# Operating System

## Introduction

1. What is an OS? What are the functions performed by an OS?
2. Differentiate between single processor and multiprocessor system? What are the advantages of multiprocessor system? What are the disadvantages of multiprocessor system? What do you mean by symmetric and asymmetric multiprocessing?
3. What is clustered system? How does it differ from multiprocessor system?
4. Differentiate between multiprogramming, time sharing and multi tasking. **[CU 2011]**
5. Define - Interrupt and Interrupt vector table
6. What are the different types of interrupt available? Mention each one of them in brief.
7. What do you mean by user mode and kernel mode? "The lack of a hardware supported dual mode can cause serious shortcomings in OS" - Explain.
8. What is timer? What are its functions?
9. What is distributed system? What are its advantages? What do you mean by run time OS? **[CU 2010]**
10. What is a shell? "Shell is not a part of an OS" - Comment. **[CU 2014]**
11. Write a short note on System call.
12. Discuss about monolithic structure, layered structure and micro kernel structure of an OS. **[CU 2008 2012 2015]**
13. What is virtual machine? How it is implemented? What are the benefits of it?
14. What is a client-server system?
15. What is bootstrap loader? How does it work? What is firmware? How they are related?
16. Write a short note on device driver. **[CU 2008]**

## Process scheduling

1. What are the different process management techniques? Give a brief outline of at least one of them. **[CU 2011]**
2. Define a process? By drawing suitable diagram explain process state transition.
3. Describe process control block (PCB). **[CU 2006 2011]**
4. What do you mean by Global system state?
5. Differentiate between a ready queue and a device queue.
6. Name four conditions which lead to the OS, terminating a process before it has completed its work.
7. "It is necessary for a PCB to be updated during the time that the running process has access to the CPU" – Discuss.
8. What do you mean by Context switching? State the role of PCB in context switching.
9. What do you mean by scheduler? By drawing a suitable diagram explain the invocation mechanism of different schedulers? **[CU 2015]**
10. "Long term scheduler selects a good process mix of I/O bound and CPU bound processes." - Justify the statement. **[CU 2013]**
11. What is process scheduling? Why scheduling is necessary? **[CU 2006 2008]**

12. What is a role of a dispatcher?
13. Differentiate between a Zombie and an Orphan Process. **[CU 2016]**
14. What are the criteria for process scheduling? **[CU 2007]**
15. What is preemptive and non-preemptive scheduling? Differentiate between them. **[CU 2013]**
16. State the advantage sand disadvantages of FCFS scheduling algorithm.
17. "SJF scheduling algorithm is optimal and gives minimum average waiting time." – prove the statement.
18. What are the major limitations of SRTF algorithm?
19. Describe a scheduling algorithm which is a close approximation of SRTF algorithm.
20. Which one among the following scheduling algorithms is expected to result in better response time for smaller jobs?
21. Discuss starvation and aging. **[CU 2011]**
22. Consider the following -

| Process | CPU burst time | Arrival time |
|---|---|---|
| $P_1$ | 8 | 0.0 |
| $P_2$ | 4 | 0.4 |
| $P_3$ | 1 | 1.0 |

    (a) What is ATAT of the process with FCFS?
    (b) What is ATAT for SJF algorithm?

    **[CU 2004]**

23. Consider the following

| Process | CPU burst time (in ms) | Arrival time (ms) |
|---|---|---|
| $P_1$ | 10 | 0 |
| $P_2$ | 8 | 0 |
| $P_3$ | 3 | 2 |
| $P_4$ | 7 | 5 |
| $P_5$ | 1 | 11 |

    (a) Find AWT and ATAT for SJF with preemption.
    (b) Find AWT and ATAT for RR with with q = 3ms.

    **[CU 2014]**

24. Consider the following -

| Process | CPU burst time (in ns) |
|---|---|
| $P_1$ | 13 |
| $P_2$ | 3 |
| $P_3$ | 9 |
| $P_4$ | 7 |
| $P_5$ | 11 |

    Draw the Gantt chart for SJF and RR scheduling with q = 3 ns. Which is better and why? **[CU 2012]**

25. Consider the following -

| Process | CPU burst time | Arrival time |
|---|---|---|
| $P_1$ | 3 | 0 |
| $P_2$ | 6 | 2 |
| $P_3$ | 4 | 4 |
| $P_4$ | 6 | 6 |
| $P_5$ | 2 | 8 |

    Using SRTF compute the following -

    (a) Draw Gantt

(b) Find the ATAT, AWT and ART.

