

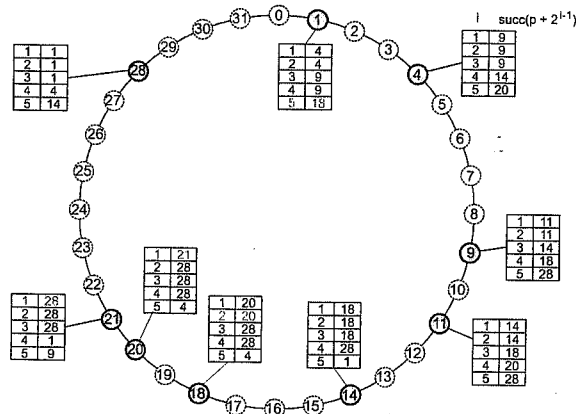
MAKE SURE THAT YOUR HANDWRITING IS READABLE

- 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->createObjectAdapterWithEndpoints( "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->createObjectAdapterWithEndpoints( "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.