Operating Systems Test 1

Number of Questions: 35 **Section Marks: 30**

Directions for questions 1 to 35: Select the correct alternative from the given choices.

1. Which of the following service is provided by an Operating System?
(i) Access to I/O Devices
(ii) Controlled access to files
(iii) System Access
(iv) Accounting
(A) (i), (ii) (B) (iii), (iv)
(C) (i), (ii), (iii) (D) (i), (ii), (iii), (iv)

2. In which of the following modes, privileged instructions will be executed?
(A) Kernel mode only
(B) User mode only
(C) Either kernel mode or user mode
(D) execution of privileged instruction is independent of mode

3. In which of the following environment, the computer memory can hold three, four or more programs and a single CPU switches among all of them for execution?
(A) Uniprogramming (B) Multiprogramming
(C) Multiprocessing (D) Both (B) and (C)

4. What is the principle objective of Time sharing system?
(A) Maximize processor use
(B) Minimize response time
(C) Maximize memory usage
(D) Minimize CPU idle time

5. Which of the following will not be included in the Process Control Block of a process?
(A) Process state (B) Program counter
(C) Priority (D) None of the above

6. Which of the following best explains 'process spawning'?
(A) The OS creates a process at the explicit request of another process.
(B) The OS creates a process to perform a function on behalf of a user program.
(C) A process is created when a user logs on to the system.
(D) The OS creates a process as per its requirement.

7. For which of the following reason, a process will move from 'Running' state to 'Blocked' state?
(A) Timeout (B) Dispatch
(C) Suspend (D) Event wait

8. If a process is in secondary memory and is available for execution as soon as it is loaded into main memory, then it is in _____ state.
(A) Ready (B) Blocked
(C) Blocked/Suspend (D) Ready/Suspend

9. Which of the following will be a reason for Process Suspension?
(A) Swapping
(B) Interactive user request
(C) Parent process request
(D) All the above

10. Which of the following is TRUE?
(A) The overhead involved in mode switch is more compared to process switch.
(B) The overhead involved in process switch is more compared to mode switch.
(C) The overhead involved in process switch is same as mode switch.
(D) comparing the overhead involved in process switch and mode switch is irrelevant.

11. Viruses, Logic bombs and Backdoors are examples of
(A) Parasitic malware
(B) Self-replicated malware
(C) Self-contained malware
(D) Active malware

12. Which of the following details will be maintained by each thread, in a multithreaded environment?
(i) Register state (ii) Priority
(iii) Stack
(A) (i), (ii) (B) (ii), (iii)
(C) (i), (iii) (D) (i), (ii) and (iii)

13. Which of the following are advantages of using User-Level-Threads (ULT) over Kernel-Level-Threads?
(i) There is no need of kernel mode privileges for thread switching.
(ii) ULTs can run on any OS.
(iii) A system call cannot block the entire process.
(A) (i), (ii) (B) (i) only
(C) (ii), (iii) (D) (i), (iii)

14. Consider a multiprogramming environment, in which two processes are running and one process is unaware of another process, then which of the following problems will occur?
(A) Mutual exclusion (B) Deadlock
(C) Starvation (D) All the above.

15. Which of the following will be (a) requirement(s) for mutual exclusion?
(A) A process remains inside its critical section for a finite time only.
(B) A process that halts in its non critical section must do so without interfering with other processes.
(C) When no process is in a critical section, any process that requests entry to its critical section may be permitted to enter with some delay.
(D) Both (A) and (B)

16. Identify the correct sequence of actions from the following, to read data with a Virtual address using TLB and cache (Assume TLB and cache has miss):
(i) Access the TLB
(ii) Read from cache
(iii) Access memory to get address
(iv) Access memory to read data.
(A) (i), (ii), (iii), (iv) (B) (i), (iii), (ii), (iv)
(C) (i), (ii), (iv), (iii) (D) (i), (iii), (iv), (ii)

17. A 2-Level page translation scheme has 4 K byte pages and 4 Byte page table entries. The virtual address has 32-bits. What is the number of bits required to access first level; second level page table entries and offset in a page respectively?
(A) 9, 9, 14 (B) 12, 12, 8
(C) 10, 10, 12 (D) 8, 12, 12

18. What is the effective access time for TLB with 90% hit rate, 1 ns to access TLB and 10 ns to access memory. (Assume a 2-level page table)
(A) 1 ns (B) 2 ns
(C) 3 ns (D) 4 ns

19. Consider the page reference string: 1, 2, 3, 4, 1, 2, 5, 1, 2, 3, 4, 5. The number of page frames allocated is 3. Using FIFO, in which way, the number of page faults change by increasing the page frames allocated to 4.
(A) increases by two (B) decreases by two
(C) increases by one (D) decreases by one

20. A 512 KB file is stored contiguously on one disk track. Each track contains 1024 sectors, each sector is 512 bytes. Average seek time is 1 ms. And the rotational speed is 15000 rpm. What is the average access time to read the entire file?
(A) 2 ms (B) 4 ms
(C) 7 ms (D) 3 ms

21. Consider mapping a Virtual memory of 1 GB onto a physical memory organized into 256 page frames of 4 KB each. Assume that the smallest addressable unit is 1 byte. Then which of the following is TRUE?
I. The page table fit in the main memory
II. The frame table fit in a single page.
(A) I only (B) II only
(C) Both I and II (D) Neither I nor II

22. Consider below program segment:

```
# include < stdio.h>
# include < unistd.h>
.....
int main ()
{
pid p;
p = fork ();
if (p = = 0)
{
fork ();
fork ();
for k ():
}
return 0;
}
```

Including the initial parent process, how many processes will be created?
(A) 7 (B) 15
(C) 8 (D) 9

23. Consider the following resource requests.
P_1 requests exclusive use of both R_1 and R_2
P_2 requests exclusive use of both R_2 and R_3
P_3 requests exclusive use of both R_3 and R_4
P_4 requests exclusive use of both R_4 and R_2
Resources are assigned in process request order. (P_1 is first). Which of the following is TRUE?
(A) Given system is in deadlock.
(B) There is a possibility of deadlock after P_1 finishes its execution.
(C) There is no deadlock in given system.
(D) After P_1, if P_2 executes then there is a possibility of deadlock.

24. Which of the following instructions can only be executed in kernel mode?
(i) Load Instruction
(ii) Modify PC register
(iii) Modify SP register
(iv) Modify the register that controls kernel/user mode.
(v) Direct access to I/O device.
(A) (i), (ii), (v) (B) (i), (iii), (iv)
(C) (iv), (v) (D) (ii), (iv)

Directions for questions 25 and 26: A computer with a 32-bit address uses a 2-level page table. The virtual address format is shown below:

1^{st}-level page table	2^{nd}-level page table	Off set

25. What is the page size?
(A) 1024 B (B) 2048 B
(C) 4096 B (D) 8192 B

26. How many pages are there?
(A) 2^9 (B) 2^{11}
(C) 2^{12} (D) 2^{20}

27. Suppose that a 32-bit virtual address is broken up into four fields p, q, r and s. The first three are used for a 3-level page table system. The fourth field, s is the offset. Then which of the following is TRUE?
(A) The number of pages depend on the total number of bits in p, q, r combined.
(B) The number of pages depend on the total number of bits in p, q, r and s combined.
(C) The number of pages depend on the split among the fields p, q, r.
(D) The number of pages depend on the split among the fields p, q, r and s.

28. A computer provides each process with 65, 536 bytes of address space. A particular program has a text size of 32768 bytes, a data size of 16386 bytes and a stack size of 15870 bytes. If a page may not contain parts of two different segments then which of the following is TRUE?
(A) The program will fit in the address space if the page size is 4096 bytes.
(B) The program will fit in the address space if the page size is 2048 bytes.
(C) The program will fit in the address space if the page size is 1024 bytes.
(D) The program will fit in the address space if the page size is 512 bytes.

29. The Newton–Raphson method is applied to compute a root of the equation $f(x) = x^4 - x^3 - x^2 - 21x + 18 = 0$. With $x_0 = 3.1$ as the initial solution, the method converges to an exact solution after how many iterations?
(A) 1 (B) 4
(C) 7 (D) 10

30. How many disk operations are needed to fetch the inode for the file Admin/OS/UNIX/File/src.p?
Assume that the inode for this root directory is memory but nothing else along the path is in memory. (Note: All directories fit in one disk block)
(A) 5 (B) 10
(C) 4 (D) 8

31. The beginning of a free space bitmap looks like below after the disk partition is first formatted:
1000 0000 0000 0000 ……
The system always searches for free blocks starting at the lowest numbered block. So after writing file *A*, which uses 5 blocks, the bit map looks like: 1111 1100 0000 0000 Then what will be the bit map after performing following
actions:
(i) File *B* of 6 blocks is written
(ii) File *A* is deleted
(iii) File *C* of 7 blocks is written
(iv) File *B* is deleted
(A) 1111 1111 0000 0000 ……..
(B) 1111 1111 1111 1100 ……
(C) 1111 1100 0000 1100 ……
(D) 1000 0000 0111 1111 ……

32. Consider below features:
(i) This scheduler has more speed.
(ii) The scheduler has less control over the degree of multiprogramming.
(iii) The scheduler is minimal in time sharing systems.
Which scheduler has above features?
(A) Long-term scheduler
(B) Medium-term scheduler
(C) Short-term scheduler
(D) None of these

33. Consider a system consisting of four processes and single resource. The current status of the Claim and Allocation matrices are:

$$C = \begin{bmatrix} 4 \\ 3 \\ 10 \\ 7 \end{bmatrix} \qquad A = \begin{bmatrix} 2 \\ 2 \\ 4 \\ 2 \end{bmatrix}$$

What is the minimum number of units of the resource(s) needed to be available for this state to be safe?
(A) 0 (B) 1
(C) 2 (D) 3

Common Data Questions 34 and 35:
Consider two CPU scheduling algorithms for a single CPU: Round Robin scheduling and Shortest job First scheduling. Consider below five processes with arrival times and expected CPU time.

