Faculty Name(s) : Dr.Senthilkumar [illegible]
Class Number(s) : VL2025260502141, VL2025260502155
Date of Examination : 15.03.2026
Exam Duration : 90 minutes
Maximum Marks: 50

General instruction(s):

- Answer All Questions (M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)

Course Outcomes

3. Examine important approaches in distributed systems to support synchronization and fault tolerance.
4. Derive solution that ensures reliability, security, scalability and robustness in Internet.

Q. No	Question	M	CO	BL
1.	An e-commerce company, GlobalCart, provides a SOAP web service named OrderService. This service supports operations such as placeOrder, cancelOrder and trackOrder. Each operation uses properly typed XML Schema variables such as orderId (xs:string), customerId (xs:string), amount (xs:decimal) and status (xs:string). The company now introduces a Premium tier and plans to create a new interface called PriorityOrderService. This new interface must include all existing operations of OrderService and additionally provide a new operation called expeditedShipping, which takes orderId (xs:string) and priorityLevel (xs:int) as input and returns confirmationCode (xs:string) and updatedDeliveryDate (xs:date). Using WSDL 2.0 concepts, explain how PriorityOrderService can be defined so that it reuses the operations of OrderService without redefining them, while still maintaining proper type definitions for all variables.	10	3	
2.	An online auction site "QuickBid" uses Lamport logical clocks to timestamp bids from users across the globe. Because physical clocks cannot be synchronized perfectly, the system relies on the happened-before relation (L) to order bids. User A (P1) sends Bid B1 with a local Lamport timestamp of 5. User B (P2) receives Bid B1 when their local clock is at 3.User B then immediately sends a counter-bid B2. According to the Lamport clock rules, what must User B (P2) set their local clock to upon receiving Bid B1 to ensure the counter-bid B2 is correctly ordered?. Suppose two independent users submit bids that both receive a Lamport timestamp of 10. How can the system create a total ordering to decide which bid wins? Explain a situation in this auction where Bid X has a lower Lamport timestamp than Bid Y ($L(X) < L(Y)$), yet we cannot conclude that X actually happened-before Y. Why does Lamport time not guarantee causality in this case?	10	4	
3.	At the distributed systems laboratory of Indian Institute of Technology Madras, nine M.Tech students are running a distributed auction simulation on nine networked machines, each assigned a unique process ID: 11, 18, 24, 31, 42, 57, 63, 75, and 90. The system follows the Bully Election Algorithm to select a coordinator,	10		

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CONTINUOUS ASSESSMENT TEST - II

WINTER SEMESTER 2025-2026

SLOT: A2+TA2

	where the process with the highest ID acts as the coordinator. Initially, process 90 is the coordinator, but it crashes during peak auction activity. Process 31 detects the failure and initiates an election. I. According to the Bully Algorithm, list the sequence of election messages P4 sends. II. Which processes will respond to P4, and what will they reply? III. Explain step-by-step how the election proceeds until a new coordinator is chosen. IV. How many election messages are exchanged in the worst case for this scenario? V. Suppose P8 (ID 75) crashes during the election process after replying "OK." Explain how the algorithm handles this situation.			
4.	A distributed file server deployed in a university data center uses caching and achieves a hit rate of 80%. When a requested block is found in the cache, servicing the request consumes 5 ms of CPU time. If the block is not found, an additional 15 ms of disk I/O time is required. The server architects are evaluating different multithreading strategies to improve throughput and scalability. (a) Clearly stating your assumptions, estimate the server's throughput capacity (average requests per second) under the following configurations: (i) single-threaded server; (ii) two-threaded server running on a single processor; (iii) two-threaded server running on a two-processor machine. Identify the bottleneck resource in each case. (b) The architects must choose between a worker-pool multithreading architecture and a thread-per-request architecture. Compare these two models in terms of scalability, resource utilization, context-switching overhead, and performance under heavy load. Based on your throughput analysis in part (a), recommend which architecture is more suitable for this file server and justify your reasoning.	10	4	3
5.	A research team at Vellore Institute of Technology is evaluating the performance impact of upgrading its internal network from 10 Mbps to 100 Mbps. In their distributed system, measurements show that: • For a null RPC (no parameters and no return value), 20% of the total execution time is spent in network transmission, while the remaining time is spent in marshalling, context switching, and server processing. • For an RPC that transmits 1024 bytes of user data (less than one network packet), 80% of the total execution time is spent in network transmission. Assuming that only the network transmission component improves proportionally with bandwidth while all other costs remain unchanged: I. Calculate the new execution time (as a percentage of the original time) for both operations. II. Determine the percentage improvement in performance for each case. III. Explain why the performance gain differs significantly between the two RPC types. IV. Based on your analysis, discuss whether upgrading network bandwidth is always an effective way to improve RPC performance.	10	4	3