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Q.1

(a) In a three-way handshake procedure, one must ensure the selection of the initial sequence number is always unique. If station B receives an old SYN segment from A, B will acknowledge the request based on the old sequence number. When A receives the acknowledge segment from B, A will find out that B received a wrong sequence number. Station A will discard the acknowledgement packet and reset the connection.

(b) If an old SYN segment from A arrives at B, followed by an old ACK segment from A to a SYN segment from B, the connection will also be rejected. Initially, when B receives an old SYN segment, B will send a SYN segment with its own distinct sequence number set by itself. If B receives the old ACK from A, B will notify A that the connection is invalid since the old ACK sequence number does not match the sequence number previously defined by B. Therefore, the connection is rejected.

Q.2

G(x) = x^3 + 1 encoded as **1001**.

Added **3 zeros** to the end of the frame to be transmitted (because the degree of G(x) is 3): **10011101000**

							1	0	0	0	1	1	0	0
1	0	0	1	1	0	0	1	1	1	0	1	0	0	0
				1	0	0	1							
				0)	0	0	0	1						
					0	0	0	0						
					0)	0	0	1	1					
						0	0	0	0					
						0)	0	1	1	0				
							0	0	0	0				
							0)	1	1	0	1			
								1	0	0	1			
								0)	1	0	0	0		
									1	0	0	1		
									0)	0	0	1	0	
										0	0	0	0	
										0)	0	1	0	0
											0	0	0	0
											0)	**1**	**0**	**0**

Actual frame transmitted: **10011101100**

Suppose the 3rd bit from the left is inverted during transmission: **10111101100**

				1	0	1	0	1	0	0	0
1 0 0 1	1	0	1	1	1	1	0	1	1	0	0
	1	0	0	1							
	0)	0	1	0	1						
		0	0	0	0						
		0)	1	0	1	1					
			1	0	0	1					
			0)	0	1	0	0				
				0	0	0	0				
				0)	1	0	0	1			
					1	0	0	1			
					0)	0	0	0	1		
						0	0	0	0		
						0)	0	0	1	0	
							0	0	0	0	
							0)	0	1	0	0
								0	0	0	0
								0)	**1**	**0**	**0**

The remainder (**100**) shows that an error has occurred.

Q.3

(a) 135.46.63.10 in bits will be: **10000111.00101110.00111111.00001010**

Keep first 22 bits and turn remaining bits into 0: **10000111.00101110.00111100.00000000** → **135.46.60.0** (in decimal)

Therefore, the packet will forward to **Interface 1**.

(b) 135.46.57.14 in bits will be: **10000111.00101110.00111001.00001110**

Keep first 22 bits and turn remaining bits into 0: **10000111.00101110.00111000.00000000** → **135.46.56.0** (in decimal)

Therefore, the packet will forward to **Interface 0**.

Q.4

(a) **g1(x) = x + 1** is used as generating polynomial → **G = 11**

The degree of **g1(x)** is **1**.

Data to be sent: **1101100**

```
            1   0   0   1   0   0
1   1 | 1   1   0   1   1   0   0
        1   1
        ------
        0)  0   0
            0   0
            ------
            0)  0   1
                0   0
                ------
                0)  1   1
                    1   1
                    ------
                    0)  0   0
                        0   0
                        ------
                        0)  0   0
                            0   0
                            ------
                            0)  0
```

The codeword will be: **1101100**

(b) **g2(x) = x^3 + x^2 + 1** is used as generating polynomial → **G = 1101**

The degree of **g2(x)** is **3**.

Data to be sent: **110110000**

```
                          1   0   0   0   1   1
1   1   0   1 | 1   1   0   1   1   0   0   0   0
                1   1   0   1
                --------------
                0)  0   0   0   1
                    0   0   0   0
                    --------------
                    0)  0   0   1   0
                        0   0   0   0
                        --------------
                        0)  0   1   0   0
                            0   0   0   0
                            --------------
                            0)  1   0   0   0
                                1   1   0   1
                                --------------
                                0)  1   0   1   0
                                    1   1   0   1
                                    --------------
                                    0)  1   1   1
```

The codeword will be: **110110111**

Q.5.

TCP / IP over Ethenet allows data frames with a payload size up to 1460 bytes. Therefore, **L = 100, 500, 1000** are within this limit.

TCP: 20 bytes of header

IP: 20 bytes of header

Ethernet: 18 bytes of header and trailer

Therefore:

L = 100 bytes, $\frac{100}{100+20+20+18} = 63\%$ efficiency

L = 500 bytes, $\frac{500}{500+20+20+18} = 90\%$ efficiency

L = 1000 bytes, $\frac{1000}{1000+20+20+18} = 95\%$ efficiency