Process	Arrival time	Expected CPU Time
P1	0	15
P2	3	13
P3	5	9
P4	6	5
P5	18	8

34. What is the average waiting time using SJF?
(A) 5 (B) 10
(C) 13.6 (D) 15.4

35. What is the average waiting time using Round Robin scheduling with time quantum of 6 units?
(A) 36.2 (B) 18.4
(C) 12.6 (D) 23.4

Answer Keys

1. D	**2.** A	**3.** B	**4.** B	**5.** D	**6.** A	**7.** D	**8.** D	**9.** D	**10.** B
11. A	**12.** D	**13.** A	**14.** D	**15.** D	**16.** B	**17.** C	**18.** C	**19.** C	**20.** C
21. C	**22.** D	**23.** B	**24.** C	**25.** C	**26.** D	**27.** A	**28.** D	**29.** B	**30.** B
31. C	**32.** C	**33.** B	**34.** C	**35.** D					

Hints and Explanations

1. All those services are provided by OS. Choice (D)

2. Privileged instructions will be executed in kernel mode, in which protected areas of memory will be accessed. Choice (A)

3. In Uniprogramming, the memory holds only a single program. In multiprogram, the CPU executes more than one program in time interleaved fashion, which are present in memory. In multiprocessing, There will be more than one CPU executing more than one program. Choice (B)

4. The Time sharing system handles multiple interactive jobs, so that response time will be reduced. Choice (B)

5. PCB holds information about a process. Choice (D)

7. A process will be in blocked state if it is waiting for an event to occur. Choice (D)

10. Mode switch occurs without changing the state of process. Process switch requires some changes in its environment.

$\therefore$ Overhead of process switch is greater than mode switch. Choice (B)

11. In Parasitic malware, the fragments of programs do not exist independently Choice (A)

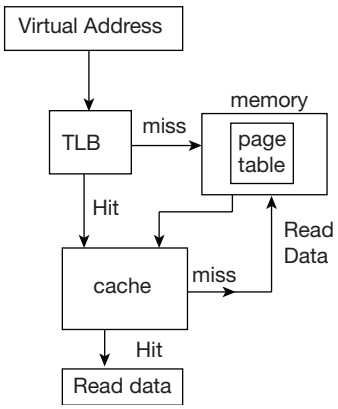
12. In multithreaded environment, each thread maintains a stack, register values, priority and other thread related state information. Choice (D)

13. In ULTs, the thread management will be done by thread library. So no need of kenel mode privileges for thread switching. On any OS, ULTs can run. A system call blocks entire process. Choice (A)

14. If processes are unaware of each other then competition exist between them. There is a possibility of Mutual exclusion, Deadlock and Starvation. Choice (D)

15. There will be no delay in permitting a process to enter its critical section if no process is in critical section. Choice (D)

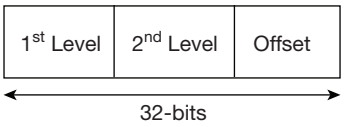
16.



So the sequence of actions will be (i), (iii), (ii), (iv) Choice (B)

17. Page size = 4 KB = 2^{12} B.

$\Rightarrow$ 12-bits required to identify a byte in a page.

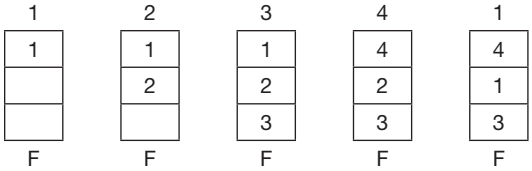


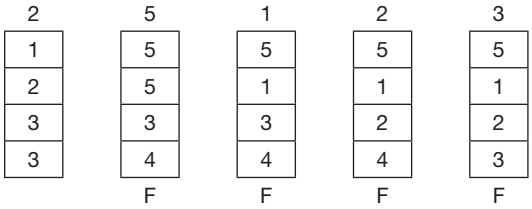
Number of entries in 2nd level Page table $= \frac{2^{12}}{4} = 2^{10}$

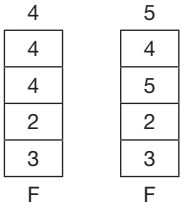
$\therefore$ 10 bits required for 2nd level. Similarly for first level also 10-bits required. Choice (C)

18. Effective TLB access time
= hit ratio * TLB access time + (1-hit ratio) * (TLB access time + memory access time *2)
= 0.9 * 1 + (0.1) * (1 + 20) = 0.9 + 2.1 = 3 ns.
Choice (C)

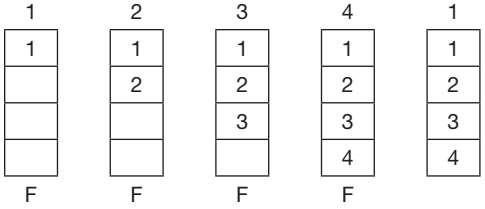
19. Initially, page frames allocated = 3

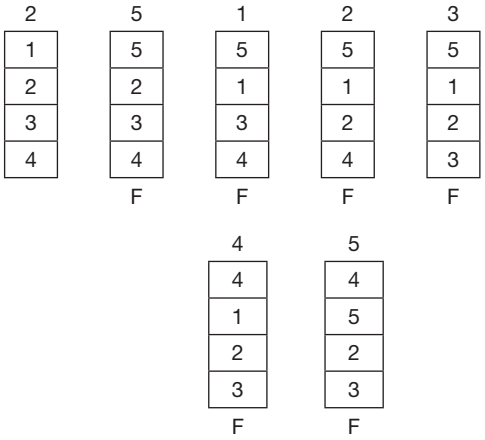






$\therefore$ Number of page faults = 9
Page frames Allocated = 4





∴ Number of page faults = 10

∴ Number of page fault increases by one. Choice (C)

20. Seek time = 1 ms

Rotational speed = 15000 RPM.

15000 RPM = 15000/60 RPS = 250 rps

$$\text{Rotational delay} = \frac{1}{2\times250} = 2 \text{ ms}$$

$$\text{Transfer time} = \frac{512\times1024}{250\times1024\times512} = 4 \text{ ms}$$

∴ Total time = seek time + Rotational delay + Transfer time = 7 ms Choice (C)

21. Virtual memory = 1 GB = 2^{30} B

Page frames = 256

Page size = 4 KB

Physical memory = 256 * 4 K = 2^{20} B.

$$\text{Number of pages} = \frac{2^{30}}{2^{12}} = 2^{18}$$

Page table size will fit in main memory. (main memory = 2^{20} B, Page table size = 2^{18} * PTE,

PTE will be less than 4 B)

∴ I is true

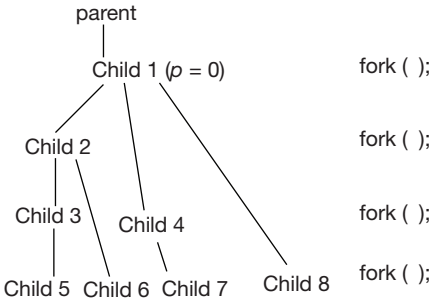
Frame table size = 256 * (8 + 18) = 6656 bits

This can fit in a page.

∴ It is true. Choice (C)

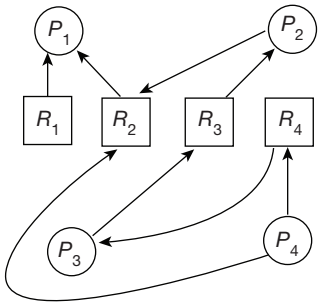
22. Fork () is used to create a child process *A* parent process returns the id of its children. A child process returns zero The first fork () call creates a child process. Only for child process $p = 0$, so child process only executes 3 fork() call statements, which creates 7 child processes.

