Name:	

Part 2

Memory aids allowed
90 minutes

Scoring:

1.a	1.b	1.c	2.a	2.b	3.a	3.b	Total Part 2
2	0.5	1.5	2	1	1.5	1.5	10/20

Show your calculations on the blank space below each question.

1. Consider the following two 3 km links over which we are considering the application of ARQ mechanisms. Assume that information frames are sent in one direction and supervision frames are sent in the other direction; information frames are L = 1500 bit long, dismiss supervision frame size. Also assume no errors.

- Link 1, channel capacity in each direction 1kbit/s, propagation delay 5 µs/km
- Link 2, channel capacity in each direction 1 Gbit/s, propagation delay 5 µs/km

1.a. (**2/20**) What is the maximum efficiency and throughput if we use Stop and Wait and Go-back-N (W=16) in the two links?

	Stop & Wait		Go-back-N	
	Link 1	Link 2	Link 1	Link 2
Maximum efficiency (%)				
Maximum throughput (kbit/s)				

Name:	

1.b. (**0.5/20**) Explain if the mechanisms in a) are acceptable for any of the links. With comparable efficiency and throughput, why would you use Stop and Wait cf. Go-back-N? Which is simpler and why?

1.c. (**1.5/20**) Assume now a frame error ratio of 0.1% on link 2 (1 Gbit/s). What's the maximum efficiency and throughput for Go-back-N (W=8,16,32, 64)?

	W=8	W=16	W=32	W=64
Maximum efficiency (%)				
Maximum throughput (kbit/s)				

Name:	

2. A computer network engineer needs to specify network resources for 10 flows. The flows are random (Poisson arrival) with average bitrates of 128 kbit/s and packet size 2000 bits. The engineer has three options: 1) specify a 160 kbit/s dedicated fixed bandwidth channel for each flow; 2) specify a 256 kbit/s dedicated fixed bandwidth channel for each flow; 3) statistically multiplex the ten channels into a single fixed bandwidth channel of 1600 kbit/s.

2.a. (**2/20**) Compute the following values for each option.

	Option 1	Option 2	Option 3
Per channel			
Individual channel capacity (kbit/s)	160	256	1600
Traffic intensity ρ (%)			
Avg. packet arrival/s			
Avg. packet delay (ms)			
Avg. packet queue size (waiting + service)			
Total			
Total channel capacity (kbit/s)			

2.b. (**1/20**) Which option should the engineer select and why? How would this change if the flows had constant bitrate? Would multiplexing help?

Name:	

3. Consider the following routing table of host 172.16.13.4 on a local network.

Destination Network	Flags	Gateway (next hop)
172.16.13.0/25		0.0.0.0
172.16.14.0/23	G	172.16.12.2
172.16.16.0/30	G	172.16.12.3
default (0.0.0.0)	G	172.16.12.1

3.a. (**1/20**) Fill the table below for host 172.16.13.4's network. Justify.

Subnet address and mask	
Subnet broadcast address	
Number of addresses available for network interfaces in the subnet	

3.b. (**1/20**) The ping command is issued from the host 172.16.13.4 and is targeted at the following addresses. Assuming the ARP table is empty before issuing the ping commands, which IP addresses and respective MAC addresses should be in the ARP table? Justify.

Ping target addresses: **172.16.13.6**, **172.16.15.140**, **172.16.13.201**.

ARP table addresses after all pings			