Kasarani Campus
Off Thika Road
P. O. Box 49274, 00101
NAIROBI
Westlands Campus
Pamstech House
Woodvale Grove
Tel. 4442212
Fax: 4444175

KIRIRI WOMENS' UNIVERSITY OF SCIENCE AND TECHNOLOGY
UNIVERSITY EXAMINATIONS, 2024/2025 ACADEMIC YEAR
THIRD YEAR, FIRST SEMESTER EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE (COMPUTER SCIENCE)

KCS 2301 ADVANCED OPERATING SYSTEMS

DATE:4TH DECEMBER 2024
TIME: 2:30PM – 4:30PM

INSTRUCTIONS TO CANDIDATES
ANSWER QUESTION ONE (COMPULSORY) AND ANY OTHER TWO QUESTIONS

QUESTION ONE: COMPULSORY (30 MARKS)

A bank wants to design a distributed system that can process transactions such as deposits, withdrawals, and transfers. To ensure high availability and fault tolerance, the system must be resilient to crash faults, omission faults, and Byzantine faults. The system will be replicated across several servers in different locations to handle high traffic. Mechanisms such as active and passive replication will be used to ensure that transactions are processed correctly even when some servers fail. The bank is also considering using Paxos or Raft as consensus algorithms to ensure that all servers agree on the state of the system. The bank needs to decide how to balance performance with fault tolerance and how to handle both network partitions and server crashes.

a) Which type of replication (active or passive) would be more appropriate for this banking application Discuss **(5 Marks)**

b) Describe How can the system ensure that a transaction is either fully completed or rolled back (in case of failure) using checkpointing mechanisms? **(5 Marks)**

c) What are the trade-offs between using Paxos and Raft as the consensus algorithm in this fault-tolerant system? Which would be better suited for this application? **(5 Marks)**

d) Discuss How does the use of quorum-based protocols in this distributed system ensure consistency in the presence of failures? **(5 Marks)**

e) In the event of Byzantine faults, how can the system be designed to prevent malicious or faulty servers from corrupting the transaction process? **(5 Marks)**

f) Discuss the strategies can the bank implement to handle network partitions while ensuring that no data inconsistency occurs? **(5 Marks)**

QUESTIONS TWO: 20 MARKS

a) Explain **THREE** key differences between synchronous and asynchronous computations in distributed systems. **(6 Marks)**

b) Describe **FOUR** scenario where asynchronous computations might outperform synchronous computations in a distributed system. Justify your answer. **(6 Marks)**

c) In a synchronous system, message delivery is guaranteed to occur within a fixed time. Discuss four ways How does this assumption simplify the design of fault-tolerant distributed algorithms? **(8 Marks)**

QUESTION THREE: 20MARKS

a) Compare and contrast TCP and UDP protocols in the context of communication in distributed systems. **(6 Marks)**

b) Explain how a distributed system can achieve reliable communication over an unreliable network. Discuss the role of acknowledgments and retransmissions. **(6 Marks)**

c) Describe **FOUR** role of a sliding window protocol in ensuring efficient communication in data networks. **(8 Marks)**

QUESTION FIVE: 20MARKS

a) Describe **FOUR** Bully Election Algorithm and explain how it works in a distributed system with nodes of different priorities. How does the system recover if the elected leader fails? **(8 Marks)**

b) Discuss **THREE** Ricart-Agrawala algorithm for distributed mutual exclusion. How does it ensure that no two nodes enter the critical section simultaneously? **(6 Marks)**

c) In distributed systems, what are the key challenges of achieving consensus in the presence of faults? How do fault-tolerant consensus algorithms like Paxos address these challenges? **(6 Marks)**

QUESTION FIVE: 20 MARKS

a) Define cloud computing and explain its key characteristics. **(6 Marks)**

b) Discuss **THREE** roles of virtualization in cloud computing. **(6 Marks)**

c) Explain how distributed applications are developed and deployed in cloud environments. **(6 Marks)**

d) Describe the concept of elasticity in cloud computing.? **(2 Marks)**