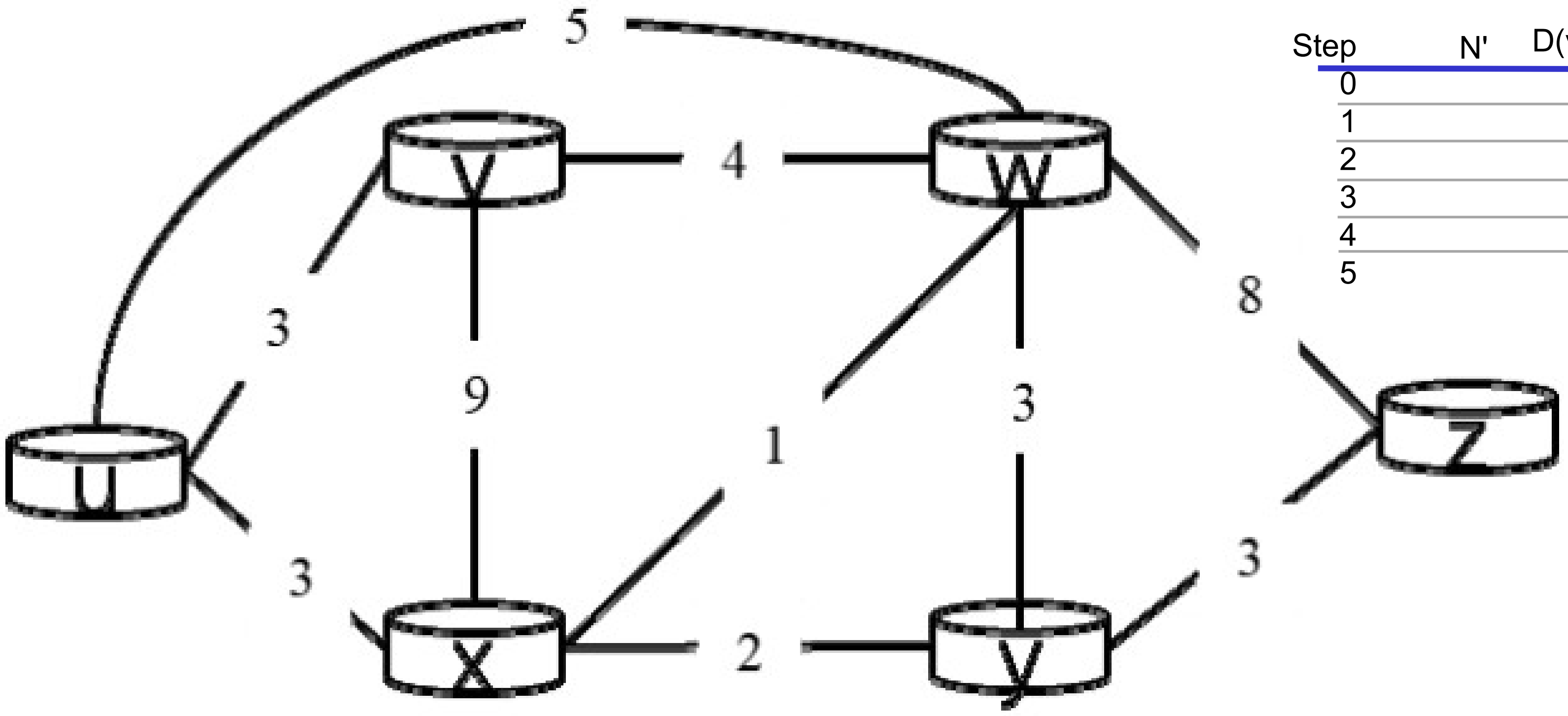
5. (6 points) Consider the 6-node network shown below, with the given link costs. Using Dijkstra's algorithm, find the least cost path from source node U to all other destinations and answer the following questions.

(1) What is the shortest distance to node w and what node is its predecessor?

(2) What is the shortest distance to node z and what node is its predecessor?

(3) What is the shortest distance to node u and what node is its predecessor?



		v	w	x	y	z
Step	N'	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0						
1						
2						
3						
4						
5						

Please prepare a piece of A4 paper, and write down your name and student number.

