

CS 5204
Fall, 1999
Midterm Examination

100 points

Name: _____

Directions: Answer questions 1 through 4 and question 6 on your own paper. Answer questions 5 and 7 on the exam pages. Be sure that your name is on all the pages that you turn in.

1. (10 points) Name and briefly describe three uses of the concept of non-determinism seen in the course. Describe each use in 20 words or less.
2. (15 points) Below is the tuple space code for the client and the server in a client-server problem. This code has a sequencing property: requests are removed by the server from the tuple space in order of their index number. Modify this code to allow multiple servers. The multiple server system should maintain the sequencing property.

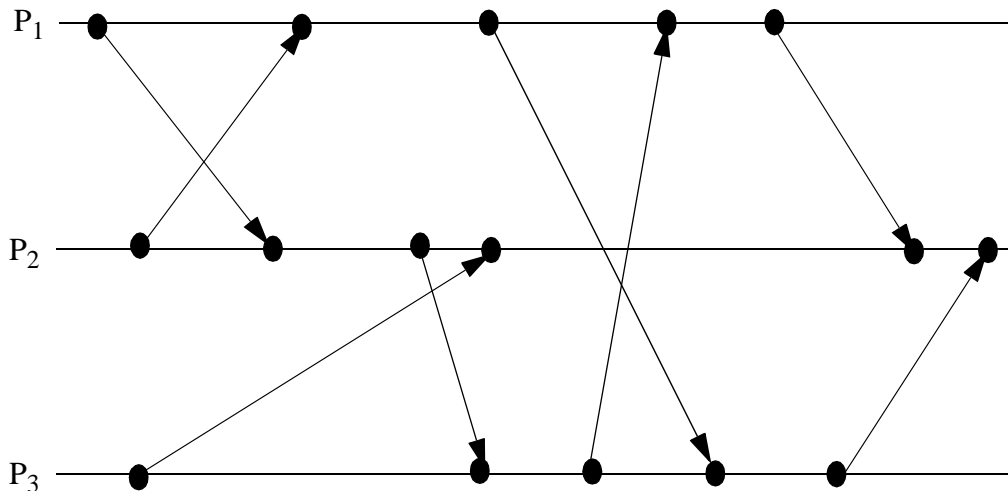
Server	Client
<pre>server() { int index = 1; while(1) { in ("request", index, ? req); ... out("reply", index++, reply); } }</pre>	<pre>client() { int index; ... in("index", ? index); out("index", index+1); ... out("request", index, request); in("reply", index, ? reply); }</pre>

3. (10 points) Give three differences between monitors and mobile agents. Describe each difference in no more than 20 words.
4. (15 points) A communicating sequential process (CSP) whose code is shown below receives messages from processes A, B, and C, and sends messages to process D. Assuming that process A always sends a 0, process B always sends a 1, and process C always sends a 2, describe the pattern of values received by process D.

```
boolean f:=true;
int x; int y:=1;
*[ f; A?(x) --> D!(x); f:=false [ ]
  y==2;!f;B?(x) --> D!(x); y:=x; f:=true; [ ]
  y==1;!f;C?(x) --> D!(x); y:=x; f:=true;
]
```

5. (15 points) The diagram below shows three processes that communicate via messages.

- (a) Label the diagram below to show the vector timestamp of each event.
Assume that the clock on each system is initially zero (0) and is incremented by 1 for each event.
- (b) On the diagram, draw a circle around each event that is concurrent with the last event on P_3 .

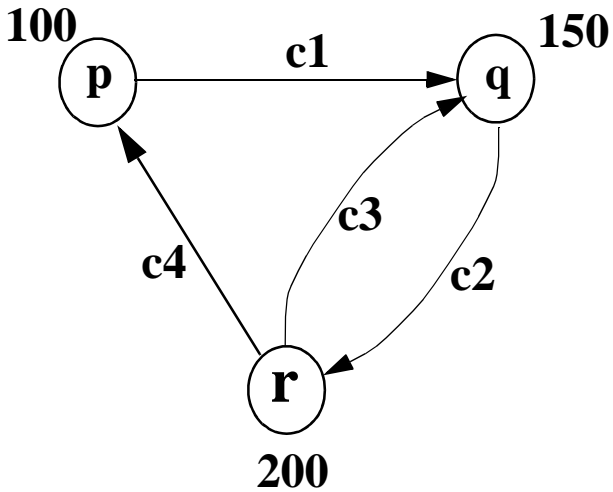


6. (15 points) The Birman-Schiper-Stevenson protocol is being used by a system. Node 3 has queued two messages from node 1 with the timestamps $(3,3,2)$ and $(4,3,2)$. The vector clock on node 3 is $(2,2,2)$. What will node 3 do:

- (a) if it receives a message with the timestamp $(2,4,2)$?
- (b) if it receives a message with the timestamp $(2,3,2)$?

Your answers must be explicit about the order in which messages are delivered.

7. (20 points) Fill in the table below with the information recorded by the global state recording (snapshot) algorithm for the system shown in the figure on the left. Assume that the messages are sent and received in the order indicated in the sequence at the right.



- (1) p sends 20 to q
- (2) p sends marker to q
- (3) q sends 20 to r
- (4) r sends 10 to q
- (5) q receives 20 from p
- (6) q receives marker from p
- (7) q sends marker to r
- (8) r sends 10 to p
- (9) r receives 20 from q
- (10) r receives marker from q
- (11) r sends marker to p
- (12) r sends marker to q
- (13) r sends 10 to q
- (14) q receives 10 from r
- (15) p receives 10 from r
- (16) p receives marker from r
- (17) q receives marker from r
- (18) q receives 10 from r

Recorded State					
Node	State	Channel			
		C1	C2	C3	C4
p					
q					
r					