International Institute of Information Technology, Hyderabad

(Deemed to be University)

CS3.301 Operating Systems and Networks

Question cum Answer Booklet

Mid Semester Examination

Max. Time: 1.5 Hr **Max. Marks: 45**

Roll No: _____ Programme: _____ Date of Exam: _____

Room no: _____ Seat No: _____ Invigilator's Signature:_____

Special Instructions about the exam:

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 nine questions with five MCQs and carries 45 marks. For MCQs you can select one or more options that applies as answers for a given MCQ. Please refrain from writing long explanations for MCQ questions. **Keep the explanations short and to the point.**
4. Please state any assumptions made clearly.
5. **Feel free to use extra page** for any calculations/rough work but **they won't be considered for evaluations**.

Additional sheet for rough work is allowed: Yes

Marks Table (To be filled by the Examiner)

Question No / Marks	Initial Marks	Final Marks	Name of the Examiner who marked
1			
2			
3			
4			
5			
6			
7			
8			
9			

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

Congrats on being selected as a mentor for the OSNHack day. The hackathon aims to promote system design thinking among undergraduate students. OSNHack will be a 90-minute event and consists of various challenges based on types of Unix Operating systems, which offers a network stack for communication based on the OSI model. The teams aim to put efficiency (time, memory usage, energy, etc.) as the primary goal for designing their solutions. The students have been divided into teams, and as a mentor, your responsibility is to talk to different teams and guide them with their questions. For each correct solution to a challenge, the teams will be awarded some points. The final points the team receives will be used to create a ranking. Your goal is to solve the queries of the different teams in the best possible manner. All the best for the mentor role.

1. One of the teams is developing their own OS, which uses the concept of segmentation for memory management. Being a simple OS, the team has decided that each process will be divided into four segments, namely, code1, code2, stack and heap. However, the designers require your input on how an address translation mechanism can be built around this concept of segmentation. For demonstration, the team is considering that apart from the OS, only one process can be in the physical memory, which is divided into different segments as follows:

Segment	Base	Size	Grows Positive?
Code1	32K	2K	1
Code2	34K	2K	1
Heap	36K	3K	1
Stack	28K	2K	0

The team is executing a process which has a virtual address space of 16 KB with Code1 (0-2K), code2 (2K-4K), Heap (4K-7K) and Stack (14K – 16K). During the execution, the process refers to an address 15KB:

   a. How to map the segment from virtual address space to physical address space? (2 points)
   b. What will be the actual location in the physical memory? (4 points)
   c. With the same assumption of virtual address space as above, what will be the physical address corresponding to a memory reference of 8KB? (2 points)

2. Another team is trying to build a scheduler for their OS using a round-robin policy with a time slice of 1 ms. However, the team is unclear about how effective and efficient the selected scheduling policy would be. To evaluate this, they require your support. As an example scenario, the team is considering three processes: i) a C program that runs for 8 ms and performs in-memory computation; ii) a background program which runs for 7 ms with only I/O operation; and iii) an email program that periodically checks for emails which executes for a total of 8 ms. Please help the team in understanding how round robin can be used in this scenario with the help of a diagram and calculate the average turnaround time and response time while using this policy. Do you want to recommend any other scheduling policy to the team? (8 Points)

3. As you walk around, you notice that a team is trying to build a streaming application on top of their Unix-based OS which streams videos in near real-time to another application on another machine. The team is using UDP at the transport layer, but they believe they can implement some mechanism to verify the correctness of the data at the destination. Can you help the team come up with a simple mechanism (remember, UDP headers are minimal) that can help with a verification process? As an example, you can consider a stream of data 11100110011001101101010101010101 to demonstrate the verification process. (6 points)

4. You observed that like many teams, one another team also has used paging for memory management where they have devised a technique using swap space to manage even processes with large virtual address space. However, the exact policy for page replacement has yet to be decided. The team has two types of traces of page access in mind, and they are looking at the main memory as a cache with size 3 pages:

   Trace 1: 0, 1, 2, 0, 1, 3, 0, 3, 1, 2, 1

   Trace 2: 1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5

   The team is deliberating between FIFO and LRU. Demonstrate using the necessary metrics and the trace table for the two different policies and further which among them would you recommend and why? What if main memory can hold 4 pages? (8 points)

5. A team is developing a network application that uses TCP in the transport layer. They want your suggestion on what header fields can be used for ensuring reliability. What do you recommend? (3 points)

    a. Just use sequence number
    b. Make use of acknowledgement number
    c. Checksum can be used to guarantee reliability.
    d. Leverage Urgent pointer.

6. You noticed that one team plans to use Paging as the memory management technique. However, the team has figured out that one big challenge with Paging is the memory overhead since the page table needs to be first accessed, and then the page table entry needs to be fetched to perform the address translation. This results in two accesses to the memory for each address translation. Is there some better mechanism that you can suggest to the team to handle this? (3 points)

    a. Use swap space as a solution
    b. Make use of a dedicated cache mechanism inside MMU
    c. Increase the page size
    d. None of the above

7. One team is using Paging for memory management in their OS. The team is considering a 32-bit address space with 2 KB pages. The team estimates each entry in the page table to consume 4 bytes. What according to you will be the approximate memory overhead of using paging if the team estimates the OS to support around 100 processes? (3 points)
    a. 400 MB
    b. 800 MB
    c. 1250 MB
    d. 1600 MB

8. As the team computed the overhead and came up with a cache mechanism for reducing size of page table, the team noticed another challenge: when a process like game or any process with address space larger than the physical address space was being executed, some processes pages were not in the main memory (RAM). Moreover, they also observed that sometimes a small process was getting a chance to execute in between. What could be the reason? (3 points)

    a. The game might have had some I/O operation which allowed OS to perform context switch
    b. Some pages of the game may not be in the main memory which resulted in a context switch
    c. The game might have tried to access a page but its entry was not present in the TLB which resulted in a context switch
    d. None of the above

9. The team is trying to come up with a time out interval to handle loss of data. To this end, the team observed the round-trip time for sending the data segment from one process to another process (until acknowledgement is received) is 106 ms. Before observing this, the team have estimated that on average the round-trip time can be about 100 ms and sometimes the deviation between what they have observed and estimated can be around 5 ms. What is the TCP time out interval that you would recommend to be used for values of alpha = 0.125 and beta = 0.25? (3 points)
    a. 100.75 ms
    b. 131.0 ms
    c. 121.0 ms
    d. 103.85 ms

**********Now it’s time to wait for final points**********