Consider the two 16-bit words (shown in binary) below. Recall that to compute the Internet checksum of a set of 16-bit words, we compute the one's complement sum [1] of the two words. That is, we add the two numbers together, making sure that any carry into the 17th bit of this initial sum is added back into the 1's place of the resulting sum); we then take the one's complement of the result. Compute the Internet checksum value for these two 16-bit words:

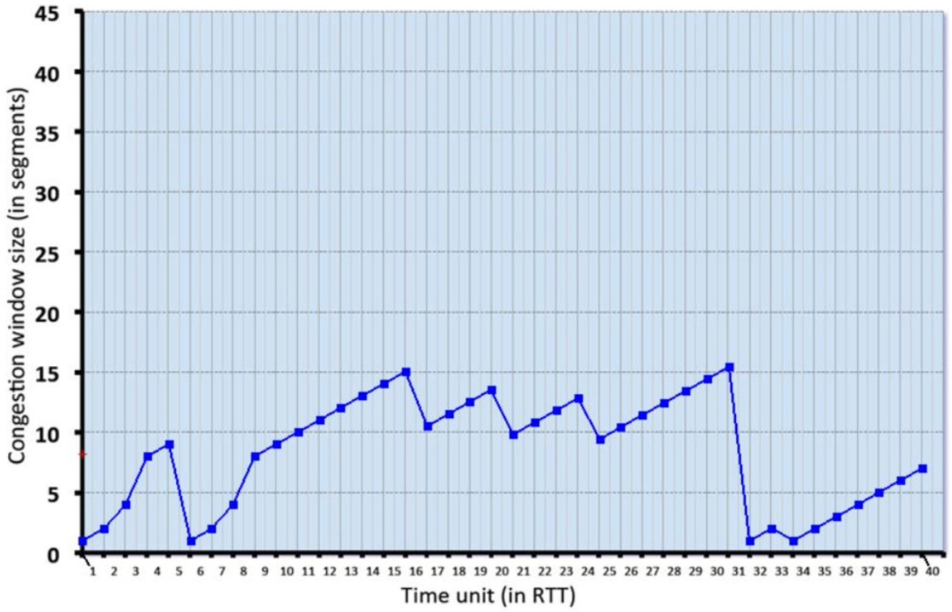
00100001 11001000

11111110 00011001

Please answer the following questions.

1) What is the sum of these two 16 bit numbers?
2) Using the sum from question 1, what is the checksum?

Consider the figure below, which plots the evolution of TCP's congestion window at the beginning of each time unit (where the unit of time is equal to the RTT). In the abstract model for this problem, TCP sends a "flight" of packets of size cwnd at the beginning of each time unit. The result of sending that flight of packets is that either (i) all packets are ACKed at the end of the time unit, (ii) there is a timeout for the first packet, or (iii) there is a triple duplicate ACK for the first packet. In this problem, you are asked to reconstruct the sequence of events (ACKs, losses) that resulted in the evolution of TCP's cwnd shown below. The initial value of cwnd is 1 and the initial value of ssthresh is 8. Format your answer like: 1,3,5,9 (If none submit blank)



1) Give the times at which TCP is in slow start.

2) Give the times at which TCP is in congestion avoidance.

