PART A MARKS:

ID NO. -   NAME -

Birla Institute of Technology & Science Pilani, Hyderabad Campus
First Semester 2023-2024
CS F372: Operating Systems

Comprehensive Examination (Regular)

Type: Closed Book   Time: 180 minutes   Max Marks: 120   Date: 14/12/2023

Part A (25 x 2 = 50 Marks)

Instructions:
- ❖ The question paper consists of 2 parts - Part A and Part B.
- ❖ Part A contains 25 questions, each of 2 marks. Part A is of 50 marks.
- ❖ Answers for Part A must be written legibly in the Part A booklet at the designated places (boxes given after every question) IN INK/PEN.
- ❖ Answers for Part A written anywhere else other than the designated places/boxes will not be considered for evaluation. Answers written in pencil will not be considered.
- ❖ There is no time restriction for either part. Manage your time properly for both Parts A and B.
- ❖ Answer all the questions.
- ❖ Part A booklet consists of total 8 pages.
- ❖ Write your ID and Name IN INK/PEN at the top of each page of Part A booklet. If you do not write your name and ID, NO MARKS WILL BE AWARDED AT ALL.
- ❖ Evaluators are free to make their own assumptions for unclear/illegible and messy handwriting.
- ❖ There is no need to show any calculations or write explanations for any question of Part A.
- ❖ If any pages are missing from the booklet or are unclear, report immediately to the invigilator.
- ❖ Use the main answer script for rough work. Write your Name and ID in INK/PEN on the regular answer script and submit it along with the two booklets at the end of the exam to your invigilator.
- ❖ There is no part marking for Part A. Only the answers written in the boxes will be evaluated.
- ❖ The rough work will not be considered for evaluation.
- ❖ There is no negative marking for Part A.
- ❖ Calculators are allowed. No exchange of calculators during the exam is allowed.
- ❖ You are not allowed to remove any page(s) from Part A.
- ❖ Do not attach any page(s) to the Part A booklet. If any page becomes loose, make a hole at the top left corner of the booklet (with your pen) and tie the pages with a string.
- ❖ Struck out or cancelled answers will not be considered under any circumstance.

RECHECK:

NOTE: SUBMIT PART A, PART B AND MAIN ANSWER SCRIPT SEPARATELY AT THE END OF THE EXAM.

1. Write whether the following complete statement given inside double quotes is **True or False**. **Any answer other than True or False will not be considered.**

"Device controller is a software component that works as a bridge between the hardware device and the operating system or an application program."

> **ANSWER:**
>
> **FALSE**

2. Write whether the following complete statement given inside double quotes is **True or False**. **Any answer other than True or False will not be considered.**

"Loadable kernel modules do not require message passing to invoke the modules, but microkernels require message passing."