∴ Total processes = 7 + 1 + 1 = 9



Choice (D)

23. The resource allocation graph of given system is shown below:



Initially P_1 completes and releases its resources. Now if P_4 acquires R_2, then P_2 waits for R_2, P_4 waits for R_4, P_3 waits for R_3. There is a circular wait. But if P_2 acquires R_2 then there will be no deadlock. Choice (B)

24. Load, modify *PC*, *SP* are not protected instructions. Modifying the register that controls kernel/user mode is a protected instruction. Otherwise any process can make itself run in kernel mode. I/O devices are only directly accessible by the *OS*. Choice (C)

25. Offset = 12 bits

Using 12-bits, we can access 2^{12} bytes. So the page size is 2^{12} = 4096 bytes. Choice (C)

26. $$\text{Number of pages} = \frac{\text{Virtual memory}}{\text{Page size}}$$

$$\text{Number of pages} = \frac{2^{32}}{2^{12}} = 2^{20}$$ Choice (D)

27. The number of pages depend on $p + q + r$. Choice (A)

28. Given total address space = 65536 bytes

Text size = 32768 bytes

Data size = 16386 bytes

Stack size = 15870 bytes

If page size = 4096

$$\text{Total pages in memory} = \frac{65536}{4096} = 16$$

$$\text{Pages for text} = \frac{32768}{4096} = 8$$

$$\text{Pages for data} = \frac{16386}{4096} = 5$$

$$\text{Pages for stack} = \frac{15870}{4096} = 4$$

Total pages required for process = 8 + 5 + 4 = 17

∴ Choice (A) is wrong.

Similarly if page size is 2048, the memory consists of 32 pages. If page size is 1024, the memory consists of 64 pages, but process requires 65 pages.

If page size = 512 bytes,

Memory consists of 128 pages and process requires 128 pages.

∴ Choice (D) is correct Choice (D)

29. The iterative formula for finding root of $f(x) = 0$ in Newton–Raphson method is

$$x_{k+1} = x_k - \frac{f(x_k)}{f'(x_k)}$$

By using this formula, starting with $k = 0$ and $x_0 = 3.1$, it can be easily observed that $x_4 = 3$ (the exact root)
$\therefore$ After 4 iterations, the method converges to exact root. Choice (B)

30. As all directories fit in one disk block, then all required data on a directory is stored in the inode itself.
To open /Admin/OS/UNIX/file/src.p
We do following reads:
1. inode of /→ Already in memory
2. Directory for /
3. inode of /Admin
4. Directory of /Admin
5. inode of /Admin/OS
6. Directory of /Admin/OS
7. inode of /Admin/OS/UNIX
8. Directory of /Admin/ OS/UNIX/File
9. inode of /Admin/OS/UNIX/File
10. Directory of /Admin/ OS/UNIX/File
11. inode of /Admin/OS/UNIX/file /scr.p

$\therefore$ 10-disk read operations required. Choice (B)

31. Bitmap after writing A is
1111 1100 0000 0000 …..
File B (6 Blocks): $\underbrace{1111\ \ 11}_{A}\ \ \underbrace{11\ \ 1111}_{B}\ \ 0000\ \ .....$
Delete A : 1000 0011 1111 0000 ……
File C (7 blocks): $\underbrace{1111\ \ 11}_{C}\ \ \underbrace{11\ \ 1111}_{B}\ \ \underbrace{1100}_{C}\ \ .....$
Delete B: $\underbrace{1\,111\ \ 11}_{C}\ \ 000000\ \ \underbrace{110}_{C}\ \ .....$
$\therefore$ Final bitmap : 1111 1100 0000 1100 ... Choice (C)

32. A short-term scheduler selects the process which is ready to execute. It does not have that much of control over degree of multiprogramming Choice (C)

33.

$$\text{Allocation} = \begin{matrix} p_1 \\ p_2 \\ p_3 \\ p_4 \end{matrix}\begin{bmatrix} 2 \\ 2 \\ 4 \\ 2 \end{bmatrix}$$

Total resources (R) = 10, Available (V) = 0
Need 1 more additional resource for execution of P_2.
$\Rightarrow$ $R = 11$, $V = 1$
Now p_2 can complete. And it releases its allocted resources.
$\Rightarrow$ $R = 11$, $V = 3$
p_1 requires 2 more resources. After execution it releases those 2 + allocated resources i.e., 4
$\Rightarrow$ $R = 11$, $V = 5$
Now p_4 can execute with the available and allocated resources.
$\Rightarrow$ $R = 11$, $V = 7$
Now p_3 can execute.
$\therefore$ One additional resource required.
Choice (B)

34. Shortest-job-First algorithm will select the shortest CPU burst time first.

P_1	P_4	P_5	P_3	P_2
0	15	20	28	37	50

Waiting time of $P_1 = 0$
Waiting time of $P_2 = 37 - 3 = 34$
Waiting time of $P_3 = 28 - 5 = 23$
Waiting time of $P_4 = 15 - 6 = 9$
Waiting time of $P_5 = 20 - 18 = 2$

$\therefore$ Average waiting time $= \dfrac{(0+34+23+9+2)}{5}$

$= 13.6$ units
Choice (C)

35. In Round Robin algorithm with time quantum 6 units, each job executed for 6 units and wait in waiting queue. The job with more waiting time will be executed first.

P_1	P_2	P_3	P_4	P_1	
0	6	12	18	23	29

P_2	P_5	P_3	P_1	P_5	
35	41	44	47	49	

Waiting time of $P_2 = (6 - 3) + (29 - 12) = 20$
Waiting time of $P_3 = (12 - 5) + (41 - 18) = 30$
Waiting time of $P_4 = (18 - 6) = 12$
Waiting time of $P_5 = (35 - 18) + (47 - 41) = 23$

Average waiting time $= \dfrac{32+20+30+12+23}{5} = 23.4$
Choice (D)

Operating Systems Test 2

Number of Questions: 35 **Section Marks: 30**

Directions for questions 1 to 35: Select the correct alternative from the given choices

1. Suppose we have variable logical records of length 10 bytes, 20 bytes and 30 bytes, while the physical block size in disk is 15 bytes. What is the maximum and minimum fragmentation seen in bytes?
(A) 10 and 5 (B) 10 and 0
(C) 5 and 0 (D) 5 and 5

2. Match the following:

List-A	List-B
1. Contiguous allocation policy	(i) Internal fragmentation
2. Chained list allocation	(ii) External Fragmentation
3. Indexed allocation	

(A) 1–(i), 2–(i), 3–(i) (B) 1–(i), 2–(i), 3–(ii)
(C) 1–(ii), 2–(i), 3–(i) (D) 1–(ii), 2–(ii), 3–(i)

3. Suppose that the scheduling algorithm favors those processes that have used the least processor time in the recent past. Then which of the following is TRUE?
(A) The algorithm favors I/O bound programs.
(B) The algorithm favors CPU bound programs.
(C) Fair treatment to all the programs.
(D) The algorithm favors longer programs.

4. Which of the following is not a necessary condition for deadlock?
(A) Mutual exclusion (B) Hold and wait
(C) Circular wait (D) Reentrancy

5. What will be the state of a process after it encounters an I/O instruction?
(A) Ready (B) Blocked
(C) Idle (D) Running

6. Which of the following is used by a program to request a service from an operating system's kernel that it does not normally have permission to run?
(A) Context switch (B) Threads
(C) System call (D) Service call

7. Which of the following is the reason for having threads within a process?
(i) Threads are lighter in weight than processes.
(ii) Threads have high performance when the processes have both I/O and CPU activity.
(iii) Threads are useful on systems with multiple CPU's.
(A) (i), (ii) (B) (ii), (iii)
(C) (i), (iii) (D) (i), (ii), (iii)

8. Which of the following is TRUE?
(A) No protection required between threads.
(B) Different threads in a process are always independent.
(C) All the threads cannot share open files, child processes.
(D) Each thread will maintain Accounting Information.

9. Which of the following is FALSE with respect to a monitor?
(A) Only one process can be active in a monitor at any instant.
(B) A monitor is a collection of procedures.
(C) Procedures declared outside the monitor can access monitor's internal data structure.
(D) Monitors can be used to provide mutual exclusion.

10. Which of the following is a reason for process scheduling?
(i) When a new process is created.
(ii) When a process exits.
(iii) When a process blocks.
(iv) When an interrupt occurs.
(A) (i), (ii) (B) (i), (iii), (iv)
(C) (ii), (iii) (D) (i), (ii), (iii), (iv)

11. Match the following:

List-A	List-B
1. First Come First Serve	I. High throughput
2. Shortest Process Next	II. Fair treatment of processes
3. Round Robin	III. Non-preemptive

(A) 1-II, 2-III, 3-II (B) 1-III, 2-I, 3-II
(C) 1-I, 2-III, 3-II (D) 1-I, 2-II, 3-III

12. To use process switching in hardware, instead of interrupts, the CPU needs to know about
(A) Process table data structure
(B) System calls
(C) CPU burst time
(D) PC only

13. Which of the following is FALSE?
(A) Throughput is the number of processes that complete their execution per unit time.
(B) Turnaround time is the amount of time required to execute a particular process.
(C) Waiting time is the amount of time, a process has been waiting in the ready queue.
(D) Response time is the amount of time taken to get the output.

