Question 1 – IP Packets (20%)

An IPv4 packet with a UDP payload (protocol number 0x11) of size 1000 bytes and ID = 1 was sent from address 190.30.10.7 to address 150.73.10.17 with TTL = 128.
The sender allows network devices to fragment the packet along the way.

1. Describe how the IP header looks at the time of transmission.
   You may ignore DSCP, ECN, and the checksum in your answer.

2. It is given that there are 2 routers between the sender and the receiver, and that the packet arrives at the destination in 30 ms.
   Repeat part (1) for the packet upon reception, assuming it was not fragmented along the way.
   (You may write only the fields that changed from the previous section.)

3. Now assume that the packet must pass through a network where the MTU is 500.
   Describe how the IP header of each fragment will look upon reception.
   (You may write only the fields that changed from the previous section.)

4. How does the receiving computer know that it has received all fragments of the packet?

5. If the sender wanted to prevent fragmentation of the original packet along the way, what should it do?
   What would happen along the path if it did this to the original packet before sending it?

Question 2 – IP Addresses (20%)

A certain network is divided into several subnets.
A router in the organization contains the following routing table:

Network Name	Network	Exit Port
A	10.0.90.0/23	1
B	10.0.170.0/23	3
C	10.0.96.0/20	2
D	10.0.64.0/18	1
E	10.0.160.0/19	2
F	0.0.0.0/0	3

1. What is the role of row F?

2. For the following five packets, calculate to which exit port each will be routed:

Datagram Name	Destination IP Address
P	10.0.80.21
Q	10.0.168.15

Datagram Name	Destination IP Address
R	10.1.100.1
S	10.0.72.18
T	10.0.0.255

3. Is it possible to remove a row from the table without changing the routing of any message (in general, not only for the five packets above)?

Question 3 – ICMP (20%)

Briefly explain how ICMP can be used to discover the Maximum Transmission Unit (MTU) along a path to a given destination.
Explain how to do this optimally.
What is the number of messages required in this case?
(The answer may be given in Big-O notation as a function of the MTU.)

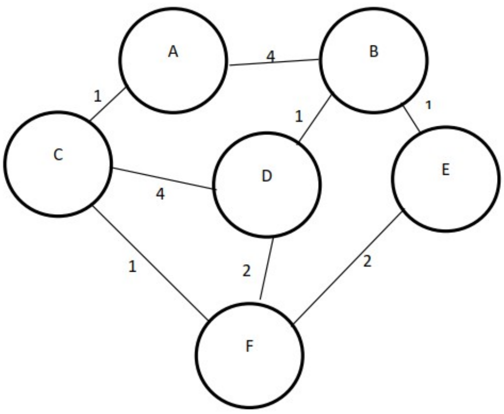
Question 4 – Routing Algorithms (20%)

The network shown in the figure below is given, including the **edge costs** between the different nodes.

1. Assume the network uses the Distance Vector routing algorithm in its basic form.
   What is the routing table at node A (i.e., its distances to all other nodes)
   at the beginning of the process, and at the end of the process (after convergence)?
   Also show the next hop field.

2. Now assume the edge E–F is disconnected.
   Will the algorithm converge?
   If yes, what will be the distances at node A?
   If not, how will the distance table at node D look over time?

3. Answer the previous section again for the case where, after the situation described in part (b), the edge B–E is also disconnected.



Question 5 – BGP (20%)

The following network is given:

- Each numbered cloud represents an AS (Autonomous System).
- Yellow lines represent peer-to-peer relationships.
- Red arrows represent provider–customer relationships.
- Routing uses BGP with the common BGP policy rules taught in class.
- Assume that BGP has converged.

1. In this section, assume that in each AS there is only one network, denoted simply by the AS number.
   For each of the other networks, specify which route will be selected when routing from AS 5.

2. Repeat part (1), this time for routing from AS 1.