> **ANSWER:**
>
> **TRUE**

3. Consider the tree-structured directory shown below. If the current directory is **root/User1**, then is the relative pathname for **Quiz2** is given as **root/User1/TOC/Quiz2**? Answer in **Yes or No**. **Any answer other than Yes or No will not be considered.**
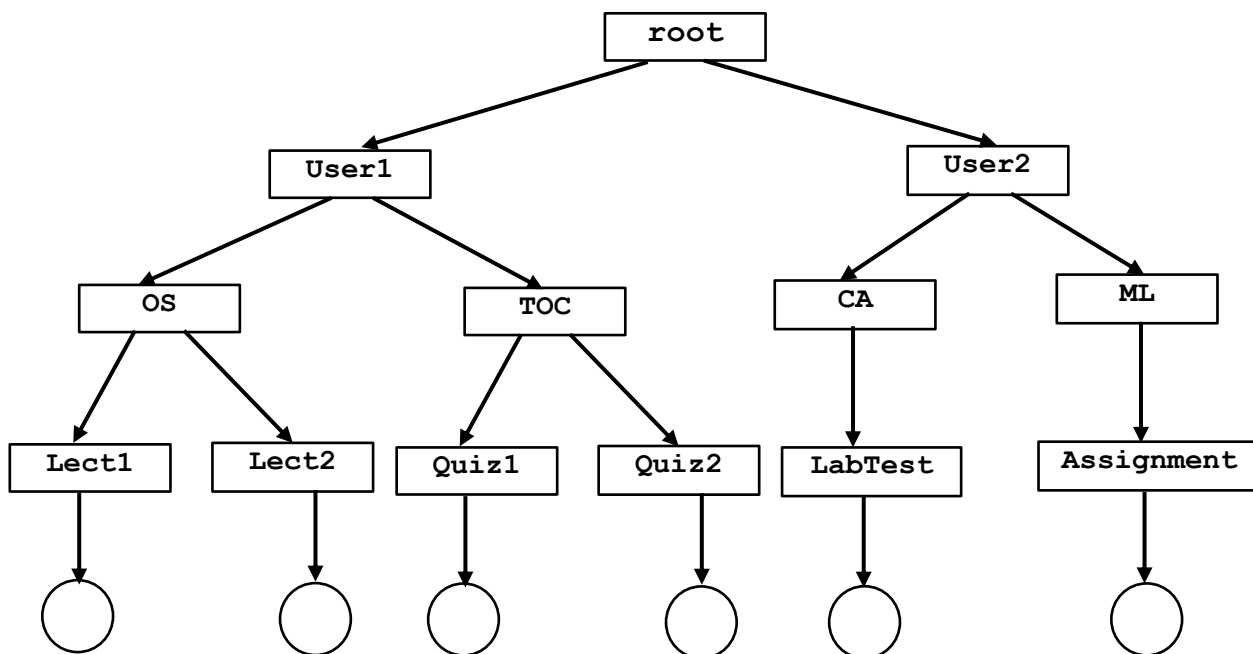
> **ANSWER:**
>
> **NO**

4. A counting semaphore **S** is initialized to a value **x**. After that 35 **wait()** and 19 **signal()** operations are performed on **S**. The final value of **S** is now **x/2**. Determine the initialization value **x** of **S**. Assume semaphore implementation with busy waiting.

ANSWER:

32

5. A system uses paging-based memory management scheme with a page size of 512 bytes. A process P is of size 14,240 bytes. Assume memory to be byte addressable on this system. Determine in **bytes** the amount of internal fragmentation, if any, for this process. **Answer should be given in bytes only.**

ANSWER:

96

6. Consider the following solution to the critical section problem for two processes, P0 and P1. The pseudocodes for P0 and P1 are shown below. The two processes share an integer variable turn, a boolean array flag and a boolean variable wait. Does the given solution satisfy mutual exclusion? Answer in **Yes or No**. **Any answer other than Yes or No will not be considered.**

<table>
<tr><td>

P0

```
int turn = 0;
int flag[2] = {false, false};
int wait = false;
turn = 1;
flag[0] = true;
while(flag[1]){
    flag[0] = false;
    while(turn != 0 || wait == true);
}
//CRITICAL SECTION
flag[0] = false;
```

</td><td>

P1

```
int turn = 1;
int flag[2] = {false, false};
int wait = false;
turn = 0;
flag[1] = true;
while(flag[0]){
    flag[1] = false;
    while(turn != 1 || wait == true);
}
//CRITICAL SECTION
flag[1] = false;
```
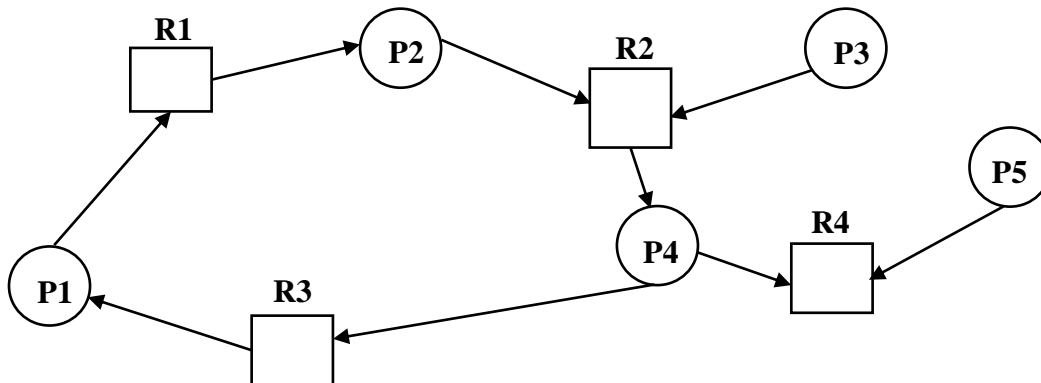
</td></tr>
</table>