14. Which of the following scheduling algorithm is also referred as preemptive version of FCFS?
(A) Shortest Job First
(B) Round Robin
(C) Shortest Remaining Time First
(D) None of these

15. Which of the following malware can result in pop-up ads or can redirect a browser to a commercial site?
(A) Spyware (B) Adware
(C) Zombie (D) Backdoor

16. In 48-bit machine, with 4 GB RAM and 8 KB page size, how many entries will be there in the page table if it is inverted?
(A) 2^{35} (B) 2^{20}
(C) 2^{19} (D) 2^{13}

17. Consider the following process and resource requirement of each process.

Process	Resource 1		Resource 2	
	Used	Max	Used	Max
P1	2	3	2	4
P2	2	4	2	3
P3	3	5	2	5

Assume that there are a total of 8 instances of resource type 1 and 7 instances of resource type 2. What is the state of this system?
(A) Can go to safe or unsafe state based on sequence.
(B) Safe state
(C) Unsafe state
(D) Deadlock state

18. Consider a system that has two CPU's and each CPU has two threads. Suppose three programs *P*1, *P*2 and *P*3 are started with run times 10, 15 and 25 ms respectively. What is the minimum time required to complete the execution of these programs?
(A) 25 ms (B) 35 ms
(C) 45 ms (D) 40 ms

19. A computer system has enough room to hold five programs in its main memory. These programs are blocked on I/O, half the time. What fraction of the CPU time is wasted?
(A) 96.8% (B) 32%
(C) 3.125% (D) 50%

20. A computer has 4 GB of RAM, of which the operating system occupies 256 MB. The processes are all 128 MB and have the same characteristics. If the goal is 95% CPU utilization, what is the maximum I/O wait that can be tolerated?
(A) 90.4% (B) 85.4%
(C) 72% (D) 50%

21. A file system with 4 KB blocks can access 64 GB worth of data through an i-node triple indirect block.
How many bits does the file system use for block pointers?
(A) 8 (B) 16
(C) 32 (D) 64

22. In a File Allocation table, each entry is of size 24-bits. For a 32 GB disk, what is the minimum size of a file allocation in this system?
(A) 1 KB (B) 2 KB
(C) 4 KB (D) 8 KB

23. On a system with 2^{64} bytes of memory and fixed partitions with a partition size of 2^{20} bytes, what is the minimum number of bits needed in an entry in the process table to record the partition to which a process has been allocated?
(A) 20-bits (B) 32-bits
(C) 36-bits (D) 44-bits

24. Which of the following features are required by an ideal CPU scheduling algorithm?
(i) Maximize the CPU utilization
(ii) Maximize the throughput
(iii) Minimize the turnaround time
(iv) Minimize the waiting time
(v) Minimize the response time
(A) (i), (iii), (v) (B) (ii), (iv), (v)
(C) (i), (ii), (iv), (v) (D) (i), (ii), (iii), (iv), (v)

25. Consider the following set of processes:

Process	Burst time	Priority
P1	10	3
P2	1	1
P3	2	3
P4	1	4
P5	5	2

The processes are assumed to have arrived in the order *P*1, *P*2, *P*3, *P*4 and *P*5 all at time 0. What is the average Turnaround time using Shortest Job First scheduling?
(A) 5 (B) 7
(C) 15 (D) 19

26. Consider the given concurrent processes:

```
Process P0:
while (true)
{
    while(turn = = 1);
    critical section
    turn = 1
    remainder section
}
Process P1:
    while (true)
{
        while (turn = = 0);
            critical section
        turn = 0
        remainder section
}
```

'turn' is a global Boolean variable, Which will take either 0 or 1. Which of the following is TRUE for above two processes?
(A) There is mutual exclusion and progress.
(B) There is progress but no mutual exclusion

(C) There is mutual exclusion but no progress.
(D) There is no mutual exclusion and no progress.

27. Consider '*n*' concurrent processes P_1, P_2, ... P_n whose code is shown below:

```
var mutex : semaphore
mutex = 1;
process Pi:
    Repeat
        wait (mutex);
            critical section
        signal (mutex);
            Remainder section
        until false;
```

Then which of the following is TRUE?
(A) There is mutual exclusion.
(B) There is no mutual exclusion in the system.
(C) There is a deadlock in the system
(D) Both (B) and (C)

28. Which of the following correctly specifies the 'wait' operation of a counting semaphore?
(A) semvalue = semvalue – 1;
if semvalue < 0 then
Add this process to Blocked queue.
(B) semvalue = semvalue + 1 ;
if semvalue ≤ 0 then
Block the process;
(C) semvalue = semvalue – 1;
if semvalue ≤ 0 then
Block the process;
(D) semvalue = semvalue – 1;
if semvalue < 1 then Block the process

29. Identify the TRUE statements from the following:
(i) Logical address is generated by the CPU.
(ii) Physical address is the address seen by the memory unit.
(iii) The user program always deals with physical address.
(A) (i), (ii) (B) (i), (iii)
(C) (ii), (iii) (D) (i), (ii), (iii)

30. The correct sequence of steps required for page fault handling from the following is:
(i) Search in the page table.
(ii) Search for the page in the backing store.
(iii) Reset page table
(iv) Bring in missing page
(v) Restart instruction
(vi) The OS takes control on trap.
(A) (i), (ii), (iv), (v), (vi), (iii)
(B) (ii), (i), (v), (iv), (iii), (vi)
(C) (i), (vi), (ii), (iv), (v), (iii)
(D) (i), (vi), (ii), (iv), (iii), (v)

31. If the multiprogramming level increases rapidly then the processor utilization:
(A) always increases (B) always decreases
(C) decreases some times (D) doesn't effected

Common Data for Questions 32 and 33
Consider a swapping system in which memory consists of the following hole sizes in order:11 KB, 5 KB, 21 KB, 19 KB, 8 KB, 10 KB, 13 KB and 16 KB.

32. Which hole is taken for successive segment requests 13 KB, 11 KB and 10 KB for First-fit?
(A) 13 KB, 11 KB, 10 KB (B) 21 KB,11 KB,19 KB
(C) 11 KB, 5 KB, 21 KB (D) 13 KB, 16 KB, 11 KB

33. Which hole is taken for successive segment requests 12 KB, 10 KB, 9 KB for Best-fit?
(A) 21 KB, 19 KB, 11 KB (B) 13 KB, 16 KB, 11 KB
(C) 13 KB, 10 KB, 11 KB (D) 13 KB, 11 KB, 10 KB

Common Data for Questions 34 and 35
A computer has four page frames. The time of loading, time of last access and modify (*M*) bits of each page are shown as below.

Page	Load Time	Last access time	M
0	149	198	1
1	255	280	0
2	85	293	0
3	129	285	1

34. Which page will FIFO algorithm replace next?
(A) page 0 (B) page 1
(C) page 2 (D) page 3

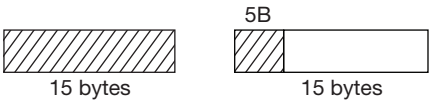
35. Which page will LRU algorithm replace next?
(A) page 0 (B) page 1
(C) page 2 (D) page 3

Answer Keys

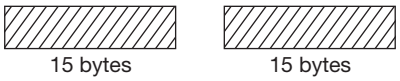
1. B	**2.** C	**3.** A	**4.** D	**5.** B	**6.** C	**7.** D	**8.** A	**9.** C	**10.** D
11. B	**12.** A	**13.** D	**14.** B	**15.** B	**16.** C	**17.** D	**18.** A	**19.** C	**20.** A
21. A	**22.** B	**23.** D	**24.** D	**25.** B	**26.** C	**27.** A	**28.** A	**29.** A	**30.** D
31. C	**32.** B	**33.** C	**34.** C	**35.** A					

Hints and Explanations

1. Record lengths are 10, 20, 30 Bytes
Physical block size = 15 bytes.
Maximum fragmentation occurs with 20 byte records.



∴ Maximum fragmentation = 10 bytes
Minimum fragmentation occurs with 30 byte records.



