction code with m=11 and n=15. The sequence of 15 bits received by the receiver is 1 0 0 1 1 0 0 1 1 0 0 1 1 0 0.

a) (5 points) What was the sequence of 11 bits sent?

b) (1 point) Did an error occur? Where?

c) (2 points) Briefly indicate all assumptions made.

4) The DL layer receives a sequence of 15 packets from the NL (packets P1, P2, ...., P15). Assume that each packets fits into one DL frame. The DL employs SRP with a window size of 4.

a) (2 points) Indicate the DL number that will be assigned to each packet

b) The receiver has received a sequence of packets numbered 0, 1, 2, 3, 4, X.

i. (3 points) What are the possible values for X? (can X be 0? 1? 2? ...... 12? etc)

ii. (3 points) Explain a scenario which makes such values of X possible

iii. (2 points) When a packet with a number X is received indicate what the receiver should do with the packet (discard or store)

5) In the context of PPP

a) (1 point) What is the type of framing used?

b) (4 points) What are the functions of LCP and NCP? Why are they needed?