PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester 2 **Academic Year**: 2009

Date: 24 February 2010 **Time**: 13.30-16.30 (3 hours)

Subject Number: 241-422 **Room**: Robot Head

Subject Title: Computer Graphics Systems Engineering Modelling and Simulation

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Exam Duration: 3 hours

This paper has 16 pages, 12 questions and 120 marks (20%).

Authorised Materials:

- Writing instruments (e.g. pens, pencils).
- Textbooks, a notebook, handouts, and dictionaries are permitted.

Instructions to Students:

- Scan all the questions before answering so that you can manage your time better.
- Attempt all questions in English.
- Write your name and ID on every page.
- Any unreadable parts will be considered wrong.

When drawing diagrams or coding, use good layout, and short comments; marks will not be deducted for minor syntax errors.

Cheating in the exam

Minimum punishment: Subject failed and study suspension for one semester.

Maximum punishment: Expelled.

NO	Time (Min)	Marks	Collected	NO	Time (Min)	Marks	Collected
1	40	37		7	15	6	
2	15	12		8	10	10	
3	20	10		9	10	10	
4	20	10		10	10	10	
5	10	10		11	10	10	
6	10	10		12	10	10	

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Question 1 (37 marks; 80 minutes)

a) Explain the significance of *time* in a simulation? (1 marks)

b) What are the differences between *event-driven simulation* and *time-driven simulation* frameworks in terms of time advancement? (2 marks)

c) What is *parallel* or *distributed* simulation and why is it important? (2 marks)

d) How do multiprocessors *share* memory? (1 marks)

e) Compare *parallel computers* and *distributed computers*? (4 marks)

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f) Compare *virtual environments* and *analytic simulations*? (4 marks)

g) Give the examples of *simulation time*, *physical time* and *wallclock time*. (3 marks)

h) Compare *real-time* and *as-fast-as-possible* modes of execution? (2 marks)

i) Compare *simulation executive* and *simulation application*? (2 marks)

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j) Compare *broadcast* and *publish-and-subscribe* mechanism of message passing? (2 marks)

k) What technique is used in *callback* functions? (1 marks)

l) Compare *dynamic* and *static* **data distribution**? (2 marks)

m) Why does **data distribution** prefer *region* to *point*? (1 marks)

n) Compare *push* and *pull* clock synchronization algorithms using a **central time server**? (2 marks)

o) What is the *local causality constraint* and why is it important? (2 marks)

p) What does the *Lower Bound on the Time Stamp* guarantee? (1 marks)

q) How *lookahead* can **speed up** a parallel and distributed simulation? What can *lookahead* be **derived from**? (2 marks)

r) What does a *null message* contain? And how can the null message algorithm help with *deadlock avoidance*? (2 marks)

s) Give examples of how *livelock* and *deadlock* can occur? (2 marks)

deadlock	livelock

Question 2 (12 marks; 15 minutes)

a) If we would like the simulation to run **3-time slower** in synchrony with an equivalent advance in wallclock time, what is the required *scaling factor* and what is the *transfer equation* of the simulation time and wallclock time?

(4 marks)