∴ Minimum fragmentation = 0 Bytes. Choice (B)

2. In Contiguous file Allocation, each file occupies a set of contiguous blocks on the disk. It suffers from external fragmentation. In linked and indexed allocation, there is internal fragmentation. Choice (C)

3. The algorithm favors I/O bound programs because of the relatively short CPU burst request by them.
Choice (A)

4. The necessary and sufficient conditions for deadlock are Mutual exclusion, Hold-and-wait, No-preemption and Circular wait. Choice (D)

5. During I/O instruction execution, a process will be in 'Blocked' state. Choice (B)

6. A system call is used to get services of OS's kernel.
Choice (C)

8. No protection is required between threads. (As it is impossible and not necessary). Threads are dependent on each other. Threads can share open files and child processes. Accounting information is maintained by process. Choice (A)

9. Procedures declared outside the monitor can't access monitor's internal data. Choice (C)

10. All the four are reasons for process scheduling.
Choice (D)

11. FCFS, SPN both are non-preemptive. FCFS's throughput is not that much emphasized. It also penalizes short processes. SPN penalizes long processes. Its throughput is high. Round Robin is preemptive and it treats all processes fairly. Choice (B)

12. To use process switching, the CPU needs to know about process table and state. Choice (A)

13. Response time is the amount of time it takes from, when a request was submitted until the first response is produced. Choice (D)

14. Round Robin is the preemptive version of FCFS.
Choice (B)

15. Advertising that is integrated into software is adware.
Choice (B)

16. In inverted page table, the number of entries is the number of frames in the main memory.
Main memory capacity = 4 GB = 2^{32}B
Page size = frame size = 8 KB = 2^{13}B

$\therefore$ Number of entries $= \frac{2^{32}}{2^{13}} = 2^{19}$ Choice (C)

17. Total resources $(R) = \begin{bmatrix} R_1 \\ R_2 \end{bmatrix} = \begin{bmatrix} 8 \\ 7 \end{bmatrix}$

Total used resources $= \begin{bmatrix} 7 \\ 6 \end{bmatrix}$

Available resources$(V) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$

$P1$ requires (1, 2) resources.
$P2$ requires (2, 1) resources.
$P3$ requires (2, 3) resources.
No process can execute with available resources.
So the system is in deadlock. Choice (D)

18. On one CPU, at a time only one program will be executed. At a time two programs will be in running state. If $P1$, $P2$ are executed on CPU1 and $P3$ executed on another CPU, the execution time will be 25 ms.
Choice (A)

19. CPU utilization = $1 - p^n$
where n is the degree of multiprogramming and 'p' is the fraction of time a process spends waiting for I/O.
Here $n = 5$

$p = \frac{1}{2}$

$\therefore$ CPU time wasted $= \left(\frac{1}{2}\right)^5 = \frac{1}{32} 0.03125 = 3.125\%$

Choice (C)

20. RAM capacity = 4 GB = 2^{32} B
OS capacity = 256 MB = 2^{28}B
Remaining = $2^{32} - 2^{28} = 4026531840$
Process capacity = 128 MB = 2^{27}B

$\therefore$ Number of processes fit in remaining space

$= \frac{4026531840}{2^{27}} = 30$

30 processes can be placed in memory at a time.
Let 'P' is the probability that a process has an I/O.
If all the 30 processes are in I/O, the probability is P^{30}.
CPU idle percentage = 5%
By equating both,
$P^{30} = 0.05 \Rightarrow P = 0.904$
So we can tolerate processes with upto 90.4% I/O.
Choice (A)

21. Data accessed using inode triple indirect block = 64 GB
Block size = 4 KB
(Number of blocks)^3 × block size
= Data accessed using triple indirect blocks
(Number of blocks)^3 × 4 K = 64 G

$\Rightarrow$ (Number of blocks)$^3 = \frac{2^{36}}{2^{12}}$

$\Rightarrow$ Number of blocks = 2^8

$\therefore$ Bits required for block pointer = 8-bits

Choice (A)

22. Disk capacity = 32 GB = 2^{35}B
Each entry size = 24-bits
Using 24-bits, we can access 2^{24} B.

$\therefore$ Minimum size of a file allocation

$= \frac{2^{35}}{2^{24}} = 2^{11}\text{B} = 2\text{ KB}$ Choice (B)

23. Memory = 2^{64}B
Partition size = 2^{20}B

Number of partitions $= \frac{2^{64}}{2^{20}} = 2^{44}$

$\therefore$ 44-bits required for an entry in the process table.

Choice (D)

24. All those features are required by an ideal algorithm.
Choice (D)

25. In SJF the job with smallest CPU burst will execute first. The Gantt chart for given processes is shown below:

P2	P4	P3	P5	P1
0	1	2	4	9	19

Turn Around Time (TAT) of $P1$ = 19 (waiting time + CPU burst)
TAT of $P2$ = 1
TAT of $P3$ = 4
TAT of $P4$ = 2
TAT of $P5$ = 9

Average TAT $= \frac{19+1+4+2+9}{5} = \frac{35}{5} = 7$ units

Choice (B)

26. Initially 'turn = 0' then P_0 only can enter the critical section and if P_1 tries to enter, it is not possible to enter critical section.
Only one process can enter critical section. So there is mutual exclusion. But there is no progress. ($\because$ A process cannot be able to enter into critical section even if no process is in critical section). Choice (C)

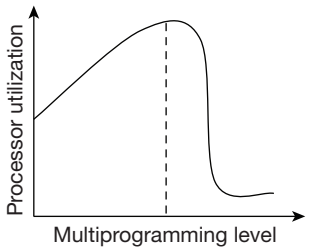
27. Only one process can enter the critical section at a time. So there is mutual exclusion. Choice (A)

28. The wait operation decrements the semaphore value. If it is less than zero, block the process. Choice (A)

29. User program deals with logical address.
Choice (A)

30. Page fault occurs when the page for which CPU is searching is not in memory. Initially we search in the page table. If it is a trap, the OS takes the control. OS searches the backing store for the required page and places it in memory. Updates the page table and restarts the instruction. Choice (D)

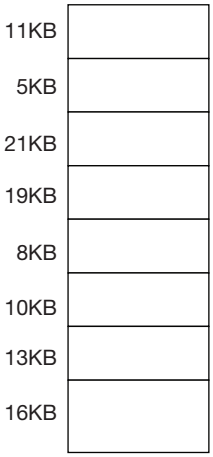
31. If the multiprogramming level increases from a small value, then the processor utilization rises.
But from a point onwards, the number of page faults rises dramatically and processor utilization collapses. The graph is shown below.



Choice (C)

Common Data for Questions 32 and 33

32. Memory system with given hole sizes is shown below:



In first-fit policy, choose the hole from beginning of the memory, using which given request is satisfied.
13 KB placed in 21 KB.
11 KB placed in 11 KB.
10 KB placed in 19 KB. Choice (B)

33. Best-fit policy searches for all holes in the memory and selects the smallest hole using which the memory request will be satisfied.
12 KB placed in 13 KB
10 KB placed in 10 KB
9 KB placed in 11 KB Choice (C)

34. FIFO will replace the page which entered first into the memory.
Load time of page 2 is least

$\therefore$ FIFO replaces page 2. Choice (C)

35. LRU replaces the page whose access time is least.
Access time of page 0 is least. So LRU replaces page 0.
Choice (A)

Operating Systems Test 3

Number of Questions: 25 **Section Marks: 30**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. Round Robin scheduling with large time slice behaves as:
(A) FCFS
(B) Priority based scheduling
(C) Multi-level queue scheduling
(D) Preemptive SJF

2. Priority inversion means:
(A) Shortest Job waits for longest job
(B) High priority process waits for low priority process
(C) Longest job waits for shortest job
(D) both (A) and (C).

3. Consider the following table with 4 processes:

Process	Arrived Time	Burst Time
P1	0	5
P2	1	4
P3	2	2
P4	3	3

If Longest Remaining Time scheduling (Preemptive longest Job First) is used, then the average turnaround time is _____.
(A) 11 (B) 12
(C) 13 (D) 14

4. Consider the following table:

Process	Arrival Time	Burst Time
P0	0	4
P1	1	3
P2	1	3
P3	2	5

If Longest Job First scheduling is used then the average waiting time is _____.
(A) 5.00 (B) 5.25
(C) 5.50 (D) 5.75

5. Consider the following table:

Process	Arrival Time	Turn around Time
P0	0	15
P1	0	2
P2	0	18
P3	0	20
P4	0	7

If priority scheduling is used for scheduling, what is the burst time of process P_o?
(A) 15 (B) 13
(C) 8 (D) 3

6. As the time quantum increases for Round Robin scheduling, generally the average waiting time:
(A) Increases
(B) Decreases
(C) Unchanged
(D) Cannot be determined

7. Consider three processes $P0$, $P1$, $P2$ arrived at Time 0, with the burst times x, y, z respectively. $x < z < y$. What is the average waiting, if SJF is used for scheduling?
(A) $\frac{x+y+z}{2}$ (B) $\frac{x+z}{3}$
(C) $\frac{2x+z}{3}$ (D) $\frac{x+z+y}{3}$

8. Consider the following table:

Process	Arrival Time	Burst Time
P0	0	8
P1	1	4
P2	2	2

What is average waiting time of processes which have taken more than one slot for completion, When SRTF is used for scheduling?
(A) 2.66 (B) 3.0
(C) 4.0 (D) 3.33

9. Match the following:

List 1		List 2	
(a)	Ready → Running	1.	Dispatching
(b)	Running → Waiting	2.	Preemption
(c)	Waiting → Ready	3	Completion
(d)	Running → Terminate	4.	I/O Request
(e)	Running → Ready	5	Event occurred

	a	b	c	d	e
(A)	1	2	3	4	5
(B)	1	4	5	3	2
(C)	1	4	2	3	5
(D)	1	2	5	4	3

10. Consider the following:

Process	Arrival Time	Burst Time
A	0	4
B	1	6
C	5	3
D	7	2

What is the waiting time of process D, if FIFO scheduling is used?