26. Consider the following -

| Process | CPU burst time | Priority | Arrival time |
|---|---|---|---|
| $P_1$ | 10 | 3 | 0 |
| $P_2$ | 5 | 2 | 1 |
| $P_3$ | 2 | 1 | 2 |

Using preemptive priority scheduling algorithm draw Gantt chart and find AWT. **[CU 2015]**

27. Consider the following -

| Process | CPU burst time (ns) | Arrival time (ns) |
|---|---|---|
| $P_1$ | 10 | 0 |
| $P_2$ | 5 | 1 |
| $P_3$ | 4 | 2 |
| $P_4$ | 7 | 6 |

Using RR scheduling with q = 2 ns, draw the Gantt Chart and hence find AWT and ATAT. **[CU 2016]**

28. Describe a scheduling algorithm which is a close approximation of SRT algorithm.

29. How does the performance of RR scheduling algorithm depend on the size of the time quantum? **[CU 2008]**

30. Consider an operating system capable of loading and executing a single user process at a time. The scheduling algorithm used in FCFS. If FCFS is replaced by SRTF, a 50% improvement in performance is claimed in throughput of the system. What is the expected improvement in the CPU utilization where each job is assumed to spend 80% on I/O operations? **[CU 2005]**

31. In a certain system an average process runs for a time ($t$) before blocking an I/O. A process switch requires a time ($S$) as overhead. For Round-Robin scheduling with time quantum ($q$) find CPU efficiency for each of the following situations -

- $Q = 0$
- $Q > t$
- $Q = S$
- $Q \to 0$
- $S < Q < t$

32. "There is no way to know the length of next CPU burst" - Is there any way to approximate the length of next CPU burst?

33. What do you mean by priority scheduling?

34. "SJF is a special case of priority scheduling" - Discuss.

35. What do you mean by Multilevel Feedback Queue Scheduling?

36. What advantage is there in having different time quantum sizes on different levels of a multilevel queuing system?

37. Differentiate between static scheduling and dynamic scheduling.

# Process synchronization

1. Define race condition. How race condition can be avoided? **[CU 2007 2009]**

2. What do you mean by process synchronization?

3. What are mutually exclusive processes? **[CU 2007]**

4. Illustrate with an example the necessity to define critical section for concurrency control. **[CU 2008 2010 2011]**

5. Is it possible to have multiple critical sections in a process? **[CU 2006]**

6. What do you mean by critical section problem? What are the requirements for a solution for the critical section problem? **[CU 2013]**

7. Explain a two-process synchronization algorithm. Also state the limitation of such a scheme.

8. Explain Peterson's solution for critical section problem. **[CU 2015]**

9. Explain Lamport's Bakery algorithm for critical section problem. **[CU 2013]**

10. What is a semaphore? Define the term 'critical section' in semaphore. Briefly explain the role of semaphore for critical section problem. **[CU 2007 2008 2012 2014]**

11. What is a binary semaphore? Explain the two primitives – wait and signal with reference to a binary semaphore. Does a binary semaphore satisfy the requirements for a solution of critical section problem?

12. Differentiate between a binary semaphore and a counting semaphore. **[CU 2007 2008 2012 2014 2016]**

13. What do you mean by spin lock? "Spin locks are undesirable in uni-processor systems but desirable in multiprocessor systems" – justify.

14. How would implement counting semaphore with the help of binary semaphore?

15. Consider a set of sequential processes that can not show any variable except semaphores. Can these processes communicate with each other? **[CU 2004]**

16. What are the limitations of a semaphore? How the limitations of semaphore can be overcome by the use of a monitor? **[CU 2005]**

    **Or**

17. What is the limitation of classical definition of semaphore? Give a modified definition of semaphore where the disadvantage is avoided? **[CU 2001]**

18. Process P and Q have access to semaphores $S_1$ and $S_2$ and the operations *Wait* and *Signal*. Explain clearly what happens when the following code is executed by P and Q -
    Process P: Wait($S_1$), Wait($S_2$), ... , Signal($S_1$), Signal($S_2$)
    Process Q: Wait($S_2$), Wait($S_1$), ... , Signal($S_2$), Signal($S_1$) **[CU 2003]**

19. Explain –

    (a) Producer-Consumer problem **[CU 2002 2009 2014]**
    (b) Dining Philosopher's problem
    (c) Sleeping Barber problem
    (d) Reader-Writer problem (using Semaphore) **[CU 2016]**

20. What do you mean by message passing? What are the primitives used in message passing system? **[CU 2013 2015]**

    Differentiate between synchronous and asynchronous communication? What is a mailbox?