ANSWER:

NO

7. Consider the following resource-allocation graph. Assume each resource type has only one instance. Determine the number of nodes present in the wait-for graph that can be obtained from this resource-allocation graph.

ANSWER:

5

8. Write whether the following complete statement given inside double quotes is **True or False**. **Any answer other than True or False will not be considered.**
"A synchronous signal is sent to all the threads of a process."

ANSWER:

FALSE

9. Consider the given table containing the memory references to page numbers and the associated timestamps of the references for a process P. If the value of Δ, i.e., working set window is 10, determine working set size of P at T15.

Timestamp	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15
Page No.	3	5	1	6	7	3	3	2	1	5	7	3	4	4	1

ANSWER:

6

10. In polling based I/O, what value of the busy bit signifies that the device controller is idle?

ANSWER:

0

11. Mailboxes are used in which type of message passing based inter process communication – **direct or indirect**? **Any answer other than direct or indirect will not be considered.**

ANSWER:

INDIRECT

12. A computer system uses the proportional allocation scheme to allocate frames to the processes. This system has a total of 234 frames, out of which 10 have already been allocated for loading the operating system. Currently, three processes, P1, P2 and P3 are requesting frames. The sizes of P1, P2 and P3 are 27 KB, 179 KB and 82 KB respectively. Calculate the number of frames that will be allocated to P2.

> **ANSWER:**
>
> **139**

13. Consider the following solution to the critical section problem for two processes, P1 and P2. The pseudocodes for P1 and P2 are shown below. The solution uses a counting semaphore S1 and two binary semaphores S2 and S3. The semaphores are initialized as follows: S1 = 2, S2 = 1, S3 = 1. Assume semaphore implementation with busy waiting. Does the given solution lead to a deadlock? Answer in **Yes or No**. **Any answer other than Yes or No will not be considered**.

P1	P2
wait(S1);	wait(S1);
wait(S2);	wait(S3);
wait(S3);	wait(S2);
//CRITICAL SECTION	//CRITICAL SECTION
signal(S1);	signal(S1);
signal(S2);	signal(S3);
signal(S3);	signal(S2);

> **ANSWER:**
>
> **YES**

14. Consider the following POSIX compliant C code snippet. Assume all relevant header files are included and all function calls execute successfully. How many times OS will be printed on executing this code?

```c
int main(){
    pid_t p1, p2, p3;
    p1 = fork();
    if(p1 == 0){
        p2 = fork();
        if(p2 > 0){
            p3 = fork();
            printf("\nOS\n");
        }
        else if(p2 == 0){
            p3 = fork();
            printf("\nOS\n");
        }
    }
    else{
        p2 = fork();
        execlp("/bin/ls", "ls", "-l", NULL);
        printf("\nOS\n");
    }
}
```

> **ANSWER:**
>
> **4**

15. A hard disk has a transfer rate of 10 MB/second and is constantly transferring data to memory using DMA. The CPU needs to be involved for 500 milliseconds for each DMA transfer. If the total size of the data to be transferred is 495 MB, what is the **percentage** of CPU time consumed for the entire DMA transfer operation? **No marks will be awarded for an answer not given as a percentage.**

> **ANSWER:**
>
> **1**

16. Consider the following file allocation table containing information for a file named Project.doc as well as its directory entry. An entry NIL in the file allocation table indicates an unused disk block and EOF denotes a special value marking the end-of-file for Project.doc. Note that the file allocation table contains information for only Project.doc. You don't have to worry about other files. Assume the first disk block number of this system to be 0. Each disk block is 512 bytes in size. The information present inside Project.doc can be considered as an array of bytes and the first byte is numbered as 0. Determine the disk block number on which the byte number 2347 of Project.doc is stored. Assume memory to be byte addressable. The indexing of the file allocation table entries is done using the same convention as discussed in the lecture.