(A) 3 (B) 2
(C) 6 (D) 12

11. Preemptive scheduling takes place when _____.
(I) process switches from Running to Ready
(II) process switches from Waiting to Ready
(III) process switches from Running to waiting
(IV) process terminates
(A) I, II (B) I, II, IV
(C) I, II, III (D) I, II, III and IV

12. Blocking and Non-blocking message passing is also known as:
(A) Synchronous and Asynchronous
(B) Direct and Indirect
(C) Limited Buffer and Zero buffer
(D) Pipes and FIFO

13. Number of child processes created for the following code segment is _____.

```
fork();
fork();
fork();
fork();
```

(A) 4 (B) 8
(C) 15 (D) 16

14. Which of the following statements are TRUE about threads?
I. Thread library provides support to both user and kernel level threads.
II. Threads improves the Responsiveness and Resource sharing.
III. Kernel level thread switching is faster than user level switching.
IV. User level thread maintenance is faster than kernel level threads.
(A) I and III (B) II and IV
(C) II and III (D) I, II and III

15. Match the following:

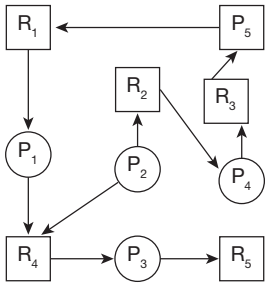
List 1		List 2	
P.	Starvation	1.	FCFS
Q.	Ageing	2.	Round Robin
R.	Context switching overhead	3.	Preemptive Priority
S.	Batch processing	4.	Highest Response Ratio next

	P	Q	R	S
(A)	1	4	2	3
(B)	4	1	3	2
(C)	3	4	2	1
(D)	1	4	3	2

16. Consider a system with four processes *A*, *B*, *C* and *D* and '*m*' instances of resource '*r*'. The resource requirements are 5, 7, 3 and 4 instances of resource '*r*' respectively. What is the minimum value of '*m*', hence system is dead lock free?
(A) 7 (B) 16
(C) 19 (D) 15

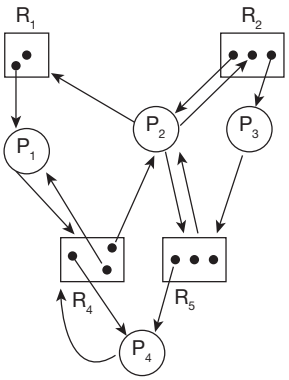
17. Which of the following system state may lead to deadlock? Let the system contains '*r*' instances of resources with '*n*' processes.
(Resource requests of each process represented in sets)
(A) $n = 5, r = 20, \{5, 5, 5, 5, 5\}$
(B) $n = 5, r = 20, \{5, 5, 4, 5, 5\}$
(C) $n = 6, r = 26, \{6, 6, 4, 3, 3, 2\}$
(D) $n = 6, r = 26, \{6, 6, 4, 3, 3, 3\}$

18. Consider the following Resource allocation Graph:



Which of the following cycle exist in it's equivalent wait-for-Graph?
(A) $P1 \rightarrow P2 \rightarrow P3 \rightarrow P4 \rightarrow P5 \rightarrow P1$
(B) $P1 \rightarrow P2 \rightarrow P3 \rightarrow P5 \rightarrow P1$
(C) $P1 \rightarrow P3 \rightarrow P4 \rightarrow P5 \rightarrow P1$
(D) $P2 \rightarrow P3 \rightarrow P4 \rightarrow P5 \rightarrow P1 \rightarrow P2$

19. Consider the following Resource allocation graph:



Which of the following dead lock cycle occurs in the given graph?
(A) $P_2 \rightarrow P_3 \rightarrow P_2$ (B) $P_2 \rightarrow P_1 \rightarrow P_4 \rightarrow P_2$
(C) Both (A) and (B) (D) None of the above

20. A counting semaphore has a value—a at a certain time, it represents:
(A) '*a*' number of processes waiting
(B) '*a*' number of process in critical section
(C) Either (A) or (B)
(D) None, negative values are not allowed on Counting semaphore

21. Semaphores _____.
(A) are process synchronization tools to avoid deadlock.

(B) are process synchronization tools to avoid race condition.
(C) uses Test And Set for synchronization.
(D) All the above

22. The system is running with 5 processes. Consider the following code segments for synchronization:

```
process 1:
while(1)
{
signal (mutex);
<Critical Section; >
signal (mutex);
}
Process i where i = 2,3,4,5.
while (1)
{
wait (mutex);
< Critical Section >
signal (mutex);
}
```

'mutex' is a binary semaphore.
Atmost how many processes can enter into the critical section?
(A) 1 (B) 2
(C) 3 (D) 5

23. Let $P0$ and $P1$ are two processes, each accesses two binary semaphores $s1$ and $s2$ to enter critical section. $s1$ and $s2$ are initialized to 1.

P_0:	P_1:
X;	W;
<critical section>	<critical section>
Y;	Z;

Consider the following code segments:

I.	wait ($s1$);	wait ($s2$);
II.	wait ($s2$);	wait ($s1$);
III.	signal ($s1$);	signal ($s2$);
IV.	signal ($s2$);	signal ($s1$);

Which of the following may lead to deadlock?

	X	Y	W	Z
(A)	I	III	II	IV
(B)	I	III	I	III
(C)	II	IV	II	IV
(D)	I	III	I	IV

24. Consider the following snapshot of a system:

	Max			Allocation		
Process	R_1	R_2	R_3	R_1	R_2	R_3
a	3	2	4	1	1	1
b	5	5	2	2	3	2
c	4	4	3	3	1	1
d	3	4	4	1	0	1

Available = {5, 3, 2}
Which of the following is not a safe sequence?
(A) *a b c d* (B) *b c d a*
(C) *b a c d* (D) *c a d b*

25. In the above system, if process '*A*' requests for {0, 1, 2} resources and if the request is granted, then the system state is _____.
(A) safe state
(B) unsafe state
(C) deadlock
(D) either (B) or (C)

Answer Keys

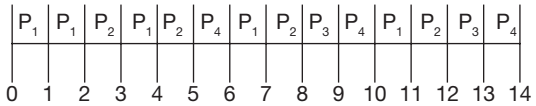
1. A	**2.** B	**3.** A	**4.** B	**5.** C	**6.** A	**7.** C	**8.** C	**9.** B	**10.** C
11. D	**12.** A	**13.** C	**14.** B	**15.** C	**16.** B	**17.** A	**18.** C	**19.** D	**20.** A
21. B	**22.** D	**23.** A	**24.** A	**25.** A					

Hints and Explanations

1. Choice (A)

2. Choice (B)

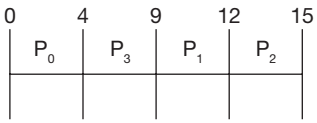
3.



Process	AT	CT	TAT
P_1	0	11	11
P_2	1	12	11
P_3	2	13	11
P_4	3	14	11

$$\text{Average TAT} = \frac{11+11+11+11}{4} = 11$$ Choice (A)

4.

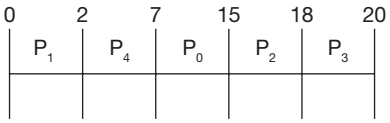


Process	AT	BT	CT	TAT	WT
P_0	0	4	4	4	0
P_1	1	3	12	11	8
P_2	1	3	15	14	11
P_3	2	5	9	7	2

Average $WT = \dfrac{(0+8+11+2)}{4} = \dfrac{21}{4} = 5.25$

Choice (B)

5. Gantt Chart:

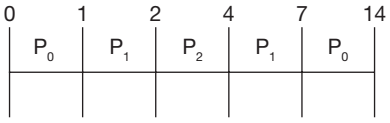


Waiting Time of P_0 is 7.
$BT = TAT - WT = 15 - 7 = 8$ Choice (C)

6. Choice (A)

7. Choice (C)

8.



Process	AT	TAT	WT
P_0	0	14	6
P_1	1	6	2
P_2	2	2	0

Processes P_0 and P_1 executed in multiple slots.

Hence average waiting time of (P_0 and P_1) $= \dfrac{6+2}{2} = 4$

Choice (C)

9. Choice (B)

10. Processes 'D' schedules at time 13.
Waiting Time = 13 – 7 (AT) = 6 Choice (C)

11. Choice (D)

12. Choice (A)

13. Choice (C)

14. Choice (B)

15. Choice (C)

16. **Method 1:**
Each process requirement is S_i for process 'i'.

i	–	A	B	C	D
S_i	–	5	7	3	4

Assume for each process i, (S_i – 1) resources are allocated.

A	B	C	D	
4	6	2	3	allocated

This system state result in deadlock i.e., the system with ≤15 resources may lead to deadlock.
If atleast one extra resource available in this state, the system becomes deadlock free.
∴ 16 resources required.

