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: NOV 2023	PAPER: THEORY
DURATION: 3 HRS	MARKS: 100

FIRST OPPORTUNITY EXAMINATION QUESTION PAPER	
EXAMINER(S)	Ms. NDINELAGO NASHANDI
MODERATOR:	PROF JOSE QUENUM

THIS QUESTION PAPER CONSISTS OF 4 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 four **(4)** pages including the cover page.

SECTION A:

*   *Answer all the questions in the provided booklet.*
*   *The section consists of 7 questions.*

1. Explain the concept of fault tolerance in the context of distributed storage systems, with a focus on the Google File System (GFS). Discuss the mechanisms and strategies implemented by GFS to achieve high availability [4 marks].

2. Explain transparency as one of the main challenges in designing and building Distributed Systems? Provide and explain any three types of Transparency. [8 marks]

3. List and explain the key properties of indirect communication. [4 marks]

4. List and explain the three types of order delivery in group communication. [6 marks]

5. List and elaborate on any three forms of group communication. [6 mark]

6. Explain how a client write operation is performed in GFS (Google file Systems).[10 marks]

7. Differentiate between immutable and mutable files in Distributed File Systems (DFS) discussing their characteristics and implications for data consistency and access control. [8 marks]

SECTION B:

*   *Answer all the questions in the provided booklet.*
*   *The section consists of 5 questions.*

1. Describe the core concepts and components of Apache Kafka and explain how they work together to provide a scalable and fault-tolerant messaging system. [10 marks]

2. Present the architecture of a Hadoop Distributed File System (HDFS) cluster. Discuss in detail the read and write operations using HDFS. [8+5 marks]

3. What is meant by a logical clock? Describe Lamport's concept of a logical clock. (2+6 marks)

4. Outline the sequential procedure of Cristian's Algorithm. Detail the interaction between the client and server to synchronise the client's time with that of the server. [8 marks]

5. Consider Figure 1 that shows four processes (P1, P2, P3, P4) with events a, b, c,...
   and messages communicating between them. Assume that initial logical clock
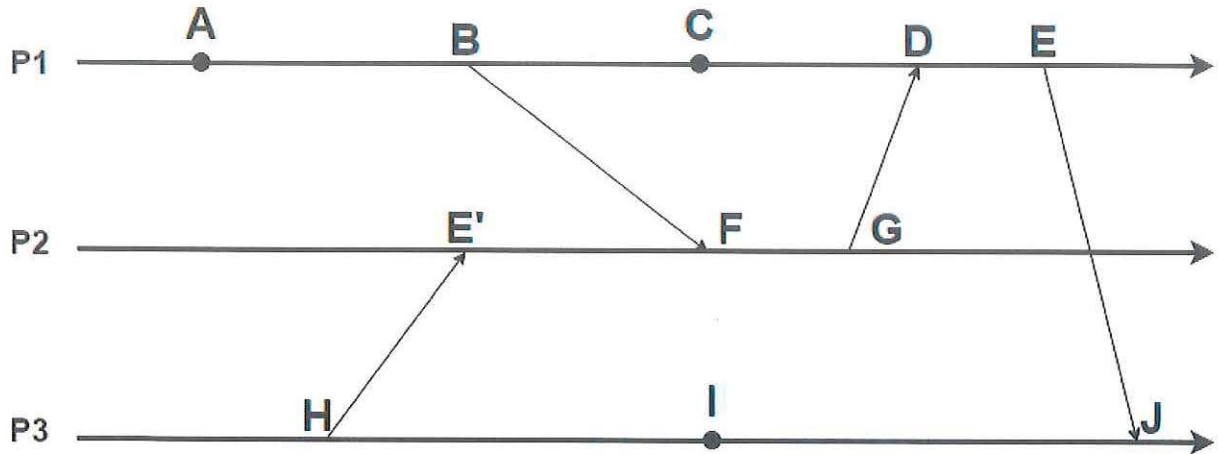   values are all initialized to 0.

Figure 1: Three processes P1, P2, P3 run events A,B,C,D,.... to send and receive messages

a) List the Vector Clock timestamps for each event shown in Figure 1.Provide timestamps for each labelled event. [11 marks]
b) Identifying Concurrent Events [4 marks]

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