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International Institute of Information Technology, Hyderabad

(Deemed to be a University)

CS3.301 Operating Systems and Networks – Monsoon 2025

Quiz 2

Max. Time: 45 mins **Max. Marks: 20**

Roll No: ____________________ **Programme:** ______________

Student's Signature: ____________ **Invigilator's Signature:**____________________

Special Instructions to the students

1. Answers written with pencils won't be considered for evaluation
2. Please **read the descriptions** of the questions (scenarios) carefully.
3. There are a total of six questions (for a total of 20 marks) with four MCQs. For MCQs, you can select one/all that apply as answers for a given MCQ. Please refrain from writing long explanations for MCQ questions. **Keep the explanations short and to the point (4-5 lines).**
4. There is also one additional bonus question. The score on this will be computed towards the overall course bonus.
5. **Feel free to use the extra page** for any calculations/rough work, but **they won't be considered for evaluations**.

Marks Table (To be filled by the Evaluator)

Question No / Marks	Initial	Final	Name of the Evaluator
1			
2			
3			
4			
5			
6			
Bonus			

General Instructions to the Students

1. Place your Permanent / Temporary Student ID card on the desk during the examination for verification by the Invigilator.
2. Reading material such as books (unless open book exam) are not allowed inside the examination hall.
3. Borrowing writing material or calculators from other students in the examination hall is prohibited.
4. If any student is found indulging in malpractice or copying in the examination hall, the student will be given 'F' grade for the course and may be debarred from writing other examinations.

Best of Luck

Welcome to the Operating Systems and Networks Design Competition organized by the AgenticOS team. The competition is designed to test your concurrency skills and your understanding of network concepts at the link, application, and network layers. They are seeking new team members in this area. They wanted to put you to the test to determine if you could join their team. You have 45 minutes to respond to some questions they have for you. Each question is worth a certain number of points, and the total number of points you obtain determines your place on the team.

1) The team believes that they have built their operating system with support for concurrency through semaphores. They want you to test their semaphore implementation by solving the classic producer-consumer problem, where there is: i) one common buffer of size N, ii) there are producer threads that can add items to the buffer and iii) consumer threads that can consume from the buffer. The main constraints are that producer threads cannot produce items to a full buffer, and consumer threads cannot consume from an empty buffer. They want you to do the following **(5 points):**

   a) Write a pseudocode that leverages semaphores for addressing the producer-consumer problem **(3 points)**
   b) What would happen if both the producer and consumer initialise the semaphores: *full* (full is to check if the buffer is full, consumer waits on full) and *empty* with value 1, and what would happen if full is initialised to *N*? **(2 points)**

2) The team was trying to implement a solution for the classic reader-writer problem. The team feels that there will be more readers than writers in the runtime. They wanted your opinion on the main trade-off between fairness and throughput in a reader-writer implementation **(3 points)**
   a) Favouring writers increases throughput but causes starvation for readers
   b) Favouring readers increases throughput but may starve writers
   c) Throughput and fairness are always balanced
   d) Writers and readers never conflict

3) The team is considering different locking mechanisms to prevent race conditions and support concurrency. They want your advice on whether to use spinlocks or classical mutex locks. Assume that a context switch takes time T. What is an appropriate upper bound (in terms of T) for how long a thread should hold a spinlock? If a thread holds a spinlock longer than this, what would be a better mechanism and why? **(3 points)**
   a) The upper bound is T
   b) The upper bound is 2T
   c) The upper bound is 4T
   d) There is no specific upper bound; all locks perform equally well.

4) The AgenticOS team has a network team focusing on implementing the networking protocols. They wanted to check if you understand the networking concepts. They are currently working on the DNS resolution part, and they have a query: A computer with hostname *client.example.com* wants to send data to another host *server.university.edu* using its domain name. During the DNS lookup process, the query reaches the TLD server.
If the final goal is to resolve the IPv4 address of the destination host, what type of record will the TLD server return**? (3 points)**

   A. A record
   B. NS record
   C. CNAME record
   D. PTR record

5) Now that the AgenticOS has set up the network infrastructure, they would like to test by connecting a host machine to the network and sending data to another machine. The network has a subnet mask of 255.255.255.0, and the IP address of the switch is 172.16.10.12. The team wants to connect a host to this network, and the host must send data to another machine with IP 192.168.10.17/16. Given this scenario, the team would like you to select all the statements from the list below that are true with respect to how this communication proceeds and reason on the selected ones. *Please note that all your selection has to be correct in order to get any points* **(3 points):**

   A. The host will first perform DHCP to obtain an IP address, subnet mask, and default gateway.

   B. The host will use ARP to find the MAC address of 192.168.10.17 before sending the packet.

   C. The host will use ARP to resolve the MAC address of its default gateway after obtaining its IP.

   D. The default gateway will forward the packet toward 192.168.10.17 because it lies outside 172.16.10.0/24.

   E. The host and 192.168.10.17 are in the same subnet because both have class-B private addresses.

6) The team is planning to deploy AgenticOS in a server machine, which will serve as a web cache. The cache uses a thread pool to serve multiple client requests concurrently. Cached objects are stored in shared memory with an LRU policy. For cache hits, objects should be served in parallel; for cache misses, exactly one thread should fetch from the origin and update the cache. Which design best ensures correctness and high concurrency? **(3 points)**

   a) Protect the entire cache (reads and writes) with a single global mutex
   b) Use a reader–writer lock per object
   c) Rely on HTTP/1.1 persistent connections to serialize cache access
   d) Use per-thread spinlocks around all cache operations

Bonus Question

Consider a variation of the dining-philosophers problem in which all chopsticks are placed at the center of the table, and any philosopher may pick up any three chopsticks from the center to eat. Requests for chopsticks are made one at a time. Describe a simple rule for determining whether a philosopher's request for a chopstick can be satisfied *without causing deadlock*. **(3 points)**

Now that you have completed the task, it's time to wait to know your final points!!!

**********Extra Space**********