Method 2:

$$\sum_{i=1}^{n} S_i < (m+n)$$

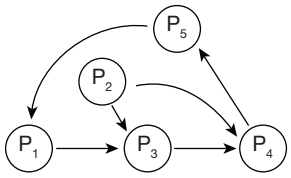
S_i – resources required for process 'i'.
m – number of resources in system
n – number of process in system.
$(5+7+3+4) < m+4 \Rightarrow m = 16$ Choice (B)

17. Use this formula to check deadlock state.

$$\sum_{i=1}^{n} S_i < (m+n)$$

S_i – Resources required for process 'i'.
m – Number of resources
n – Number of process Choice (A)

18. The wait-for-graph for given resource allocation graph is shown below:



Choice (C)

19. No dead lock exists in given graph. Choice (D)

20. Choice (A)

21. Choice (B)

22. Assume that process 2 entered critical section that results in wait of process 3, 4 and 5. But process 1 can enter. Then one more process can enter C.S. If process 1 leaves C.S., then again one more process can enter C.S. Similarly if process 1 enters and exits the C.S. again, 2 more processes can enter C.S. Choice (D)

23. Semaphores may be signalled in any order. But semaphores must be locked in same order. Choice (A)

24. Need of process 'A' is {2, 1, 3}, which is greater than available. Choice (A)

25. Process 'B' can execute in resultant state, which leads to completion of A, C and D. Choice (A)

Operating Systems Test 4

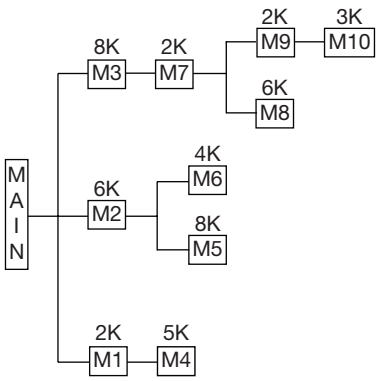
Number of Questions: 25 **Section Marks: 30**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. Suppose that, the time to service a page fault is 10 sec on average, memory access time is 1 m sec. If a page fault occurs for every 10000 references, what is the average memory access time?
(A) 1.9999 m sec (B) 1 m sec
(C) 9.999 m sec (D) 1.9999 μ sec

2. If an instruction takes 'n' micro seconds and page fault takes an additional 'm' micro seconds. If the average page fault occurs for every 'k' instructions, then effective access time is ____.
(A) $(n + m)/k$ (B) $m + n/k$
(C) $n + m/k$ (D) $n + m * k$

3. The overlay tree of the program is shown below:



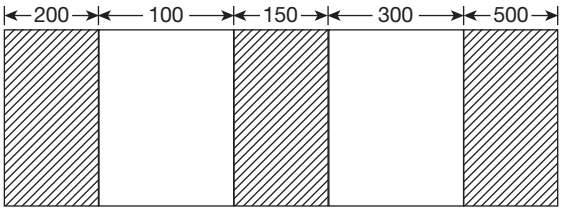
What will be the minimum partition size required to execute the program?
(A) 50K (B) 11K
(C) 8K (D) 20K

4. Dirty bit for a page table _____.
(i) helps to reduce number of page faults
(ii) helps to reduce page fault penalty
(iii) helps to avoid unnecessary writes on a paging device.
Which of the following is true?
(A) (i) (ii) (B) (i) (iii)
(C) (ii) (iii) (D) (i) (ii) and (iii)

5. A 2000 KB memory is managed using variable partitions but with no compaction. If, there exists two free partitions with sizes 400 KB and 250 KB. The smallest allocation request that could be denied is:
(A) 225K (B) 375K
(C) 425K (D) 650K

6. The address sequence generated during the execution of a program is given below:
681 351 357 421 499 099 118 129 654 454
There exists only one free frame, with the size 100 records per frame. If pure demand paging is used, what is the number of page faults?
(A) 10 (B) 9
(C) 8 (D) 7

7. Consider the following heap.



The hatched regions are not free. The sequence of requests for the blocks of size 250, 25, 75, 50 can be satisfied if we use:
(i) First fit (ii) Best fit
(iii) Worst fit
(A) (i) (ii) (B) (ii) (iii)
(C) (i) (iii) (D) (i) (ii) and (iii)

8. Consider a system with 128 MB physical memory and a 32-bit virtual address space. If the page size is 2 KB, what is the approximate page table size?
(A) 2 MB (B) 4 MB
(C) 8 MB (D) 16 MB

9. Match the following:

List–1		List–2	
1.	Virtual memory	p.	Spatial locality
2.	Shared memory	q.	Mutual exclusion
3.	Look-ahead buffer	r.	Temporal locality
4.	Look-aside buffer	s.	Address translation

	1	2	3	4
(A)	p	q	r	s
(B)	s	q	r	p
(C)	q	p	s	r
(D)	s	r	q	p

10. Let a memory has five free blocks $2k$, $4k$, $6k$, $8k$ and $20k$. These blocks are allocated using best fit strategy. The allocations requests are stored in a queue as shown below:

Job	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8
Size	$2k$	$16k$	$4k$	$5k$	$7k$	$12k$	$8k$	$18k$
Time	4	9	3	7	6	2	8	10

The time at which the process '$P7$' will be completed is _____.
(A) 8 (B) 14
(C) 21 (D) 39

11. Consider a memory consisting of the following holes in the given order:
20K, 15K, 28K, 18K, 23K, 24K and 30K
For the request sequence 24K, 22K and 18K, the first fit allocates the Blocks _____.
(A) 24K, 23K, 18K (B) 28K, 23K, 20K
(C) 28K, 24K, 20K (D) 28K, 23K, 24K

12. Consider the following statements:
*S*1: Segmentation may suffer from external fragmentation.
*S*2: Paging may suffer from internal fragmentation.
*S*3: Segmentation may suffer from internal fragmentation.
*S*4: Paging may suffer from external fragmentation.
Which of the following are true?
(A) *S*1, *S*3 (B) *S*3, *S*4
(C) *S*1, *S*2 (D) *S*1, *S*2, *S*3, *S*4

13. Inverted Page Table contains,
(A) Page Number, Process ID, Offset.
(B) Page Number, Frame Number, Link Field
(C) Page Number, Process ID, Link field
(D) Page Number, Frame Number, Process ID

14. Consider a simple paging system with 4 GB main memory and 256 MB virtual memory. The page size is 1 KB. Based on this dat*a*, Match the following:

List-1		List-2	
1.	Bits in Logical Address	p.	22
2.	Bits in Frame Number	q.	18
3.	Entries in Page Table	r.	28
4.	Bits in Page Number	s.	2^{18}

	1	2	3	4
(A)	r	p	s	q
(B)	p	q	r	s
(C)	r	p	q	s
(D)	r	s	p	q

15. Consider the following page reference sequence:
2, 1, 5, 2, 2, 1, 3, 6, 4, 2, 5, 1, 3, 6
How many page faults will occur using LRU, FIFO and optimal respectively, if the memory contains 6 frames?
(A) 6 6 6 (B) 6 5 4
(C) 5 6 4 (D) 7 8 6

16. In a particular Unix OS, the *i*-node block of size 2K, contains 10 direct data block, addresses, one address for single indirect block. One for double indirect block, and one for Triple indirect block. Each block can contain 128 addresses. The approximate maximum size of the file in the file system is _____.
(A) 2 GB (B) 4 GB
(C) 8 GB (D) 16 GB

17. Consider a system with four files of sizes 11150 B, 4970 B, 5520 B and 10640 B. For storing these files on disk we can use either 100 B blocks or 200 B blocks but not both. For each block 4 B are used for book information. A disk block can store either book keeping information or file data, but not both.
What is the total number of blocks required for files using 100 B blocks and 200 B blocks respectively?
(A) 340 and 338 (B) 340 and 169
(C) 340 and 170 (D) 315 and 163

18. Hard disk transfers 20 MB/sec using DMA. The processor runs at 1.2 GHz takes 600 and 1800 clocks to initiate and terminate DMA transfer respectively. If the size of transfer is 10 KB, what is the percentage of processor time consumed for the transfer operation?
(A) 4% (B) 0.4%
(C) 1% (D) 10%

19. Consider a disk pack with 16 platters, each with 2 surfaces, 256 tracks per surface, 512 sectors per track and 1 KB sector size. The capacity of the disk and number bits required to address a sector uniquely in the disk are respectively:
(A) 8 GB, 32 bits (B) 4 GB, 22 bits
(C) 4 GB, 32 bits (D) 16 GB, 22 bits

20. Which of the following request set will cause the head to change its direction after servicing every request assuming that the head does not change direction if there is a tie in SSTF and all the requests arrive before the servicing starts?
(A) 1, 129, 160, 168, 171, 174, 191, 255
(B) 0, 128, 160, 168, 171, 175, 191, 255
(C) 0, 129, 159, 168, 171, 174, 191, 255
(D) 0, 128, 160, 168, 171, 175, 190, 255