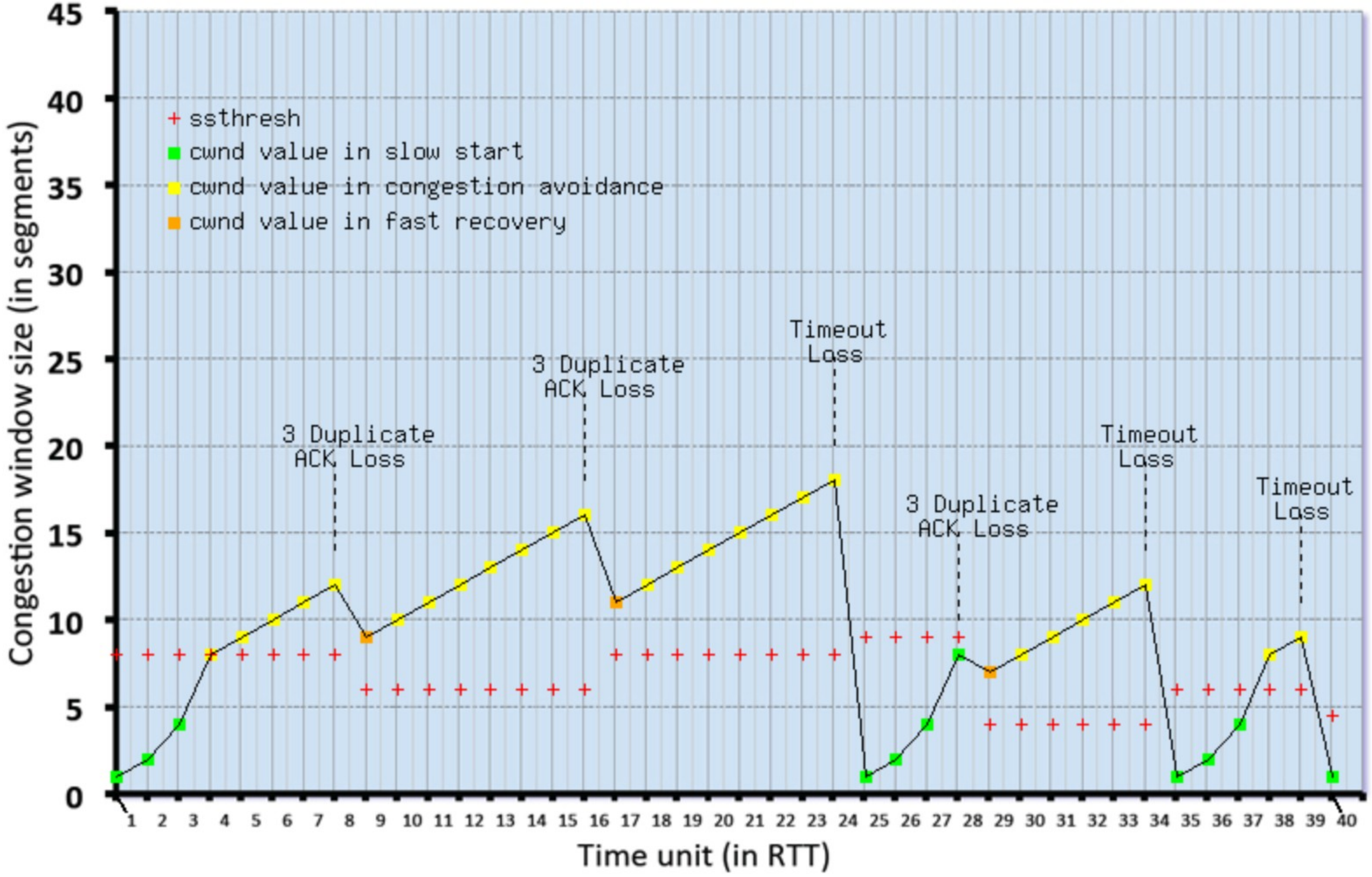
3) Give the times at which TCP is in fast recovery.

4) Give the times at which packets are lost via timeout.

5) Give the times at which packets are lost via triple ACKs.

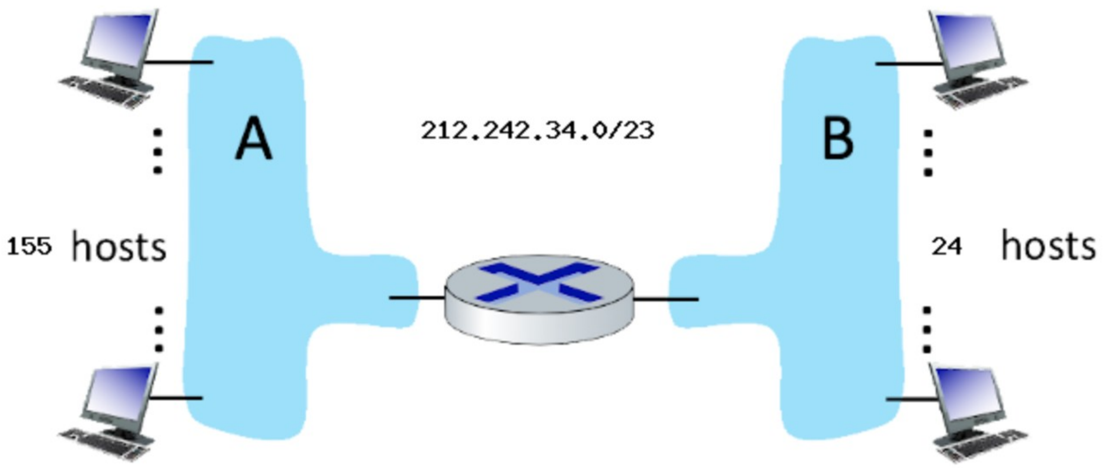
6) Give the times at which the value of ssthresh changes.

