NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF COMPUTING AND INFORMATICS

DEPARTMENT OF SOFTWARE ENGINEERING

QUALIFICATION: BACHELOR OF COMPUTER SCIENCE	
QUALIFICATION CODE: 07BCMS, 07BAIT	**LEVEL:** 6
COURSE: DISTRIBUTED SYSTEMS AND APPLICATIONS	**COURSE CODE:** DSA612S
DATE: JANUARY 2025	**PAPER:** THEORY
DURATION: 3 HRS	**MARKS:** 70

SUPPLEMENTARY / SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	**Ms. NDINELAGO NASHANDI**
MODERATOR:	**PROF JOSE QUENUM**

THIS QUESTION PAPER CONSISTS OF 6 PAGES
(Including this front page)

INSTRUCTIONS TO STUDENTS:

1. Read all the questions, passages, scenarios, etc., carefully before answering.
2. Answer all the questions.
3. Number each answer clearly and correctly.
4. Write neatly and legibly.
5. Making use of any crib notes may lead to disqualification and disciplinary action.
6. Use the allocated marks as a guideline when answering questions.
7. Looking at other students' work is strictly prohibited.
8. This paper consists of six **(6)** pages including the cover page.

SECTION A: 10 marks

Multiple Choice questions (select the correct letter)

1. Global Position System (GPS) satellites use the Network Time Protocol (NTP) to keep their clocks synchronized.
   A. False
   B. True
2. Which of the following is the primary method for communication between processes in a distributed system?
   A. Shared database
   B. Network sockets
   C. Message passing
   D. Direct memory access
3. What does 'consistency' refer to in the context of distributed systems?
   A. The uptime of nodes in the network
   B. All nodes seeing the same data at the same time
   C. The uniformity of code across nodes
   D. The geographical distribution of nodes
4. Which of the following is a common challenge in distributed systems?
   A. Limited ability to handle multiple data types
   B. Increased security risks
   C. Dependency on internet connectivity
   D. Reduced performance due to system distribution
5. In distributed systems, what is the principle of transparency?
   A. The complexities of the system are hidden from the user.
   B. Nodes can transparently transmit data to each other.
   C. All transactions are open for public audit.
   D. Systems are transparently interchangeable.

6. Vector Timestamp Ordering Algorithm is an example of-
   A. Centralized Mutual Exclusion
   B. Distributed Mutual Exclusion
   C. Physical Clock Synchronization
   D. Logical Clock Synchronization
7. Which of the following is a common method for achieving fault tolerance in distributed systems?
   A. Prioritizing tasks
   B. Increasing server processing power
   C. Client-side caching
   D. Replicating data across multiple machines
8. An RPC (remote procedure call) is initiated by the _____
   A. server
   B. client
   C. client after the server
   D. a third party
9. We define the clock drift as ...
   A. The difference in time between two clocks.
   B. The interval between consecutive clock synchronization events.
   C. The adjustment required to align a clock with the average time.
   D. The rate at which a clock's time gradually deviates from the true time.
10. Which among the following is the duties of the Data Nodes
   A. Manage file system namespace
   B. Stores meta-data
   C. Regulates client's access to files
   D. Perform read-write operation as per request for the clients

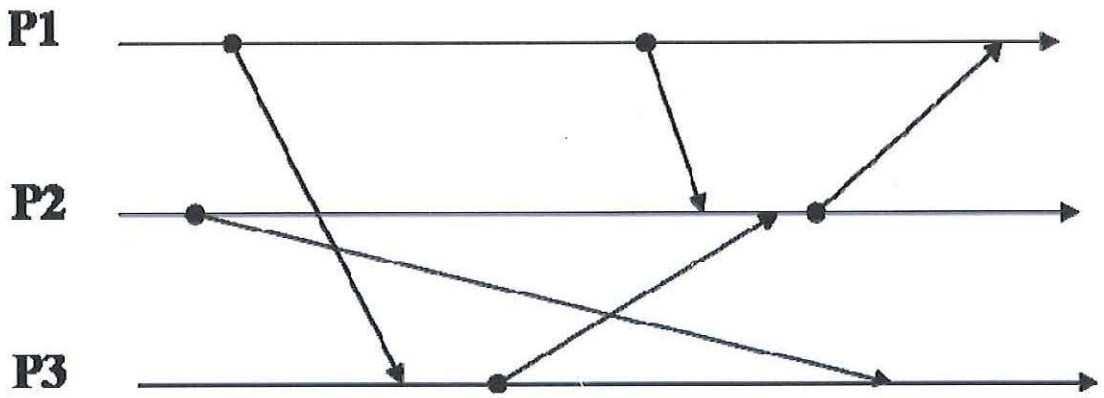
SECTION B: 38 marks

1. Explain the caching model used in a Distributed File System (DFS) and describe the common cache update policies. What are the key benefits and potential disadvantages of implementing caching in a DFS? [12 marks]
2. Present the architecture of a Google File System (GFS) and explain how a client read operation is performed in GFS. [10 marks]
3. Explain how Google File System handles a node failure? [4 marks]
4. Define the publish/subscribe communication paradigm. In your explanation, discuss the roles of publishers, subscribers, and message brokers, as well as how this model differs from traditional client-server communication. Provide two examples of real-world applications where the publish/subscribe model is commonly used. [8 marks]
5. Differentiate between subscription flooding and filter-based event routing models in a publish-subscribe system. [4 marks]

SECTION C: 22 marks

- *Answer all the questions in the provided booklet.*
- *The section consists of 3 questions.*

1. Briefly explain the difference between logical and physical clocks. Why it is difficult to synchronize physical clock? [2+3 Marks]
2. Outline three techniques for synchronizing physical clocks. [9 marks]
3. Consider the following event diagram for processes P1, P2 and P3 executing in a distributed system. Compute the time stamps that is carried on each message.



Assume that initial logical clock values are all initialized to 0 as follows (0,0,0) hence **vector for P1-----> P3: (1, 0, 0)**

P2-----> P3: _____

P3------>P2: _____

P1------>P2: _____

P2------>P1: _____

[8 points]

********** End of the Paper **********