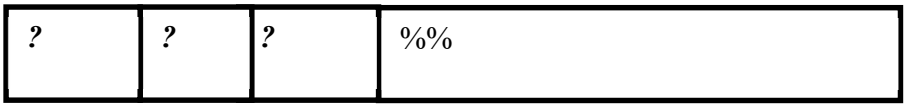
Assignment 4: CMPT 371
To be completed in groups of 1 or 2

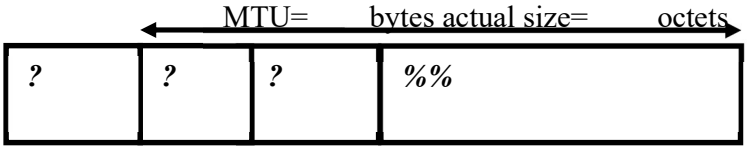
1) **[20 points]** A source host sends a packet with an MTU of 1500 octets in an Ethernet frame. The MTU or maximum transmission unit indicates the length of the data field in the Ethernet frame (the length of the IP packet). The length of the IPv4 header is 38 octets. The length of the TCP header is 20 octets. On its way to the destination the packet passes through a network with a MTU of 906 octets. Explain how the packet is fragmented by filling in the requested information in the diagram below. You should create a copy of the diagram below including the information requested in your solution. The data you are to fill in is indicated in two ways
   - A space after an = needs to be filled with a numeric value
   - A ? needs to be replaced with a label indicating the type of header and its length in octets
   - A %% indicates that the field should hold the length of the application data (without any encapsulating headers). In addition to the final answer you should provide an equation showing how that length was calculated (either words or just an expression showing how you combined the supplied values to determine the length.).

   Remember the payload of the IP fragment for each fragment (except the last) must be a multiple of 8.

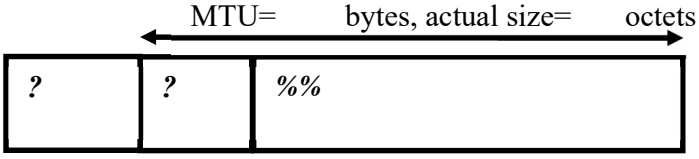
Original Ethernet frame before fragmentation



Ethernet frames containing IP fragments after fragmentation



More=
Offset= octets



More=
Offset= octets
= ***(value in header field)***

2) **[20 points]** Consider the distributed Bellman-Ford algorithm used in the first generation internet. At station A, new routing tables have just arrived from A's nearest neighbors D and E. The cost from A to D is 4 and the cost from A to E is 4. These newly received distance vectors are given below. Based on these newly received distance vectors calculate a new distance vector for node A.

1)	from D		from E	
	Cost	Next	Cost	Next
A	1	A	2	A
B	3	E	3	B
C	3	E	2	C
D	-	-	2	D
E	1	E	-	-
F	4	E	3	C
G	1	G	3	D
H	3	E	2	H
I	5	E	4	H

			New table	
	Cost Through D	***Cost Through E***	***Cost***	***Next***
A				
B				
C				
D				
E				
F				
G				
H				
I				

3) **[30 points]** Write a Python or C or C++ program that will forward a packet.

- Initially your program should read the routing table from a file. A sample routing table is given below. An input file for the routing table is given in the file forwardTableTest1.txt posted along with the assignment. The format described below and illustrated in the sample input file must be followed in your program. The format be used to test your code when grading. If your code does not correctly read the input in this format when testing your code will fail tests and you will lose marks.
    - No column titles will be used in the file
    - Each line of data in the input file will contain the information in one row of the routing table.
    - Values within each line of the file will be separated by single tabs.
    - Values within each line of the file will be in the same order as the corresponding row of the table below
- Put the input routing table into order so the first row tested will be the row with the longest mask and the last row with the shortest mask.
- Print the routing table (in sorted order) to the screen
- Convert all input addresses in the routing table to binary
- For each packet to be forwarded
    - Read the IP destination address of the packet to be forwarded
    - Convert the IP destination address to binary.
    - Implement the forwarding algorithm, all calculation should be done in binary (e. g. Using bitwise AND).
    - The program must include the use of the metric
    - The following output should be printed to the screen. The >>>>>>> and <<<<<<< will be replaced with the actual input or calculated / determined values.
        i. The destination IP address is >>>>>>>>>>
        ii. The next hop IP address is >>>>>>>>>
        iii. The port the packet will leave through is <<<<<<

      Note that the >>>>>>>> represents the dotted decimal form of the iP address And the <<<<<< represents the port number (an integer)
- After forwarding a packet (and before forwarding the next packet)
    - Ask if the user wishes to forward another packet
    - If the answer is no terminate the program
    - If the answer is yes ask for the destination IP address of the next packet to be forwarded
    - Route the next packet
    - Repeat the last four points until the program terminates

Sample routing table for testing

Destination	Gateway address	mask	metric	interface
201.123.32.0	*	255.255.224.0	0	eth1
201.123.64.0	123.122.0.2	255.255.192.0	1	eth2
201.123.64.0	123.123.0.2	255.255.192.0	0	eth3
202.123.40.0	*	255.255.248.0	0	eth4
124.124.0.0	*	255.255.254.0	0	eth0
125.125.1.0	124.124.1.1	255.255.254.0	0	eth0
0.0.0.0	124.123.1.1	0.0.0.0	0	eth0

4) A CRC is constructed to generate a 7 bit Frame Check sequence for a 24 bit message. The generator polynomial is $X^7 + X^6 + X^4 + X^3 + X + 1$

The message bits for a particular message are

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

a) **[4 points]** Draw a shift register circuit to perform the calculation of the CRC bits.

b) [4 points] List four examples of the types of errors an FCS can detect.

c) [6 points] Can the errors represented by each of the following error polynomials *E*(*X*) be detected by the CRC? Why or why not?

```
00100001001000010000100010000001
00000001101011000000000000000000
11011010110011001100000000000000
```

d) [8 points] Determine the FCS using polynomial division. Show your work

e) [8 points] Determine the FCS using your shift register circuit. Show your work.