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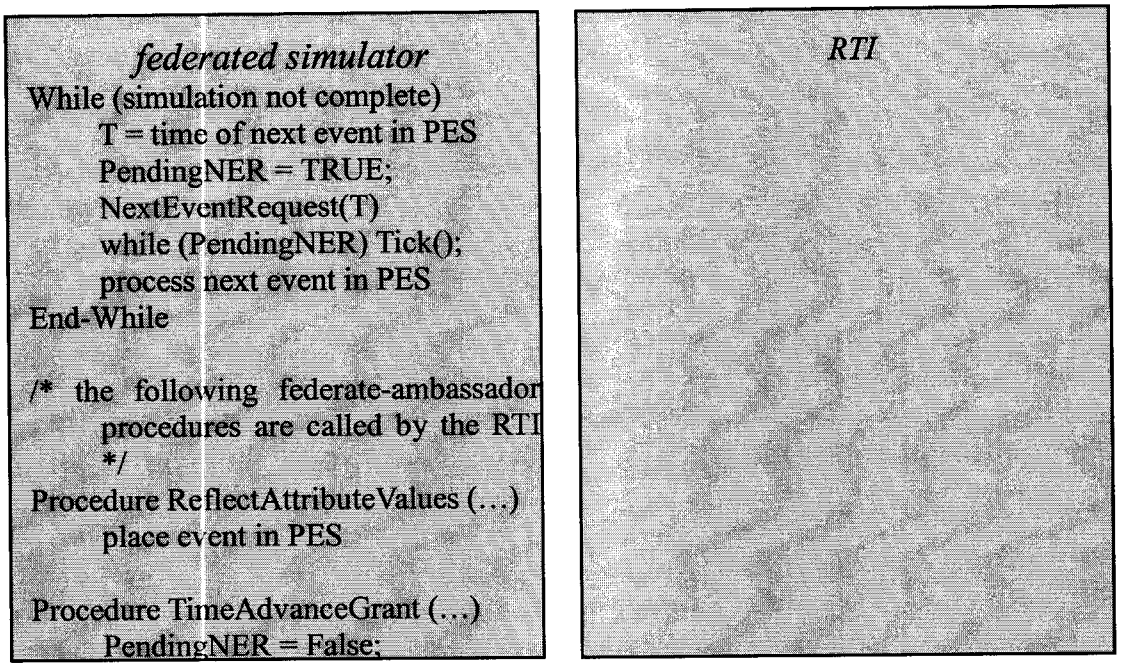
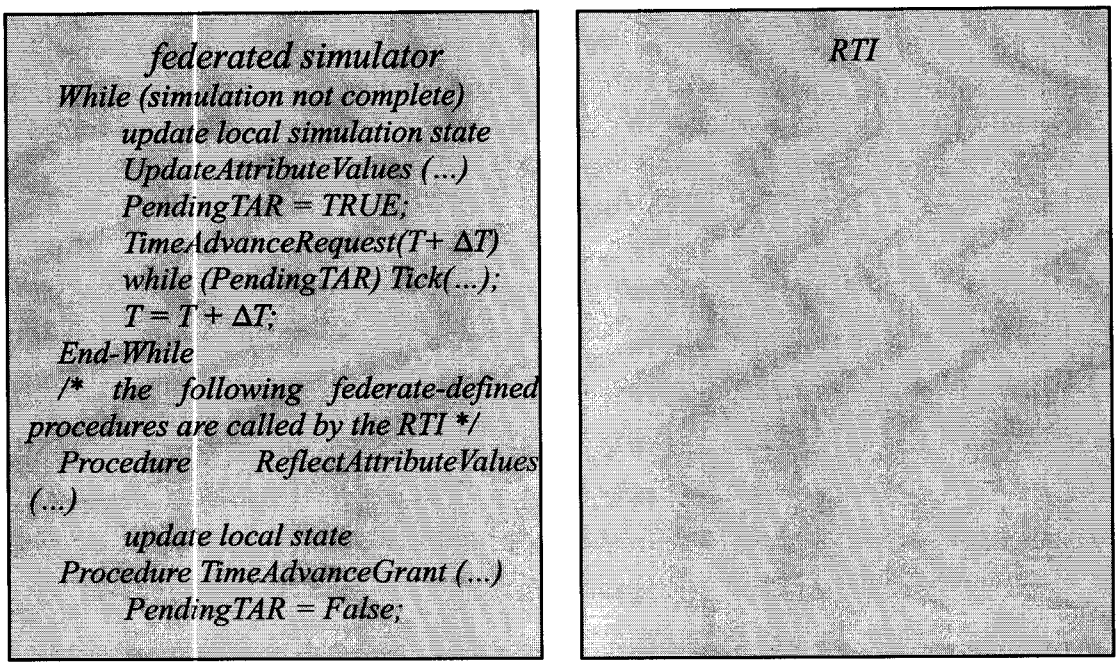
b) Show the **call back functions** between the RTI and the following federate program that *requests for next events to be processed.* (4 marks)



c) Show the **call back functions** between the RTI and the following federate program that requests for *time advancement.* (4 marks)



