Assignment 4 Solutions

1 (a) Reliable and timely delivery of message is important because there's a possibility of election of multiple leaders if the victory message does not reach all the nodes in time.
(5 points)

1 (b) It is not possible to elect two leaders if reliable deliver is assumed. The node with the highest weight gets elected as a leader. If there are two nodes with the same weight, then process ID is used to break the tie.
(5 points)

2 (a) GPS clock might be inaccurate because of the distance between the satellite and the receiver, atmospheric conditions etc.
(5 points)

2 (b) Distributed Applications : Cellular Networks, (5 points)

3 (a) A and B need to exchange their list of operations and order them according to time.
(5 points)

3 (b) Yes it is valid.
There are many valid sequences, one of which is :
y=1;
z=1;
print (x,y);
x=1;
print (y,z);
print (x,z);
(5 points)

4 (a) NOT STRICT - In P3 R(x)a should be R(x)b

4 (b) NOT SEQUENTIAL - P3 and P4 should read b and c in the same order, either b before c or c before b, depending on whether P1 or P2 wrote x first

4 (c) CAUSAL - P1's W(x)c is causally dependent on P2's W(x)a, because P1 read a before it wrote c, so P3 and P4 must read a before c P1's W(x)c and P2's W(x)b are not causally dependent, so P3 and P4 can read b and c in either order

4 (d) FIFO - the same process P2 wrote a and then b, so P3 and P4 must read a before b; different processes P1 and P2 wrote b and c, so P3 and P4 can read b and c in different orders
(10 points)

5 (a) There are multiple possible answers to this question depending on the assumptions you make.

Assuming all the three writes in P1 have been propagated and R(y)c happens after W(y)c in P1
Not release consistent. In P3, the value of x read will be b and not a.

Assuming W(x)a and W(y)c have been propagated and R(y)c happens after W(y)c in P1
Release consistent.

Assuming R(y)c happens after W(y)c in P2
Not release consistent because all the values written within the locks are propagated to all the processes. So x will be updated to d and R(x)a should be R(x)d.

But it was fairly ambiguous and I have given full credit to everyone who's given a valid reason.
(5 points)

5 (b) Entry consistent. When P2 acquires a lock for x, then the value of x is brought up to date, i.e., b. But since the read doesn't take place within synchronization variable, any value can be read and thus, R(x)a is valid.

Note that for entry consistency, reads outside synchronization variables can be arbitrary but that's not the case for release consistency.
(5 points)