

Instructions:

- The quiz is for 45 minutes.
- Answer all the questions. The quiz is for 25 points.
- No clarifications shall be provided during the quiz.

Part -A: Answer the following questions by choosing the correct answer(s). Each question is for 1 point. No partial credit for answering only a subset of the correct answers.

1. Which of the following are correct with respect to the 2-Phase Commit protocol?
 - a. The protocol can tolerate failures of communication links and machines.
 - b. The protocol can tolerate only machine failures
 - c. The protocol tolerates Byzantine failures of machines.
 - d. All of the above.
2. Which of the following are true with respect to consistent hashing?
 - a. It minimizes the number of items that have to be moved when the set of buckets change.
 - b. It always guarantees perfectly uniform load distribution
 - c. When the set of buckets change, the hash value of all items changes.
 - d. Using virtual nodes helps replication.
3. In the Dynamo database system, what is the purpose of the quorum mechanism?
 - a. Ensure that all writes and reads are eventually consistent.
 - b. Ensure high availability
 - c. Ensure that every read returns the most recent successful write
 - d. All of the above.
4. How does the king process help in the phase-king algorithm?
 - a. Broadcast the final decision value
 - b. Break ties when processes disagree
 - c. Detect faulty processes
 - d. Verify message authenticity
5. The phrase BASE refers to which of the following?
 - a. Basically Available, Soft State, and Eventually Consistent
 - b. Basically Available, Static State, and Eventually Consistent
 - c. Basically Available, Soft State, and Extremely Consistent
 - d. Broadly Available, Static State, and Extremely Consistent
6. Let $r_b(x) = (3x + 4)/100$ and $r_i(x) = (7x+2)/100$ be two hash functions for buckets and items, respectively. Assume that there are four buckets with ids 18, 7, 22, and 30. Mention the mechanism that identifies the bucket an item should be stored at according to consistent hashing. In addition, mention the bucket that an item with id 15 and with id 28 belong to.
7. Which of the following graphs have a maximal independent set whose size is in $\Theta(n)$, where n is the number of nodes in the graph?
 - a. A cycle graph
 - b. A complete graph
 - c. A tree
 - d. All of the above

Part – B: Answer the following questions in brief. Each question is for six points.

Question 1. Define the problem of Byzantine agreement. State if agreement is possible with six nodes of which two are Byzantine faulty. Justify your answer. **(Points: 2+1+3=6)**

Question 2. Explain the properties of consistent hashing. Explain with an example how the finger table of the Chord system works. **(Points: 3+3=6)**

Question 3. Consider the 2-phase commit protocol and answer the following questions.

- a) Suppose that the coordinator crashes after issuing the Prepare message but before sending the Commit message. How can the participants react in the protocol?
- b) Suppose that one of the participants does not send its reply to the Prepare message from the coordinator. How does the coordinator complete the protocol?
- c) Suppose that a participant votes to commit in the first phase of the protocol and crashes. How can the protocol complete?

(Points: 2+2+2=6)