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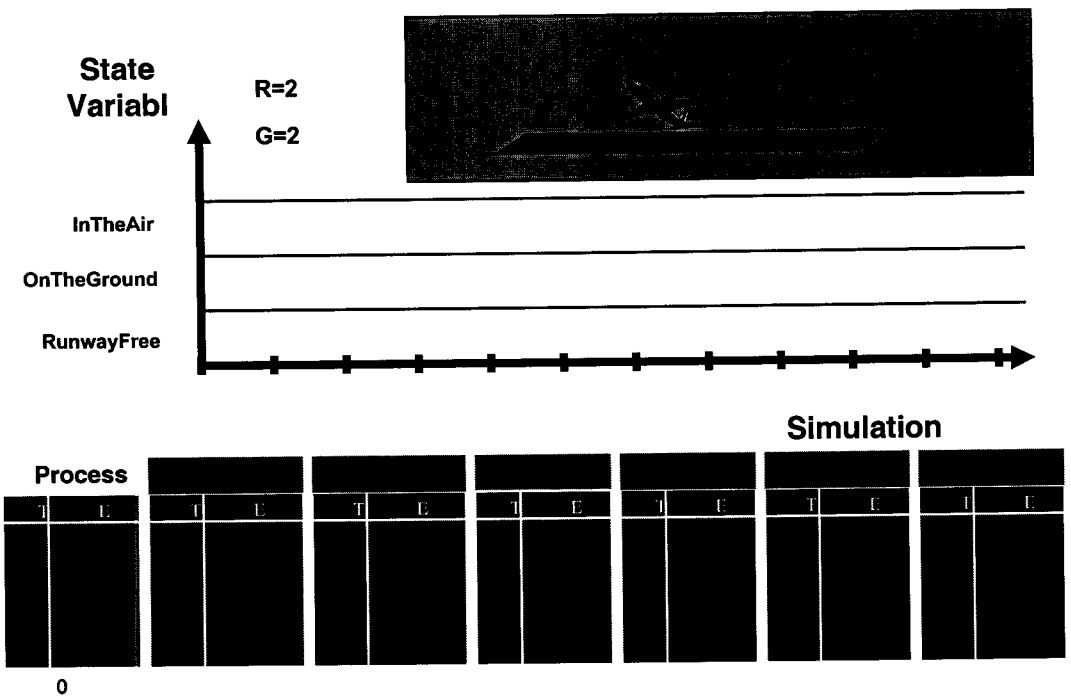
Question 3 (10 marks; 20 minutes)

From the following process program, show the relationship between state variables and time when R = 2 and G = 2, and airplanes F1 and F2 are scheduled to arrive at 1 time unit and 3 time units consecutively.

```
/* simulate aircraft arrival, circling, and landing */
Integer: InTheAir;
Integer: OnTheGround;
Boolean: RunwayFree;
1       InTheAir := InTheAir + 1;
2       WaitUntil (RunwayFree);                    /* circle */
3       RunwayFree := FALSE;                       /* land */
4       AdvanceTime(R);
5       RunwayFree := TRUE;
        /* simulate aircraft on the ground */
6       InTheAir := InTheAir - 1;
7       OnTheGround := OnTheGround + 1;
8       AdvanceTime(G);
        /* simulate aircraft departure */
9       OnTheGround := OnTheGround - 1;
```