21. Explain the functions performed by an OS for Inter Process Communication. **[CU 2013]**

# Deadlock handling

1. Define deadlock. State the necessary and sufficient condition for deadlock to occur. **[CU 2009 2011]**

2. State the utility of resource allocation graph (RAG) in deadlock detection.

3. Imagine a system with 3 processes $P_1$, $P_2$ and $P_3$ and 2 types of resources $R_1$ and $R_2$. $R_1$ has two instances which are currently allocated to $P_2$ and $P_3$. $P_1$ is waiting for $R_1$. $R_2$ has only one instance which is allocated to $P_1$ and $P_3$ is waiting for it.

   Draw the RAG and decide whether the system is in deadlock or not. **[CU 2014]**

4. An OS contains 3 user processes each requiring 2 units of resource R. What is the minimum number of units of R such that no deadlock will occur ever? **[CU 2015]**

5. "Presence of cycle does not necessary mean that there is deadlock in the system" – justify.

6. In deadlock detection algorithm employing the technique of graph reductions, show the order in which the graph reductions are performed is immaterial and the same final result is obtained. **[CU 2004]**

7. Explain how deadlock can be prevented? **[CU 2007]**

8. State the requirements for deadlock avoidance.

9. Describe the different ways to avoid deadlock situation. **[CU 2012]**

10. Differentiate between deadlock avoidance and deadlock prevention. **[CU 2011]**

11. Differentiate between deadlock prevention and deadlock detection. **[CU 2005]**

12. What do you mean by safe state? "A safe state is not a deadlock state. Conversely, a deadlock state is an unsafe state. Not all unsafe states are deadlocks" – justify. **[CU 2012]**

13. Briefly describe Banker's algorithm for deadlock avoidance clearly stating the assumptions made in the algorithm. **[CU 2009 2014]**

14. Consider there are 5 processes and three resource types A, B, C with 10, 5 and 7 instances respectively. Suppose at time $t_0$ the following snapshot of the system has been taken:

| | Allocation | | | Max | | | Available | | |
|---|---|---|---|---|---|---|---|---|---|
| | A | B | C | A | B | C | A | B | C |
| p1 | 0 | 1 | 0 | 7 | 5 | 3 | 3 | 3 | 2 |
| p2 | 2 | 0 | 0 | 3 | 2 | 2 | | | |
| p3 | 3 | 0 | 2 | 9 | 0 | 2 | | | |
| p4 | 2 | 1 | 1 | 2 | 2 | 2 | | | |
| p5 | 0 | 0 | 2 | 4 | 3 | 3 | | | |

15. What do you mean by wait-for-graph? How one can get it from RAG? **[CU 2016]**

16. Define live-lock.

17. An OS contains 3 resource types of 7, 7 and 10 units. The current allocation is -

| | Allocation | | | Max | | |
|---|---|---|---|---|---|---|
| | $R_1$ | $R_2$ | $R_3$ | $R_1$ | $R_2$ | $R_3$ |
| p1 | 2 | 2 | 3 | 3 | 6 | 8 |
| p2 | 2 | 0 | 3 | 4 | 3 | 3 |
| p3 | 1 | 2 | 4 | 3 | 4 | 4 |

- Comment if the the allocation is safe.
- Can the request made by $p_1$(1,1,0) be granted?

**[CU 2015]**

# Memory management

1. Define three major activities of an OS with respect to memory management. **[CU 2014]**

2. What do you mean by Single Process monitor? What is a Fence register? How fence register provides protection in single process monitor?