21. What is the maximum cardinality of request set, so that head changes its direction for every request service, if there exists a total of 4096 tracks and head can start from any track?
(A) 10 (B) 11
(C) 12 (D) 13

22. Consider a disk with 100 cylinders. The per track seek time is 2 m sec. The requests to access the cylinders occurs in the following sequence:
5, 40, 15, 12, 24, 65, 3, 18, 10
Assuming that the head is currently at 55 cylinder, what is the time taken to satisfy all the requests using SSTF.
(A) 72 m sec (B) 144 m sec
(C) 204 m sec (D) 102 m sec

23. Consider a disk with 100 cylinders. The per track seek time given as 3 m sec. The requests to access the cylinders occurs in the following sequence:
25, 45, 65, 32, 75, 15, 50, 20
What is the total seek time using FCFS disk scheduling. Assume that the initial position of head is at track 0.
(A) 269 (B) 300
(C) 807 (D) 225

24. Consider a system with 3 memory frames and the following reference string over 8 pages: 1, 2, 3, 4, 2, 8, 1, 3, 5, 7, 6, 1, 2
What will be the final content of memory if FIFO replacement policy used.
(A) 6 1 2
(B) 1 2 6
(C) 1 6 2
(D) 2 1 6

25. For the above count what will be the number of page faults if LRU is used?
(A) 10 (B) 11
(C) 12 (D) 13

Answer Keys

1. A	**2.** C	**3.** D	**4.** C	**5.** C	**6.** D	**7.** C	**8.** B	**9.** A	**10.** B
11. B	**12.** C	**13.** C	**14.** A	**15.** A	**16.** B	**17.** B	**18.** B	**19.** B	**20.** B
21. C	**22.** B	**23.** C	**24.** A	**25.** C					

Hints and Explanations

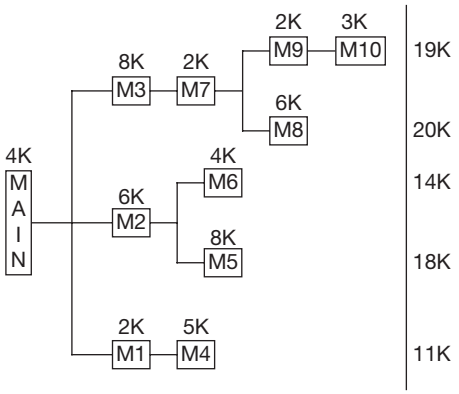
1. EAT = H*MAT + $(1 - H)$*$(P.F.T)$
H = 0.9999 (1 page fault for every 10000)
MAT = 1 m sec
$P.F.T$ = 10 sec
EAT = 0.9999 * 1 m sec + (0.0001)* 10 sec.
= 0.9999 + 1 m sec
= 1.9999 m sec Choice (A)

2. EAT = H * MAT + $(1 - H)$*$(P.F.T$ + MAT)

$$= \frac{k-1}{k} \times n + \frac{1}{k}(m+n)$$

$$= n + \frac{m}{k}$$ Choice (C)

3.



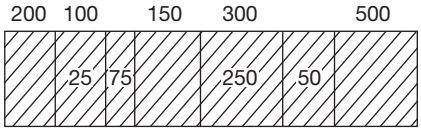
The maximum memory required when module $M8$ is under execution, which is 20K. Choice (D)

4. Choice (C)

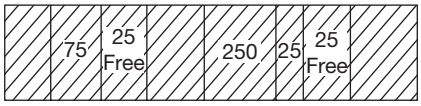
5. Choice (C)

6. 681 351 357 421 499 019 118 129 654 454
PF PF PH PF PH PF PF PH PF PF
PF → Page Fault, *PH* → Page Hit
Number of *PFs* = 7 Choice (D)

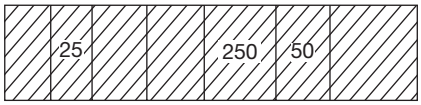
7. First Fit:



Best Fit:



50 cannot be allocated.
Worst Fit:



Choice (C)

8. Number of page $= \frac{\text{(Virtual memory size)}}{\text{(Page size)}}$

Number of frames $= \frac{\text{Main Memory size}}{\text{Page size}} = \frac{2^{27}}{2^{11}} = 2^{16}$

Page Table size = Number of pages * Number of bits to address frame
= 2^{21} * 16 bits
= 2^{21} * 2 B = 4 MB Choice (B)

9. Choice (A)

10.

2K	4K	6K	8K	20K
P1	P3	P4	P5	P2

On completion of $P5$, Block 4 will be allocated to $P7$.
Hence completion time of $P7$ is = 6 + 8 = 14
Choice (B)

11. Choice (B)

12. Choice (C)

13. Choice (C)

14. Virtual memory = 256 MB = 2^{28} B
Bits in logical address = 28

$$\text{Number of frames} = \frac{4\text{ GB}}{1\text{ kB}} = \frac{2^{32}}{2^{10}} = 2^{22}$$

Number of bits in frame Number = 22

$$\text{Number of pages} = \frac{256\text{ MB}}{1\text{ kB}} = \frac{2^{28}}{2^{10}} = 2^{18}$$

Number of entries in page table = 2^{18}
Number of bits in page number = 18 Choice (A)

15. Number of pages referred is 6, Number of frames also 6. Hence for any algorithm, number of page faults are 6. Choice (A)

16. Maximum file size

$$[\underbrace{1}_{\text{Inode}} + \underbrace{10}_{\text{Direct}} + \underbrace{(1+128)}_{\text{Single indirect}} + \underbrace{(1+128+128\times128)}_{\text{Double indirect}} + \underbrace{(1+128+128\times128+128\times128\times128)]}_{\text{Triple indirect}}$$

$2k$ (Block size)
$\cong$ 4 GB Choice (B)

17.

File Size	100B Data Blocks	Book Keeping Blocks
11150	112	5
4970	50	2
5520	56	3
10640	107	5
Total	325	15

Total = 340

File Size	200B Data Blocks	Book Keeping Blocks
11150	56	2
4970	25	1
5520	28	1
10640	54	2
Total	163	6

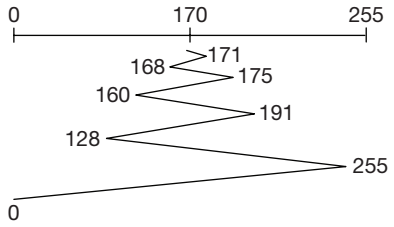
Total = 169 Choice (B)

18. **Transfer Time:**
20 MB – 1 sec
10 KB – x
x*20 MB = 1 sec * 10 KB
x = ½ m sec = 500 μ sec
CPU Time:
1.2 GHz $\Rightarrow$ 1.2 * 10^9 clocks/sec
= 1200 * 10^6 clocks/sec
CPU Time consumed = 600 + 1800
= 2400 clocks
1200 * 10^6 clocks – 1 sec
2400 clocks – y
y * 1200 × 10^6 = 1 sec * 2400
y = 2 μs
Percentage of CPU involvement

$$= \frac{2\,\mu s}{500\,\mu s} \times 100 = 0.4\%$$ Choice (B)

19. Disk Capacity = 16 * 2 * 256 * 512 * 1 KB = 4 GB
Number of sectors = 16 × 2 × 256 × 512 = 2^{22}
Choice (B)

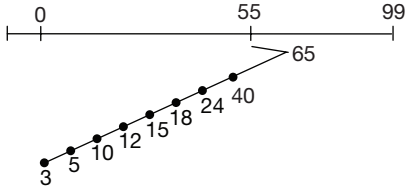
20. Assume the head at track 170 (Based on choices).
Then



Choice (B)

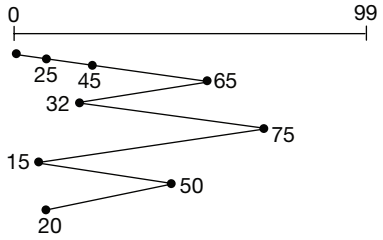
21. 4096 = 2^{12} tracks
Hence cardinality = 12 Choice (C)

22.



Total tracks moved = 72
Total seek time = 72 × 2 = 144 m sec Choice (B)

23.



Total tracks moved = |0 – 25| + |25 – 45| + |45 – 65|
+ |65 – 32| + |32 – 75| + 75 – 12| + |15 – 50| + |50 – 20|
= 25 + 20 + 20 + 33 + 43 + 63 + 35 + 30 = 269
Total seek time = 269 * 3 = 807 Choice (C)

24. Choice (A)

25.
1, 2, 3, 4, 2, 8, 1, 3, 5, 7, 6, 1, 2
x x x x ✓ x x x x x x x

~~1~~	~~4~~	~~1~~	~~7~~	2			
~~2~~	~~3~~	6					
~~3~~	~~8~~	~~5~~	1				

x $\Rightarrow$ Page Fault
✓ $\Rightarrow$ Page Hit Choice (C)