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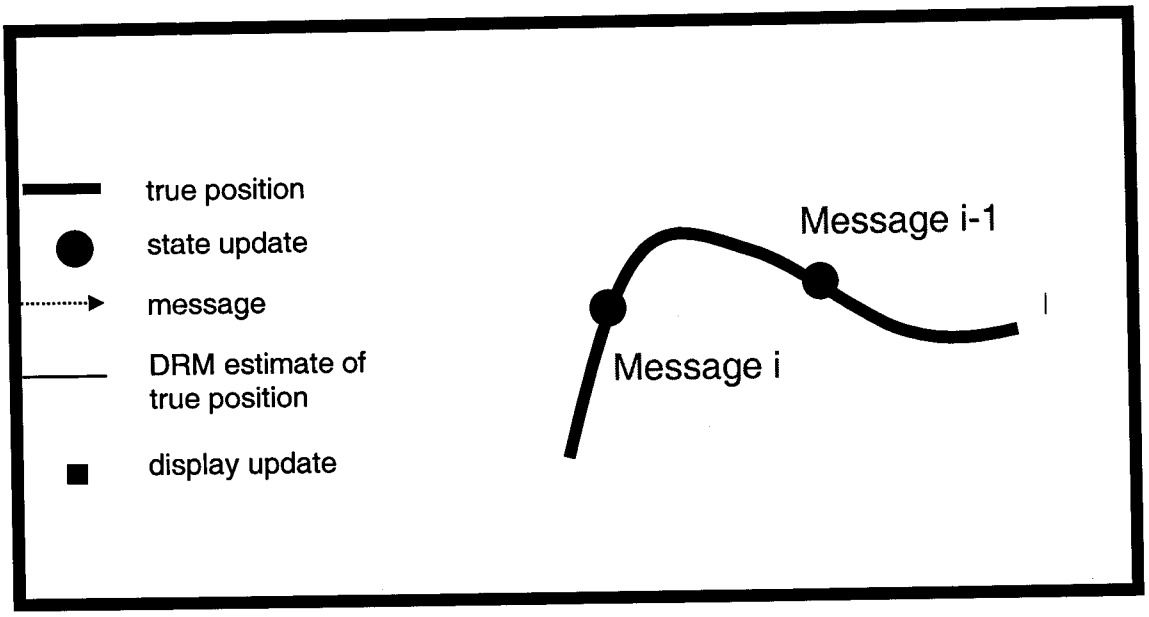
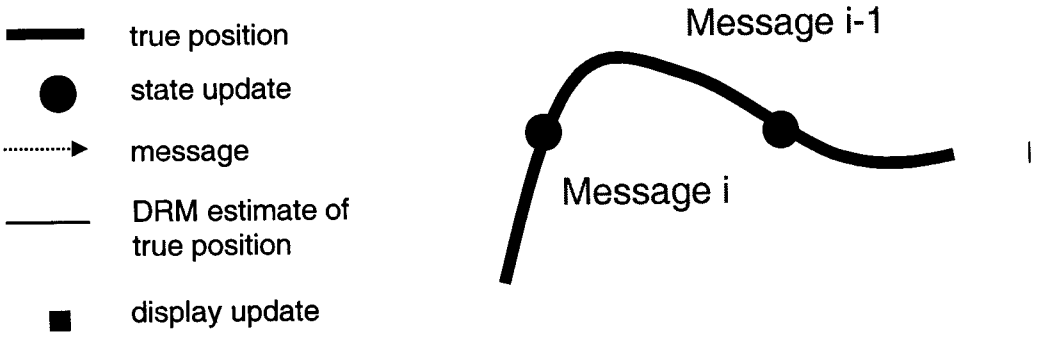
Question 4 (10 marks; 20 minutes)

From the following disjointed graph below, show how *time compensation* and *smoothing* algorithms change the display.

a) Time Compensation (5 marks)



b) Smoothing (5 marks)



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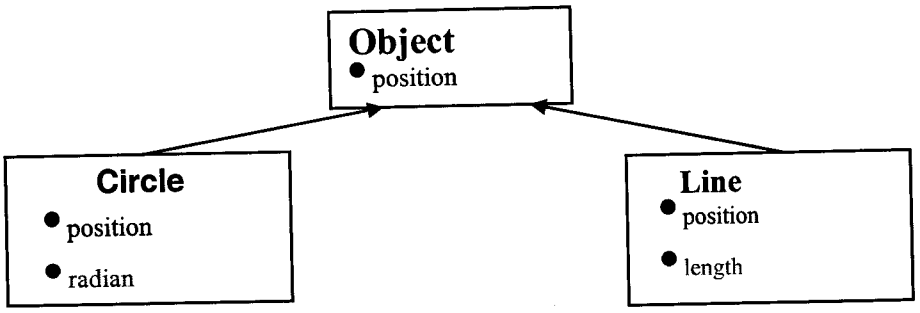
Question 5 (10 marks; 10 minutes)



From the above data distribution diagram,

a) Add class *Sphere* into the diagram.

b) Explain how other simulation nodes can receive updates from the newly added class even though the added class was not in the publication information. Use class *Sphere* in a) as an example.

b) List **possible expressions** from the *name space*.