3. What do you mean by address binding? What are the different phases of address binding?

4. Differentiate between physical and logical address space by drawing suitable diagram. **[CU 2008]**

5. What do you mean by program relocation? Differentiate between static and dynamic relocation. **[CU 2013]**

6. Differentiate between protection and security. **[CU 2012]**

7. Differentiate between dynamic loading and dynamic loading.

8. State the principle for fixed partitioning? What are the basic advantages and disadvantages of fixed partitioning? **[CU 2008]**

9. Explain the concepts of Best fit, Worst fit and First fir strategies for memory allocation in Fixed partitioning. **[CU 2016]**
10. What do you mean by internal fragmentation?
11. Compare between fixed/ static partitioning and variable/ dynamic partitioning?
12. What do you mean by external fragmentation? Explain how compaction gives solution to this? **[CU 2016]**
13. Differentiate between internal and external fragmentation. **[CU 2008]**
14. What do you mean by Paging?
15. By drawing a suitable diagram explain address translation in paging. **[CU 2013]**
16. Explain how paging suffers from internal fragmentation?
17. "In paging each memory reference can turn into two/ more memory references" - Justify. **[CU 2015]**
18. Differentiate between paging and segmentation. **[CU 2013]**
19. How protection and sharing is achieved in paging and segmentation? **[CU 2014]**
20. In which situation you would not use paging? Why? **[CU 2014]**
21. Given memory partitions of 100K, 500K, 200K, 300K, 600K (in order), how would each of the algorithms (First-fit, Best-fit, Worst-fit) in parts a, b and c place processes of 212K, 417K, 112K, 426K (in order)? Which algorithm makes the best use of memory? **[CU 2014]**
22. In a segmentation based system, the main memory has the following holes in this order - 21K, 5k, 90k, 54k, 10k, 25k, 56k; there are three new requests for memory of sizes 10k, 7k, 22k. The system does FCFS service. Explain what holes will be taken for each of first fir and best fit memory allocation techniques. **[CU 2012]**
23. Why are page sizes always a power of 2? **[CU 2008 2015]**
24. Consider a paging system with a TLB. Each memory reference takes 300ns and each look up of the TLB takes 20 ns. What is the effective memory reference time if 80% of page table references are found in TLB. **[CU 2015]**

# Virtual memory

1. What is virtual memory? State the advantages of using virtual memory. **[CU 2008 2010]**
2. Explain the process of swapping with the help of a diagram.
3. What is demand paging? Explain implementation of demand paging scheme with the help of suitable diagram.
4. Differentiate between demand paging and pure demand paging.
5. On a system using demand paged memory, it takes 120 ns to satisfy a memory request if the page is in memory. If the page is not in memory, the request takes on an average 5ms. What would be the page fault to achieve an effective access time of 1 micro second? Assume the system is running only a single process and the CPU is idle during page swaps.
6. What is meant by Hit ratio? Explain the term 'page fault'. **[CU 2008]**
7. Consider the following reference string: 1, 3, 2, 7, 2, 1, 4, 6, 2, 4, 2, 3, 7, 8, 3, 2, 4, 2, 3, 6. How many faults will occur for 4 page frames for each of the following algorithms - LRU, FIFO, Optimal page replacement. **[CU 2011]**
8. Given the references to the following pages by a process: 0 1 4 2 0 4 3 5 1 6 3 2 3 2 6 2 1 3 4 2 1 0. Find the number of page faults if the process has 3 page frames available to it and the page replacement algorithms are LRU and optimal. **[CU 2016]**

9. During a given time interval for a memory consisting of (i) 3 frames (ii) 4 frames, the following page references are given - 0 1 2 3 0 1 4 0 1 2 3 4. Using FIFO replacement compute total number of page faults in both the above cases explaining diagrammatically the FIFO replacement strategy as applied in your findings. **[CU 2008]**

10. Consider the following memory references in a memory with free frames - 6 7 8 9 6 7 0 6 7 8 9 0. Compare the number of page faults using FIFO and LRU algorithm. **[CU 2008]**

11. What do you mean by locality of reference of a string? What do you mean by thrashing?

12. Explain working set strategy which helps in preventing thrashing. **[CU 2008]**

13. What is Belady's anomaly? Discuss a page replacement algorithm that does not follow Belady's anomaly. **[CU 2013]**

# I/O and File Management

1. Differentiate between memory mapped I/O and I/O mapped I/O.

2. Explain the concept of spooling and buffering. **[CU 2016]**

3. Problems of various disk scheduling algorithms

4. Distinguish between sequential, linked and index sequential file allocation.