UNIVERSITY OF RUHUNA
BACHELOR OF COMPUTER SCIENCE (GENERAL) DEGREE LEVEL III
(SEMESTER I)
EXAMINATION – MAY 2023

RSE UNIT : CSC3172 - Distributed Systems **TIME: 2 Hours**

Answer all four Questions.

1.

a. Explain **three** (3) factors that can characterize the performance of a distributed system.

b. Define and then explain the role of *middleware* in a distributed system.

c. "Distributed systems are typically heterogeneous". Discuss the validity of this statement.

d. Explain briefly the terms, *access transparency*, *location transparency* and *replication transparency*.

e. Discuss three (3) advantages of using the Andrew distributed file system over other decentralized file systems.

2.

a. Name one (1) major disadvantage of the centralized p2p system from distributed principles point of view.

b. Consider a situation where two processes compete for a shared resource: process (A) with transaction timestamp 30 requires a resource held by a process (B) with transaction timestamp 60 and you use the following deadlock prevention algorithms for preventing deadlocks from occurring. Explain what would happen if you apply the following algorithms in this situation.

i. Wait-die
ii. Wound-wait

c. Explain the coordinator election mechanism using *ring election* algorithm in a distributed system.

d. Consider four processes, P1, P2, P3, P4 with events a, b, c … u and messages communicating between them as shown in Figure 1. Assume that initial logical clock values of all processes are all initialized to 0.

i. Provide *Lamport* logical timestamps for each event shown in Figure 1. Assume that each process maintains a single integer value as a *Lamport* clock.

ii. Provide Vector Clock timestamps for each event shown in Figure 1.

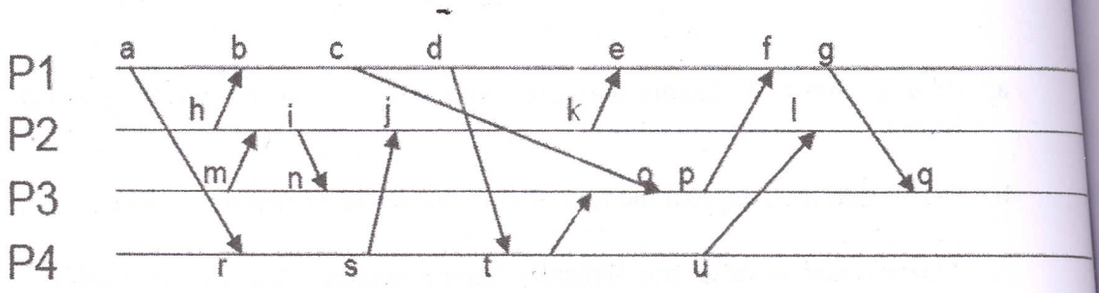

Figure 1

3.

a. Define the term 'idempotent' and identify whether the following operations are *idempotent* or not. Briefly explain your answers.

i. Squaring a number
ii. Appending data to a file
iii. Transferring Rs. 1000 from one account to another in a bank
iv. Switching on a bulb
v. Adding 0 to a number

b.

i. Compare the *Cristian* and *Berkeley* algorithms for time synchronization based on the interaction between the time server and the clients.

ii. Consider a distributed system consisting of five computers A (coordinator), B, C, D and E. At 14:15, the coordinator decides to synchronize the clock of all computers in the system and the clock of every computer in the system shows the following as given in the table. After synchronization via the Berkeley algorithm, what is the time on A's clock? Assume time needed for network communication is negligible.

Computer	Clock
A	14:15
B	14:12
C	14:07
D	14:09
E	14:12

iii. In an execution of Cristian's synchronization algorithm, the client sends a request at 5:25:56.300 and receives a response at 5:25:56.900. The server's clock reading at the response instance is 5:25:57.100. To which clock value should the client set its clock?

c.

i. What is meant by 'parameter marshalling' as implemented in RPC communication?

ii. Possible failures that may occur should be taken into consideration when RPC calls are made. Explain four (4) types of failures that may occur in RPC.

d. List the 'ACID' properties of a database transaction and explain one of them using a suitable example.

4.

a. What is meant by an *omission fault* that may occur in a distributed system? Explain a method to detect such a fault.

b. Fault tolerance is an important property of a distributed system. Over a standard network, it is hard to implement a fault tolerant system. State two (2) problems giving examples.

c. Discuss briefly three (3) causes of data center outages and the measures that can be used to prevent them.

d. Explain three (3) advantages and three (3) disadvantages of cloud computing systems.

e.

i. Describe three (3) characteristics of software as a service (SaaS) model.

ii. State three (3) commercial examples of the SaaS model.