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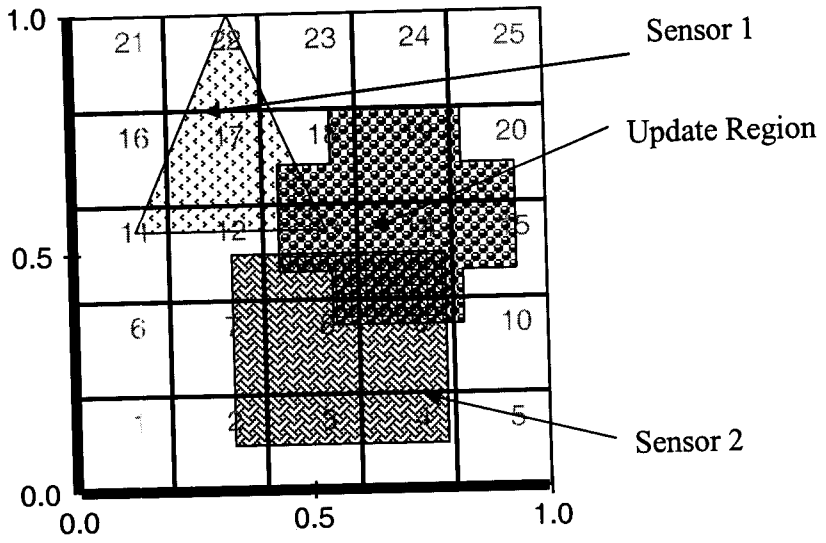
Question 6 (10 marks; 10 minutes)

From the following picture, show *duplicate* and *unwanted* updates at Sensor 1 and Sensor 2.



Question 7 (6 marks; 15 minutes)

a) According to the Network Time Protocol Latency and Offset Estimation, explain how to estimate *latency* and *offset*. (4 marks)

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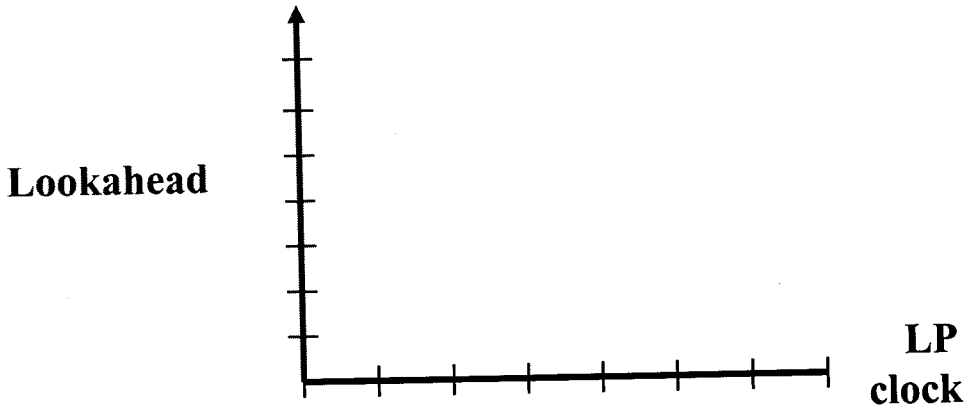
b) Suppose clock is 10 milliseconds ahead, interrupt generated every 15 milliseconds, show how to *phase in clock change* when correct or re-synchronizing clocks.

(2 marks)

Question 8 (10 marks; 10 minutes)

If a logical process is at simulation time 4 and *lookahead* is 3, use the below graph to help with answering the following questions.



a) The logical process has promised subsequent messages will have a time stamp of at least _____.

b) If *lookahead* were to increase to 10, what should be done?

c) If *lookahead* were to decrease to 1, what should be done?