1. The times where TCP is in slow start are: 1-4， 6-9， 32-33
2. The times where TCP is in congestion avoidance are: 5， 10-16， 17-20， 21-24， 25-31， 34-40
3. The times where TCP is in fast recovery are: 17,21,25
4. The times where TCP has a loss by timeout are: 5,31,33
5. The times where TCP has a loss by triple duplicate ACK are: 16,20,24
6. The times where the ssthresh changes are: 6,17,21,25,32,34


+ ssthresh
cwnd value in slow start
cwnd value in congestion avoidance
cwnd value in fast recovery
3 Duplicate ACK Loss
3 Duplicate ACK Loss
Timeout Loss
3 Duplicate ACK Loss
Timeout Loss
Timeout Loss
Congestion window size (in segments)
Time unit (in RTT)
0
5
10
15
20
25
30
35
40
45

Consider the router and the two attached subnets below (A and B). The number of hosts is also shown below. The subnets share the 23 high-order bits of the address space: 212.242.34.0/23

Assign subnet addresses to each of the subnets (A and B) so that the amount of address space assigned is minimal, and at the same time leaving the largest possible contiguous address space available for assignment if a new subnet were to be added. Then answer the questions below.



1. Is the address space public or private?
2. How many hosts can there be in this address space?
3. What is the subnet address of subnet A? (CIDR notation)
4. What is the broadcast address of subnet A?
5. What is the starting address of subnet A?
6. What is the ending address of subnet A?
7. What is the subnet address of subnet B? (CIDR notation)
8. What is the broadcast address of subnet B?
9. What is the starting address of subnet B?
10. What is the ending address of subnet B?

1. The address 212.242.34.0/23 is public.

2. Maximum number of hosts = 2^x - 2 = 2^9 - 2 = 510. The reason we have to subtract 2 from the final number is because there are always 2 addresses allocated for each address block: the subnet ID (the first address) and the broadcast address (the last address); for example, if you have 5 bits for hosts, you can have 30 hosts, because 2 of the addresses are for the subnet ID and the broadcast address which when added equals 32, which is 2^5.

3. Subnet A has 155 hosts, so it will need at least 157 addresses (for the subnet ID and broadcast address). The least number of bits that satisfy this is 8 bits. Knowing that, we take the prior subnet and add 256 the result of which is 212.242.34.0/24

4. The broadcast address of subnet A (212.242.34.0/24) is 212.242.34.255, because it is the last address in the IP range.

5. The first IP address of subnet A (212.242.34.0/24) is 212.242.34.1, found by adding 1 to the subnet address.

6. The last IP address of subnet A (212.242.34.0/24) is 212.242.34.254, found by subtracting 1 from the broadcast address (212.242.34.255).

7. Similar to the prior subnet, subnet B has 24 hosts, so it will need at least 26 addresses (for the subnet ID and broadcast address). The least number of bits that satisfy this is 5 bits. Knowing that, we take the prior subnet and add 32, the result of which is 212.242.35.0/27

8. The broadcast address of subnet B (212.242.35.0/27) is 212.242.35.31, because it is the last address in the IP range.

9. The first IP address of subnet B (212.242.35.0/27) is 212.242.35.1, found by adding 1 to the subnet address.

10. The last IP address of subnet B (212.242.35.0/27) is 212.242.35.30, found by subtracting 1 from the broadcast address (212.242.35.31).