### MAKE SURE THAT YOUR HANDWRITING IS READABLE

1a Give a simple, centralized algorithm for mutual exclusion.

4pt

1b Give a fully decentralized algorithm for mutual exclusion.

6pt

1c Compare the two algorithms with respect the number of messages that a process needs to exchange before it can proceed as only one.

6pt

2a Explain the difference between fault, error, and failure by means of a compelling example.

6pt

2b Show that having three processes of which one is faulty, is not enough to guarantee agreement between the two nonfaulty ones in a Byzantine setting.

6pt

2c Illustrate by means of an example how independent checkpointing can lead to a cascaded rollback. Be sure to explain your answer!

6pt

3a Why is the following data store not sequentially consistent? Is it causally consistent? Be sure to explain your answer.

6pt

P1:	W(x)a		
P2:		W(x)b	
P3:		R(x)b	R(x)a
P4:			R(x)a R(x)b

3b Consider a system that combines read-your-writes consistency with writes-follow-reads consistency. Is this system also sequentially consistent? Explain your answer.

6pt

4a Resolve the following key lookups for the shown Chord-based P2P system:

6pt

source	key
4	2
4	4
14	15
14	19
21	2
21	20
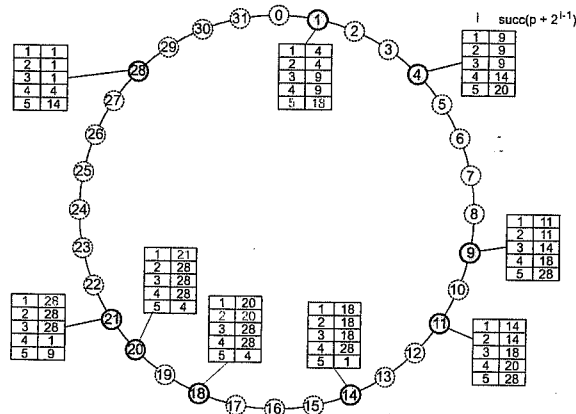
4b Which finger tables will be affected if a node with ID 7 enters the ring, and how?

6pt

4c In Chord, there is a difference between iterative and recursive lookups. Which one performs better?

6pt

4d What would be a simple extension to Chord so that network proximity is taken into account when doing a key lookup? Give an example using the previous figure.

6pt

```
(01) main(int argc, char* argv[]) {
(02)     Ice::Communicator    ic;
(03)     Ice::ObjectAdapter   adapter;
(04)     Ice::Object          object;
(05)     ...
(06)     ic = Ice::initialize(argc, argv);
(07)     adapter = ic->createObjectAdapterWithEnd Points( "MyAdapter","tcp -p 10000");
(08)     object  = new MyObject;
(09)     adapter->add(object, objectID);
(10)     adapter->activate();
(11)     ic->waitForShutdown(); }
```

5a Explain what is happening in the (incomplete) code fragment given above.   *6pt*

5b Which information will the objectID parameter contain in line (09)?   *4pt*

5c What is meant by an *activation policy* for an object adapter?   *6pt*

5d Suppose we would add the following lines (10x meaning a line inserted after line 10). How would
this affect the original code?   *4pt*

```
         ...
(07x)    adapter2 = ic->createObjectAdapterWithEnd Points( "MyAdapter1","tcp -p 10001");
         ...
(09x)    adapter2->add(object, objectID2);
         ...
(10x)    adapter2->activate();
         ...
```

Grading: *The final grade is calculated by accumulating the scores per question (maximum: 90 points), and adding 10 bonus points. The maximum total is therefore 100 points.*