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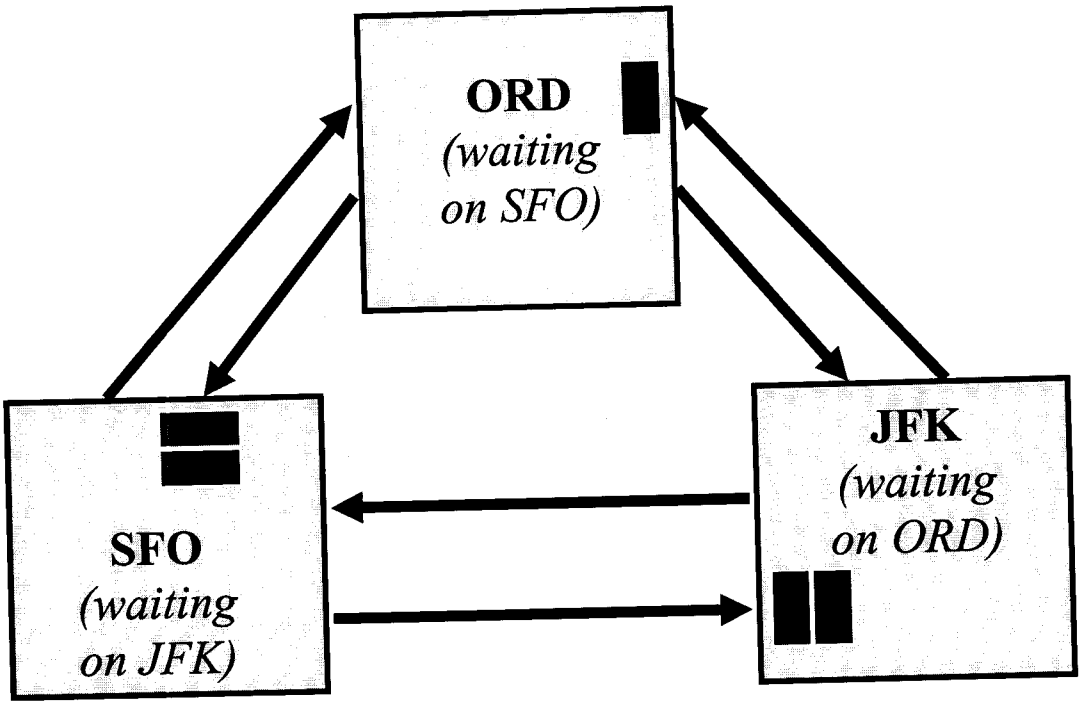
Question 9 (10 marks; 10 minutes)

The below Parallel Discrete Event Simulation that represents a collection of airports (ORD, SFO, and JFK) is facing a deadlock. In order to recover from the deadlock, find which processes are *safe* to be processed if we do not use null messages and:

1) At ORD, there is a message from JFK and it is time stamped for the simulation time 4. It is waiting for a message from SFO.
2) At SFO, there are two messages from ORD and it is time stamped for the simulation time 8 and 6. It is waiting for a message from JFK.
3) At JFK, there are two messages from SFO and it is time stamped for the simulation time 6 and 5. It is waiting for a message from ORD.



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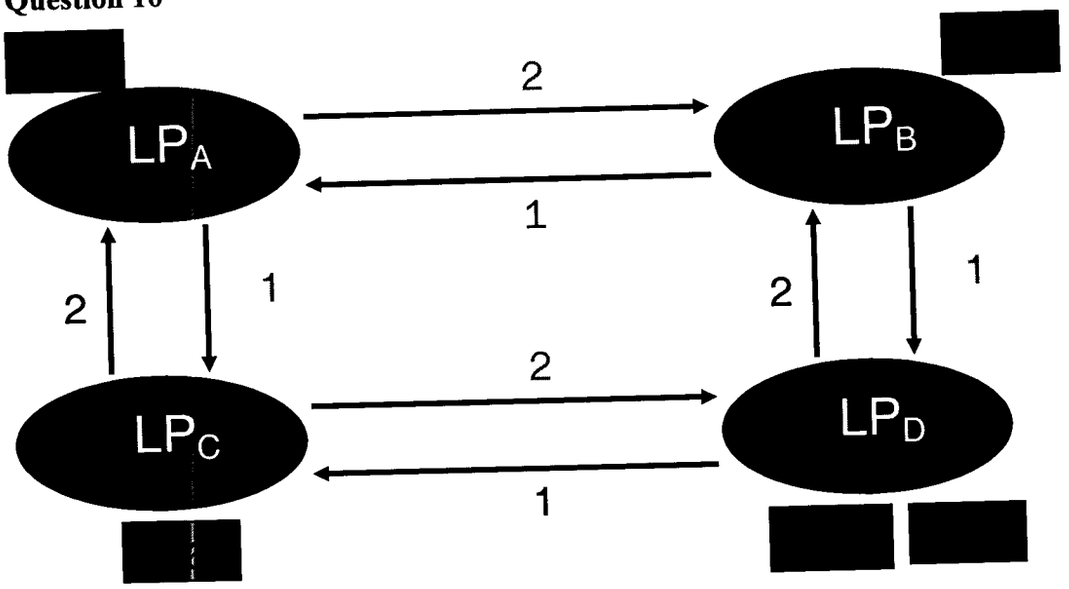
Question 10 (10 marks; 10 minutes)



