THE UNIVERSITY OF AUCKLAND

SEMESTER TWO 2019
Campus: City

COMPUTER SCIENCE

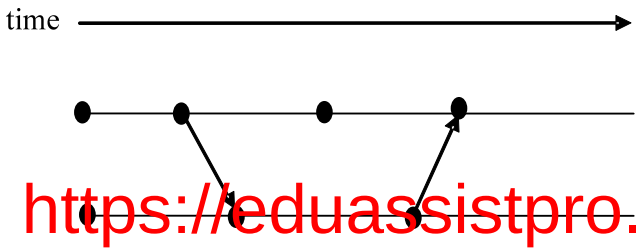
(Time Allowed: TWO hours)

NOTE: Attempt **Question 1** to **Question 3**.
Attempt **THREE** questions out of **Question 4** to **Question 7**.

https://eduassistpro.github.io/
Add WeChat edu_assist_pro

Question 1

The diagram below shows the progress of two processes, *P* and *Q*. It should be assumed that the identifiers of processes *P* and *Q* are ID_P and ID_Q respectively. *a, b, c, d, e, f* and *g* are the seven events occurred in the processes. An arrow between *X* and *Y* represents event *X* sends a message which is received by event *Y*.



(a) If the system uses a partially ordered logical clock, what is the timestamp of each of the events in the diagram?

(b) If the system uses a totally ordered logical clock, what is the timestamp of each of the events in the diagram?

(c) Compare and contrast the partially ordered logical cloc ed logical clock in terms of expressiveness and scalability. Su justification for your answer.

(6 marks)

Question 2

Centralized directory model and document routing peer systems for looking up information.

(a) Describe how the two models work.

(b) Compare and contrast the two models in terms of efficiency, reliability, and scalability. You must provide sufficient justification for your answer.

(6 marks)

Question 3

(a) Why is it difficult to obtain a consistent distributed snapshot in a distributed system? Use an example to support your argument.

(b) What are the conditions that need to be satisfied to make a global state consistent?

(c) Modify the Chandy-Lamport distributed snapshots algorithm so that all the channel states are recorded empty. You need to give a full description of the algorithm and explain why your algorithm can obtain a consistent distributed snapshot in terms of the discussion in point (b).

(18 marks)

Question 4 – Time Complexity for Distributed Algorithms

(a) Briefly describe one of the typical definitions of the *time complexity* for *synchronous* distributed algorithms.

(b) Briefly describe the typical definition of the *normalised time complexity* for *asynchronous* distributed algorithms, detailing its specific variants for

I. the FIFO scenario, and
II. the NON-FIFO scenario.

(c) Briefly discuss the relationship between the synchronous and normalised asynchronous cases. Which one is always *greater or equal* than the other, and why? Outline a convincing argume

(d) Mention well-know

I. the *sync* and time complexities, and
II. the FIFO and NON-FIFO *normalised asynchronous* time complexities.

For items I and II, NO proof or evidence is required but indicate the *order of magnitude* of each time complexity (e.g. linear, polynomial, exponential, in N, in M)

(10 marks)

Question 5 – E

Consider an EIG t L messaging rounds.
A node is called *distinguished* if its label *ends* in a *n* ber.

(a) Draw a tree diagram and highlight all *distingu* hen $N=4$ and participant #1 is faulty.

(b) For an arbitrary N, assuming that $L>F$, prove that any root-to-leaves path passes through at least one *distinguished* node.

(c) For an arbitrary N, assuming that $N>3F$, prove that, at each level, any sibling group contains a majority of *distinguished* nodes.

(d) For an arbitrary N, prove that both conditions (b) and (c) are achieved when $N \geq 3F+1$.

(10 marks)

Question 6 – Byzantine Agreement – Impossible Scenario

Outline a convincing proof that three (3) participants cannot solve the Byzantine agreement in the possible presence of one (1) faulty processor. Use a *proof by contradiction* based on the hexagon thought experiment.

Hint: this proof is a *thought experiment*, based on the following diagram:

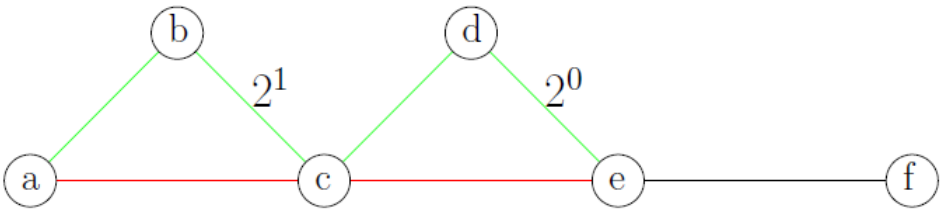
(10 marks)

Question 7

(a) What is the go oes it try to achieve (DFS, BFS, M

(b) Discuss the **exponential message complexity** of the **asynchronous Bellman-Ford** algorithm. Base your discussion on the sample dia h is a simplified version of the diagram used in the lectures.

(c) Based on (b), discuss how the **time complexit** in the FIFO scenario.



(10 marks)