



NAMIPIA UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF COMPUTER SCIENCE

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE	
QUALIFICATION CODE: 07BACS	LEVEL: 6
COURSE: DISTRIBUTED SYSTEMS PROGRAMMING	COURSE CODE: DSP620S
SESSION: January 2019	PAPER: Theory
DURATION: 3 Hours	MARKS: 95

SECOND OPPORTUNITY/SUPPLEMENTARY EXAMINATION QUESTION PAPER	
EXAMINER:	Prof. José G. Quenum
MODERATOR:	Prof. Dharm Singh Jat

This paper consists of 2 pages
(excluding this front page)

INSTRUCTIONS

1. This paper contains 5 questions.
2. Answer all questions on the exam paper.
3. Marks/scores are provided at the right end of each question
4. Do not use or bring into the examination venue books, programmable calculators, mobile devices and other materials that may provide you with unfair advantage. Should you be in possession of one right now, draw the attention of the examiner officer or the invigilator.
5. NUST examination rules and regulations apply.

PERMISSIBLE MATERIALS

None

Question 1 [10 points]

Two participants P_1 and P_2 are involved in a socket-based protocol. P_1 starts the protocol by sending P_2 a message containing a positive integer. P_2 then sends three consecutive messages. Each message contains the next prime number.

Extend the TCP-based socket diagram presented in class to represent this protocol. Consider that the message sent by P_1 contains the value 8. You are expected to indicate the actual value contained in each message sent by P_2 .

Question 2 [15 points]

Consider a kafka cluster containing three (03) brokers, CL_1 , CL_2 and CL_3 . Each topic contains three (03) partitions with a replication factor of two (02) i.e., each partition is replicated once (on another broker). Using a diagram representing the cluster illustrate how a producer submits messages to the cluster and a consumer group consumes such messages. You will be explicit about how the partitions are handled.

Question 3 [30 points]

- (a) Discuss in detail the read operation in Network File System (NFS) [8]
- (b) Discuss in detail how a read operation is carried out in Andrew File System (AFS). [5]
- (c) How is the write operation handled in AFS? [5]
- (d) Most distributed file systems involve a remote procedure call (RPC) between the client module and the server. Discuss the impact of the call semantics on a write-only scenario. [12]

Question 4 [15 points]

Consider the processes in a distributed system arranged in a ring as depicted in Figure 1. The number on the left-hand side in each process is the process identifier, e.g., P_0 . The number on the right-hand side is the value of the attribute used during the leader election.

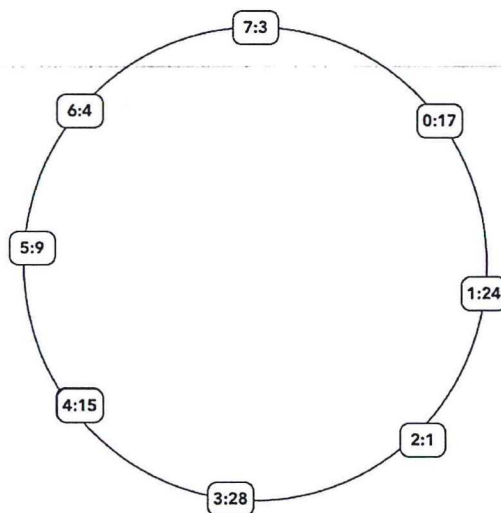


Figure 1: Processes arranged in a ring

Using the bully algorithm, describe step-by-step the execution of the leader election and the winner after the former leader, P_3 has crashed. Assume that P_0 started the election and that no failure occurred during the election.

Question 5 [25 points]

(a) Is the logical clock depicted in Figure 2 correct? If yes explain why; if not provide the correct values. [15]

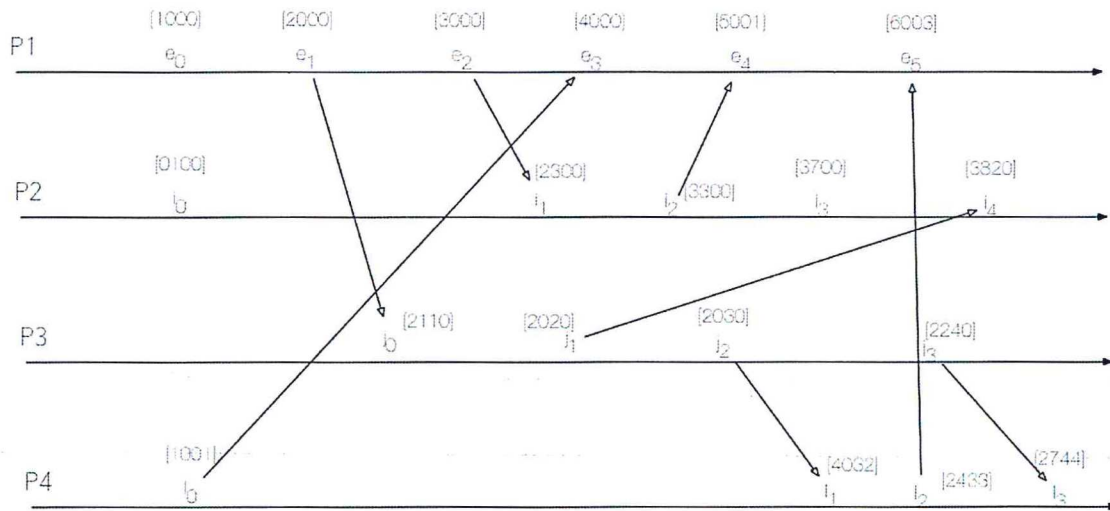


Figure 2: Event Ordering with Logical Clock

(b) Consider three (04) processes (P_1 , P_2 and P_3) as part of a distributed system. The following events (listed in order) have occurred at each process: [10]

P_1 : a and b;

P_2 : c and d;

P_3 : e and f.

In addition, the following observations have been made:

- Event c resulted from a message exchange between P_1 and P_2 after event b;
- Event f resulted from a message exchange between P_2 and P_3 after event d.

Using a diagram represent the timestamps corresponding to the logical clock for each event in the system.