File-Allocation Table

NIL
NIL
8
EOF
6
NIL
7
2
3
6

Directory Entry

File name	Start Block
Project.doc	9

> **ANSWER:**
>
> **8**

17. Consider a system implementing multilevel queue scheduling algorithm for scheduling processes. The ready queue on this system is partitioned into two queues, Q1 and Q2. Q1 is for Student processes and Q2 is for Batch processes. Processes in Q1 are scheduled using Round-Robin scheduling algorithm with a time quantum of 3 milliseconds and the ones in Q2 are scheduled using FCFS scheduling algorithm. Moreover, Student processes have higher priority than Batch processes. Consider the 4 processes - P1, P2, P3 and P4. The type, arrival times and CPU burst cycles (in milliseconds) of the processes are shown in the table below. Calculate the waiting time for P1. Assume that Round-Robin scheduling performs process preemption even if Q1 contains only one process.

Process	Nature	Arrival Time	CPU Burst Cycle (milliseconds)
P1	Batch process	0	12
P2	Student process	3	7
P3	Batch process	8	15
P4	Student Process	8	10

> **ANSWER:**
>
> **17**

18. Consider a system that uses contiguous allocation scheme for allocating disk blocks to files. The system contains a total of 200 disk blocks, numbered from 0 to 199. Each disk block is 256 bytes. The directory entries of the different files of this file system are shown in the following table. Calculate in **bytes** the amount of space wasted due to external fragmentation. **The answer should be in bytes. Otherwise, no marks will be awarded.**

File	Start	Length
Holiday.jpg	3	20
Application.doc	25	7
Letter.txt	34	39
Business.doc	75	5
Profile.jpg	80	20
List.txt	100	40
Mail.txt	145	35
Routine.doc	180	20

ANSWER:

3584

19. Write whether the following complete statement given inside double quotes is **True or False**. **Any answer other than True or False will not be considered.**

"Shared memory based inter process communication is slower than message queue based inter process communication."

ANSWER:

FALSE

20. The CPU is executing a real-time video rendering application VS. While the CPU is executing this application, it receives one maskable interrupt and one non-maskable interrupt. Which interrupt will the CPU ignore?

ANSWER:

MASKABLE

21. The time to search the TLB on a particular system is 10 nanoseconds and the main memory access time of this system is 90 nanoseconds. The effective access time (EAT) of this system is 104.5 nanoseconds. Determine the TLB hit ratio as a **percentage**. **Your answer should be given as a percentage and not as a fraction. No marks will be awarded if the answer is in fraction.**

ANSWER:

95

22. Which one of the following is not a valid state transition. Write the option number in the box.
(a) new to ready
(b) running to terminated
(c) ready to running
(d) waiting to running

ANSWER:

d

23. A computer system uses the many-to-many multithreading model. On this system, a multithreaded application **A** is running. **A** contains 4 user-level threads, UT1, UT2, UT3 and UT4. These user-level threads are mapped to 3 kernel-level threads KT1, KT2 and KT3. UT1 performs a blocking system call. Will the entire application **A** block? Answer in **Yes or No**. **Any answer other than Yes or No will not be considered.**

ANSWER:

NO

24. A system uses paging based memory management scheme. This system uses a logical address of 32 bits out of which 19 bits are used for page number. Determine in KB the page size on this system. **Answer should be given in only in KB, otherwise no marks will be awarded.** Assume memory to be byte addressable.

ANSWER:

8

25. Write whether the following complete statement given inside double quotes is **True or False**. **Any answer other than True or False will not be considered.**
"RAID level 4 is known as block-interleaved parity and RAID level 6 is known is block-interleaved distributed parity."

ANSWER:

FALSE

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