a) From the above topology, fill in the following *distance matrix*. (2 marks)

	A	B	C	D
A				
B				
C				
D				

b) Calculate the Lower Bound on the Timestamp (LBTS) on each logical process. (4 marks)

A	
B	
C	
D	

c) Which messages depend on which? (2 marks)

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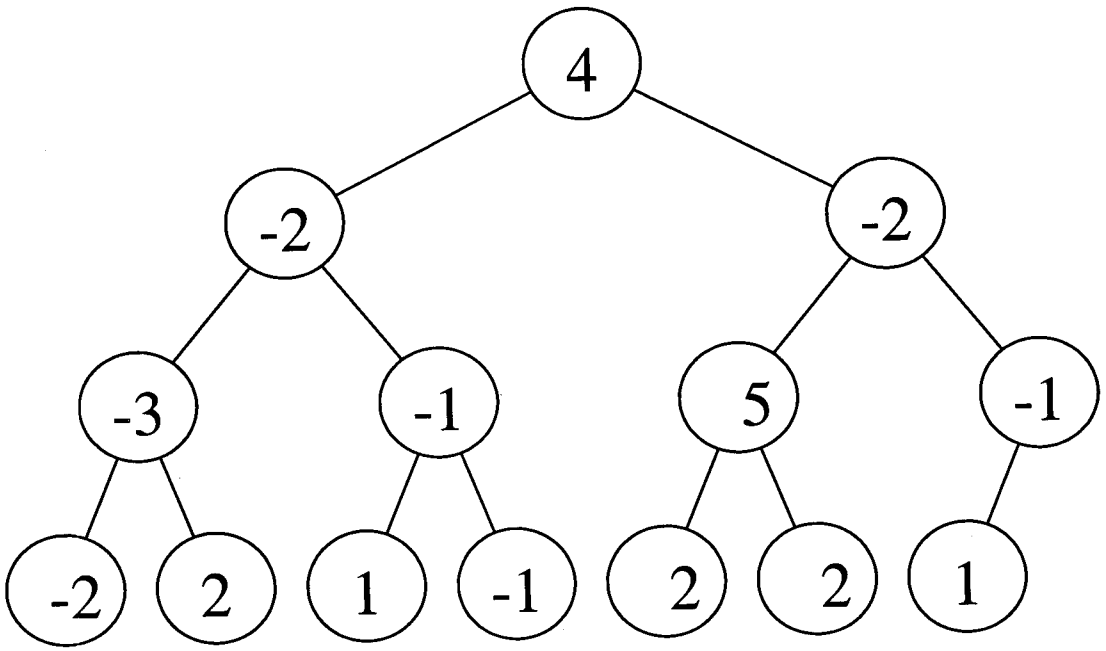
Question 11 (10 marks; 10 minutes)

From the message counters in the following topologies of logical processes, use the *Flush Barrier* to demonstrate if there are *transient messages* and how many?

a) Tree (5 marks)



There are _____ transient messages.

b) Butterfly (5 marks)

There are _____ transient messages.

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Question 12 (10 marks; 10 minutes)

Explain the concept of **deadlock detection** by *Diffusing Computations* (Dijkstra/Scholten).

----End of Examination----

Pichaya Tandayya Lecturer

Name_____ ID_____